PII Pipeline Solutions
a GE Oil & Gas and Al Shaheen joint venture

TranScan™
Inspection Report for
20 inch Crude Oil Pipeline

ExxonMobil Pipeline Company

Doniphan to Conway
Run Date: 9 August 2010

110004_20B
August 2012
Part 1 of 1
Issue 1

Al Shaheen

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Executive Summary

A TranScan survey of the ExxonMobil Pipeline Company Doniphan to Conway pipeline was successfully completed by PII Pipeline Solutions between 9 and 15 August 2010.

This survey provides information relating to defects that are associated with the longitudinal seam weld in addition to a specific criteria of TFI metal loss features which PII were requested to incorporate into an NDT pipeline listing supplied by ExxonMobil. The seam weld defects have been classified in accordance with the Seam Weld Defect Discrimination table contained in the Inspection System Performance Specification (Appendix G).

A total of **5 seam weld defects** and **5510 metal loss defects** have been reported from the inspection survey.

Of the 5 seam weld defects, none exhibit all the characteristics associated with crack-like defects. 5 seam weld defects have been classified as SEAM WELD ANOMALIES.

None of the spools on this inspection survey have been classified as having GROSS SEAM WELD ANOMALIES.

In addition to seam weld defects PII were requested to report the following metal loss features.

1. Any cluster containing axial orientated seam weld metal loss, independent of overall cluster dimensions.
2. Any cluster, both manufacturing and metal loss, with axial length greater than 5 times the circumferential width, with the circumferential width being less than 2", dimensions being after the 1"x 6t interaction rules have been applied. Any cluster in this category which touched or crossed the seam weld was identified with a separate classification.

Of the 5510 metal loss defects, 7 were classified as axial orientated seam weld metal loss and touching or crossing the seam weld. The remaining 5503 are manufacturing and metal loss features in the main body of the pipe, with axial length greater than 5 times the circumferential width and the circumferential width being less than 2".

The seam weld defects and metal loss defects in this survey are distributed throughout the pipeline. Approximately 12% of the total number of spools contain a seam weld defect or a metal loss defect.

We should hereby like to express our appreciation for the assistance and co-operation that we received from ExxonMobil Pipeline Company in the course of this project.

Report Author: **David Classen**

Report Approved by: **Joaquin Mihura** **Date:** **13rd August 2012**
Analysis Team Leader

Project Manager: **Stephen David** **Telephone:** **713-849-6366**

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Inspection Summary

This section presents a summary of inspection operation 110004_20B which was conducted by PII Pipeline Solutions for ExxonMobil Pipeline Company in the Doniphan to Conway, 20 inch nominal diameter, 142.68 miles (based on the TFI inspection data), crude oil pipeline.

The pipeline was inspected by PII Pipeline Solutions using the TranScan inspection between 9 and 15 August 2010.

This survey provides information relating to defects that are associated with the longitudinal seam weld in addition to a specific criteria of TFI metal loss features which PII were requested to incorporate into an NDT pipeline listing supplied by Exxon. The seam weld defects have been classified in accordance with the Seam Weld Defect Discrimination table contained in the Inspection System Performance Specification (Appendix G).

1.1. Seam Weld Defects

A total of 5 seam weld defects have been detected on the inspection survey. 5 seam weld defects have been classified as SEAM WELD ANOMALIES.

A breakdown of these 5 seam weld defects is as follows:

SEAM WELD FEATURE A:	0
SEAM WELD FEATURE B:	0
SEAM WELD ANOMALY:	5

Those seam weld defects classified as SEAM WELD ANOMALY are not considered to be crack-like, but display some sort of seam weld abnormality. Many of these will have originated from the manufacturing process and will have been present in the pipeline since it was commissioned. It can be difficult to achieve the normal sizing accuracy for defects of this nature depending on whether they are the result of hot working or cold working of the pipe steel. Consequently, it should be noted that the sizing accuracy specified for seam weld defects in the Inspection System Performance Specification (Appendix G) contained in the contract may not be applicable to SEAM WELD ANOMALIES.

Detailed inspection sheets for 5 of these seam weld defects are provided in Section 2. Summaries of all the seam weld defects are presented in Section 4.1.

In some inspection surveys a spool may be identified that contains a considerable number of seam weld defects which have been classified as SEAM WELD ANOMALIES. In these cases the spool is classified as having GROSS SEAM WELD ANOMALIES instead of reporting the individual SEAM WELD ANOMALY defects separately within the spool.

None of the spools on this inspection survey have been classified as having GROSS SEAM WELD ANOMALIES.

1.2. Metal Loss Defects

In addition to seam weld defects PII were requested to incorporate a specific criteria of TFI metal loss features into an NDT pipeline listing supplied by Exxon. The following metal loss features have been reported.

1. Any cluster containing axial orientated seam weld metal loss, independent of overall cluster dimensions.

2. Any cluster, both manufacturing and metal loss, with axial length greater than 5 times the circumferential width, with the circumferential width being less than 2", dimensions being after the 1"x 6t interaction rules have been applied. Any cluster in this category which touched or crossed the seam weld was identified with a separate classification.

A total of 5510 metal loss defects meeting the above criteria have been detected on the inspection survey.

Of the 5510 metal loss defects, 7 were classified as axial orientated seam weld metal loss and were classified as metal loss touching or crossing the seam weld. The remaining 5503 are manufacturing and metal loss features in the main body of the pipe,with axial length greater than 5 times the circumferential width and the circumferential width being less than 2".

Metal loss defects have been classified in accordance with the Inspection System Performance Specification (Appendix G).

Detailed inspection sheets for 10 of these metal loss defects are provided in Section 2. Summaries of all the metal loss defects are presented in Section 3.1.

1.3. Pipeline Anomalies

Detection of pipeline anomalies was not part of the analysis specification for this contract and have not been included in this report or in the pipeline data in pipeimage format.

It was requested that PII identify any metal loss or cracking associated with dents confirmed by a caliper inspection. No metal loss or cracking associated with dents were found in this report.

Please note that the girth weld numbers shown in this report have an additional zero at the end compared to those in the pipeline listing. Also the distance values are based on the TFI data and will not be a perfect match to the pipeline listing.

1.4. Inspection Quality

Inspection data was obtained for the full length (142.68 miles) between Doniphan to Conway.

The velocity of the inspection vehicle fell below the specified minimum velocity in 2 sections of the pipeline. These speed excursions covered a total distance of 121.72 ft. Within the underspeed affected areas our ability to detect and predict the dimensions of metal loss features is degraded.

In addition, a total of 239.72ft of data loss was identified in the first underspeed excursion area, located at 1117336.9 ft (comparing the recorded TranScan data against the other vendor data provided by ExxonMobil Pipeline Company). Within this section, the detection of anomalies is not possible. For further details please refer to section 4.2.1.

There was evidence of small amounts of debris in the bottom of the pipe at intermittent locations in the pipeline.

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

Defect Report

The Defect Report provides detailed inspection sheets for selected seam weld defects and metal loss defects.

2.1. Defect Selection

Seam weld defects and metal loss defects are selected for detailed analysis and reporting in accordance with the Selection Rules contained in the Specification for the Pipeline Inspection Report (Appendix F).

Detailed inspection sheets for 5 seam weld defects and 10 metal loss defects are provided in this section.

2.2. Sizing Accuracy

The metal loss and seam weld defects 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).

A number of the features detected by the survey are considered to have been caused by the manufacturing/construction process and have been marked as such. However, classification of these features with TFI technology is unclear. Consequently these features have not been included on inspection sheets or modified in any way although it is believed that for most of these features the dimensions may have been overpredicted.

2.3. Summary Tables

This section provides a summary of the seam weld defects and metal loss defects reported on the inspection sheets.

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

2.3.1. Summary of Seam Weld Defect Inspection Sheets in Distance Order

This table presents a summary of the inspection sheets that contain seam weld defects sorted in order of their absolute distance from the launch.

2.3.1 Summary of Seam Weld Defect Inspection Sheets in Distance Order

Insp. Sheet Number	Absolute Distance (feet)	Predicted Dimensions		Severity Ranking
		Axial (in)	Depth % WT	
			Peak	
6	1354066.3	5.4		
7	1354114.6	11.5		
8	1354114.9	11.3		
9	1354126.3	6.2		
11	1354288.4	2.8		

2.3.2. Summary of Seam Weld Defect Inspection Sheets in Selection Order

This table presents a summary of those inspection sheets that contain seam weld defects sorted in order of their selection priority given by the Selection Rules contained in the Specification for the Pipeline Inspection Report (Appendix F).

2.3.2 Summary of Seam Weld Defect Inspection Sheets in Feature Selection Order

Insp. Sheet Number	Absolute Distance (feet)	Predicted Dimensions		Severity Ranking
		Axial (in)	Depth % WT	
			Peak	
7	1354114.6	11.5		
9	1354126.3	6.2		
8	1354114.9	11.3		
11	1354288.4	2.8		
6	1354066.3	5.4		

2.3.3. Summary of Metal Loss Defect Inspection Sheets in Distance Order

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

2.3.3 Summary of Metal Loss Defect Inspection Sheets in Distance Order

Insp. Sheet Number	Absolute Distance (feet)	Ext. or Int.	Predicted Dimensions			Pressure Ratio (ERF)	Feature Selection Rule
			Axial (in)	Circ. (in)	Depth % WT Peak		
1	1235548.7	Ext	9.6	0.9	25	0.956	10
2	1250868.7	Ext	10.7	1.3	26	0.966	10
3	1279487.6	Ext	12.8	1.2	34	1.051	1
4	1354024.7	Ext	8.5	1.6	18	0.935	10
5	1354051.9	Ext	11.9	0.6	11	0.900	10
10	1354241.4	Ext	8.7	1.2	30	0.968	5
12	1354356.4	Ext	13.7	1.4	12	0.911	10
13	1376935.9	Ext	13.8	1.8	22	0.951	10
14	1480156.4	Ext	17.0	1.9	24	0.970	10
15	1523138.7	Ext	10.0	1.1	31	1.007	1

2.3.4. Summary of Metal Loss Defect Inspection Sheets in Selection Order

This table presents a summary of those inspection sheets that contain metal loss defects sorted in order of their selection priority given by the Selection Rules contained in the Specification for the Pipeline Inspection Report (Appendix F).

2.3.4 Summary of Metal Loss Defect Inspection Sheets in Feature Selection Order

Insp. Sheet Number	Absolute Distance (feet)	Ext. or Int.	Predicted Dimensions			Pressure Ratio (ERF)	Feature Selection Rule
			Axial (in)	Circ. (in)	Depth % WT Peak		
3	1279487.6	Ext	12.8	1.2	34	1.051	1
15	1523138.7	Ext	10.0	1.1	31	1.007	1
10	1354241.4	Ext	8.7	1.2	30	0.968	5
2	1250868.7	Ext	10.7	1.3	26	0.966	10
1	1235548.7	Ext	9.6	0.9	25	0.956	10
14	1480156.4	Ext	17.0	1.9	24	0.970	10
13	1376935.9	Ext	13.8	1.8	22	0.951	10
4	1354024.7	Ext	8.5	1.6	18	0.935	10
12	1354356.4	Ext	13.7	1.4	12	0.911	10
5	1354051.9	Ext	11.9	0.6	11	0.900	10

2.4. Inspection Sheets

This section provides detailed inspection sheets for the 5 selected seam weld defects and 10 selected metal loss defects as described previously.

2.4.1. Structure of the Inspection Sheet

Each inspection sheet provides information on the location and predicted dimensions of one defect.

The inspection sheet consists of three areas:

Feature Description

This section of the inspection sheet provides specific details about the defect.

Feature Location

This section of the inspection sheet provides information that will enable the defect to be located for excavation. Wherever possible, the position of the defect 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 defect.

The diagram represents five pipe spools, the spool containing the defect and two spools either side. The girth weld numbers and spool lengths are also given on the diagram.

2.4.2. Pictorial Representation

Accompanying each inspection sheet for a seam weld defect is a pictorial representation (contour plot) of the magnetic response derived from the reported defect.

Each inspection sheet for a metal loss defect is accompanied by two pictorial representations of the magnetic response derived from the defect, in the form of a contour plot and a monochrome overview plot.

In both the contour and overview plots the defect 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 relative distance measured from the upstream girth weld.

The monochrome overview plot shows the magnetic response derived from a metal loss defect 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 contour plot is approximately centred on the area of the pipeline in which the reported defect 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 contour plot will not normally provide a true representation of the physical profile of the reported defect.

2.4.3. Inspection Sheets 1 to 15

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

Feature Description

Type:	External Metal Loss
Orientation:	05:15 (o'clock)
Axial length:	9.6 in
Circumferential width:	0.9 in
Depth - Peak:	25% WT
Pressure Ratio (ERF):	0.956
Feature Selection Rule:	10
Nominal Pipe wall thickness for spool:	0.312 in
Absolute Distance from Launch:	1235548.7 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. AGM 21899+97
   (Girth Weld 289900 + 39.1 ft)
2. AGM 21839+07
   (Girth Weld 291480 + 0.9 ft)

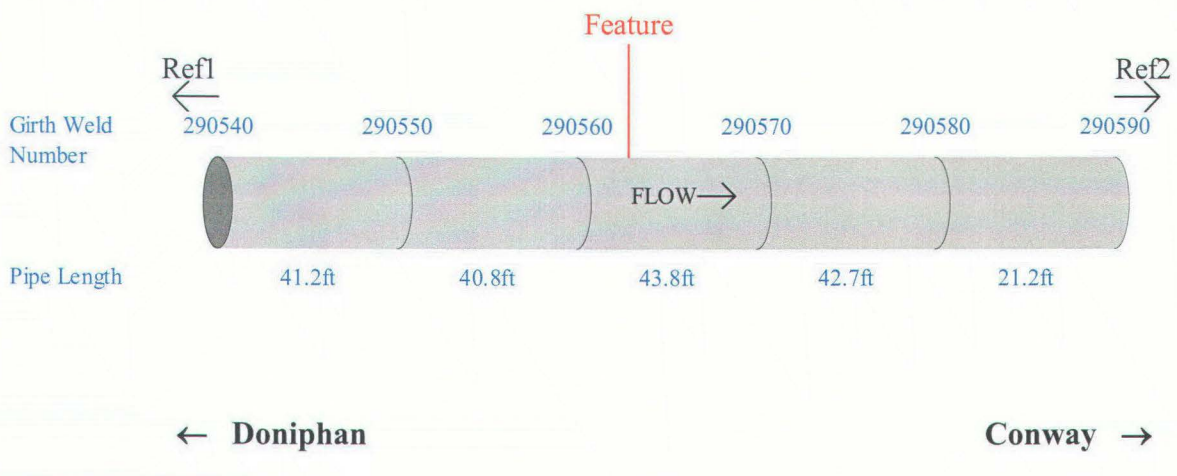
Reference Girth Weld:

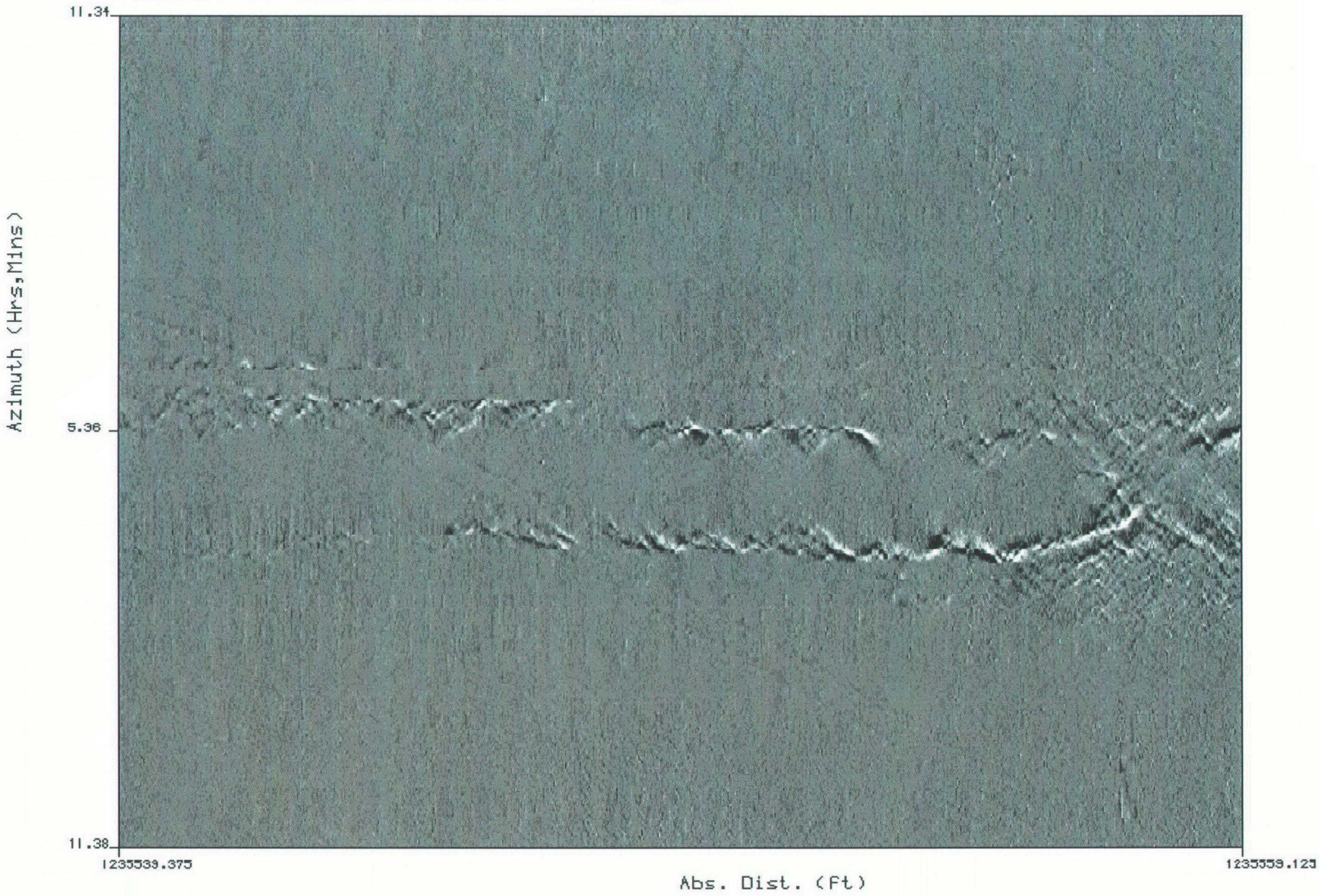
The reference girth weld at the Doniphan (upstream) end of the feature spool is number 290560.
The location of this weld is 2589.7 feet downstream from reference 1 and 3506.9 feet upstream from reference 2.

Feature:

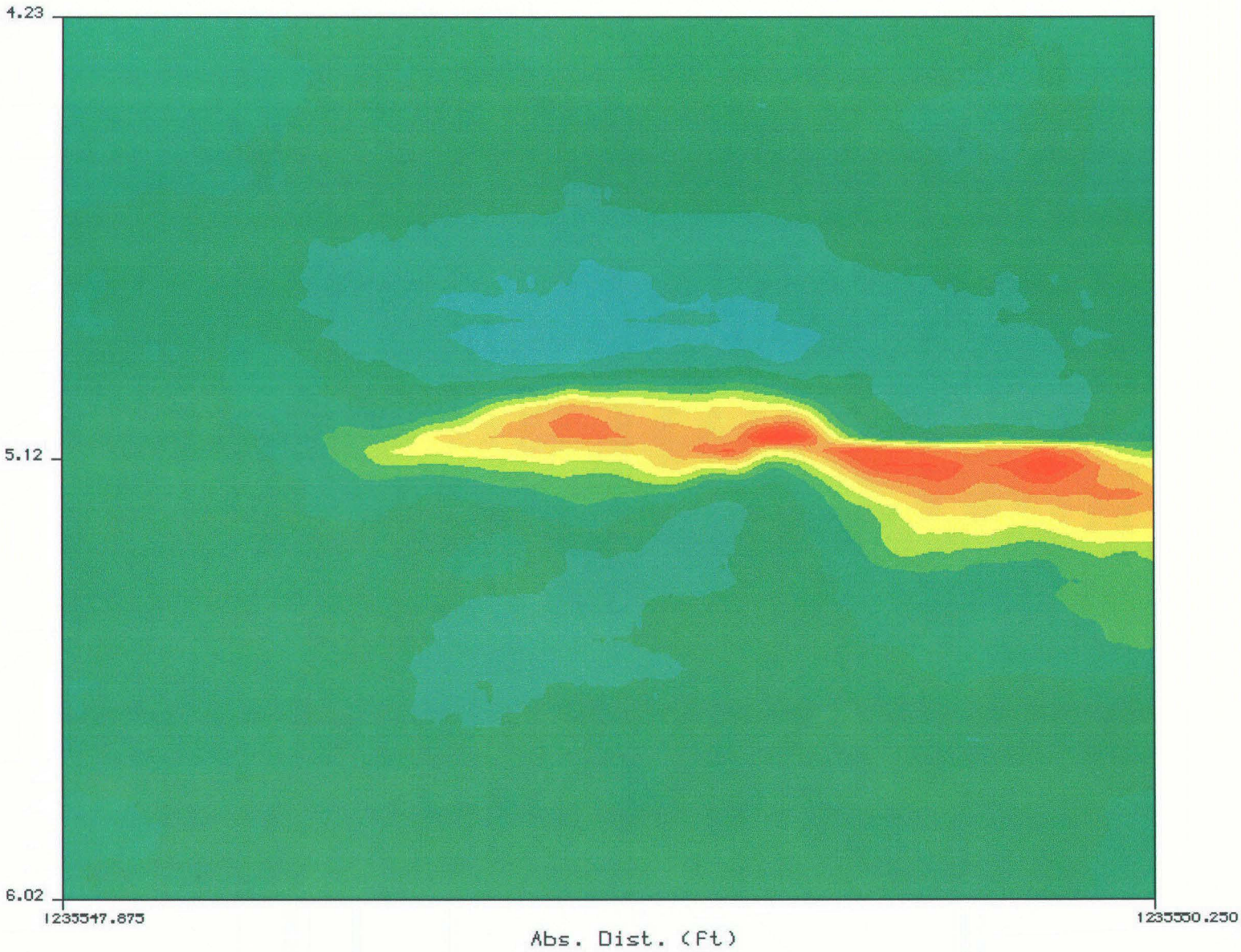
The feature is located 12.6 feet downstream from the reference girth weld.

Schematic Location Summary:





Feature 1 Detail Contour Plot 110004_20A



Feature Description

Type:	External Metal Loss
Orientation:	04:00 (o'clock)
Axial length:	10.7 in
Circumferential width:	1.3 in
Depth - Peak:	26% WT
Pressure Ratio (ERF):	0.966
Feature Selection Rule:	10
Nominal Pipe wall thickness for spool:	0.312 in
Absolute Distance from Launch:	1250868.7 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 - CHECK # C26
   (Girth Weld 293730 + 2.6 ft)
2. VALVE # 16 N.H.G. 21668+00
   (Girth Weld 295990 + 2.4 ft)

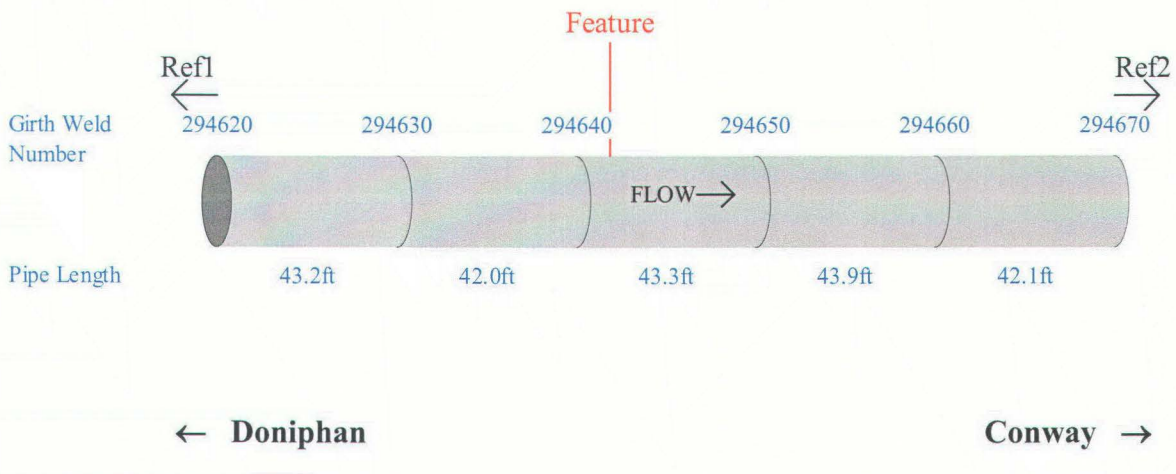
Reference Girth Weld:

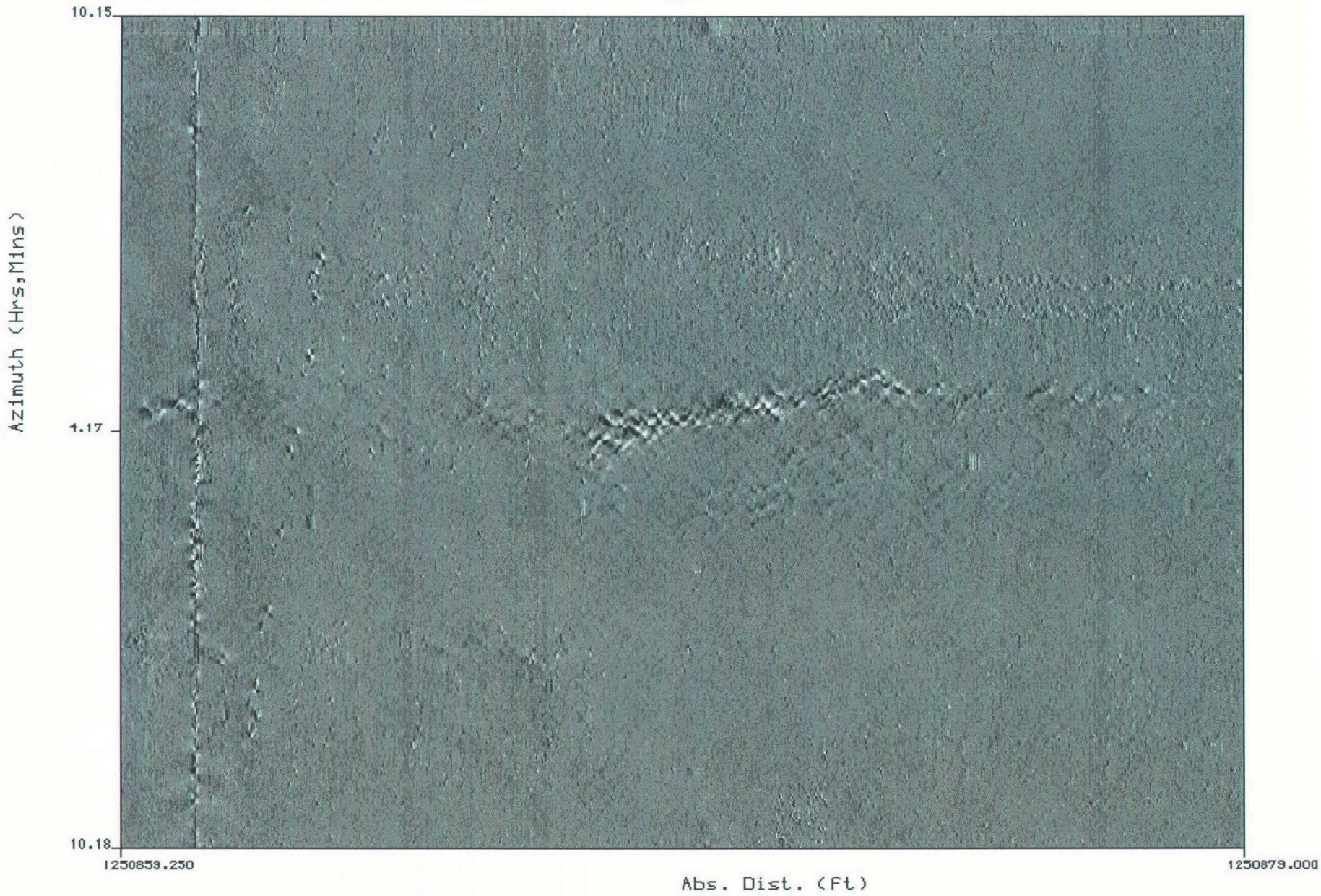
The reference girth weld at the Doniphan (upstream) end of the feature spool is number 294640.
The location of this weld is 3375.9 feet downstream from reference 1 and 5316.2 feet upstream from reference 2.

