ENT000428
Submitted: March 30, 2012

6855 S. Havana Street
Suite 350
Centennial, CO 80112-3868
PHONE: 303-792-0077
FAX: 303-792-2158
www.structint.com

Structural Integrity Associates, Inc.

G-Scan Assessment of Various Buried Piping

Inspection Dates: September 22nd and 23rd 2009

Submitted to:
Entergy Nuclear
Indian Point Energy Center
November 2009

Report No. 0900235.401.R0

Revision: 0

Project No. 0900235.00

November 2009

G-Scan Assessment of Various Buried Piping

Inspection Date: September 22nd and 23rd 2009

Prepared for:

Entergy Nuclear

Indian Point Energy Center

Prepared by:

Structural Integrity Associates, Inc.

Centennial, Colorado

Prepared by:	 Craig Chaney	Date:	11/16/09
Reviewed by:	 Ken Rach	Date:	11/16/09
Reviewed by:	 Eric Kirkpatrick	Date:	11/16/09

REVISION CONTROL SHEET

Document Number: 0900235.401.R0

Title: G-Scan Assessment of Various Buried Piping

Client: Entergy Nuclear – Indian Point Energy Center

SI Project Number: 0900235.00

Section	Pages	Revision	Date	Comments
All	All	Draft	10/26/09	Initial Issue
All	All	Draft B	11/2/09	Responded to comments and corrections from plant staff
All	All	Final	11/16/09	

Table of Contents

List of Tables

Table Page

List of Figures

Figure Page

EXECUTIVE SUMMARY

Structural Integrity Associates, Inc. (SI) performed guided wave ultrasonic testing (G-Scan) at Entergy Nuclear Indian Point Energy Center (Indian Point) on September 22nd and 23rd 2009. Six locations on the service water and condensate piping were tested for wall loss as described in Table E1.

Table E1: Summary of Locations of Tests

General Info						Pipe Data		
Loc. #	Unit	Line Name	Line #	Location	G-Scan Test #	OD (inches)	External Coating	Internal Lining
1	2	Service Water Supply Header	408	Transformer Yard Area	2979 2982	24	Coal Tar Enamel w/saturated asbestos	Mortar Lined
2	3	Service Water Supply Header	408	Service Water Valve Pit	2983	24	Coal Tar Enamel w/saturated asbestos	Mortar Lined
3	3	Cond. Ret. To CST	1080	Unit 3 CST to AFW Bldg. Bottom of Hill	2984	8	Coal Tar Enamel w/saturated asbestos	None
4	2	Cond. Ret. To CST	1509	FRV Bldg Excavation	2991	8	Coal Tar Enamel w/saturated asbestos	None
5	2	CST TO AFP	1505	FRV Bldg. Excavation	2993	12	Coal Tar Enamel w/saturated asbestos	None
6	3	CST to AFP	1070	Unit 3 CST to AFP Bottom of Hill	2995	12	Coal Tar Enamel w/saturated asbestos	None

The criteria for evaluating the indications regarding the locations are described in Table E2.

Table E2: Level Evaluation Criteria for G-Scan Indications

Level	Category Name	Description	Recommended Action
1	Substantial Area of Interest	Area is unique and indicative of indications that may reduce pressure carrying capacity or leak tightness of the pipe	Evaluate with NDE technique and/or perform direct examinations
2	Moderate Area of Interest	Area is somewhat unique and indicative of a level of degradation and/or better understanding of the area may improve the understanding of the condition of the pipe and the overall assessment	If reasonably accessible explore with another NDE technique or perform direct examination
3	Minor Area of Interest	Area where it is not clear that the indication is degradation or is another type pipe feature such as coating irregularities. These indications are relatively low in amplitude and degradation does not pose an immediate threat of leakage	Monitor the area with periodic subsequent tests to look for growth
4	Minimal Area of Interest	The feature is likely not related to degradation of the pipe but is sufficiently unique to note.	No need to monitor for its own sake. However if subsequent tests are performed feature should be evaluated for changes.

The summary of the findings are provided in Table E3.