Feature:

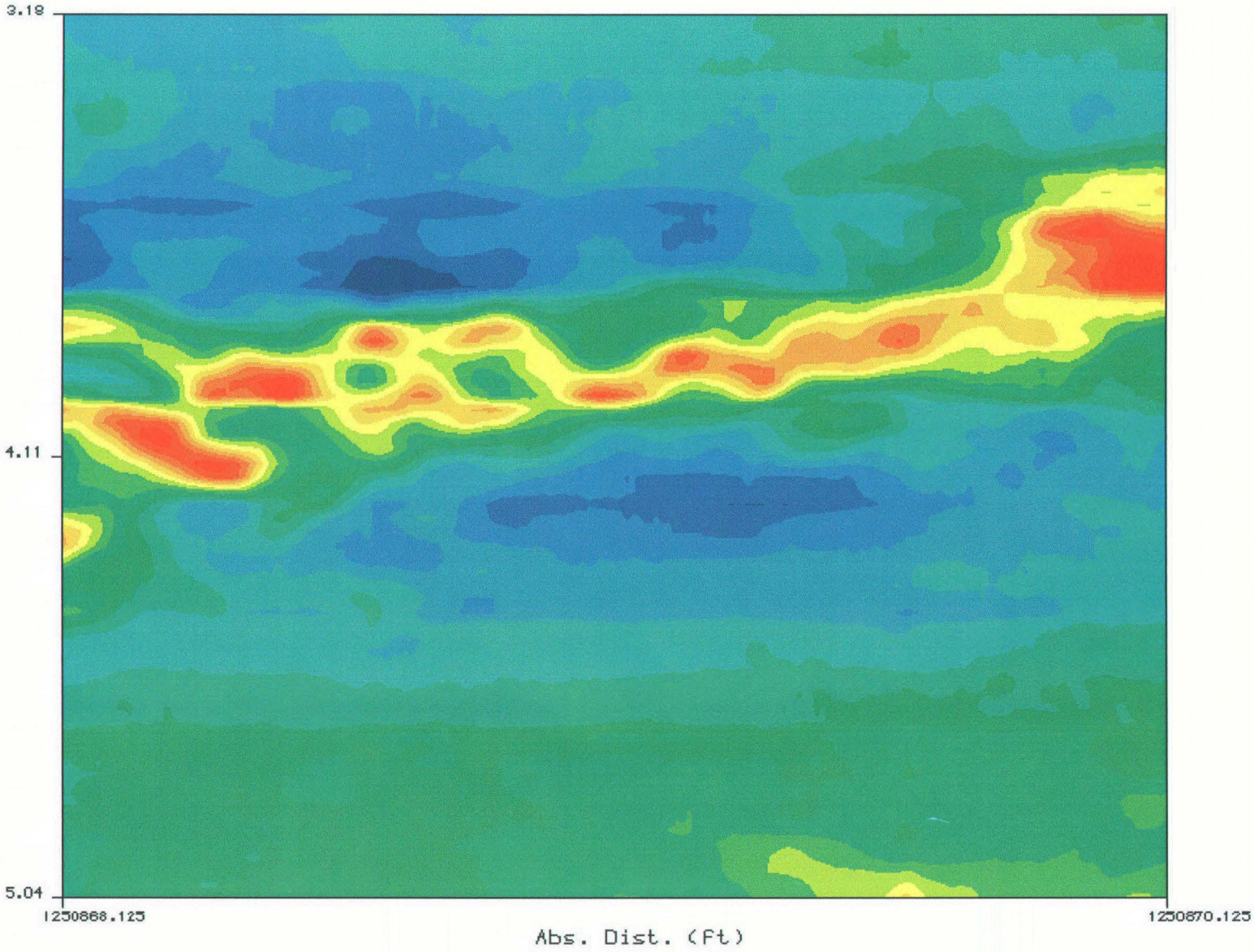
The feature is located 8.0 feet downstream from the reference girth weld.

Schematic Location Summary:





Feature 2 Detail Contour Plot 110004_20A



Feature Description

Type:	External Metal Loss
Orientation:	04:45 (o'clock)
Axial length:	12.8 in
Circumferential width:	1.2 in
Depth - Peak:	34% WT
Pressure Ratio (ERF):	1.051
Feature Selection Rule:	1
Nominal Pipe wall thickness for spool:	0.312 in
Absolute Distance from Launch:	1279487.6 feet

Comments:

This metal loss feature has the appearance of corrosion.

Feature Location

Primary Reference/s:

1. AGM 21510+92
   (Girth Weld 300000 + 23.6 ft)
2. AGM 21415+26
   (Girth Weld 302490 + 38.3 ft)

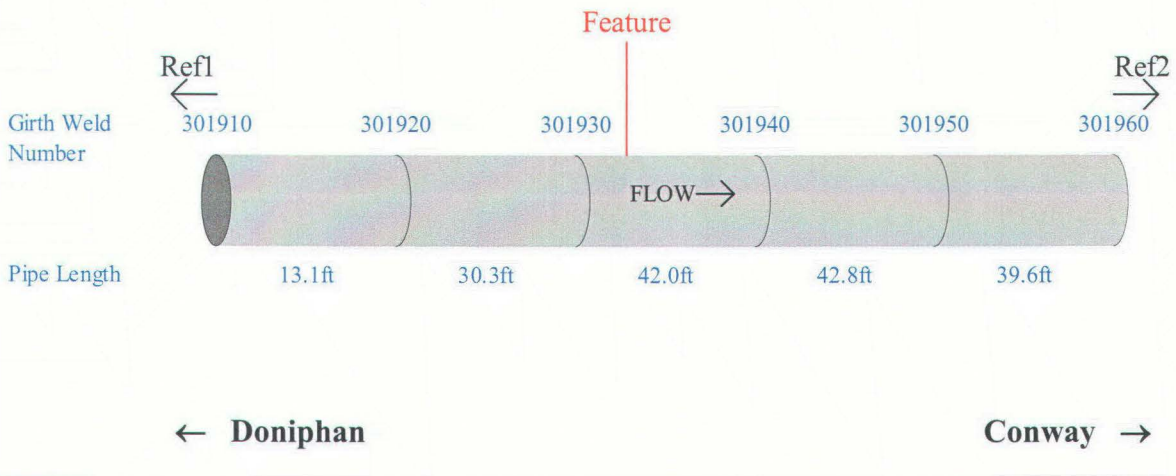
Reference Girth Weld:

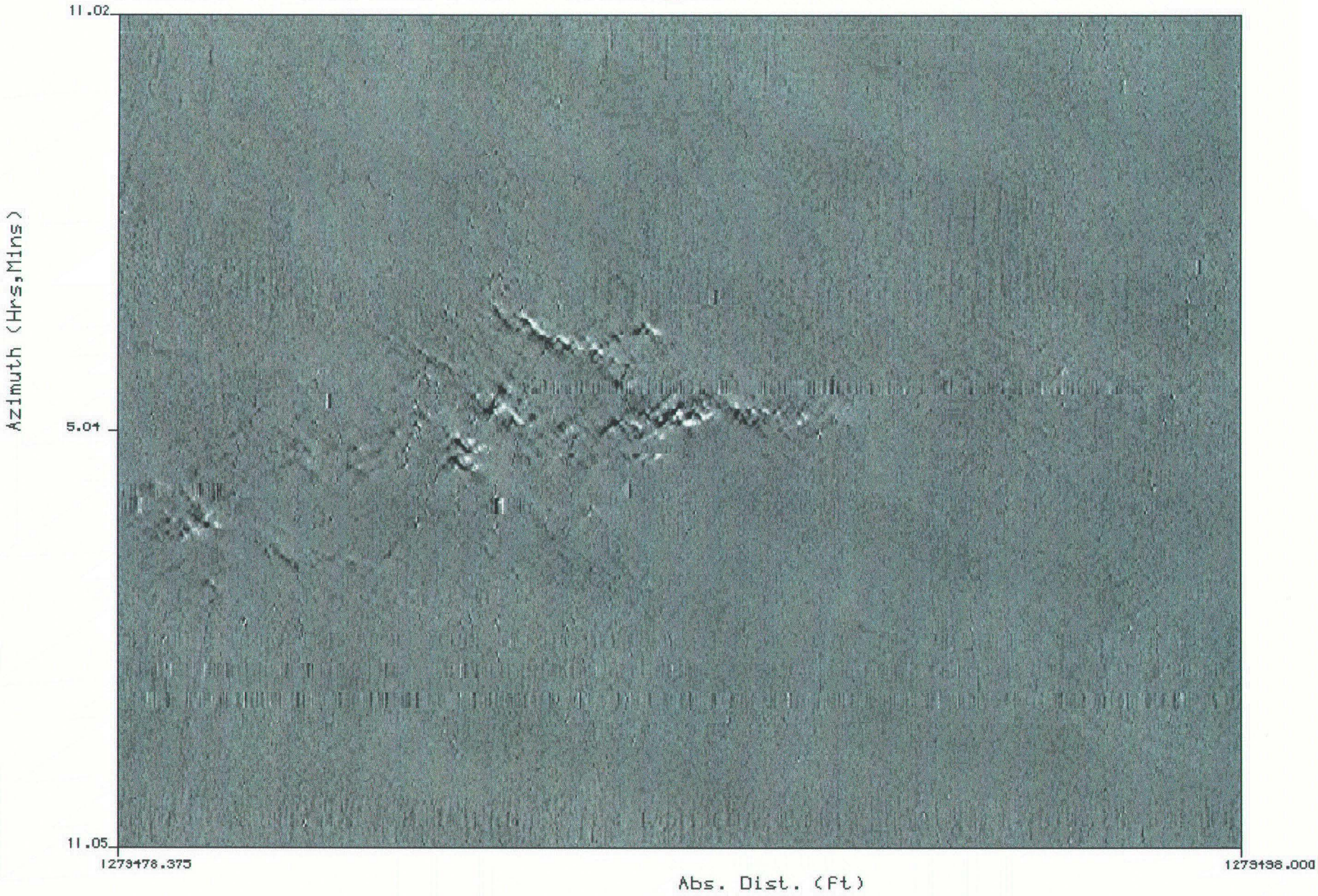
The reference girth weld at the Doniphan (upstream) end of the feature spool is number 301930. The location of this weld is 7567.0 feet downstream from reference 1 and 2384.1 feet upstream from reference 2.

Feature:

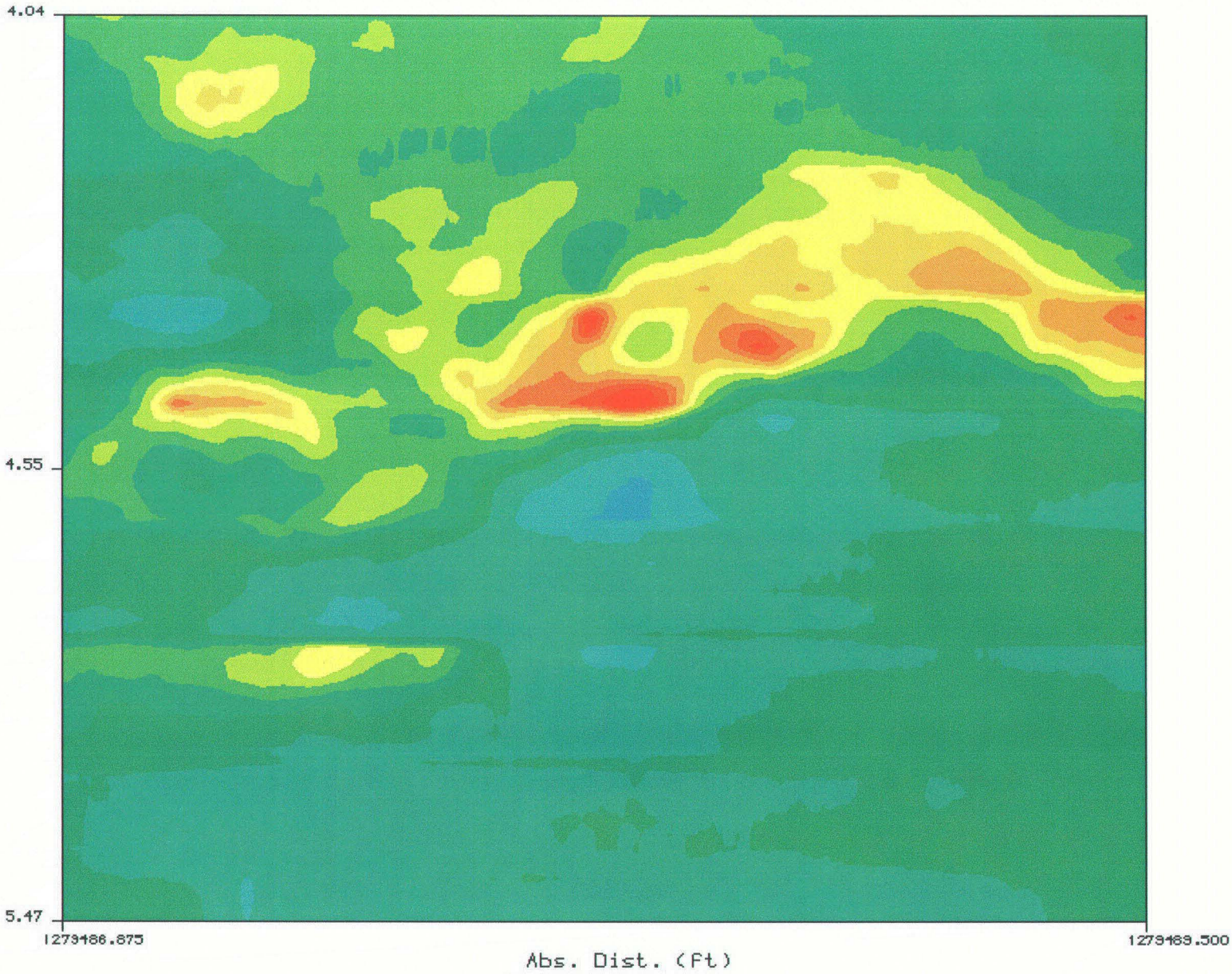
The feature is located 12.0 feet downstream from the reference girth weld.

Schematic Location Summary:





Feature 3 Detail Contour Plot 110004_20A



Feature Description

Type:	External Axial Seam Weld Metal Loss
Orientation:	05:15 (o'clock)
Axial length:	8.5 in
Circumferential width:	1.6 in
Depth - Peak:	18% WT
Pressure Ratio (ERF):	0.935
Feature Selection Rule:	10
Nominal Pipe wall thickness for spool:	0.281 in
Absolute Distance from Launch:	1354024.7 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. AGM 20700+22
   (Girth Weld 320020 + 16.5 ft)
2. VALVE # G41 20635+84
   (Girth Weld 321770 + 2.4 ft)

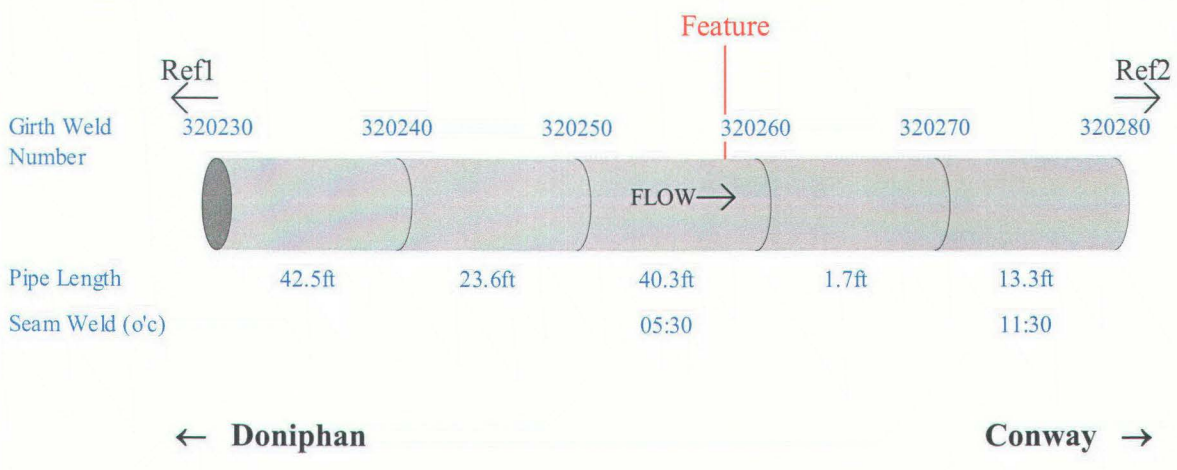
Reference Girth Weld:

The reference girth weld at the Doniphan (upstream) end of the feature spool is number 320250.
The location of this weld is 921.7 feet downstream from reference 1 and 5539.0 feet upstream from reference 2.

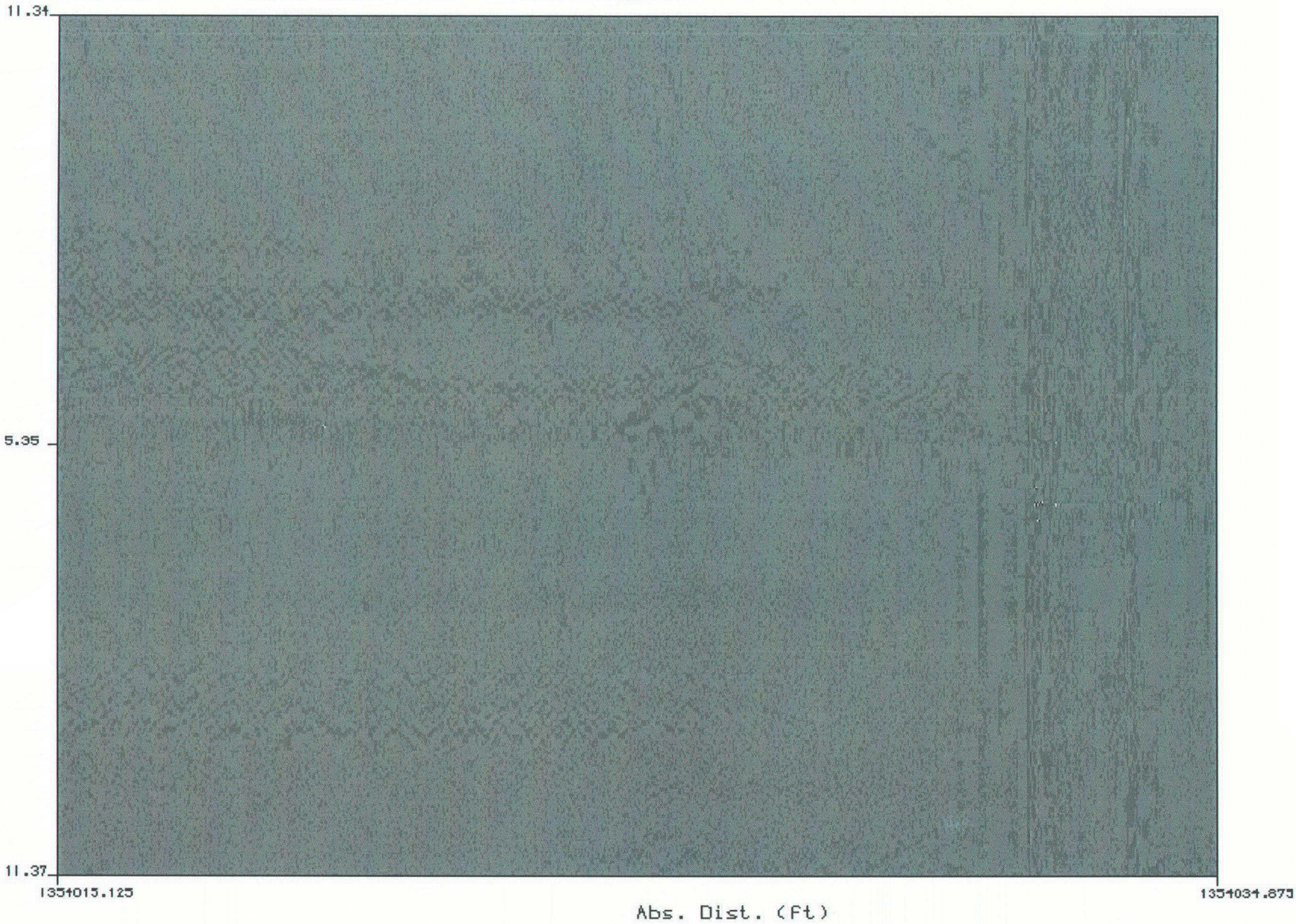
Feature:

The feature is located 33.3 feet downstream from the reference girth weld.

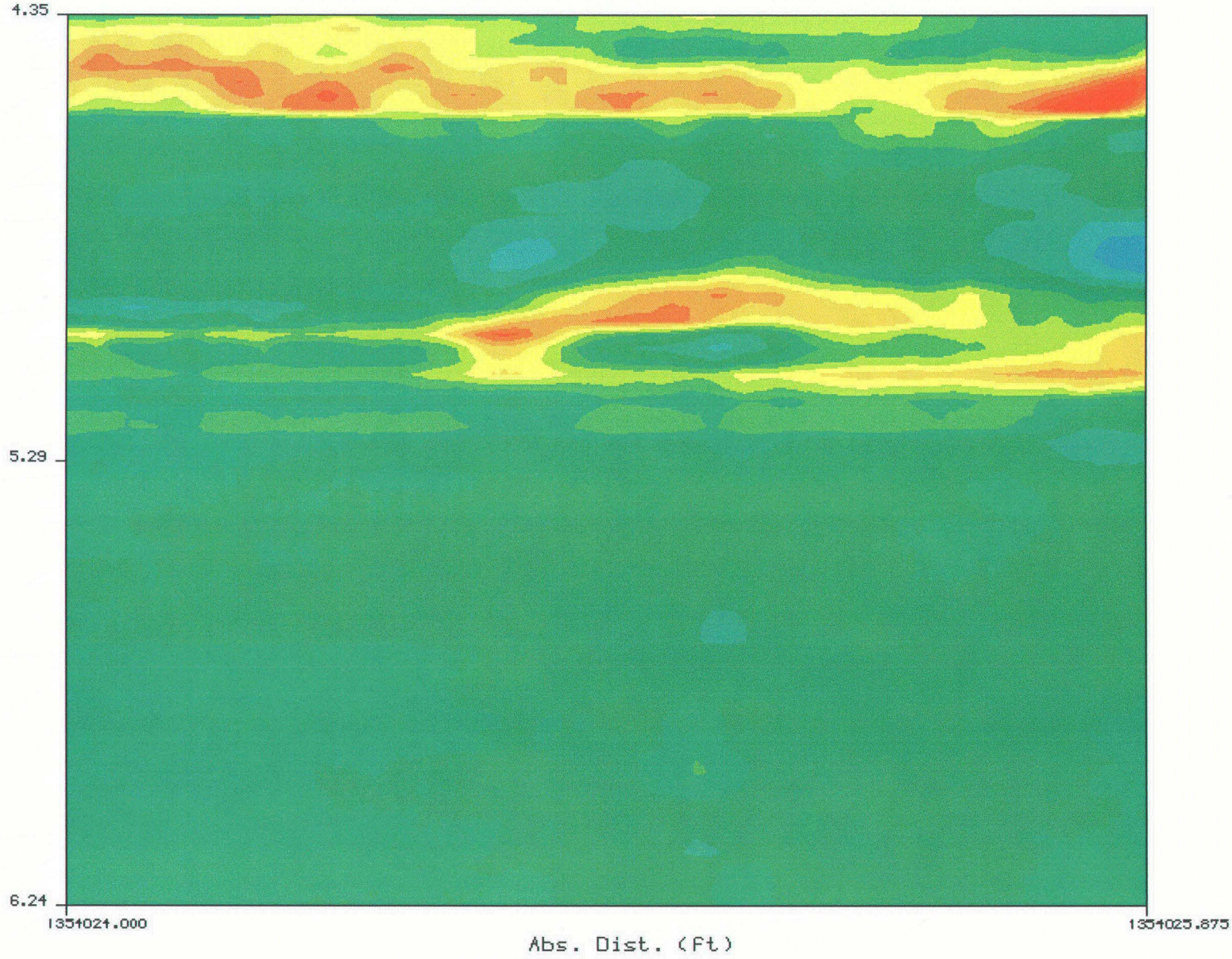
Schematic Location Summary:



Feature 4 Overview Plot 110004_20A



Feature 4 Detail Contour Plot 110004_20A



Feature Description

Type:	External Axial Seam Weld Metal Loss
Orientation:	02:00 (o'clock)
Axial length:	11.9 in
Circumferential width:	0.6 in
Depth - Peak:	11% WT
Pressure Ratio (ERF):	0.900
Feature Selection Rule:	10
Nominal Pipe wall thickness for spool:	0.281 in
Absolute Distance from Launch:	1354051.9 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. AGM 20700+22
   (Girth Weld 320020 + 16.5 ft)
2. VALVE # G41 20635+84
   (Girth Weld 321770 + 2.4 ft)

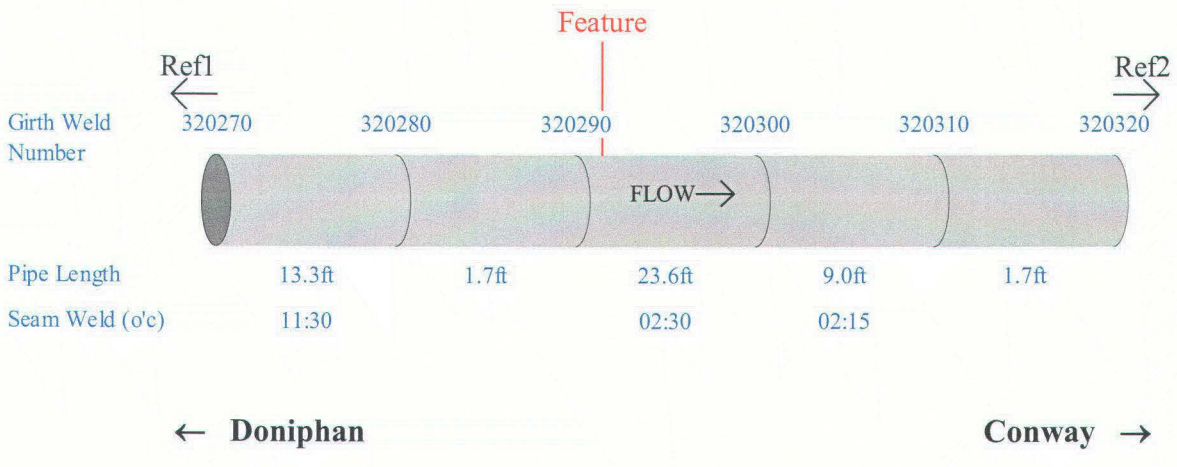
Reference Girth Weld:

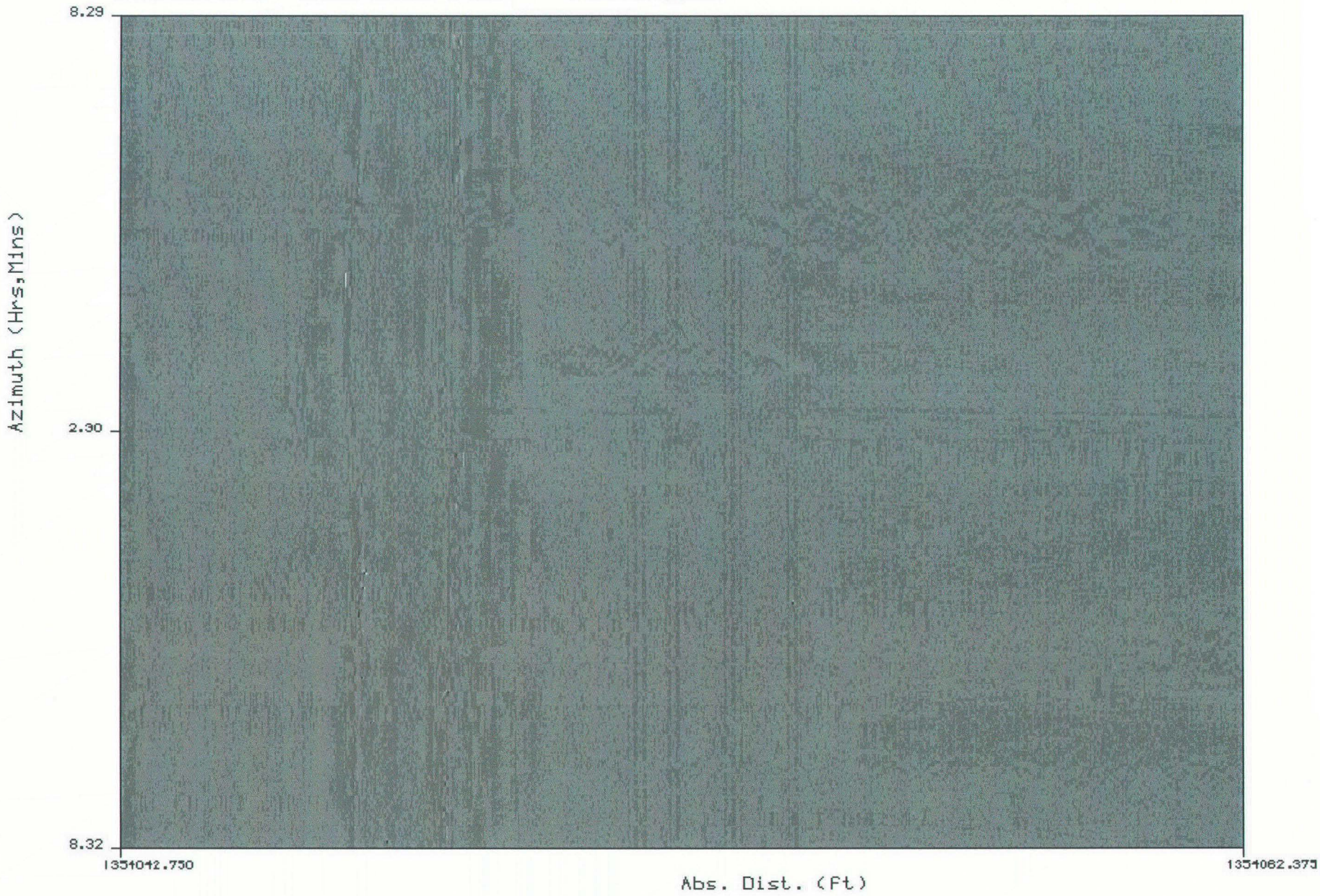
The reference girth weld at the Doniphan (upstream) end of the feature spool is number 320290.
The location of this weld is 978.8 feet downstream from reference 1 and 5481.9 feet upstream from reference 2.

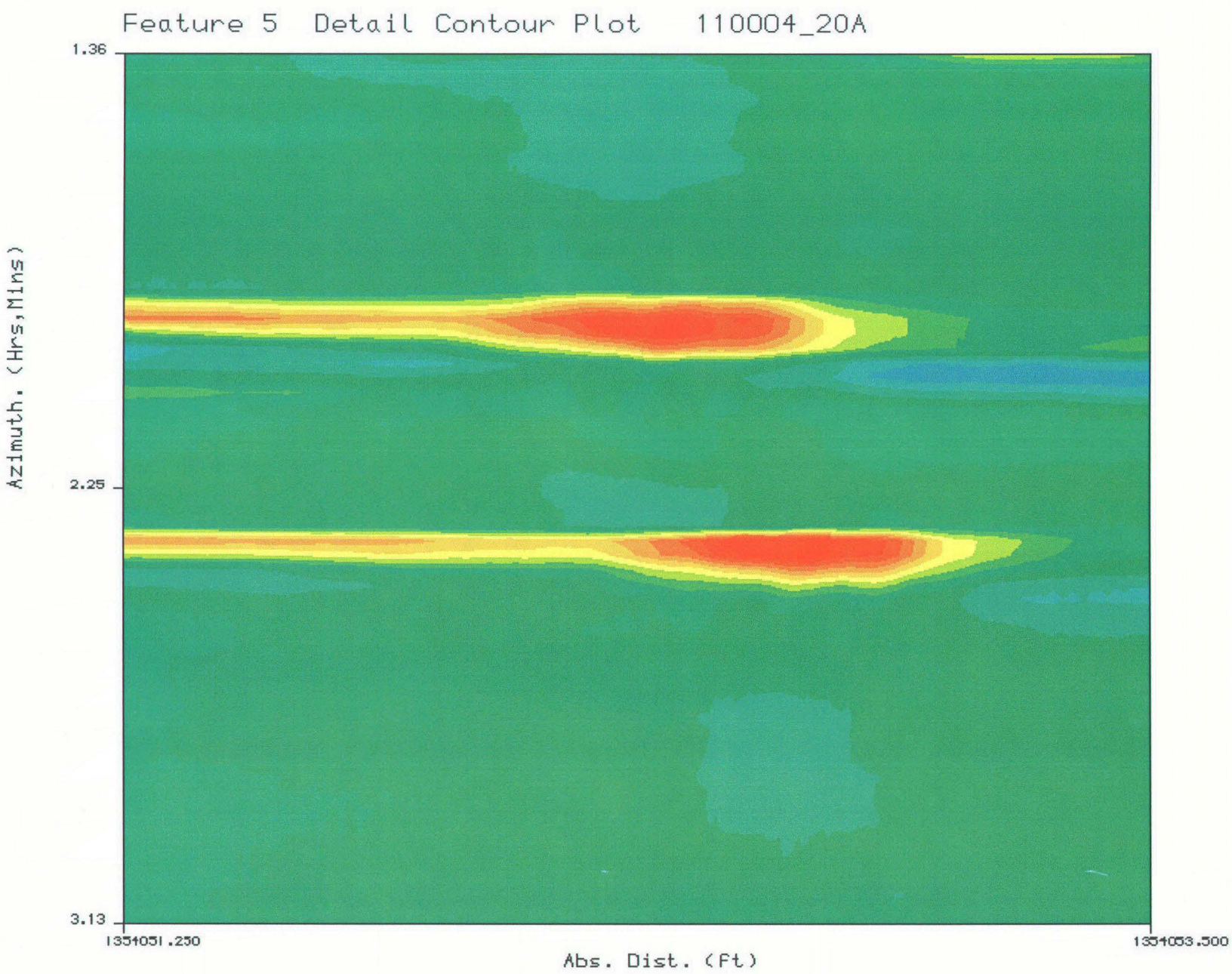
Feature:

The feature is located 3.5 feet downstream from the reference girth weld.

Schematic Location Summary:







Feature Description

Type:	Seam Weld Anomaly
Orientation:	02:30 (o'clock)
Axial length:	5.4 in
Circumferential width:	N/A
Depth:	N/A
Pressure Ratio (ERF):	N/A
Feature Ranking:	N/A
Nominal Pipe wall thickness for spool:	0.281 in
Absolute Distance from Launch:	1354066.3 feet

Comments:

This feature has the appearance of a seam weld anomaly.

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

Feature Location

Primary Reference/s:

1. AGM 20700+22
   (Girth Weld 320020 + 16.5 ft)
2. VALVE # G41 20635+84
   (Girth Weld 321770 + 2.4 ft)

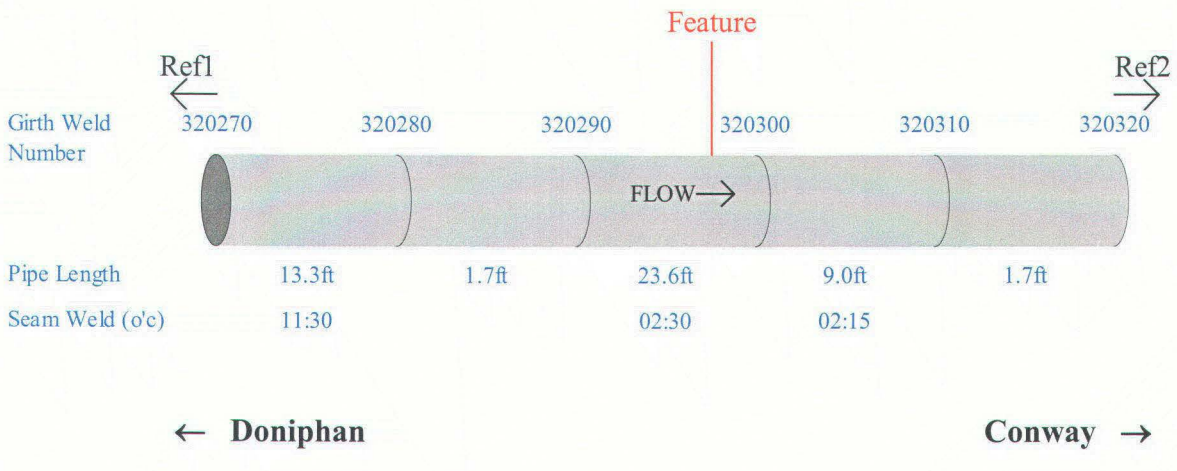
Reference Girth Weld:

The reference girth weld at the Doniphan (upstream) end of the feature spool is number 320290.
The location of this weld is 978.8 feet downstream from reference 1 and 5481.9 feet upstream from reference 2.

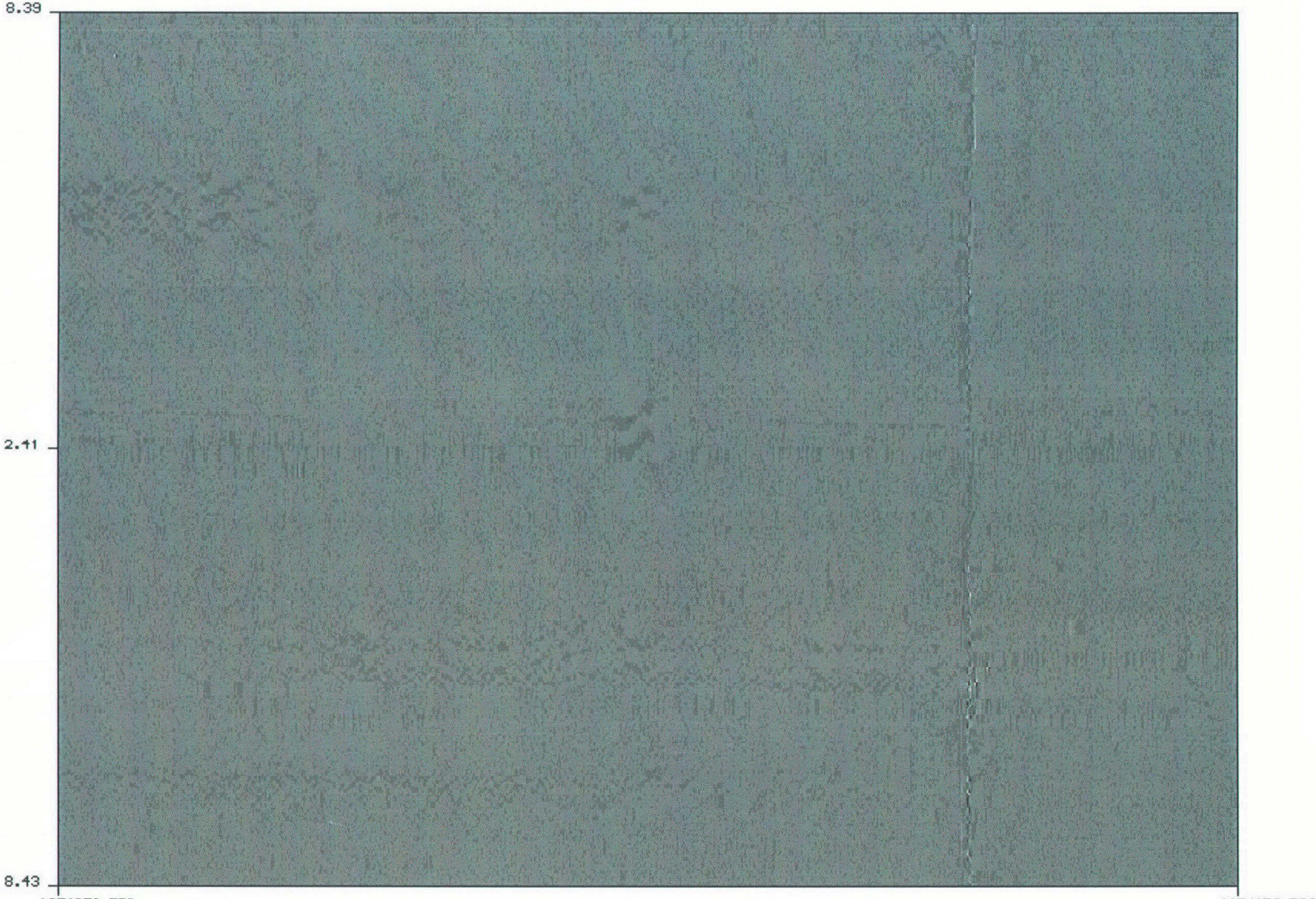
Feature:

The feature is located 17.9 feet downstream from the reference girth weld.

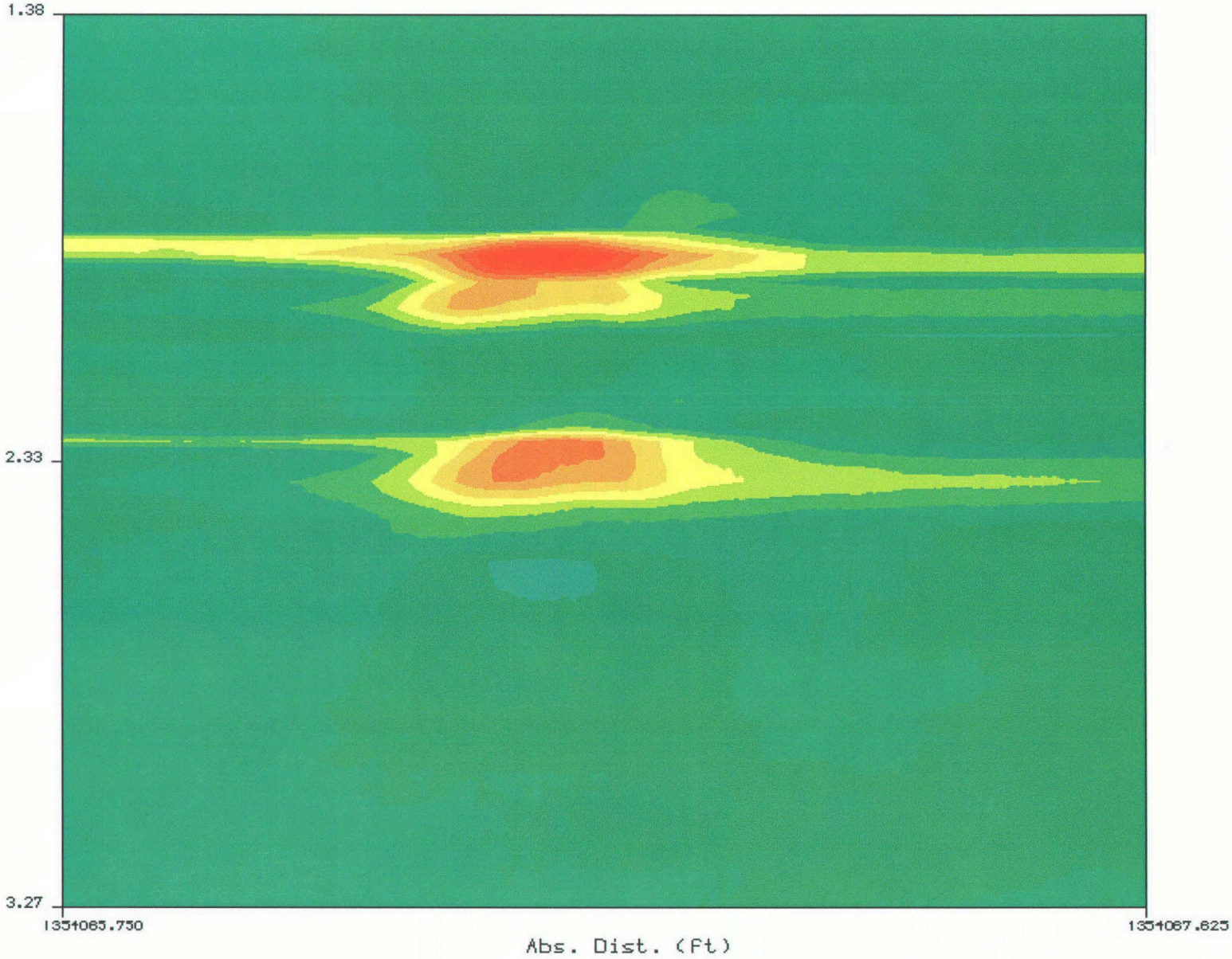
Schematic Location Summary:



Feature 6 Overview Plot 110004_20A



Feature 6 Detail Contour Plot 110004_20A



Feature Description

Type:	Seam Weld Anomaly
Orientation:	05:00 (o'clock)
Axial length:	11.5 in
Circumferential width:	N/A
Depth:	N/A
Pressure Ratio (ERF):	N/A
Feature Ranking:	N/A
Nominal Pipe wall thickness for spool:	0.375 in
Absolute Distance from Launch:	1354114.6 feet

Comments:

This feature has the appearance of a seam weld anomaly.

There is another seam weld anomaly feature within this spool.
More information on this feature is given in the Pipeline Listing.

Feature Location

Primary Reference/s:

1. AGM 20700+22
   (Girth Weld 320020 + 16.5 ft)
2. VALVE # G41 20635+84
   (Girth Weld 321770 + 2.4 ft)

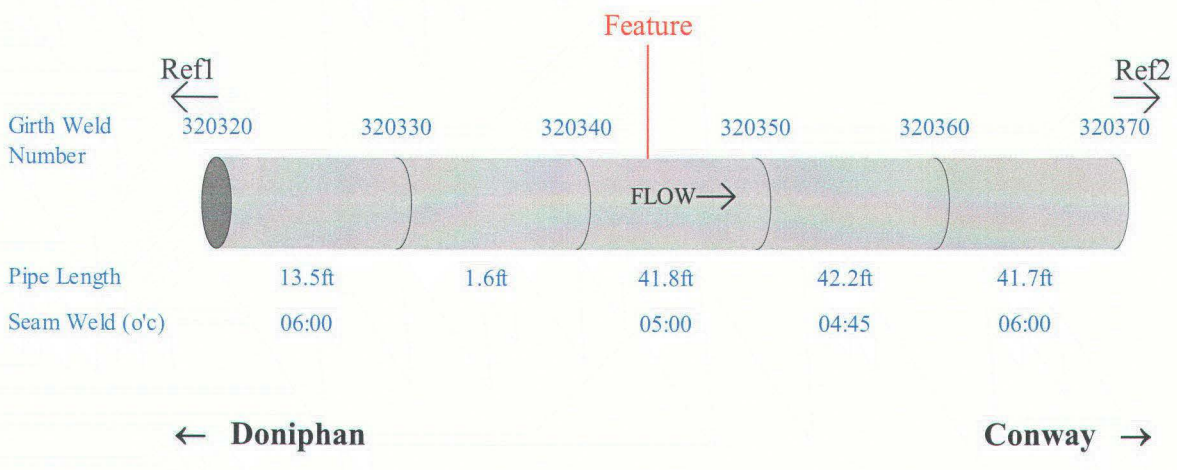
Reference Girth Weld:

The reference girth weld at the Doniphan (upstream) end of the feature spool is number 320340.
The location of this weld is 1028.2 feet downstream from reference 1 and 5432.5 feet upstream from reference 2.

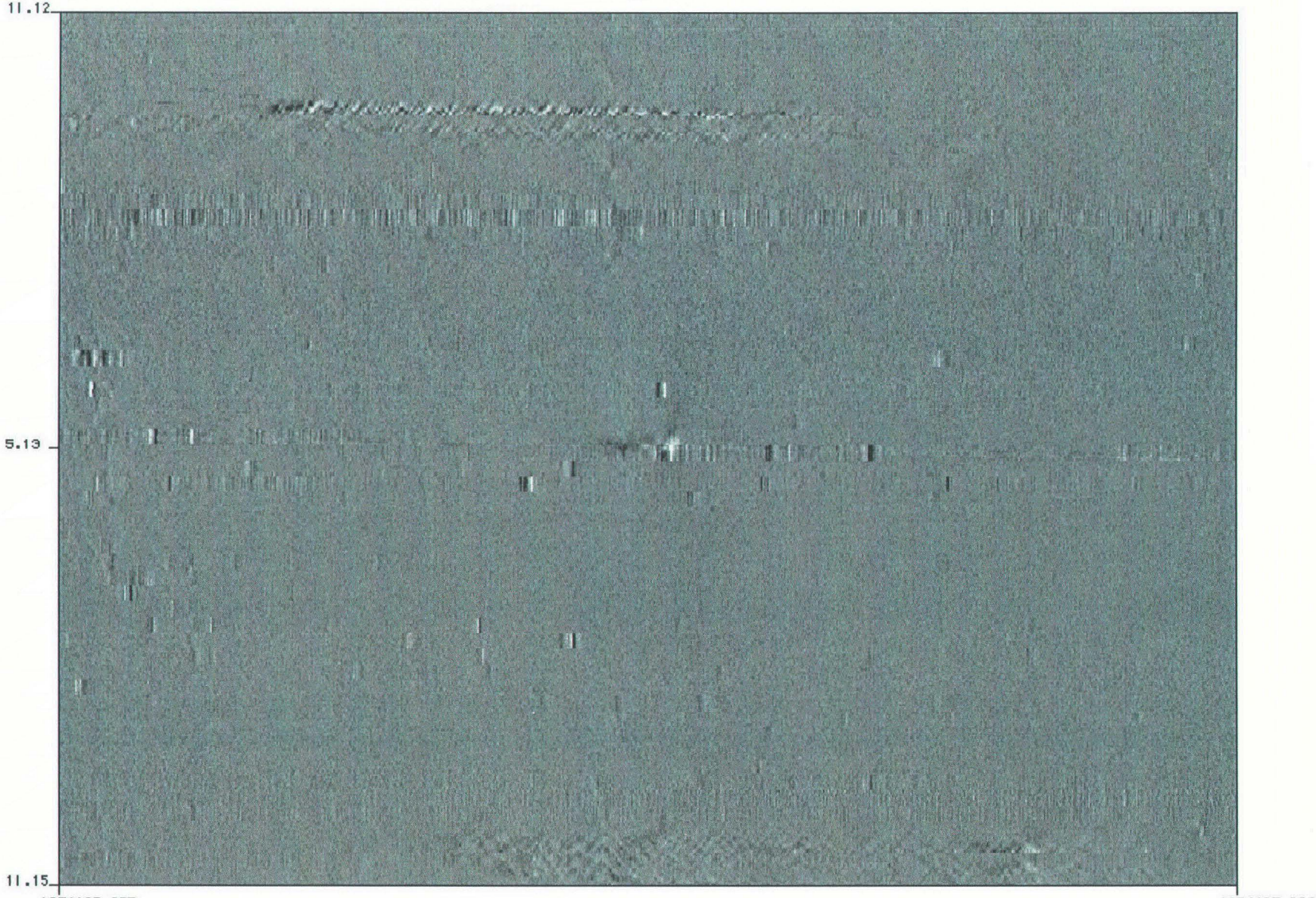
Feature:

The feature is located 16.7 feet downstream from the reference girth weld.

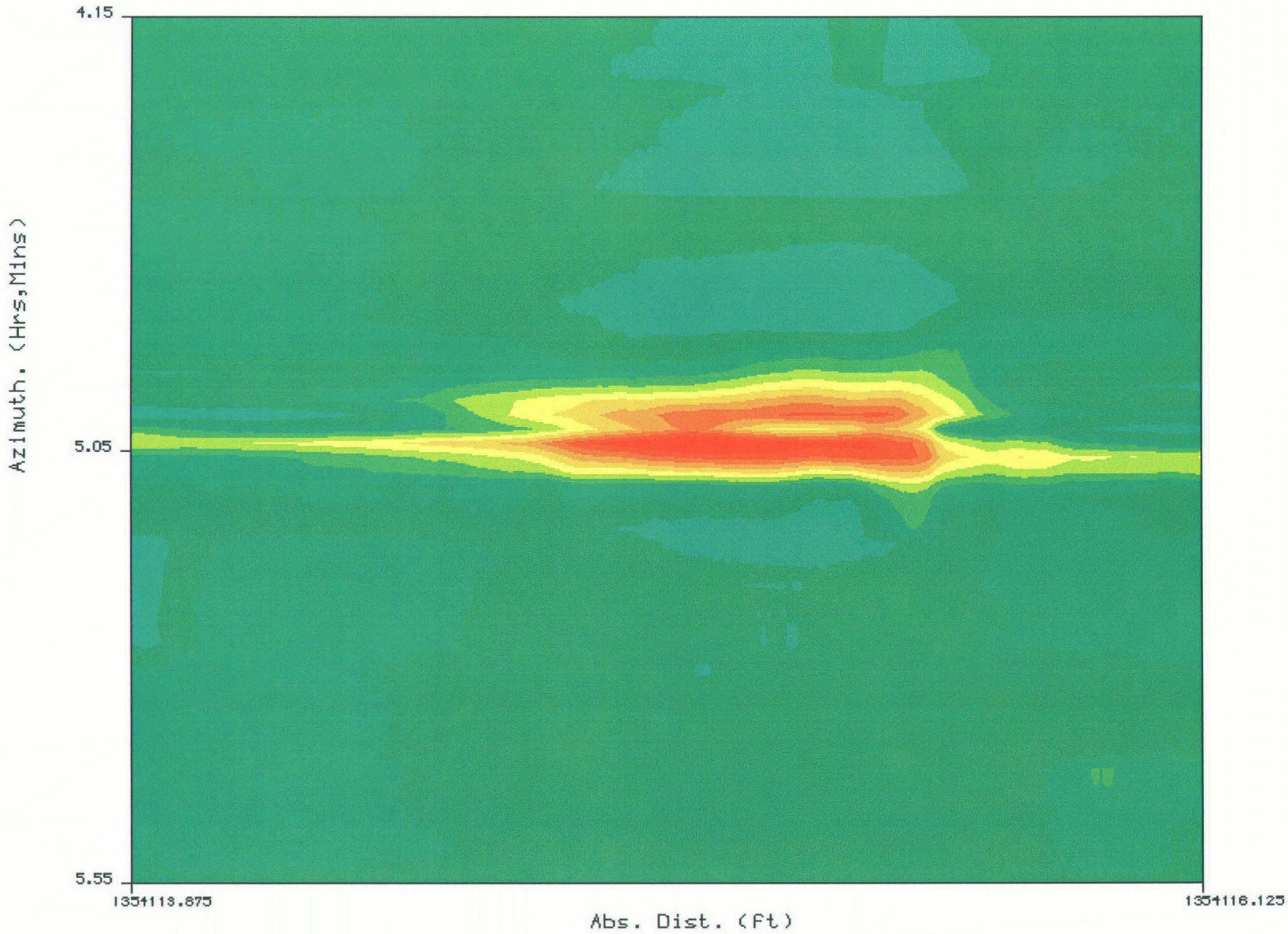
Schematic Location Summary:



Feature 7 Overview Plot 110004_20A



Feature 7 Detail Contour Plot 110004_20A



Feature Description

Type:	Seam Weld Anomaly
Orientation:	05:00 (o'clock)
Axial length:	11.3 in
Circumferential width:	N/A
Depth:	N/A
Pressure Ratio (ERF):	N/A
Feature Ranking:	N/A
Nominal Pipe wall thickness for spool:	0.375 in
Absolute Distance from Launch:	1354114.9 feet

Comments:

This feature has the appearance of a seam weld anomaly.