Table E3: Summary of G-Scan Results

General Info						Pipe Data	
Loc. #	**Unit**	**Line Name**	**Line #**	**Location**	**G-Scan Test #**	**Indication Levels**	**External Coating**
1	2	Service Water Supply Header	408	Transformer Yard Area	2979 2982	2-3	The line had under insulation corrosion. The insulation appears to go below ground. No internal wall loss was detected from B-Scan tests. There were several corrosion like indications in the buried sections of the piping. These indications could also be start and stop of coating or mortar discontinuities. Excavation would be necessary to confirm.
2	3	Service Water Supply Header	408	Service Water Valve Pit	2983	3	A bitumen coating on the pipe is 1/4" thick and caused significant attenuation of the shot. Level 3 indications were noted and are recommended to be monitored over time.
3	3	Cond. Ret. To CST	1080	Unit 3 CST to AFW Bldg. Bottom of Hill	2984	3	This line had several Level 3 indications in the buried section of the line. Recommend that these indications be monitoring over time for growth.
4	2	Cond. Ret. To CST	1509	FRV Bldg Excavation	2991	3	This section of line had through wall leaks in February 2009. The leaking section of pipe was replaced in February 2009 and is the location of the transducer collar for this test. Minor corrosion indications were noted. This is a Level 3 area.
5	2	CST TO AFP	1505	FRV Bldg. Excavation	2993	2	Several indications are observed in the piping towards the elbow. Because of the nature of these indications they are categorized as Level 2 indications.
6	3	CST to AFP	1070	Unit 3 CST to AFP Bottom of Hill	2995	2	Minor corrosion of 0.025” deep was noted at the collar location. Several corrosion like indications were identified in the buried sections of the pipe. These indications are categorized as a Level 2.

It is recommended the Level 3 indications be monitored over time. The indications in the FRV building may be further explored with direct examination, pressure tested or monitored over time. This piping may benefit from localized cathodic protection to mitigate further degradation.

1.0 INTRODUCTION

Structural Integrity Associates, Inc. (SI) performed guided wave ultrasonic testing (G-Scan) at Entergy Nuclear Indian Point Energy Center (Indian Point) on September 22nd and 23rd 2009 on various buried piping systems. Early in 2009 the plant had a leak in a buried condensate line in the FRV building. The plant staff selected the locations of these inspections to determine other areas of degradation in the buried piping.

1.1 Piping Locations Inspected

The piping systems and locations selected for inspection are described in the Table 1.1. The material and interior and exterior coatings of the pipe were provided by plant staff.

Table 1.1: Piping that was Inspected

General Info						Pipe Data					
Loc. #	Unit	Line Name	Line #	Location	G-Scan Test #	OD (inches)	Schedule	External Coating	Internal Lining	Material	Design Temp.
1	2	Service Water Supply Header	408	Transformer Yard Area	2979 2982	24	.375"	Coal Tar Enamel w/saturated asbestos	Mortar Lined	A-53 Seamless Gr. B	150 psig 160°F
2	3	Service Water Supply Header	408	Service Water Valve Pit	2983	24	.375"	Coal Tar Enamel w/saturated asbestos	Mortar Lined	A-53 Seamless Gr. B	150 psig 160°F
3	3	Cond. Ret. To CST	1080	Unit 3 CST to AFW Bldg. Bottom of Hill	2984	8	40	Coal Tar Enamel w/saturated asbestos	None	A-106 Gr. B	665 psig / 400°F
4	2	Cond. Ret. To CST	1509	FRV Bldg Excavation	2991	8	40	Coal Tar Enamel w/saturated asbestos	None	A-106 Gr. B	665 psig 400°F
5	2	CST TO AFP	1505	FRV Bldg. Excavation	2993	12	40	Coal Tar Enamel w/saturated asbestos	None	A-53 Seamless or ERW, Gr. B	Full vacuum to 150 psig 225 °F
6	3	CST to AFP	1070	Unit 3 CST to AFP Bottom of Hill	2995	12	20	Coal Tar Enamel w/saturated asbestos	None	A-53 Seamless or ERW, Gr. B	Full vacuum to 150 psig 225 °F

1.2 Importance of Piping Characteristics and Test Results

Many piping characteristics influence the G-Scan test results and are important to understand to the extent possible to aid in the interpretation of the test results. With the buried piping systems in this report the important factors were the presence or absence of external and internal coatings in conjunction with past test results. Future test readings can be compared to this baseline data to give a better understanding of the test data and condition of the pipe.