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

Feature Location

Primary Reference/s:

1. AGM 20700+22
   (Girth Weld 320020 + 16.5 ft)
2. VALVE # G41 20635+84
   (Girth Weld 321770 + 2.4 ft)

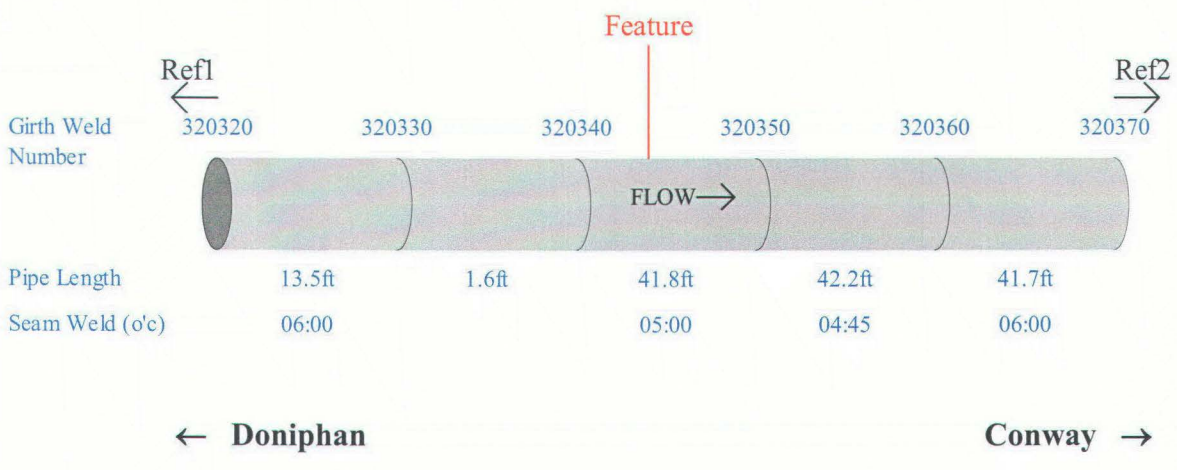
Reference Girth Weld:

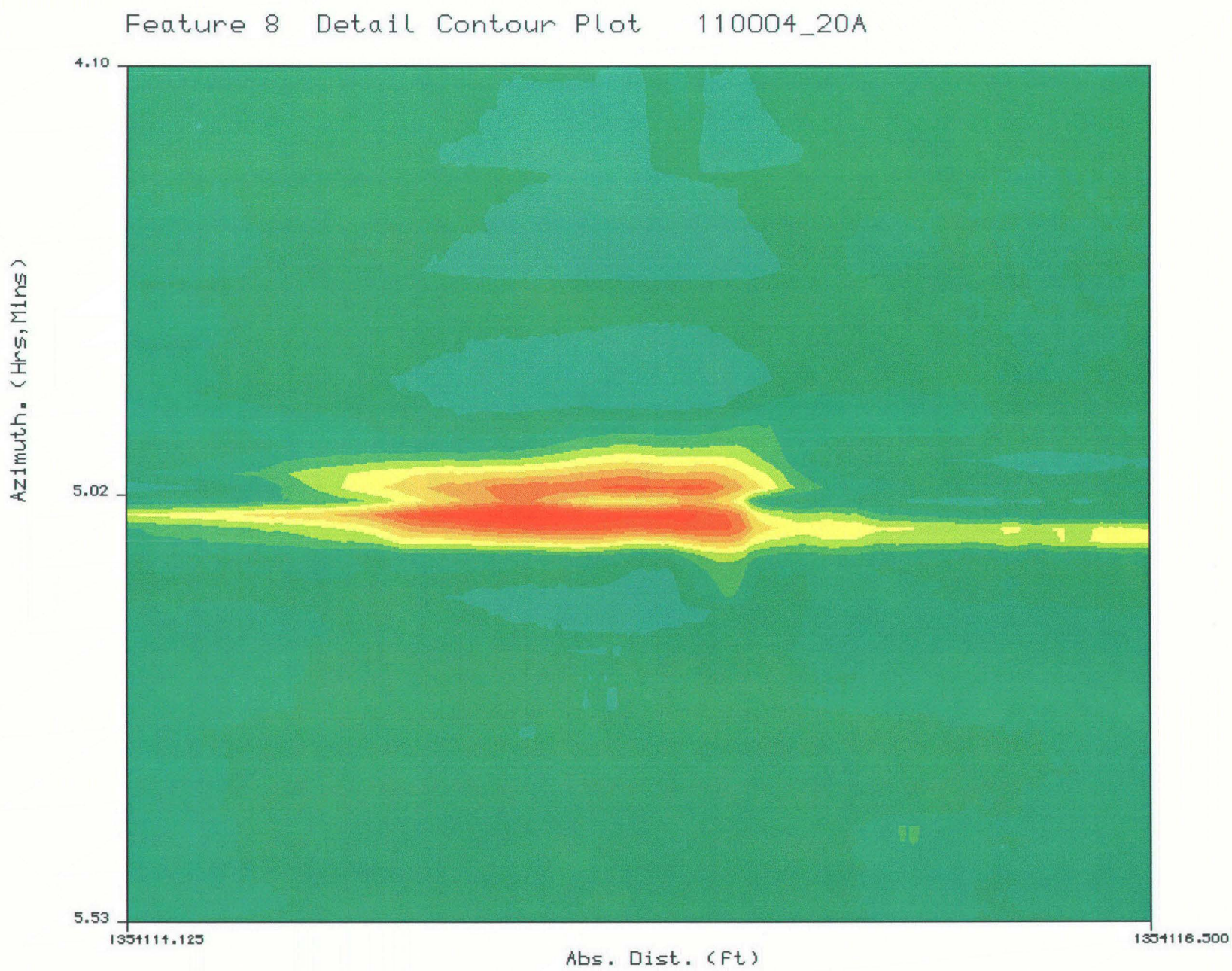
The reference girth weld at the Doniphan (upstream) end of the feature spool is number 320340.
The location of this weld is 1028.2 feet downstream from reference 1 and 5432.5 feet upstream from reference 2.

Feature:

The feature is located 17.0 feet downstream from the reference girth weld.

Schematic Location Summary:





Feature Description

Type:	Seam Weld Anomaly
Orientation:	05:00 (o'clock)
Axial length:	6.2 in
Circumferential width:	N/A
Depth:	N/A
Pressure Ratio (ERF):	N/A
Feature Ranking:	N/A
Nominal Pipe wall thickness for spool:	0.375 in
Absolute Distance from Launch:	1354126.3 feet

Comments:

This feature has the appearance of a seam weld anomaly.

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

Feature Location

Primary Reference/s:

1. AGM 20700+22
   (Girth Weld 320020 + 16.5 ft)
2. VALVE # G41 20635+84
   (Girth Weld 321770 + 2.4 ft)

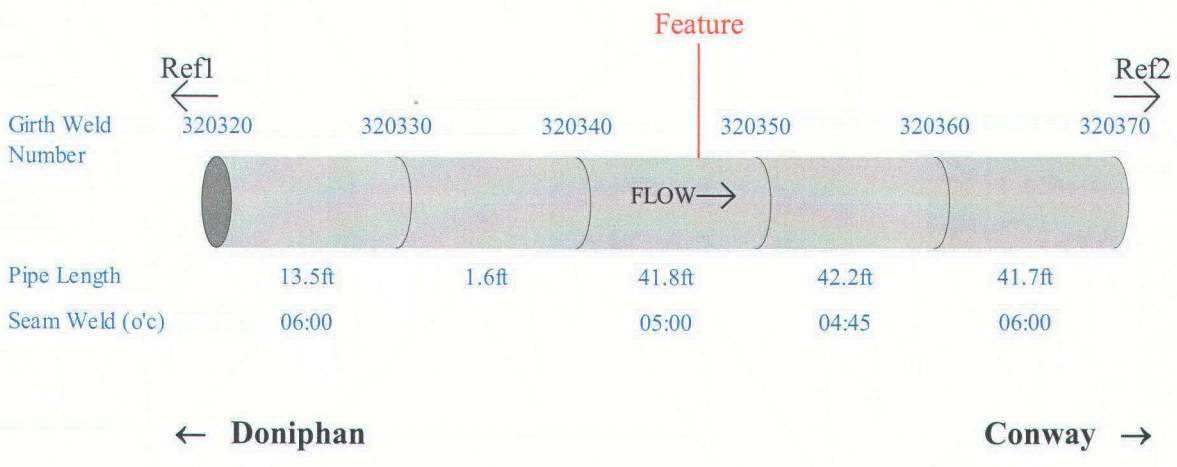
Reference Girth Weld:

The reference girth weld at the Doniphan (upstream) end of the feature spool is number 320340.
The location of this weld is 1028.2 feet downstream from reference 1 and 5432.5 feet upstream from reference 2.

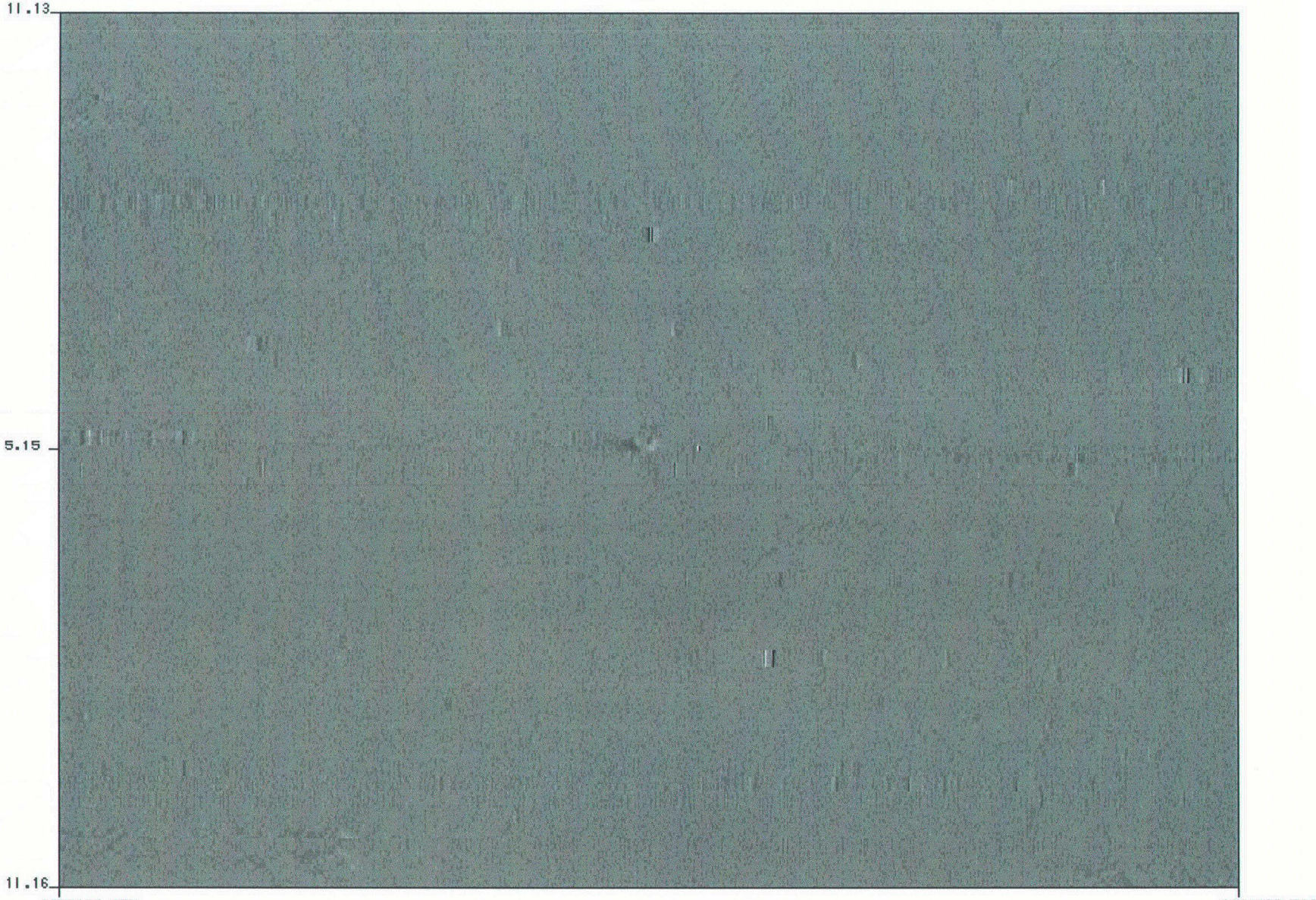
Feature:

The feature is located 28.4 feet downstream from the reference girth weld.

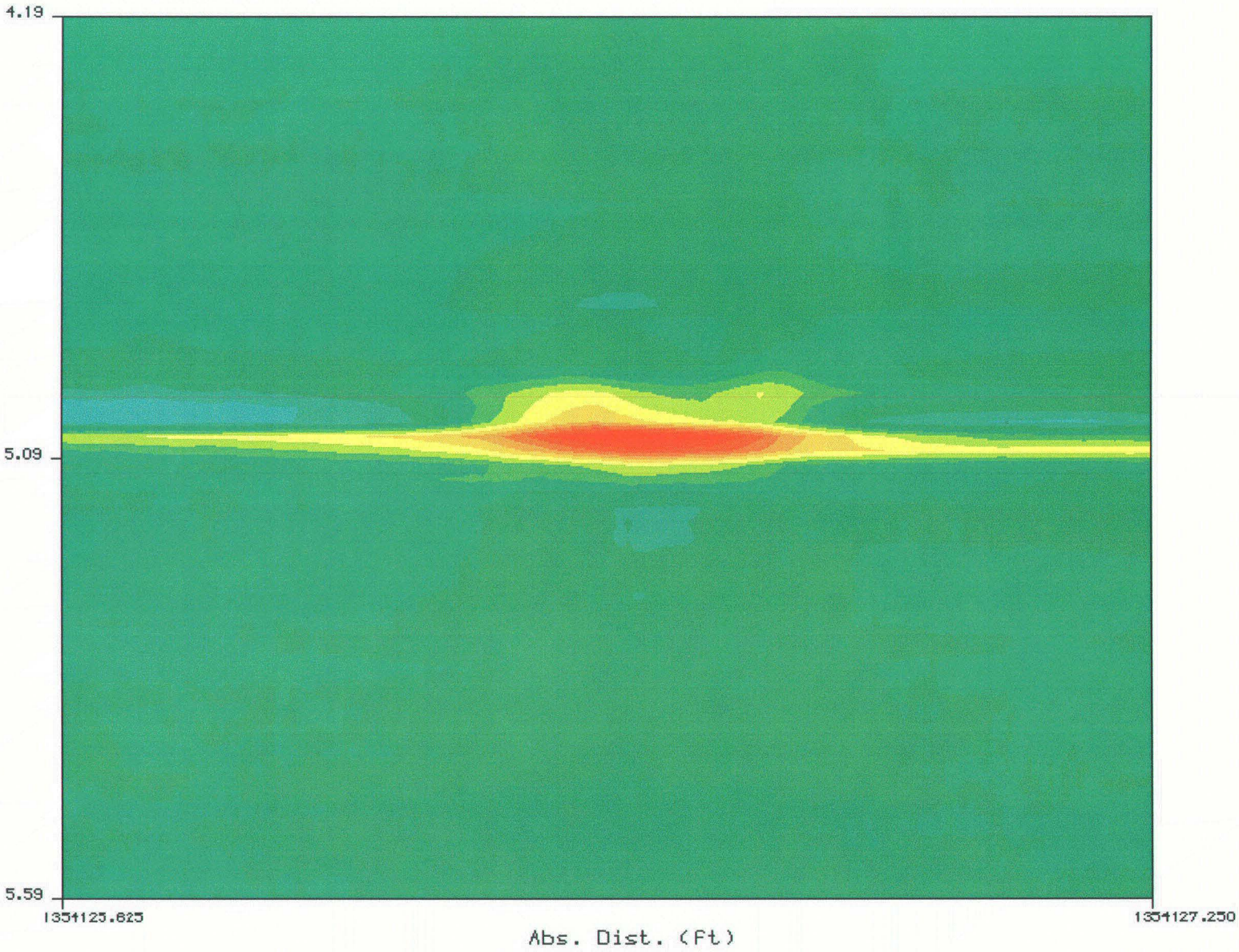
Schematic Location Summary:



Feature 9 Overview Plot 110004_20A



Feature 9 Detail Contour Plot 110004_20A



Feature Description

Type:	External Metal Loss
Orientation:	05:15 (o'clock)
Axial length:	8.7 in
Circumferential width:	1.2 in
Depth - Peak:	30% WT
Pressure Ratio (ERF):	0.968
Feature Selection Rule:	5
Nominal Pipe wall thickness for spool:	0.375 in
Absolute Distance from Launch:	1354241.4 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. AGM 20700+22
   (Girth Weld 320020 + 16.5 ft)
2. VALVE # G41 20635+84
   (Girth Weld 321770 + 2.4 ft)

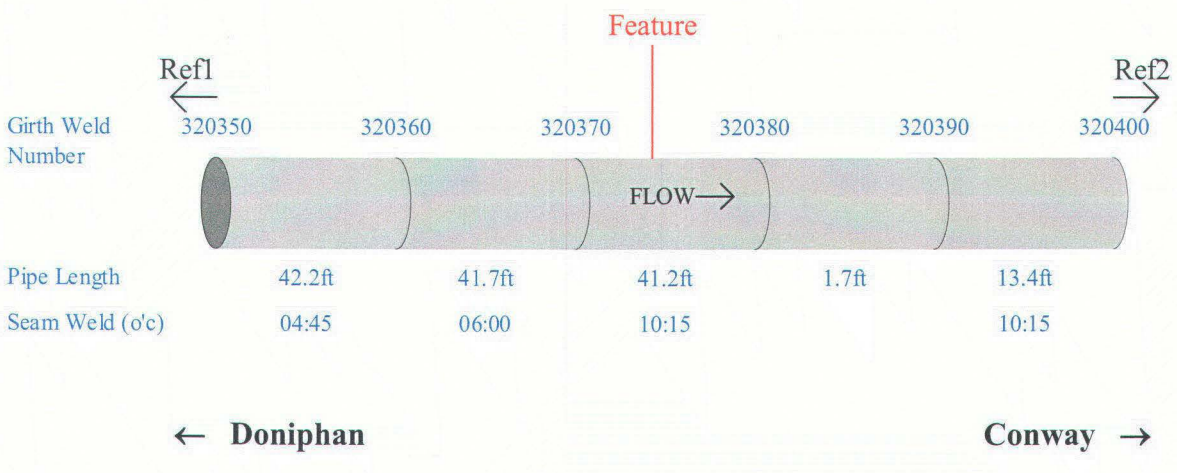
Reference Girth Weld:

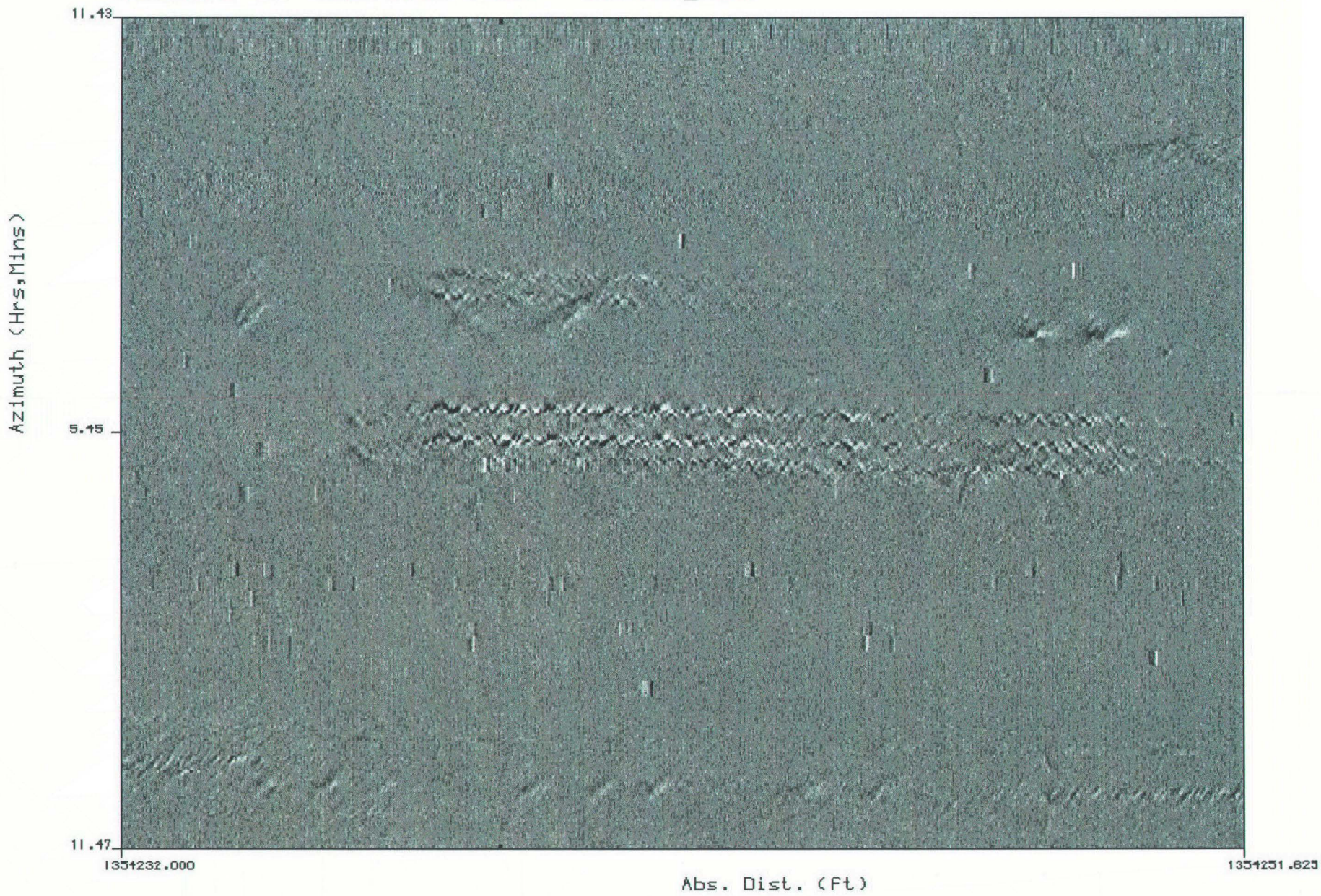
The reference girth weld at the Doniphan (upstream) end of the feature spool is number 320370.
The location of this weld is 1153.9 feet downstream from reference 1 and 5306.8 feet upstream from reference 2.

Feature:

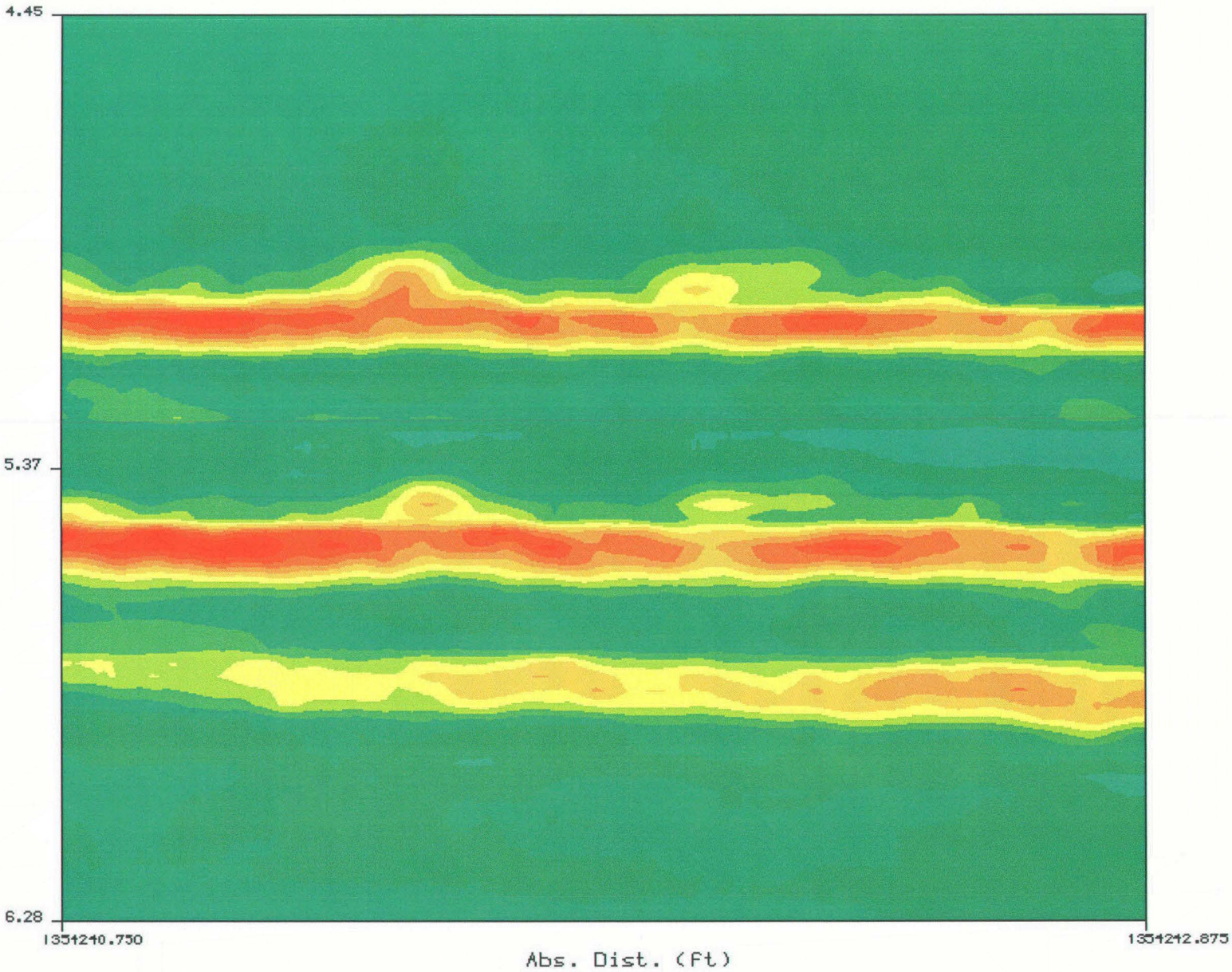
The feature is located 17.8 feet downstream from the reference girth weld.

Schematic Location Summary:





Feature 10 Detail Contour Plot 110004_20A



Feature Description

Type:	Seam Weld Anomaly
Orientation:	01:15 (o'clock)
Axial length:	2.8 in
Circumferential width:	N/A
Depth:	N/A
Pressure Ratio (ERF):	N/A
Feature Ranking:	N/A
Nominal Pipe wall thickness for spool:	0.281 in
Absolute Distance from Launch:	1354288.4 feet

Comments:

This feature has the appearance of seam weld anomaly feature.

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. AGM 20700+22
   (Girth Weld 320020 + 16.5 ft)
2. VALVE # G41 20635+84
   (Girth Weld 321770 + 2.4 ft)

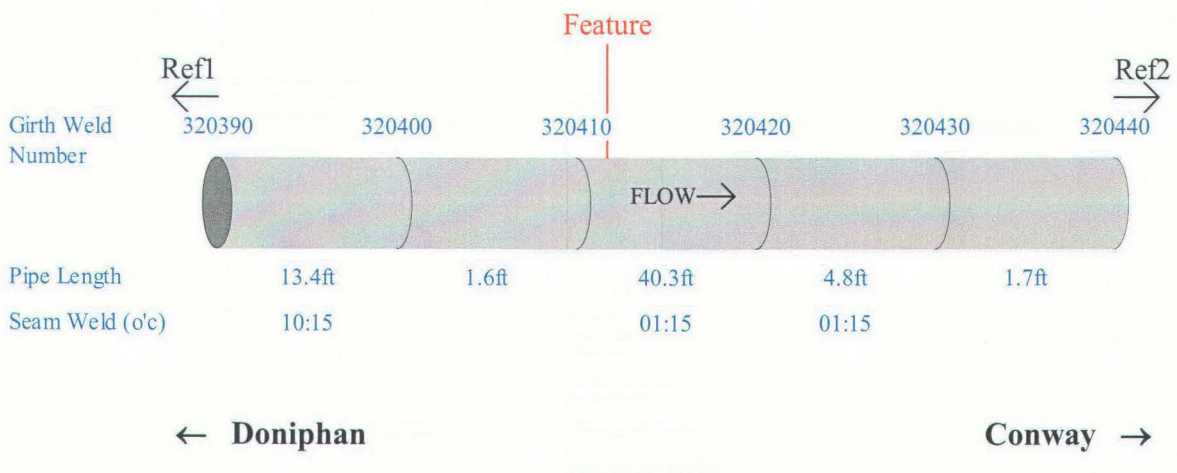
Reference Girth Weld:

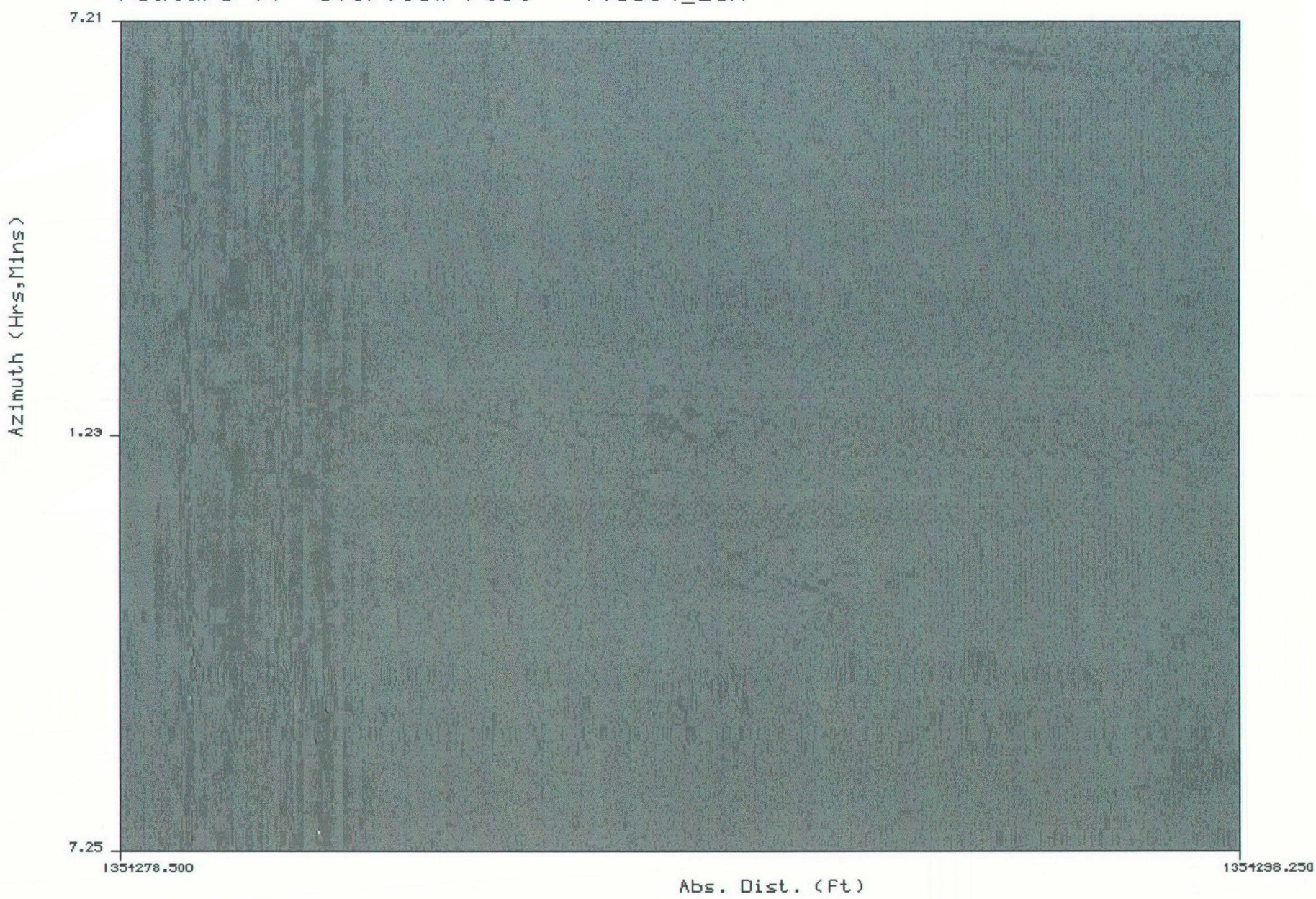
The reference girth weld at the Doniphan (upstream) end of the feature spool is number 320410.
The location of this weld is 1211.8 feet downstream from reference 1 and 5248.9 feet upstream from reference 2.

Feature:

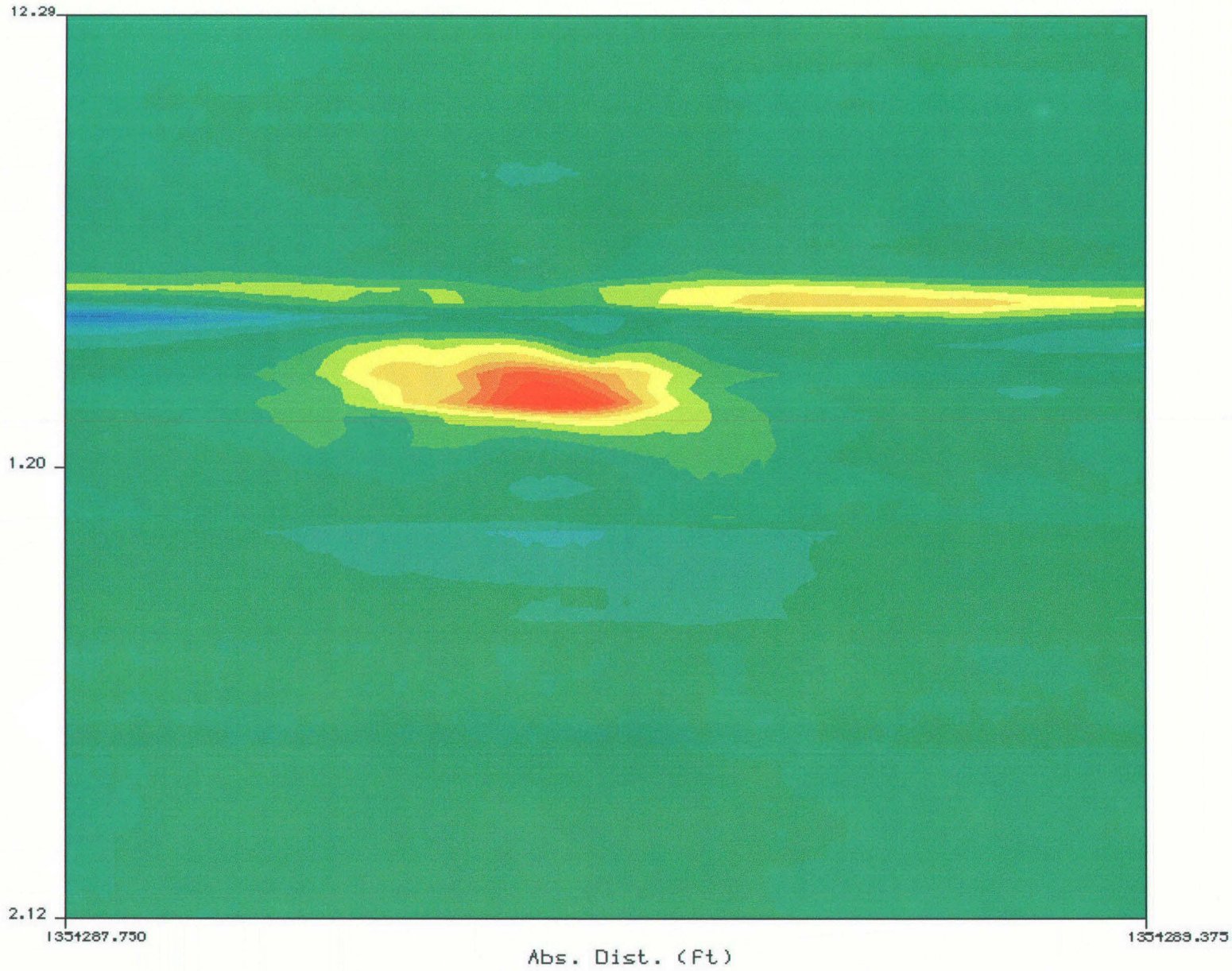
The feature is located 6.9 feet downstream from the reference girth weld.

Schematic Location Summary:





Feature 11 Detail Contour Plot 110004_20A



Feature Description

Type:	External Axial Seam Weld Metal Loss
Orientation:	06:15 (o'clock)
Axial length:	13.7 in
Circumferential width:	1.4 in
Depth - Peak:	12% WT
Pressure Ratio (ERF):	0.911
Feature Selection Rule:	10
Nominal Pipe wall thickness for spool:	0.281 in
Absolute Distance from Launch:	1354356.4 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. AGM 20700+22
   (Girth Weld 320020 + 16.5 ft)
2. VALVE # G41 20635+84
   (Girth Weld 321770 + 2.4 ft)

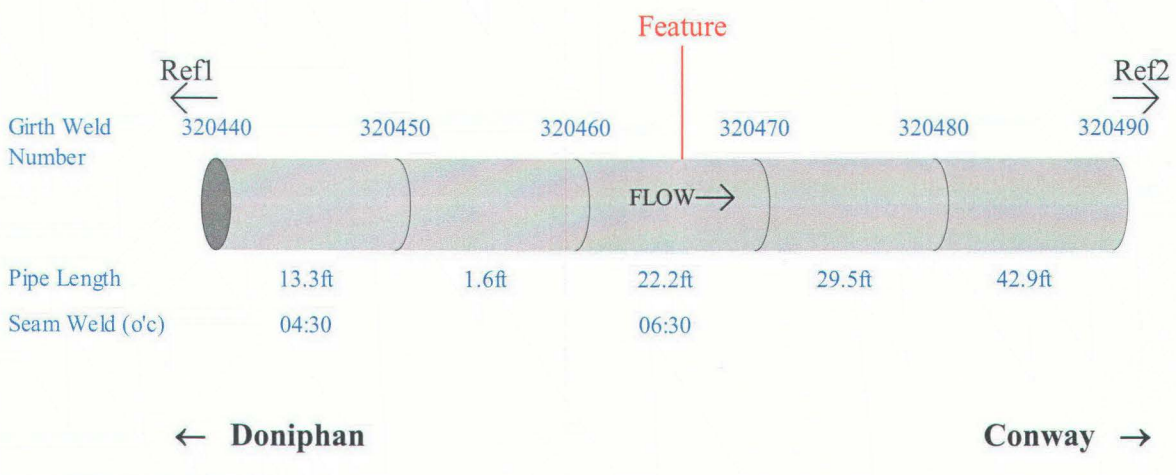
Reference Girth Weld:

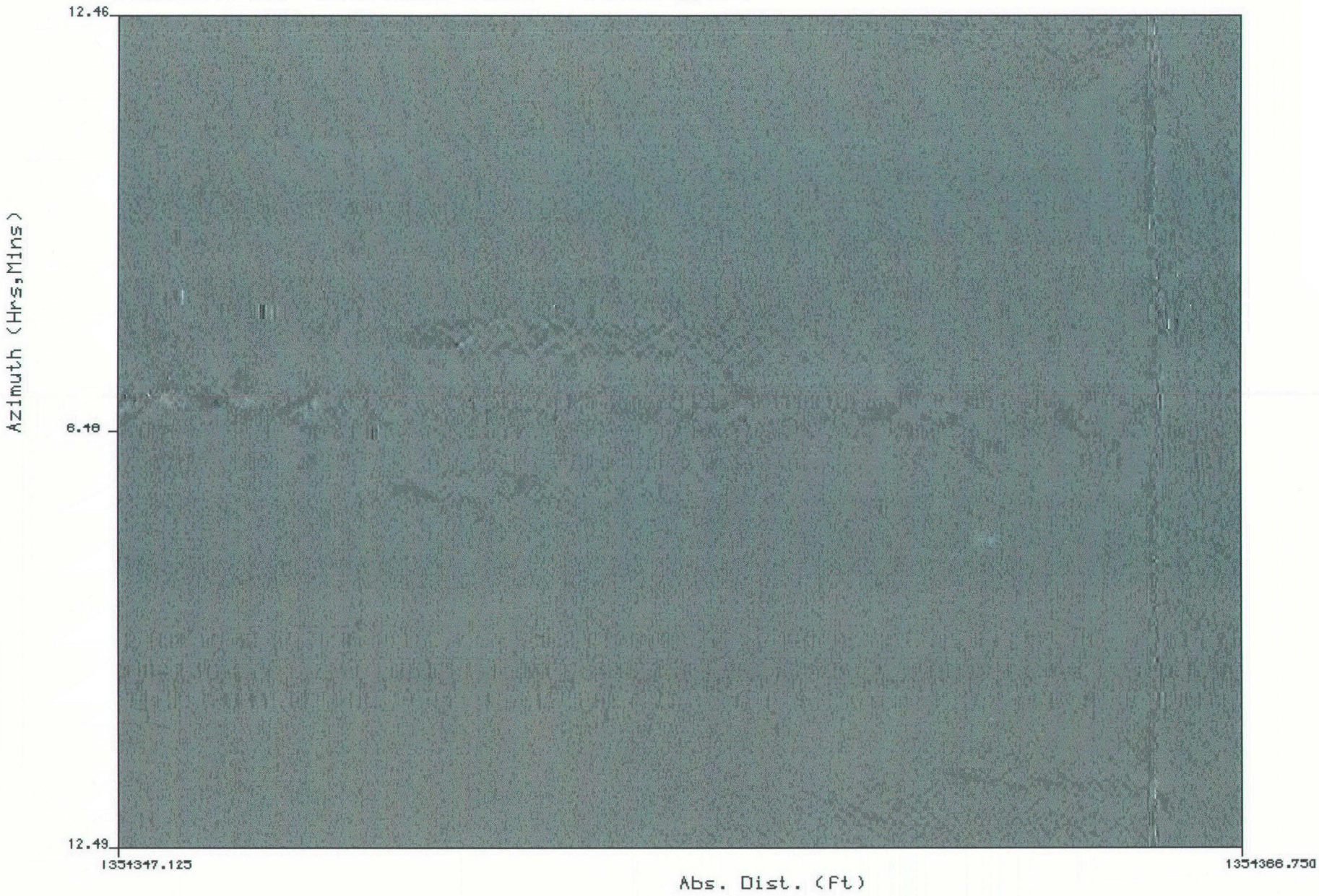
The reference girth weld at the Doniphan (upstream) end of the feature spool is number 320460.
The location of this weld is 1273.4 feet downstream from reference 1 and 5187.2 feet upstream from reference 2.

Feature:

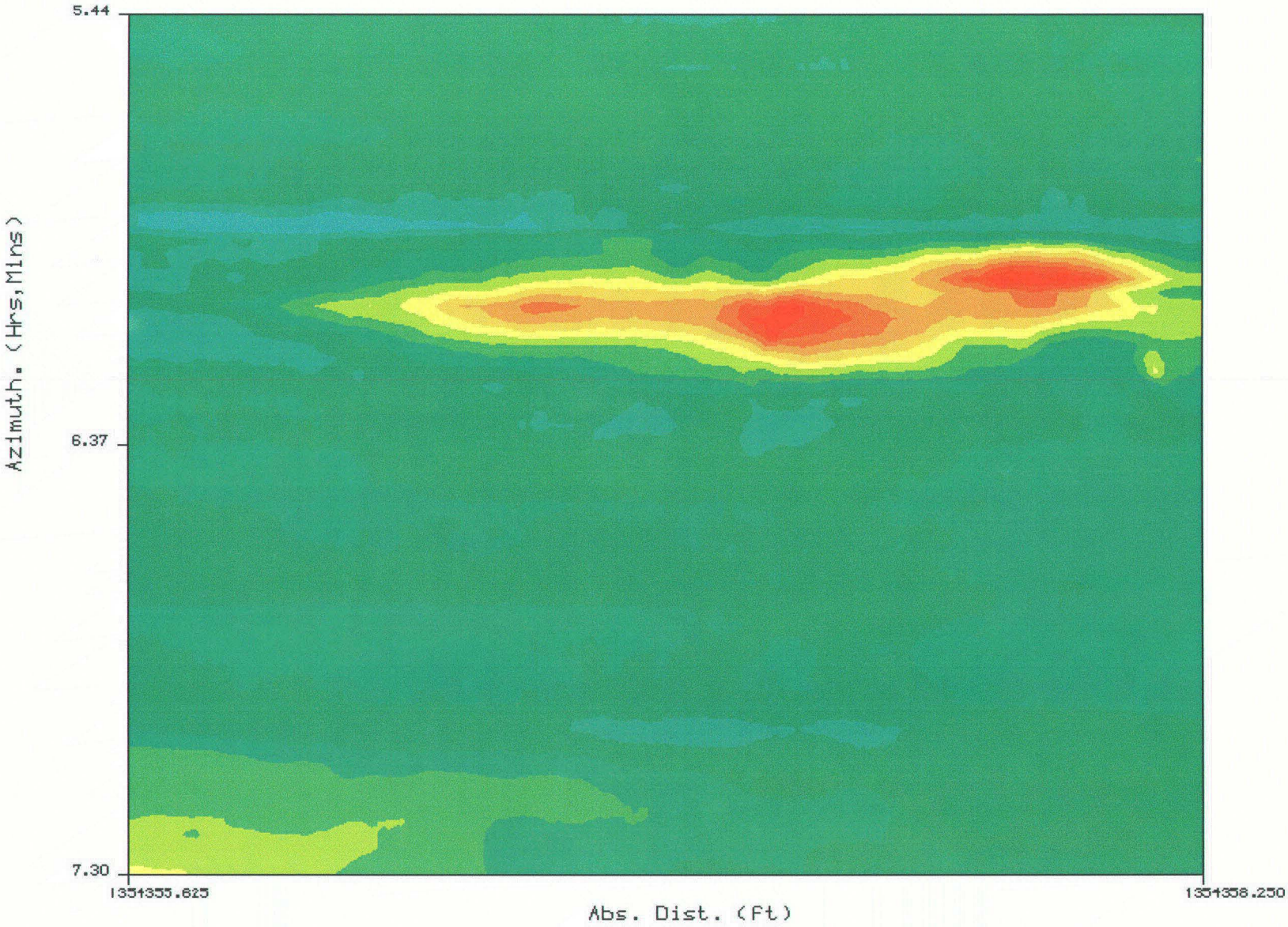
The feature is located 13.2 feet downstream from the reference girth weld.

Schematic Location Summary:





Feature 12 Detail Contour Plot 110004_20A



Feature Description

Type:	External Metal Loss
Orientation:	04:15 (o'clock)
Axial length:	13.8 in
Circumferential width:	1.8 in
Depth - Peak:	22% WT
Pressure Ratio (ERF):	0.951
Feature Selection Rule:	10
Nominal Pipe wall thickness for spool:	0.312 in
Absolute Distance from Launch:	1376935.9 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 # G42 20474+23
   (Girth Weld 325860 + 2.3 ft)
2. AGM 20410+62
   (Girth Weld 327410 + 4.7 ft)

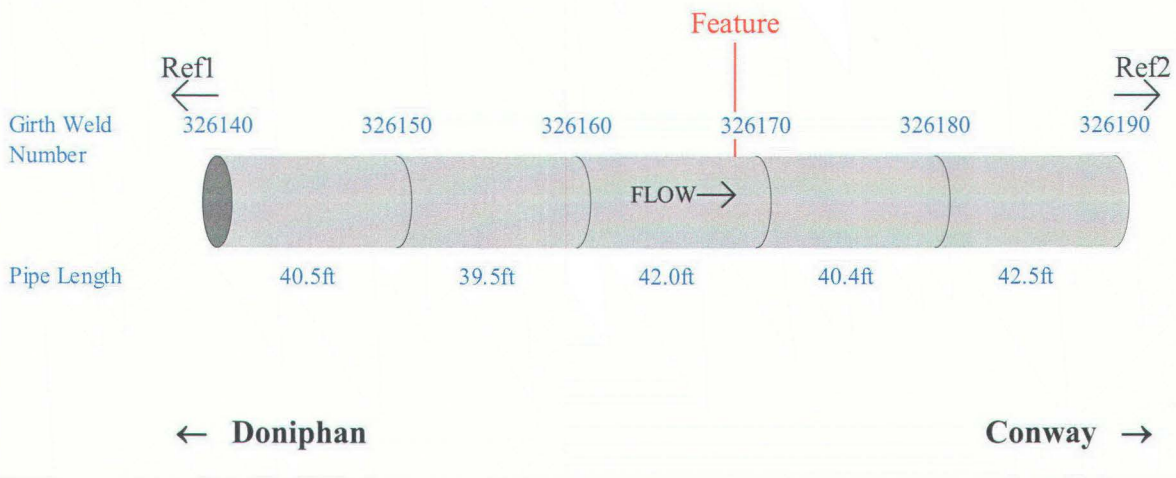
Reference Girth Weld:

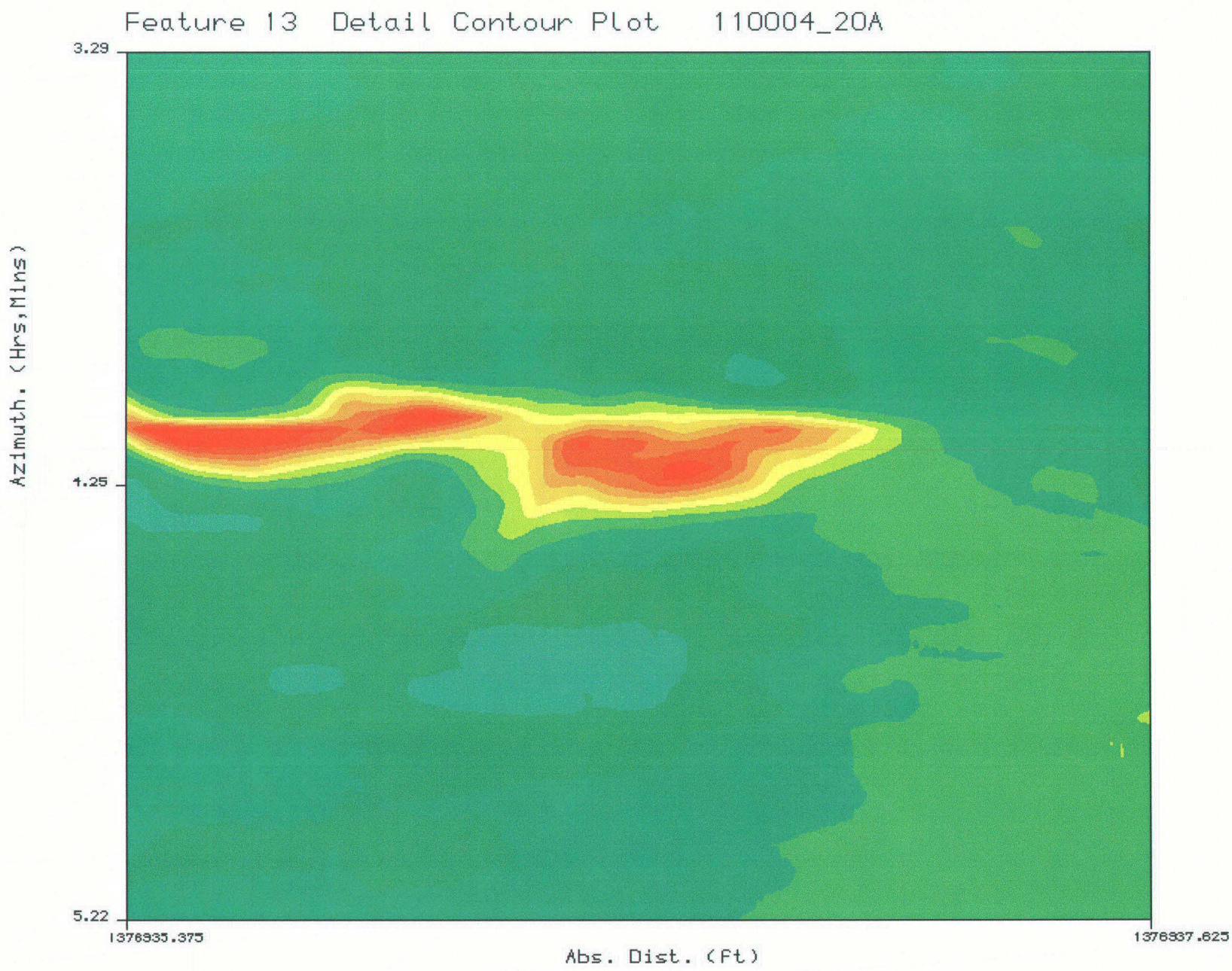
The reference girth weld at the Doniphan (upstream) end of the feature spool is number 326160.
The location of this weld is 1176.0 feet downstream from reference 1 and 5158.8 feet upstream from reference 2.

Feature:

The feature is located 37.1 feet downstream from the reference girth weld.

Schematic Location Summary:





Feature Description

Type:	External Metal Loss
Orientation:	07:30 (o'clock)
Axial length:	17.0 in
Circumferential width:	1.9 in
Depth - Peak:	24% WT
Pressure Ratio (ERF):	0.970
Feature Selection Rule:	10
Nominal Pipe wall thickness for spool:	0.312 in
Absolute Distance from Launch:	1480156.4 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 # G40 19452+76
   (Girth Weld 352170 + 2.3 ft)
2. AGM 19402+60
   (Girth Weld 353500 + 10.8 ft)

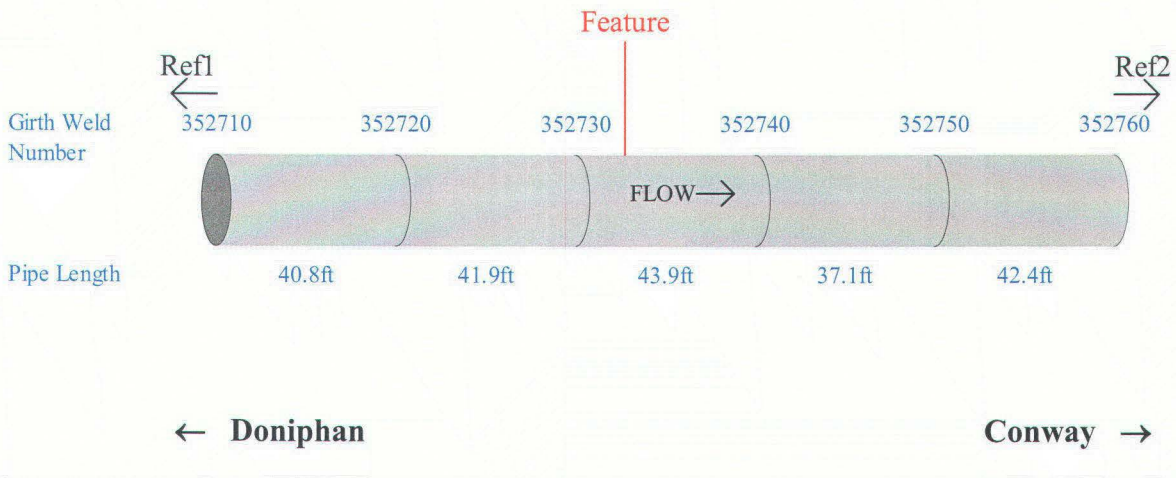
Reference Girth Weld:

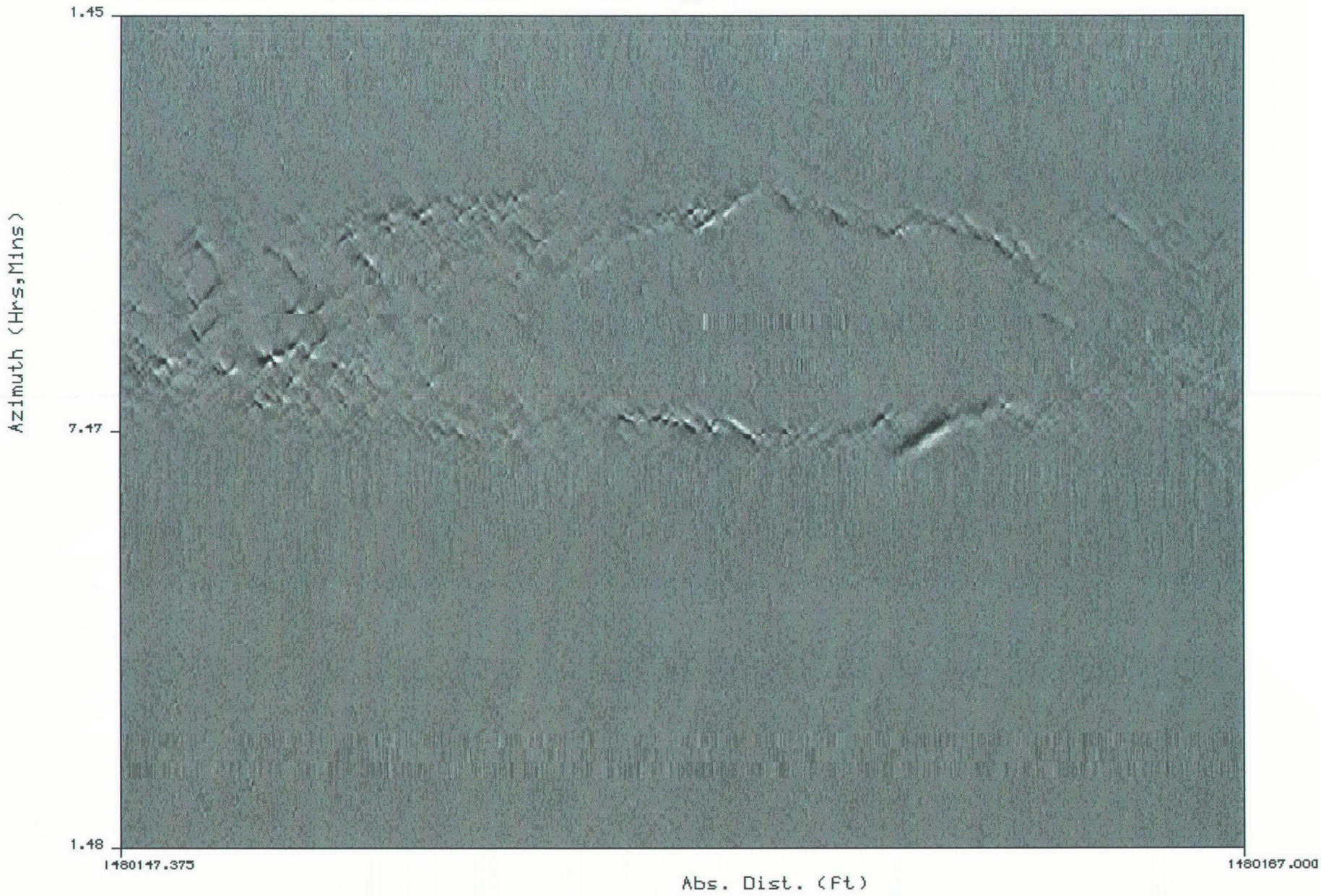
The reference girth weld at the Doniphan (upstream) end of the feature spool is number 352730.
The location of this weld is 2130.7 feet downstream from reference 1 and 2910.8 feet upstream from reference 2.