2.0 G-SCAN TECHNOLOGY

To fully understand the use and findings of G-Scan testing an understanding of the technology is needed. This section of the report provides the necessary description of the equipment, the physics the technology is based upon and the methods of interpreting the G-Scan test results.

2.1 G-Scan Equipment

Figure 2.1 shows the components of the GUL[1] G-Scan equipment. There are basically three components that are required to conduct a G-Scan test. They are the transducer collar, the pulser or G3, and a ruggedized laptop. The function of each of these components is discussed in the following sections of the report.

Figure 2.1: G-Scan Components

2.1.1 Transducer Collar

There are two types of transducer collars in the G-Scan system; a hard or rigid collar, and an inflatable collar as shown in Figure 2.2. The hard collar is usually for pipe sizes from two to ten inches and the inflatable collars are for pipes ten inches and greater.

[1] GUL: Guided Ultrasonics Limited, the manufacturer of the equipment

The collars are composed of 60 or more piezo electric transducers depending on the size of the collar. These transducers act as a sender and receiver for guided waves. The purpose of the collar is to create guided waves in the pipe and to detect reflected wave from pipe features such welds, wall loss, and pipe supports.

Figure 2.2: GUL transducer collars

Usually no surface preparation or couplant is needed for the installation of the collar[2]. The collar takes a few minutes to be installed and needs about three inches of clearance around the pipe.

2.1.2 G3 Pulsar

The GUL G3 pulsar is 3rd generation technology that provides signals and energy to the transducer collar. It performs the signal processing and conducts many diagnostic checks on both the collar and itself for each shot taken. It is connected to the laptop via an umbilical cord. It is battery powered. The most significant capability of this piece of equipment is that it allows a single shot to be analyzed at a multitude of frequencies that greatly improves the interpretation of the test results.

[2] Provided that the piping at the location of the collar has a smooth surface with or without paint. However bitumastic type coatings need to be removed at the collar location for the transducers to couple with the pipe.

Figure 2.3: GUL G3 Pulser

2.1.3 Laptop and Analysis Software

The G3 sends the test data in a file to the laptop for analysis by the technician. The laptop has specialized software that it is used to perform the analysis. The complete test results including the diagnostics and data collected at all test frequencies are stored in the laptop. The test file can be emailed and analyzed remotely. Figure 2.4 shows the report screen of the software.