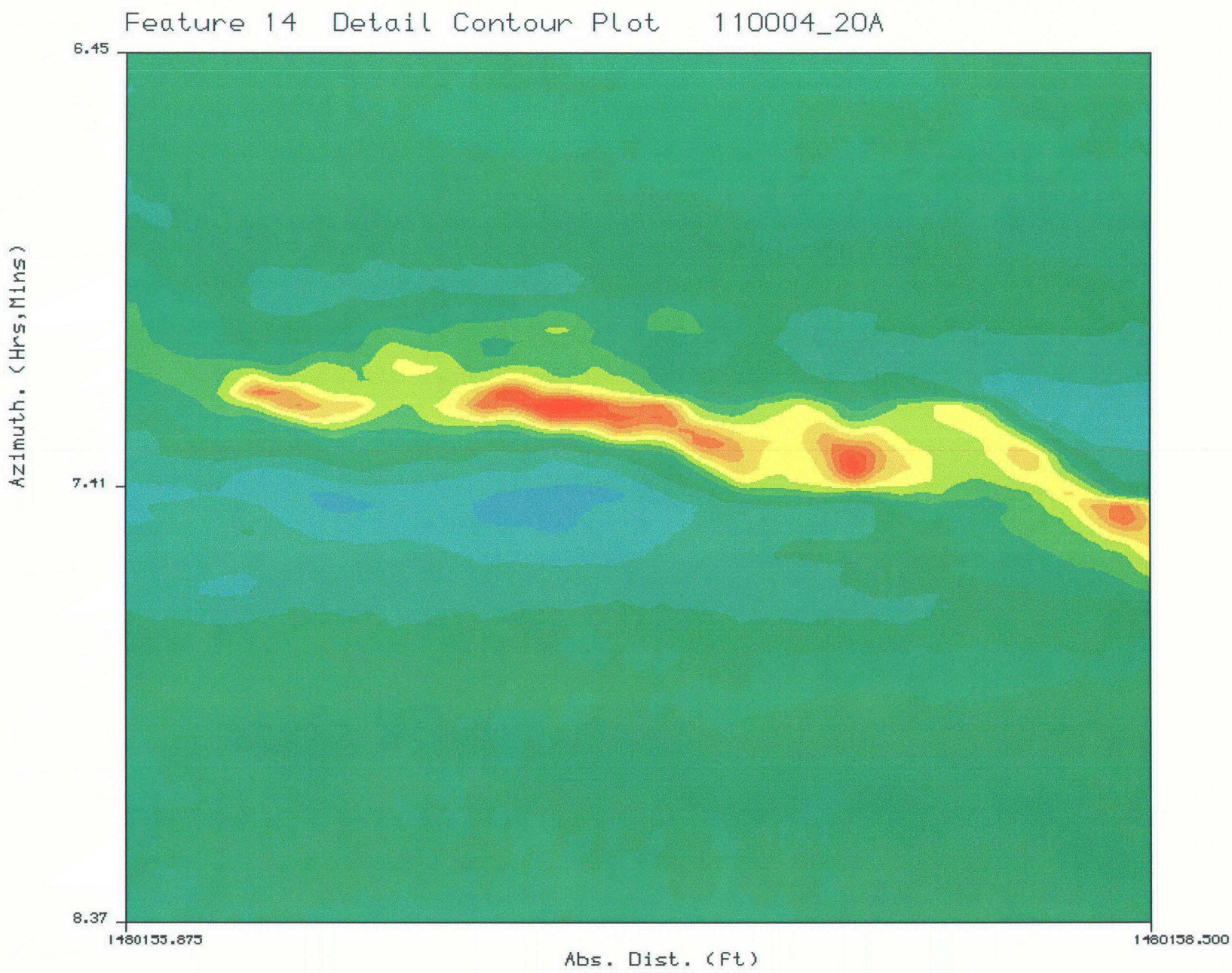
Feature:

The feature is located 11.9 feet downstream from the reference girth weld.

Schematic Location Summary:







Feature Description

Type:	External Metal Loss
Orientation:	04:30 (o'clock)
Axial length:	10.0 in
Circumferential width:	1.1 in
Depth - Peak:	31% WT
Pressure Ratio (ERF):	1.007
Feature Selection Rule:	1
Nominal Pipe wall thickness for spool:	0.312 in
Absolute Distance from Launch:	1523138.7 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. AGM 19015+89
   (Girth Weld 362930 + 26.5 ft)
2. AGM 18916+17
   (Girth Weld 365360 + 2.3 ft)

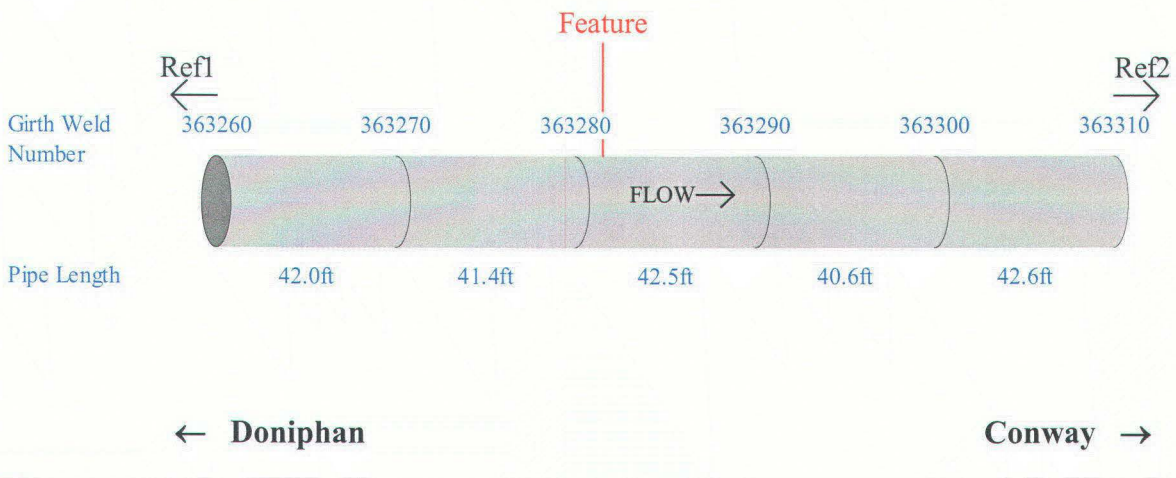
Reference Girth Weld:

The reference girth weld at the Doniphan (upstream) end of the feature spool is number 363280.
The location of this weld is 1376.4 feet downstream from reference 1 and 8617.2 feet upstream from reference 2.

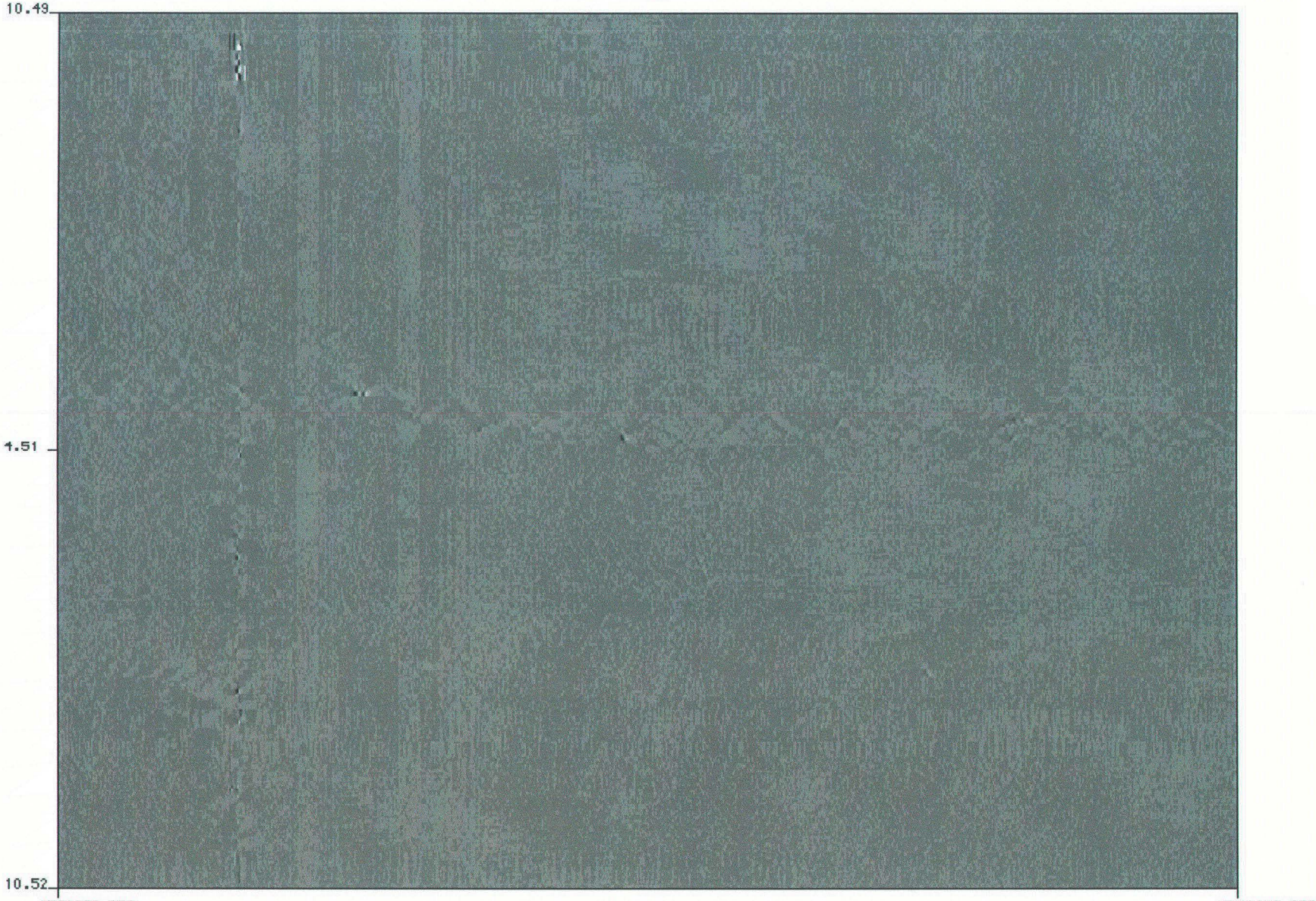
Feature:

The feature is located 6.4 feet downstream from the reference girth weld.

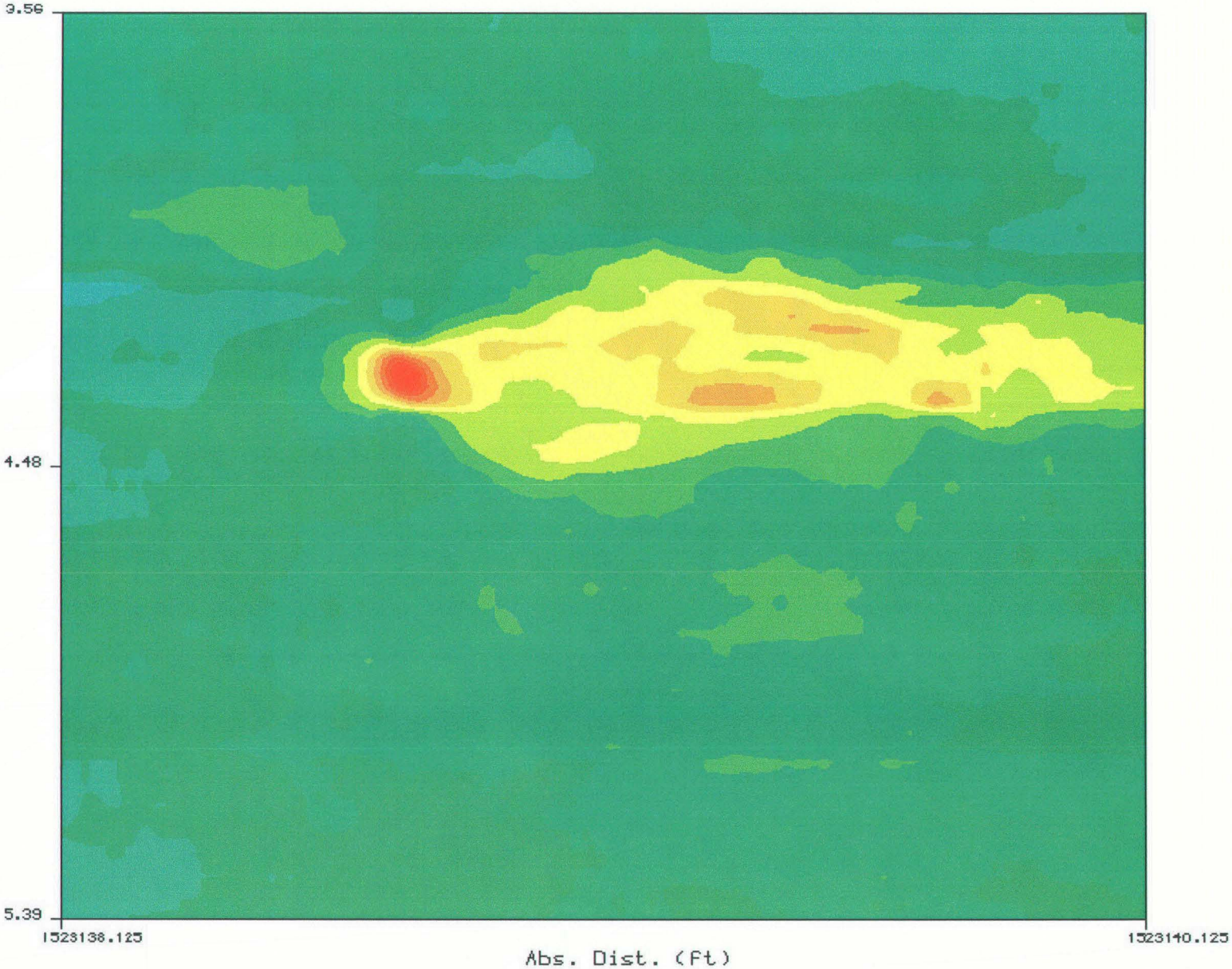
Schematic Location Summary:



Feature 15 Overview Plot 110004_20A



Feature 15 Detail Contour Plot 110004_20A



Overall Comments

Overall Comments

Seam weld defects detected on this survey have been classified in accordance with the Seam Weld Defect Discrimination table contained in the Inspection System Performance Specification (Appendix G). Metal loss defects have been classified in accordance with the Selection Rules contained in the Specification for the Pipeline Inspection Report (Appendix F). Subsequent selection of reportable defects has been determined in accordance with the Selection Rules contained in Appendix F.

Of the 5 seam weld defects, none exhibit all the characteristics associated with crack-like defects. 5 seam weld defects have been classified as SEAM WELD ANOMALIES.

None of the spools on this inspection survey have been classified as having GROSS SEAM WELD ANOMALIES.

In addition to seam weld defects PII were requested to report

1. Any cluster containing axial orientated seam weld metal loss, independent of overall cluster dimensions.

2. Any cluster, both manufacturing and metal loss, with axial length greater than 5 times the circumferential width, with the circumferential width being less than 2", dimensions being after the 1"x 6t interaction rules have been applied. Any cluster in this category which touched or crossed the seam weld was identified with a separate classification.

A total of 5510 metal loss defects meeting the above criteria have been detected on the inspection survey.

Of the 5510 metal loss defects, 7 were classified as axial orientated seam weld metal loss and were classified as metal loss touching or crossing the seam weld. The remaining 5503 are manufacturing and metal loss features in the main body of the pipe, with axial length greater than 5 times the circumferential width and the circumferential width being less than 2", dimensions being after the 1"x 6t interaction rules have been applied.

The table below summarises the defects detected in the inspection survey:

SEAM WELD DEFECTS:	SEAM WELD FEATURE A:	0
	SEAM WELD FEATURE B:	0
	SEAM WELD ANOMALY:	5
METAL LOSS DEFECTS:	AXIAL ORIENTATED SW ML:	7
	ML TOUCHING OR CROSSING THE SW:	7
	ML AWAY FROM SW:	5503

Please note that no other pipeline anomalies or fittings (with the exception of Valves and Above Ground Markers which are referenced as in the NDT pipeline listing) have been included in this report.

Please note that the metal loss classification terminology in the pipeimage data may differ from that incorporated into the NDT pipeline listing. For clarification the table below shows terminology used in the listing and the equivalent features as they appear in pipeimage.

NDT Pipeline Listing	Pipeimage data
Crack (SWF A), Long Seam Related	Seam Weld Feature (A)
Crack (SWF B), Long Seam Related	Seam Weld Feature (B)
Crack (SWF B), Below Spec, Long Seam Related	Seam Weld Feature (B)
Anomaly, Long Seam Related	Seam Weld Anomaly
ML, Axial Seam Weld, Ext	Long Axial Metal Loss External
ML EXT	Metal Loss External
ML INT	Metal Loss Internal
MFG EXT	Mill Feature External
MFG INT	Mill Feature Internal
ML, Across Seam Weld, Ext	Seam Weld Metal Loss External

Pipeline Summary Report

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

4.1. Defect Information

This section provides summaries of all the defects detected along the pipeline, in the following formats:

- Seam Weld Defect Scatter Plot
- Seam Weld Defect Distribution Histogram
- Seam Weld Defect Severity Table
- Metal Loss Defect Scatter Plot (Pressure Sentenced Plot)
- Metal Loss Defect Pressure Based Histograms
- Metal Loss Defect Depth Based Histograms
- Metal Loss Defect Severity Table
- Metal Loss Defect Orientation Plot

4.1.1. Seam Weld Defect Scatter Plot

The seam weld defect scatter plot is a graph of predicted length against predicted depth of all seam weld defects reported in a major pipeline segment.

The report contains one scatter plot for each major pipeline segment defined by the pipeline operator. Only those seam weld defects within the major segment, and any minor segments within the major segment, are shown on the respective Scatter Plot.

A list of the major segments and the value of the nominal wall thickness within each segment are provided in the nominal wall thickness listing presented in Section 4.2.6.

A seam weld defect scatter plot will not be provided if the major segment does not contain any seam weld defects.

Each seam weld defect scatter plot is presented overleaf.

SEAM WELD DEFECT SCATTER PLOT

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Major Segment 1

External Diameter 20 in
Wall Thickness 0.312 in

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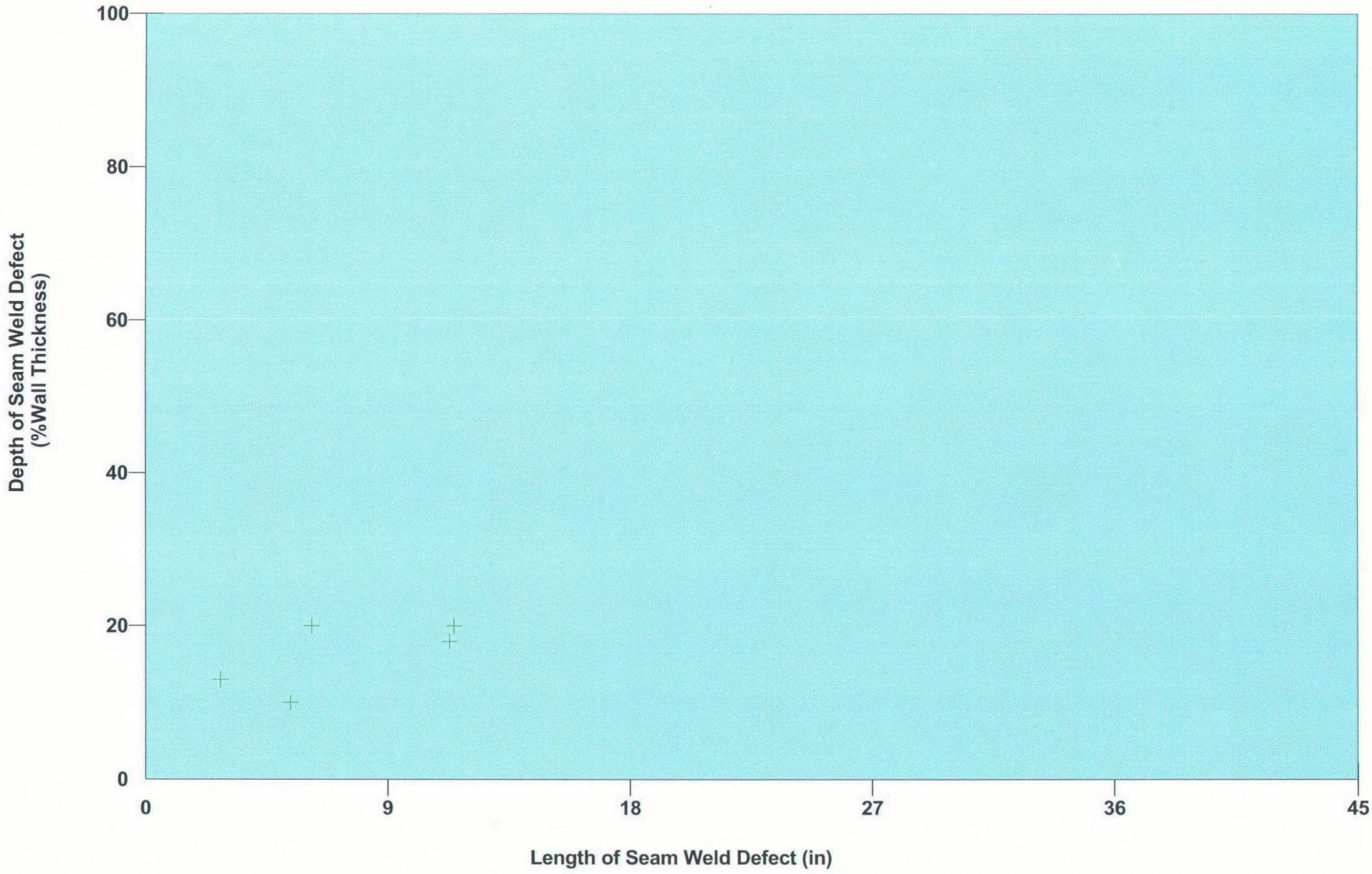

4.1.2. Seam Weld Defect Distribution Histogram

The seam weld defect distribution histogram shows the distribution of all seam weld defects, classified as SEAM WELD FEATURE A or B, detected in the pipeline. Each bar on the histogram represents the number of occurrences within a 1000 ft section of the pipeline.

A total of 5 seam weld defects have been detected on the Inspection survey. A breakdown of these seam weld defects is as follows:

SEAM WELD FEATURE A:	0
SEAM WELD FEATURE B:	0
SEAM WELD ANOMALY:	5

The seam weld defect distribution histogram is presented overleaf.

DISTRIBUTION HISTOGRAM
Seam Weld Features & Anomalies

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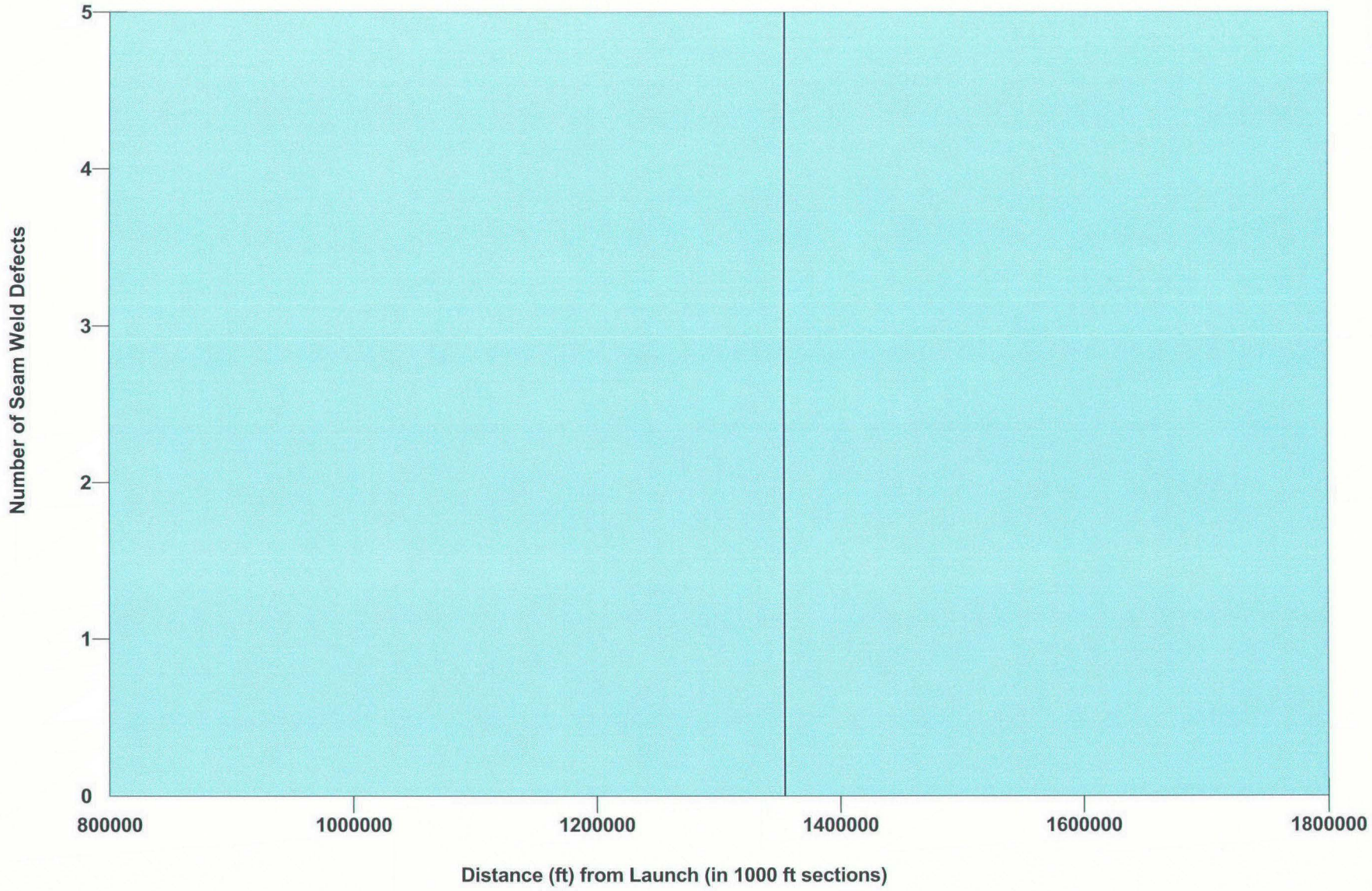

4.1.3. Seam Weld Defect Severity Table

No seam weld defects were found in this report.

4.1.4. Metal Loss Defect Scatter Plot (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 based on Modified ASME B31.G 0.85dL and defined in the Appendix to the Specification for the Pipeline Inspection Report (Appendix F).

These formulae depend on the following six variables;

two measured by the PII Pipeline Solutions inspection system:

- the predicted peak depth of the metal loss feature, or metal loss cluster;
- 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 four specified by the pipeline operator:

- the external pipe diameter (D);
- the nominal pipe wall thickness (nwt);
- the maximum allowable operating pressure (MAOP) and,
- the flow stress related to the steel grade of the pipe (S).

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

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

It should be noted that the Modified ASME B31.G 0.85dL pressure sentencing formulae strictly applies to isolated areas of corrosion in the main body of line pipe operating at stress levels not exceeding 72% SMYS (Specified Minimum Yield Strength). The procedure given in Modified ASME B31.G 0.85dL should not be used to assess corroded girth welds, longitudinal welds or long, complex interacting corrosion.

Under these conditions, points on (and below) the ERF unity curve correspond to the dimensions of the metal loss features (of the shape assumed in Modified ASME B31.G 0.85dL) that would withstand a hydrostatic pressure test at 1.39 x MAOP; where the factor 1.39 is the safety factor. For pipelines designed to operate at stress levels below 72% SMYS

the safety factor is higher than 1.39; for pipelines designed to operate at stress levels exceeding 72% SMYS the safety factor is lower than 1.39.

The ERF unity curve corresponds to the dimensions of those metal loss features (of the shape assumed in Modified ASME B31.G 0.85dL) that would withstand a pressure equal to the MAOP x safety factor.

Where the safety factor (SF) is calculated as follows:

$$SF = \frac{2\,t\,SMYS}{Pi\,D}$$

and SMYS = Specified Minimum Yield Strength.

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 ERF unity curve is calculated using the values of D, nwt, MAOP and S 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.