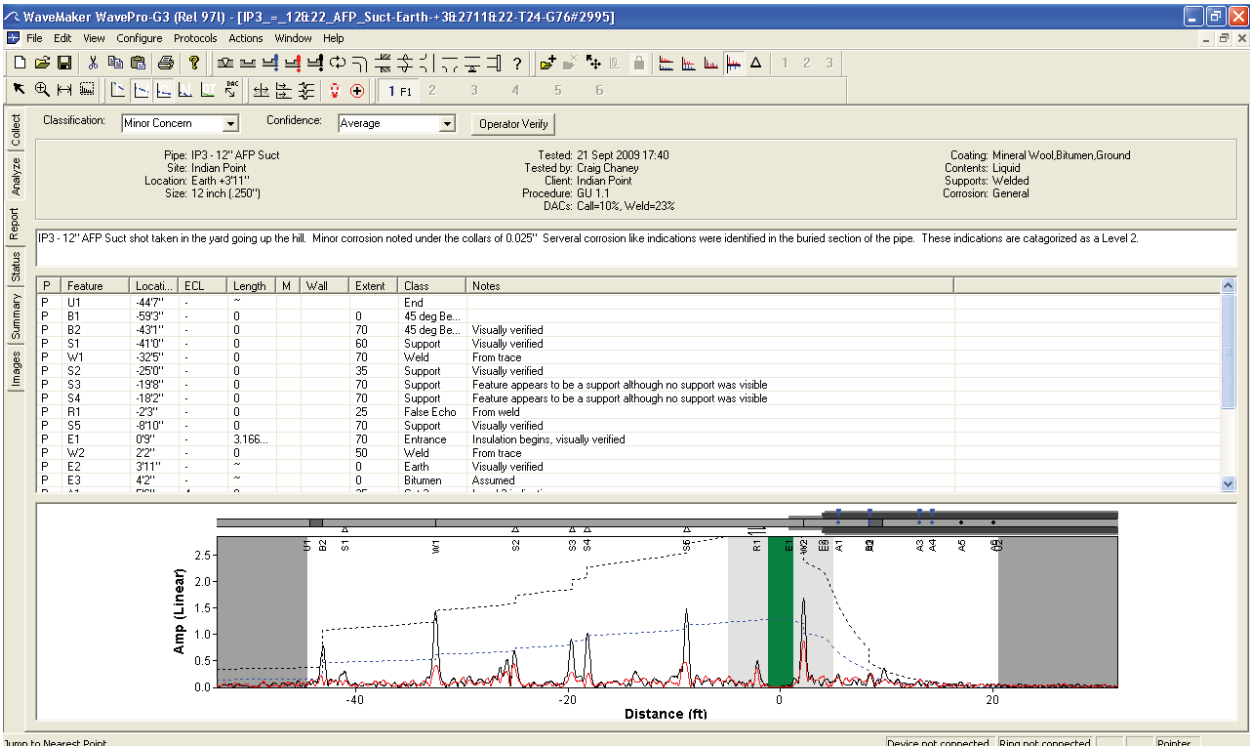

Figure 2.4: Screen shot of WavePro™ software

2.2 G-Scan Physics

The wave propagation physics of G-Scan technology is complex and difficult to fully to understand. The physics are often explained in simplified terms that will illustrate the basic concepts. However, these concepts are often times incomplete and fall short or are misleading when explaining other than straight forward test results. Nevertheless these concepts are useful to have a fundamental understanding of the technology and are provided in the following sections.

2.2.1 High Frequency Ultrasonic vs. G-Scan

Typical high frequency ultrasonics interrogates the material directly below the transducer. For wall thickness measurements it can provide readings typically within a few thousandths of an inch of the actual wall thickness. However, access to the actual location of the component to be interrogated is required. Also interrogating large surface areas is very time consuming.

As shown in Figure 2.5, G-Scan can inspect large surface areas beyond the transducer collar relatively rapidly allowing difficult to access sections of piping to be screened for wall loss that would be impractical with conventional techniques.