A list of the major segments and the values of nwt, MAOP and S that apply within each segment are provided in the nominal wall thickness listing presented in Section 3.2.6. The value for D 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 ERF unity curve.
⊕	The metal loss feature is reported on an inspection sheet and is within the major segment.
△	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 ERF 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.

METAL LOSS DEFECT SENTENCED PLOT

Doniphan to Conway

Major Segment 1

External Diameter 20 in
Wall Thickness 0.312 in
Flow Stress 52000.0 PSI
Sentencing Pressure 943.5 PSI
Safety Factor 1.39

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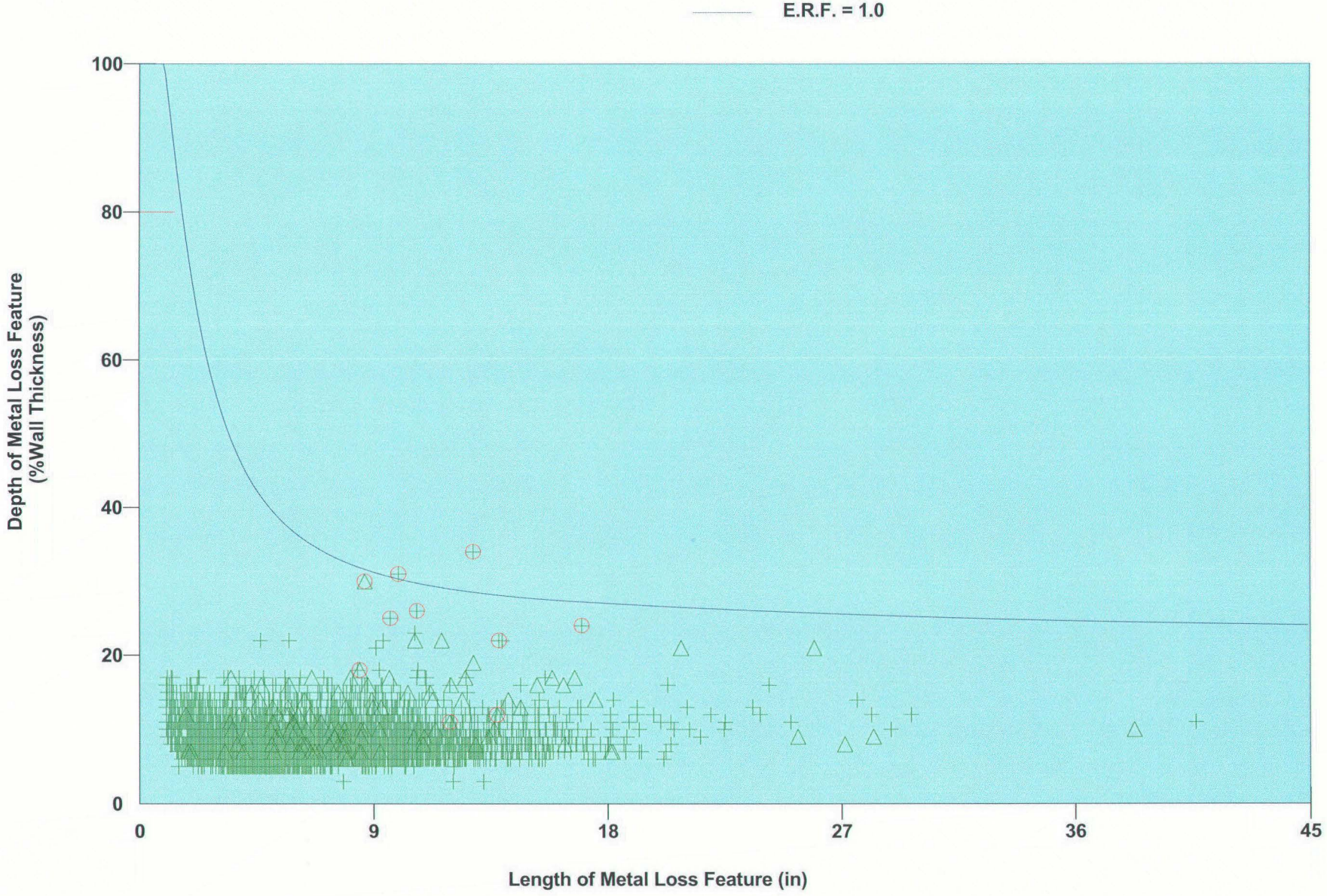

4.1.5. Metal Loss Defect Pressure Based Histograms

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 based on Modified ASME B31.G 0.85dL 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 ERF values above a chosen pressure sentenced threshold.

Each bar on the histogram represents the number of occurrences within a 5000 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 ERF values >0.800
- all metal loss features with ERF values >1.000
- all metal loss features with ERF values >1.300

Summarising from the histograms:

5510	metal loss features with ERF values >0.800
2	metal loss features with ERF values >1.000
0	metal loss features with ERF values >1.300

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

The pressure based histograms are presented overleaf.

Number of Metal Loss Features

METAL LOSS DEFECT PRESSURE BASED HISTOGRAM

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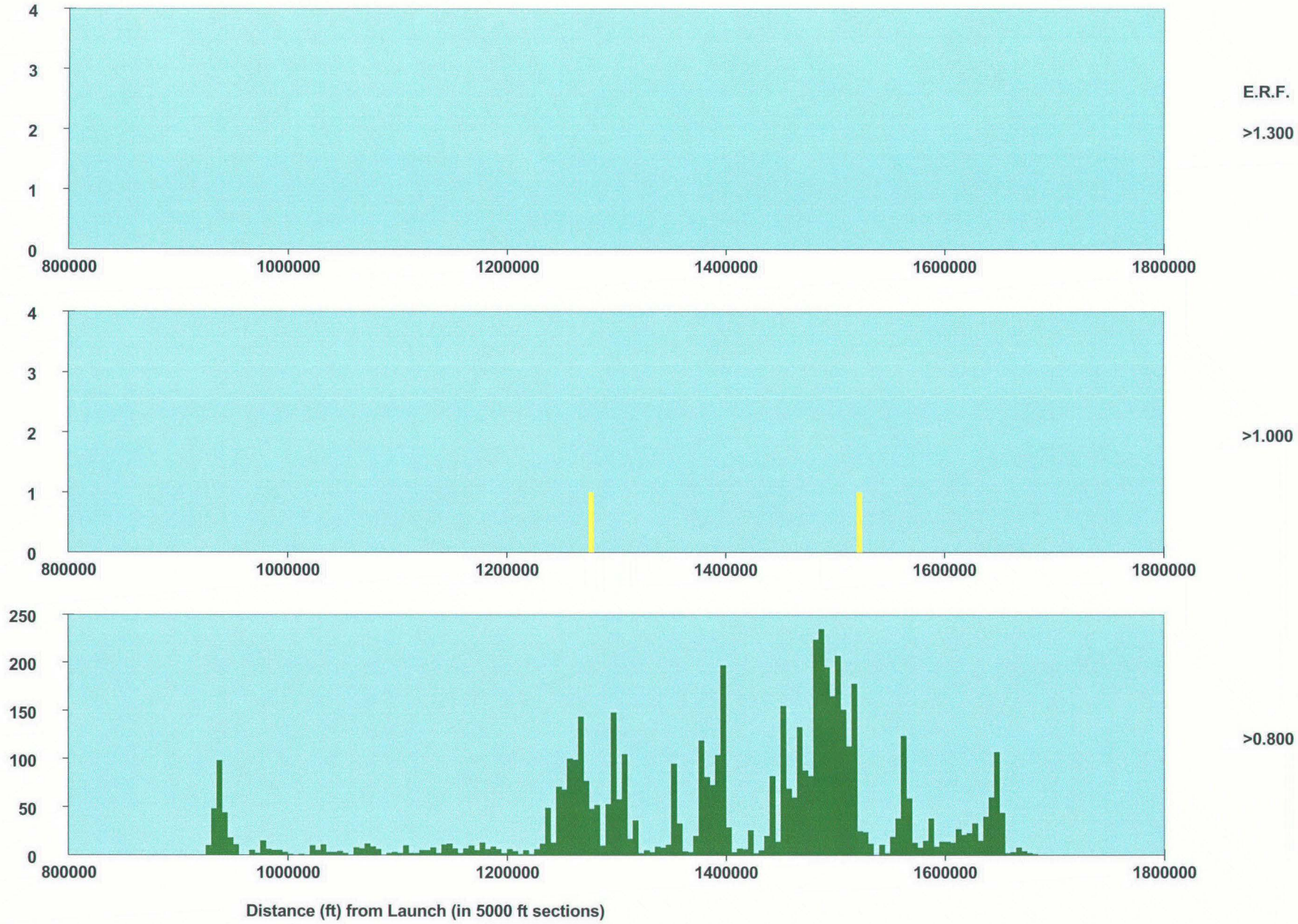

METAL LOSS DEFECT PRESSURE BASED HISTOGRAM

Doniphan to Conway

E.R.F. > 0.800
E.R.F. > 1.000
E.R.F. > 1.300

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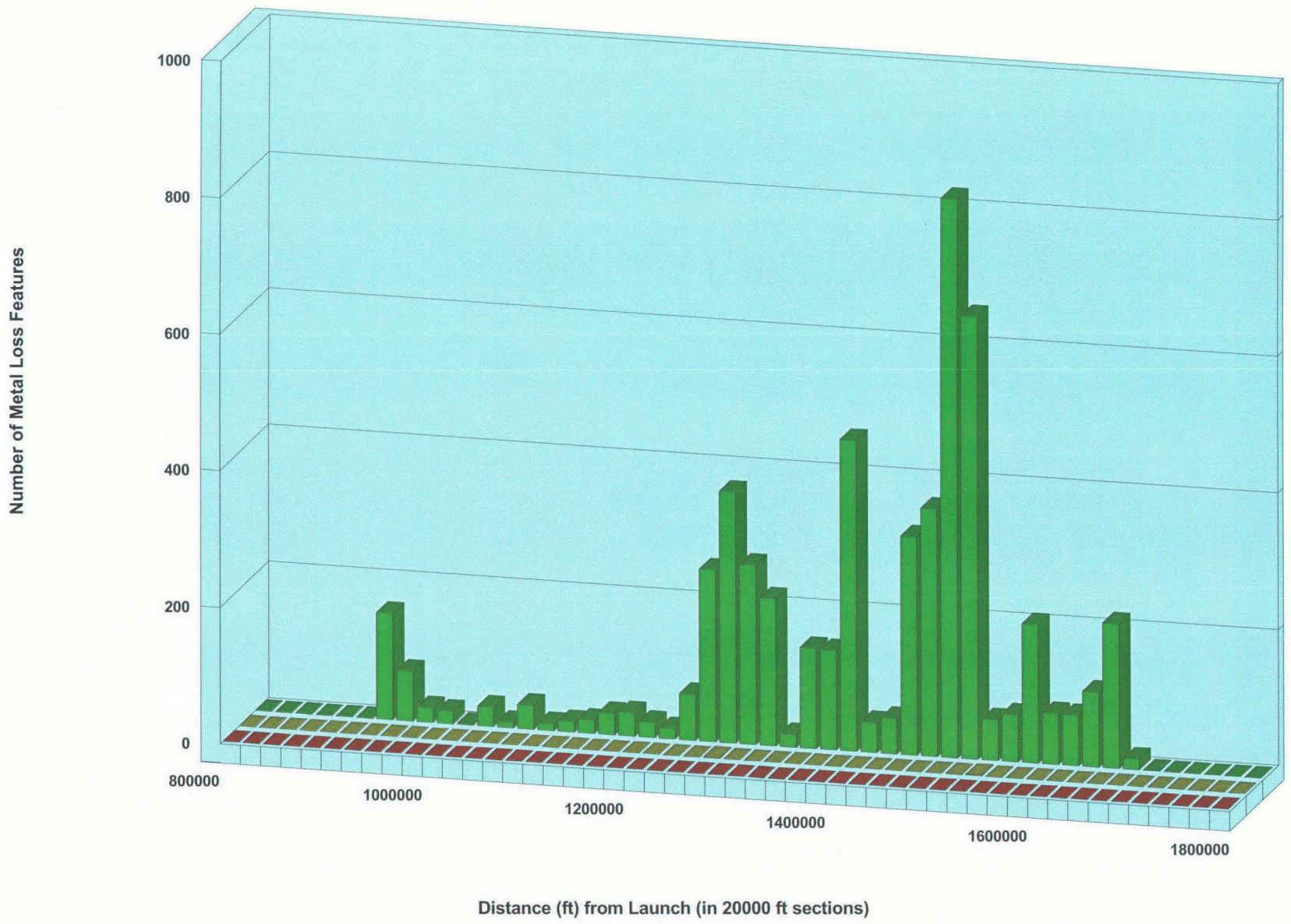

4.1.6. Metal Loss Defect Depth Based Histograms

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 5000 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 5000 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 5000 ft section of the pipeline. This is expressed as a percentage of the volume of metal in an undamaged pipe section.

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 5000 ft section of the pipeline.

Summarising from the histograms, a total of **5510** metal loss features have been identified within the pipeline. These have been graded as follows:

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

0	have a predicted peak depth of ≤ 20%t.
0	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.

5510 metal loss features with a predicted length > 3t.
Of these:

5493	have a predicted peak depth of ≤ 20%t.
17	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

Doniphan to Conway

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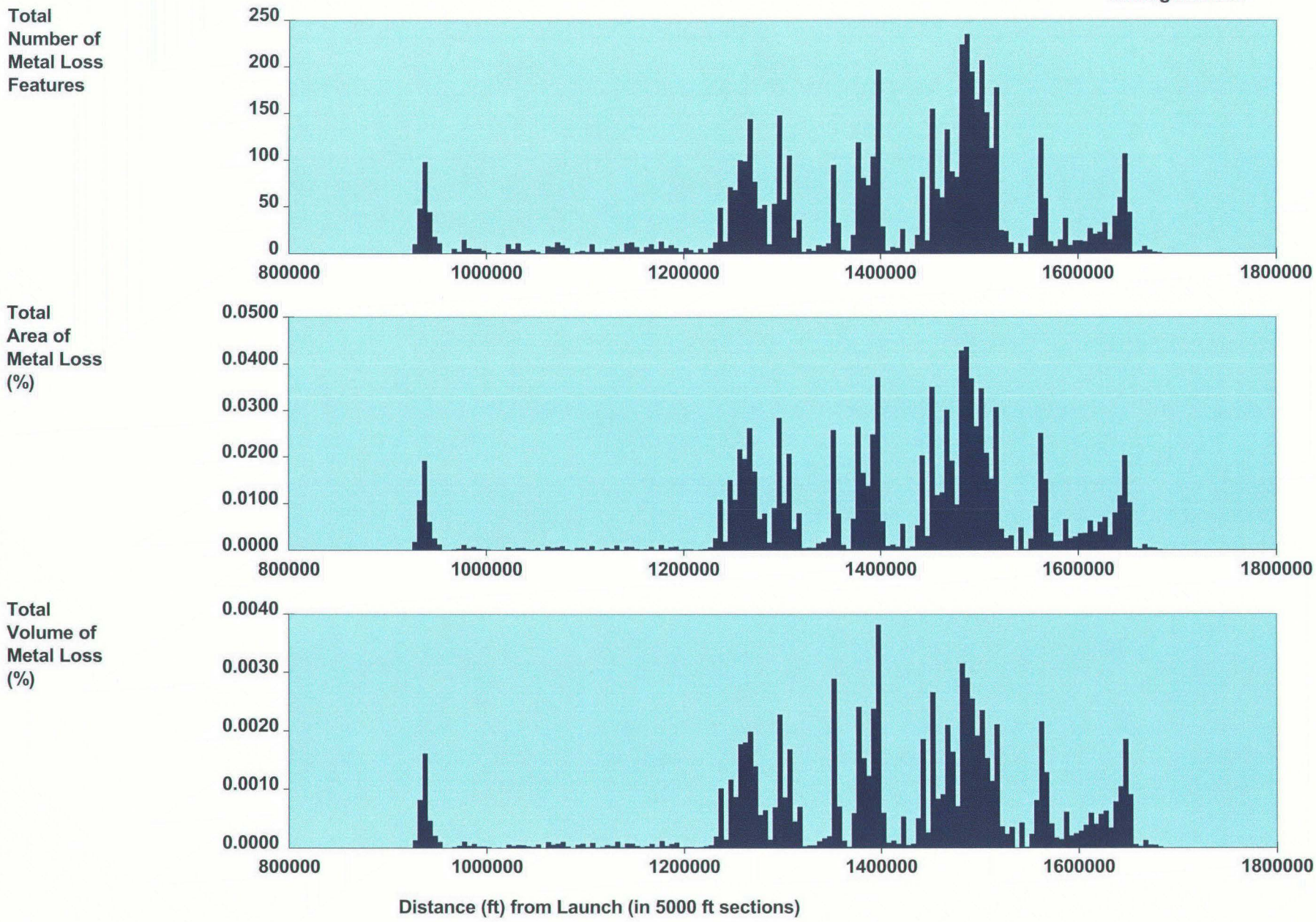

Number of
Metal Loss
Features

METAL LOSS DEFECT DEPTH BASED HISTOGRAM
Axial Length ≤ 3t
Doniphan to Conway

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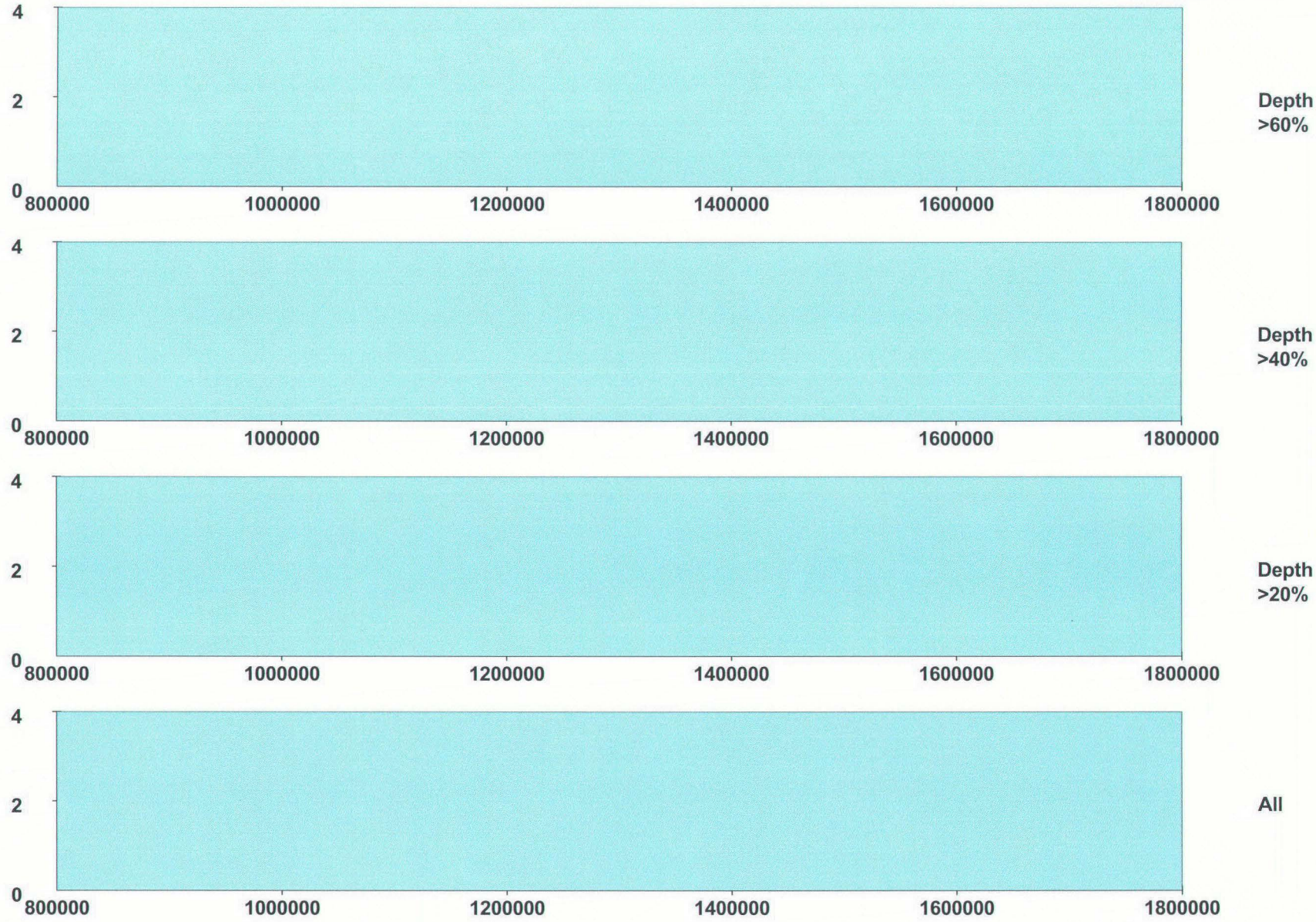

Number of
Metal Loss
Features

METAL LOSS DEFECT DEPTH BASED HISTOGRAM
Axial Length > 3t
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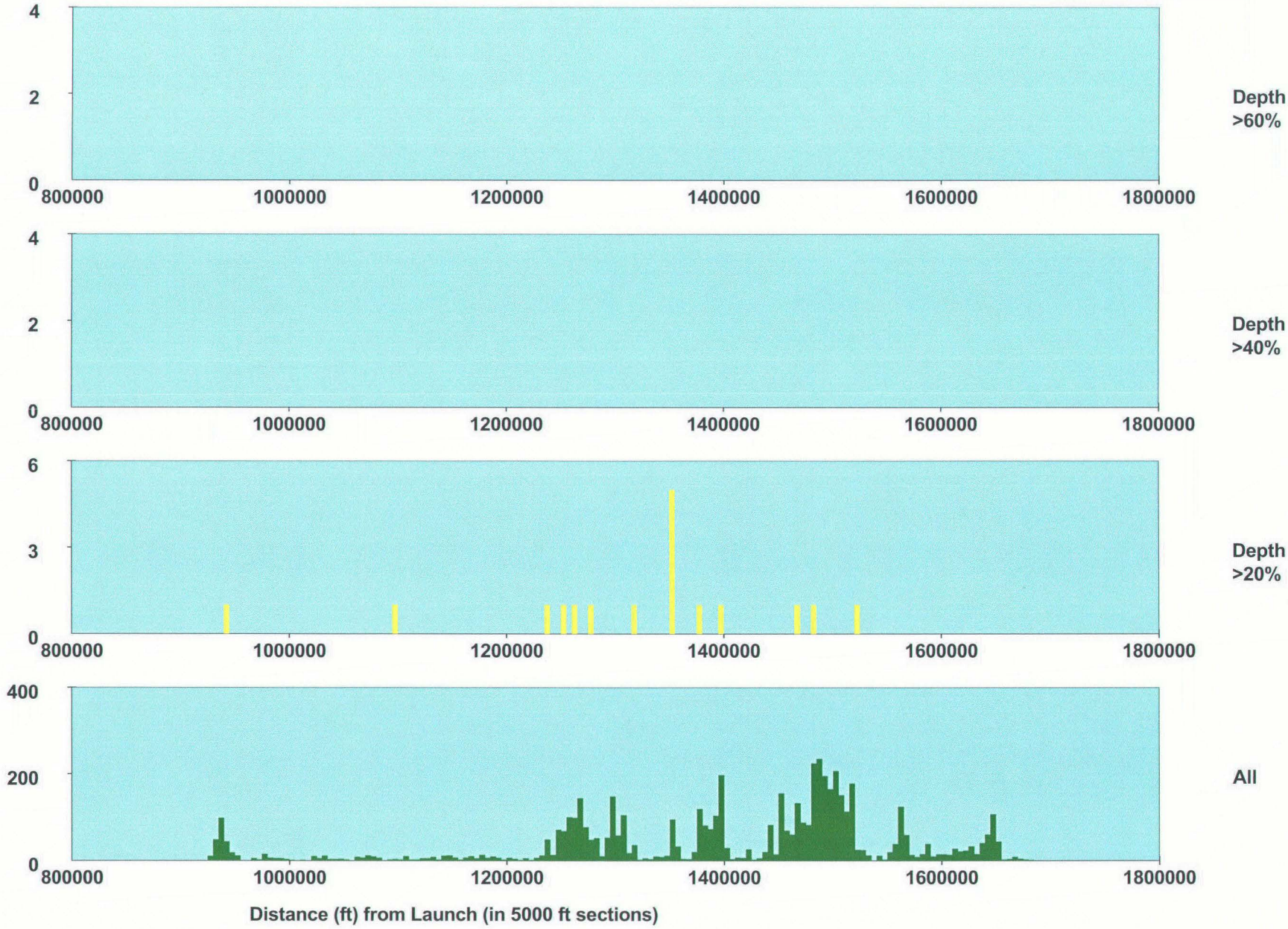
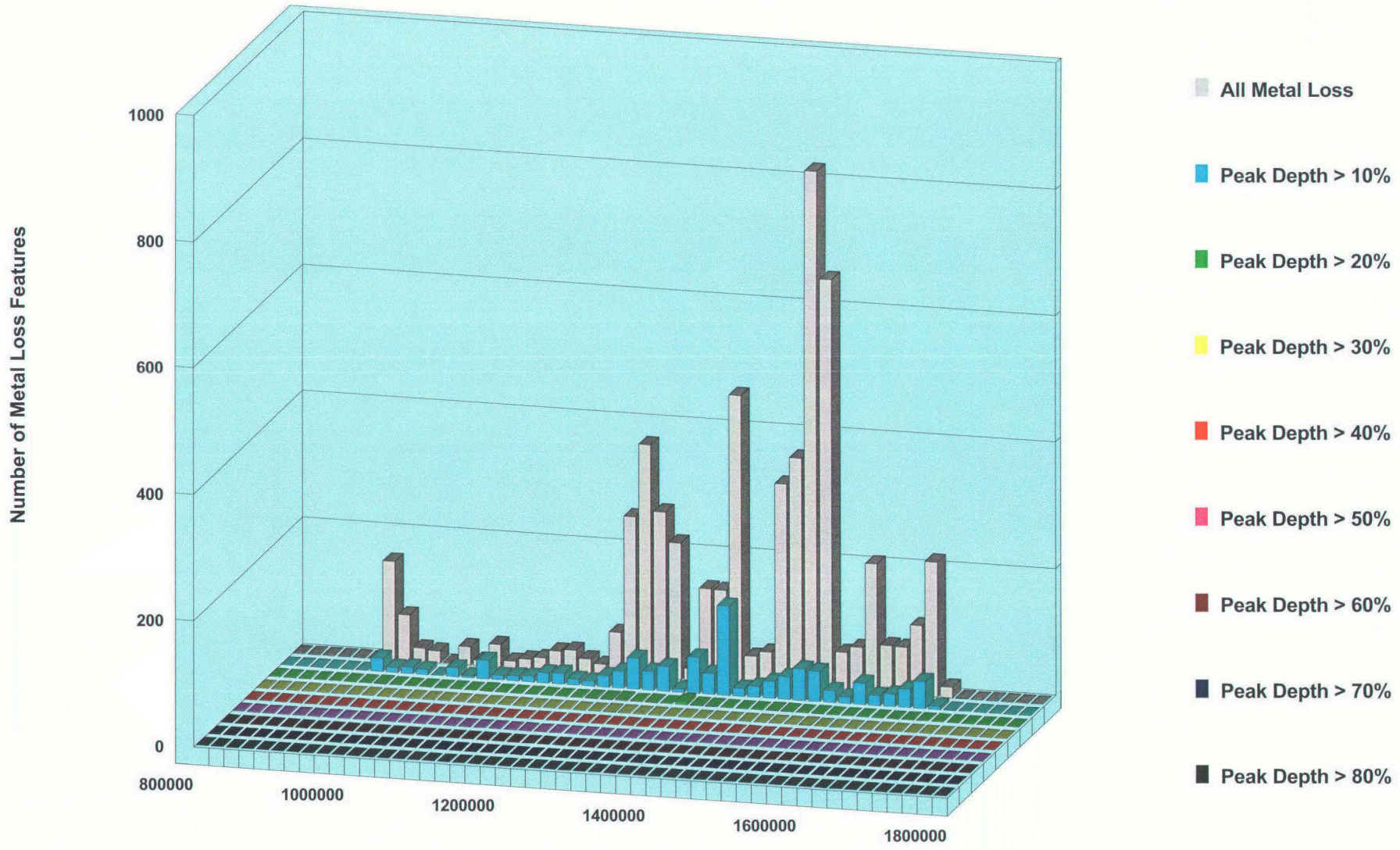


METAL LOSS DEFECT DEPTH BASED HISTOGRAM

Doniphan to Conway



4.1.7. Metal Loss Defect Severity Table

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

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

Only the worst metal loss defect 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 metal loss defect severity table lists the twenty-five pipe spools which contain the most severe metal loss defects.