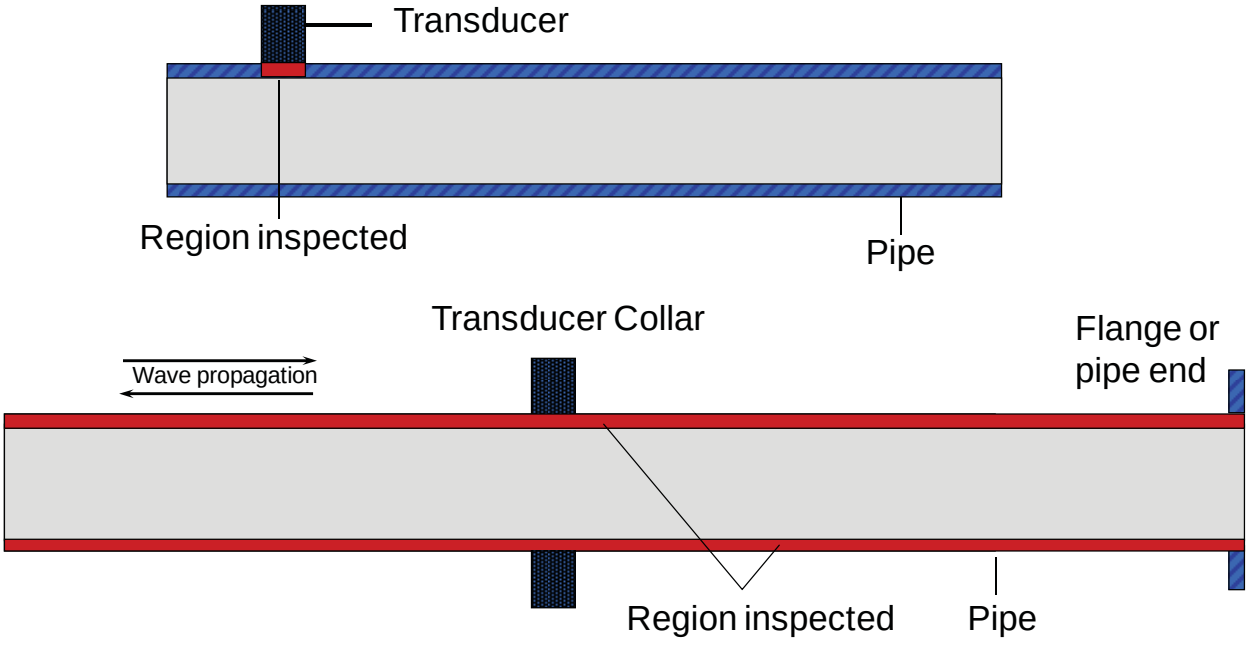

Figure 2.5: High Frequency Ultrasonics vs. G-Scan

Table 2.1 compares some of the characteristics of conventional high frequency ultrasonics with G-Scan. Note that the detection characteristics for G-Scan are multi dimensional.

Table 2.1: Standard UT vs. G-Scan

Characteristic	Standard UT	G-Scan
Frequency	High	Low
Wave Length	Short	Long
Wave Mode	Compression/Shear	Guided
Detection Characteristic	Time of Flight	Time of flight, wave mode, amplitude, pattern, response to frequency changes
Propagation mode	Pulse Echo	Pulse Echo
Measurement Type	Point to Point	Screening
Measurement	Change in thickness	Change in cross sectional area
Area of inspection	Beneath transducer	Not beneath the transducer, many feet each side of transducer collar including buried sections
Relative Accuracy in measuring wall thickness	High	Estimates wall loss in some test situations. Not usually applicable in buried applications
Relative examination area	Small	Large

2.2.2 Wave Propagation

The transducers introduce a compressional wave into the pipe that has a length that is longer than the thickness of the pipe. This difference in dimensions causes the wave to convert to a guided wave. The guided waves fill the volume of the pipe wall 360° around the pipe. The wave mode that is typically used is a torsional wave that results in the twisting of the pipe as shown in Figure 2.6.

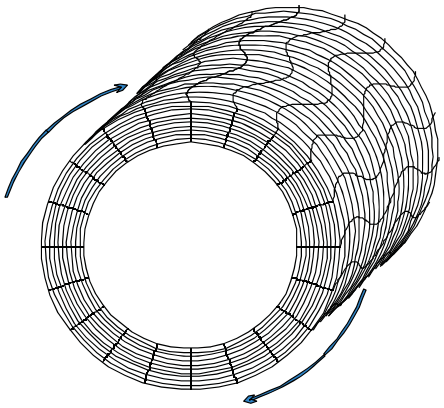

Figure 2.6: Torsional (twisting) guided wave mode

The objective of the test is to send a uniform guided wave down the pipe with minimal other wave modes.

When a guided wave comes into contact with a change in cross sectional area, there is a corresponding change in the torsional stiffness of the pipe. This change in stiffness causes acoustic impedance and results in a portion of the energy being reflected back to the transducer collar as shown in Figure 2.7. The energy that is reflected back to the transducer collar is proportional to the change in cross sectional area. The energy that continues to propagate down the pipe is the total energy minus the reflected energy. This is one mechanism of signal attenuation that governs the length of pipe that can be screened during a test. The change in cross sectional area can be either an increase or a decrease to cause a reflection. The reflection almost always results in a torsional or symmetric wave to be reflected back to the collar.