The ERF value for undamaged pipe varies between 0.821 and 0.822.

The metal loss defect severity table is presented overleaf.

4.1.8. Metal Loss Defect 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.

METAL LOSS DEFECT ORIENTATION PLOT

Doniphan to Conway

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

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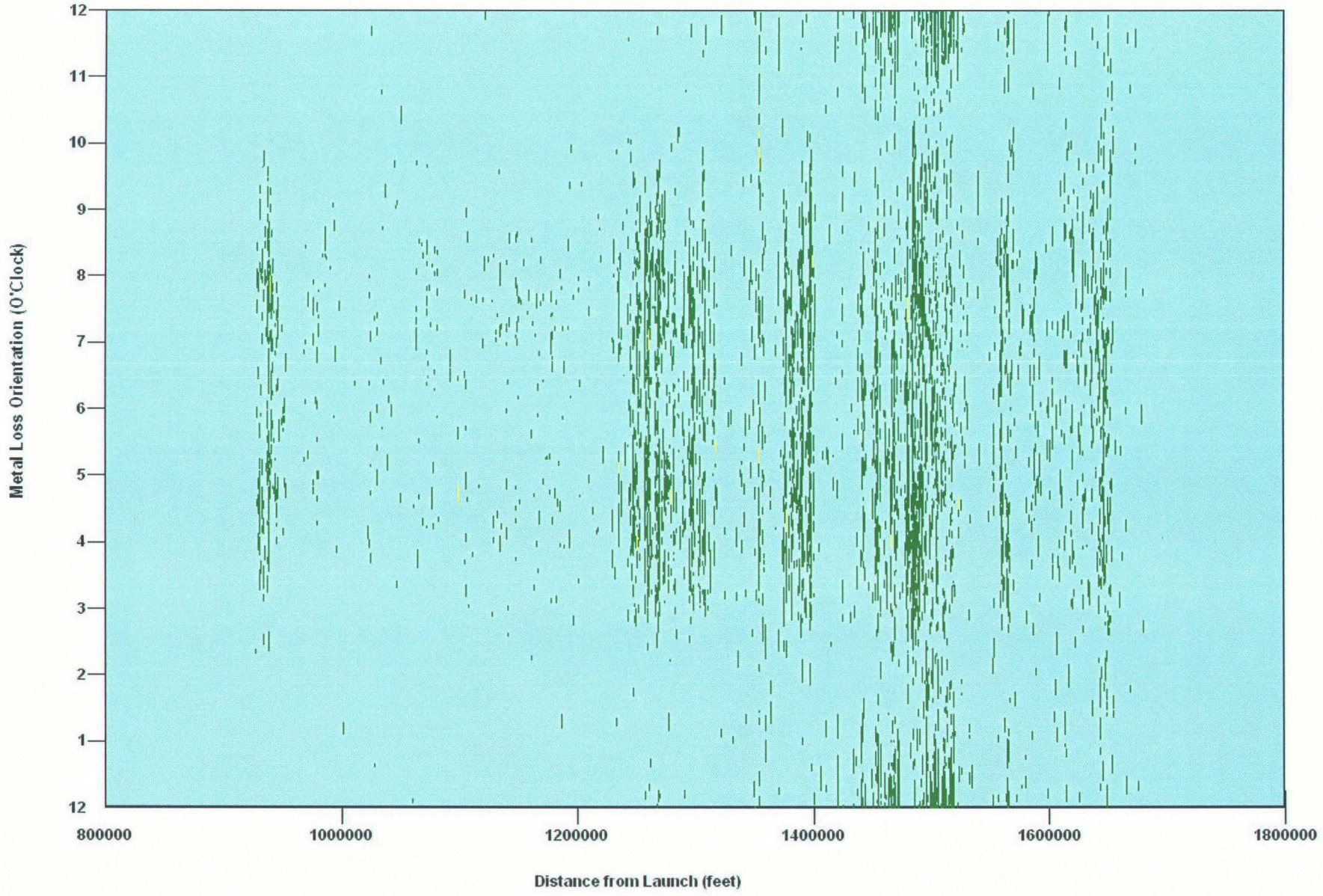

4.2. Pipeline Information

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

- Velocity Plot
- Location Reference Point Listing
- Nominal Wall Thickness Listing

4.2.1. 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 velocity of the inspection vehicle fell below the specified minimum velocity in 2 sections of the pipeline. These speed excursions covered a total distance of 121.72 ft. Within the underspeed affected areas our ability to detect and predict the dimensions of metal loss features is degraded.

In addition, a total of 239.72ft of data loss was identified in the first underspeed excursion area, located at 1117336.9 ft (comparing the recorded TranScan data against the other vendor data provided by ExxonMobil Pipeline Company). Within this section, the detection of anomalies is not possible.

The location and extent of these excursion areas is given in the table below:

ABS. DISTANCE (Ft)		GIRTH WELD		DISTANCE OF SPEED EXCURSION (ft)
FROM	TO	FROM	TO	
1117278	1117395	26420	260450	117.13
1255303	1255307	295740	295750	4.59
			Total	121.72

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 2.8 ft/s.

The velocity profile plot is presented overleaf.

VELOCITY PLOT

Doniphan to Conway

Contractual Maximum Velocity

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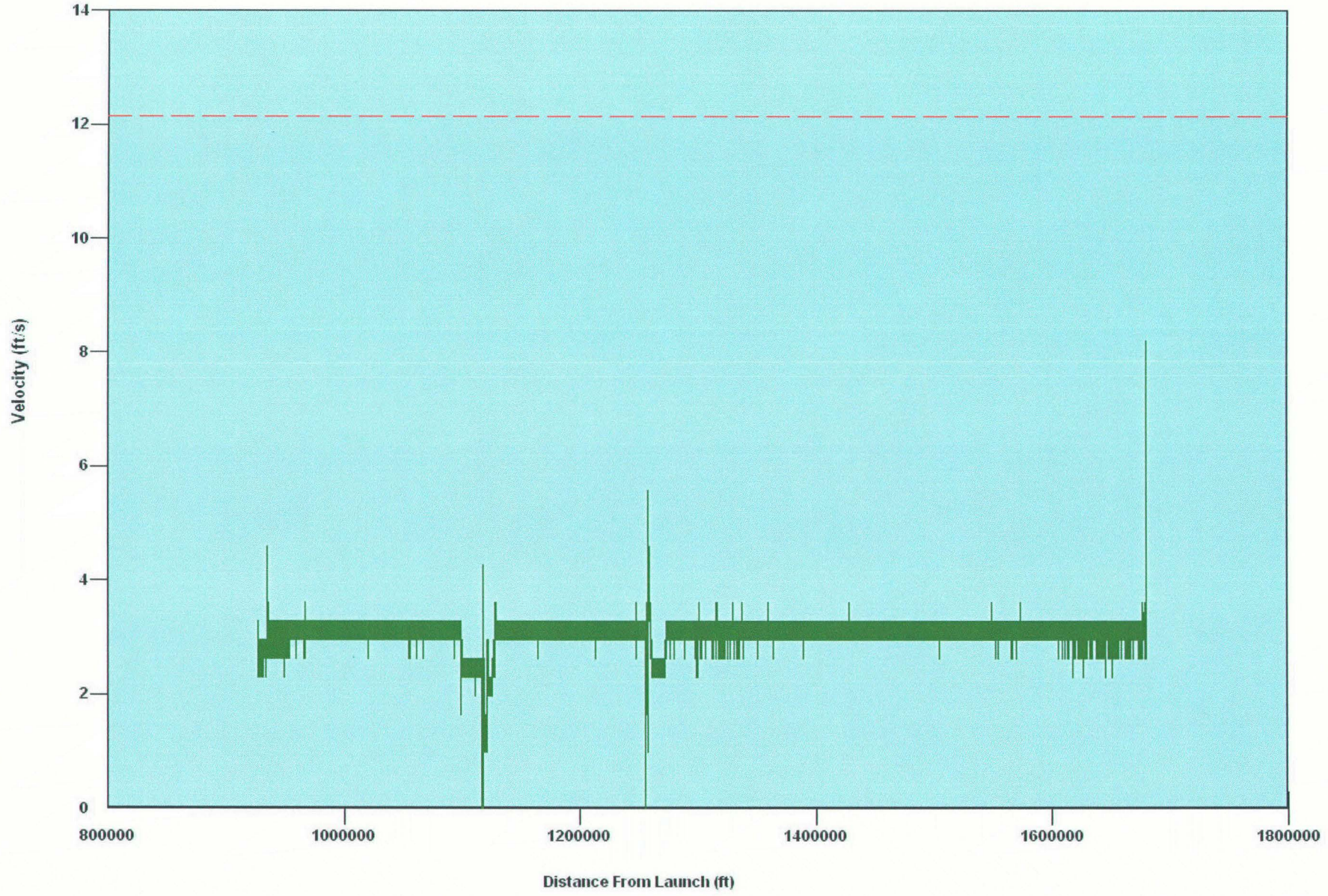


4.2.2. Location Reference Point Listing

This is a list of the line markers (timer boxes) and mainline valves that have been used to locate features along the pipeline.

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

4.2.3. 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), the maximum allowable operating pressure (MAOP) and the flow stress related to the steel grade of the pipe (S) 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, MAOP and S 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 MAOP and S values for the minor segment will be assumed to be the same as those 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, MAOP and S specified for each segment are used to calculate the ERF value of each metal loss feature detected within the segment.

The values of nwt, Pi and the Specified Minimum Yield Strength (SMYS) specified for each segment are also used to calculate the Safety Factor, where the Safety Factor (SF) is calculated as follows:

$$SF = \frac{2\ nwt\ SMYS}{Pi\ D}$$

and D is the external pipe diameter.

A table listing the pipeline segments is presented overleaf.

Glossary of Terms

Absolute Distance	The distance from the start of the pipeline to the upstream edge of the defect.
Axial Length	The predicted axial length of the defect.
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 defect is on the external or internal surface of the pipe.
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, MAOP and S that apply within it.
MAOP	The maximum allowable operating pressure for the pipeline segment, as specified by the pipeline operator.
Metal Loss Defect	An indication detected by the inspection system which has been classified as characteristic of a volumetric loss of metal from either the internal or external surface of the pipeline.
Minor Segment	A pipeline segment identified by the inspection system or pipeline operator. 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 defect.

Orientation	The location of the defect around the circumference of the pipe, as viewed in the direction of flow.
Peak Depth	The predicted peak depth of the defect, 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 defect 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 defect 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 defect 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 defect.
RPR	The calculated Rupture Pressure Ratio value of the metal loss feature.
Seam Weld Defect	Any indication detected by the TranScan TFI system on the longitudinal seam weld of the pipe spool. Seam weld defects are classified in accordance with the discrimination table in the Inspection System Performance Specification (Appendix G).
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 or seam weld defect within the pipe spool is rated.

Stress Intensity Factor	A fracture mechanics term that is used to calculate a severity ranking for crack-like seam weld defects, relative to one another **and not the pipeline operating conditions**.
Strip Map Number	The drawing number, where available, of the pipeline strip map on which the defect is located.
Type	Denotes whether the defect is on the internal or external surface of the pipe.
Upstream Girth Weld Number	The girth weld number of the girth weld located at the upstream end of the pipe spool.

Appendix A. Locating Defects And Pipeline Anomalies

Locating defects 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 defects 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 defect that is reported on the inspection sheets. If the reference point is more than 1600 feet from the defect 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 feature; 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.

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.

A3. Identification of Features

Metal objects should be easily identified. Seam weld defects, metal loss defects, and dents 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, dents or the seam weld that contains an anomaly should be easily identified.

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

A4. Contacting PII Pipeline Solutions

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

PII Pipeline Solutions Telephone Numbers:

Telephone:	+1-713-849-6300
Facsimile:	+1-713-937-0740
Address:	PII North America Inc. 7105 Business Park Drive Houston TX 77041-4040 USA

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

Contents

Illustrations

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.

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.

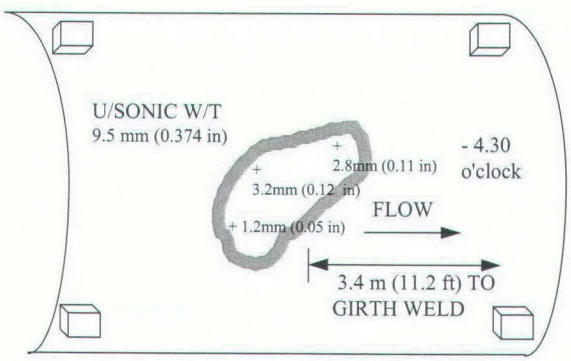


Figure 1: Example of Rubbing

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.

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.

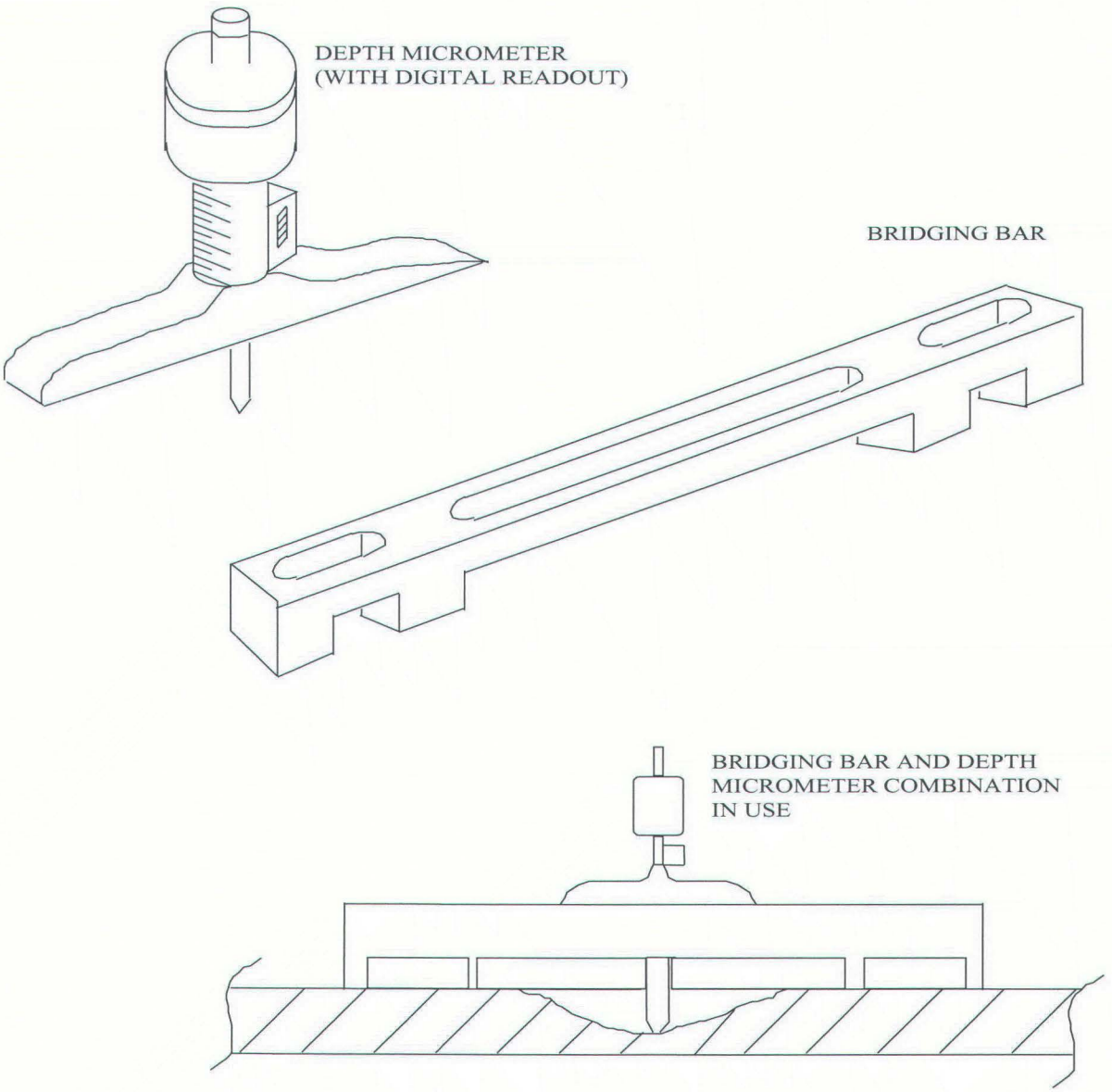


Figure 2: Typical Micrometer and Bridging Bar Arrangement

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 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.

(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.

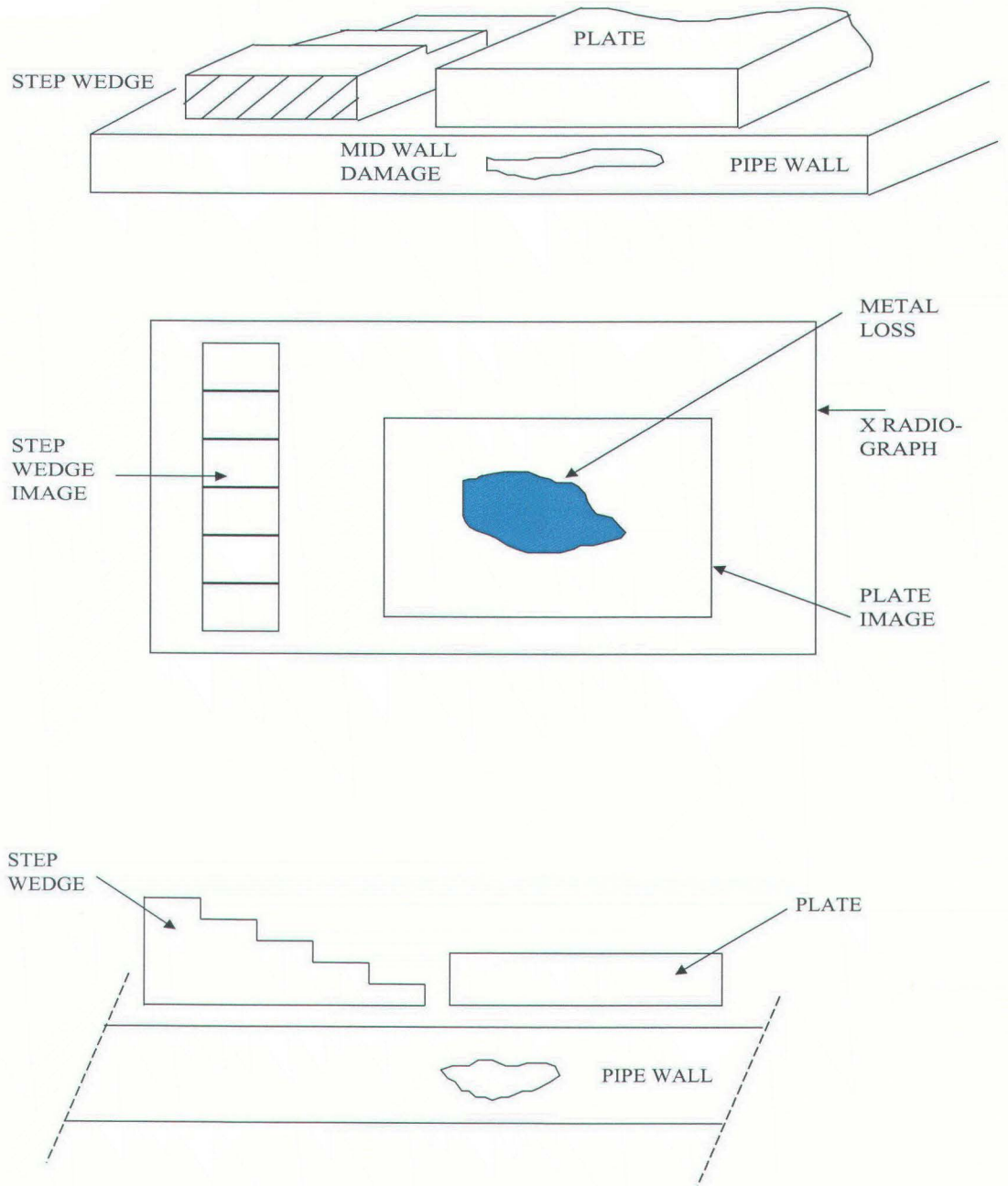


Figure 3: Typical Arrangement for X-ray Technique

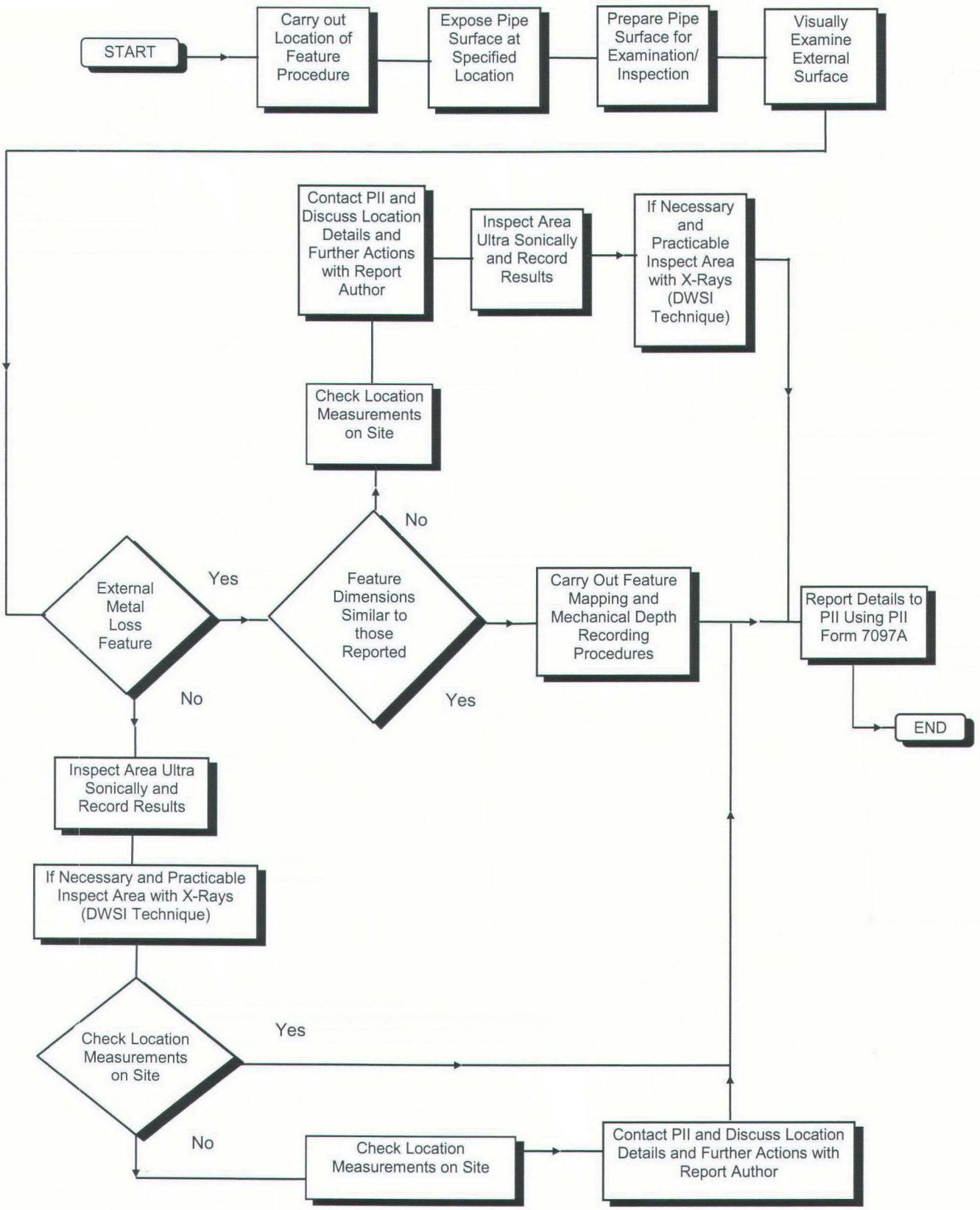


Figure 4: Procedure for Inspecting and Recording Reported Metal Loss Features - Simplified Flow Diagram

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: .....

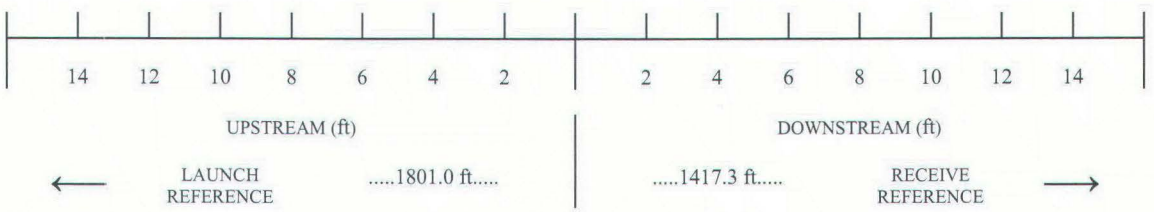
MEASURED WALL THICKNESS: .....0.361in.....

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)

Appendix C. Operational Details

Contract Number	110004_20B
Operator	ExxonMobil Pipeline Company
Launch Site	Doniphan
Receive Site	Conway
Inspection Run	
Date of Operation	09 - 15 August 2010
Data Recorded	0.0 miles to 142.68 miles
Inspection Modules	LV: 026 TV: 027 IV1: 635 BV1: 636 REC: 2/015
Processor Packs	058
Project Manager	Stephen David
Sales Manager	Jeffrey Johnson
Report Author	David Classen
Inspection Team Leader	Adolfo Manlangit

Appendix D. Pipeline Details

Contract Number	110004_20B
Date of Pipeline Commission	1948
Pipeline Outside Diameter	20 inches
Product	Crude Oil
Pipeline Length (Client Data)	142.5 miles
Pipeline Length (PII Data)	142.7 miles
API Grade	X42, X52
Predominant Pipe Type	Seamless
Previous PII Inspection	None

The nominal wall thickness listing, presented in Section 4.2.6, 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),the maximum allowable operating pressure (MAOP) and the the flow stress related to the steel grade of the pipe (S) that apply within it.

Appendix E. Additional Services

As a complement to the inspection service PII Pipeline Solutions can now 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 PII Pipeline Solutions we have access to 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.

Appendix F. Pipeline Inspection Report Specification

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

SCHEDULE 5

PIPELINE INSPECTION REPORT

TRANSCAN SEAM WELD & PIPE BODY REPORT

For the Pipeline the subject of this Contract the Pipeline Inspection Report ("**TranScan Seam Weld and Pipe Body Report**") shall comprise:

1. **Executive Summary**

2. **Seam Weld and Metal Loss Feature Report**

   2.1 Inspection Sheets

   2.2 Colour Plots of data

   For a number of the worst seam weld features and metal loss features; manually analysed and selected against pre-defined selection rules.

3. **Pipeline Summary Report**

   (a) Seam Weld and Metal Loss Information

   3.1 Scatter Plots

   3.2 Distribution Histograms

   3.3 Orientation Plot

   3.4 Severity Tables

   (b) Pipeline Information

   3.5 Velocity Plot

   3.6 Location Reference Points Listing

   3.7 Nominal Wall Thickness Listing

   (c) Summary

   Pipeline Listing

Reports shall be based on that inspection data collected from the whole surface area of each pipe joint.

Detailed definition of the contents of the report can be found on the following pages.

Appendix G. Inspection System Performance Specification

The pipeline inspection system employed by PII Pipeline Soultions 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: overleaf

SCHEDULE 3

INSPECTION PERFORMANCE SPECIFICATION TRANSCAN

1.1 DETECTION

In the seam weld

The Transcan Inspection Vehicle system will detect axial defects according to table 2 in the longitudinal seam weld and within a zone extending 50mm (2 inches) either side of the weld toe. Axial defects propagating from either internal or external surface will be detected, although the system will not discriminate between external and internal features. Axial defects aligned within 30 degrees of the pipe axis will be identified.

The system will detect, locate & size seam weld features in the pipeline according to the Table 1.

Additionally, all reasonable endeavours will be made to detect those axial defects that lie below these thresholds but above the 100% SMYS failure curve.

The probability of detection of such seam weld features is 90%. That figure will increase for deeper or longer cracks and reduce for shorter, less deep cracks.

In the pipe body

The following types of feature present in the pipeline will also 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* although the system will not discriminate between gouging and corrosion.

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 reduces as the depth and surface dimension of the feature reduces.

(b) Metal loss situated beneath repair clamps.
(c) Metal loss associated with manufacturing faults.
(d) Welds - girth, seam and spiral.
(e) Dents as small as 1%, dents with metal loss, dents with cracking
(f) Manufacturing/mill type defects.
(g) Construction damage.
(h) Changes in nominal pipe wall thickness.
(i) Pipeline fixtures and fittings including: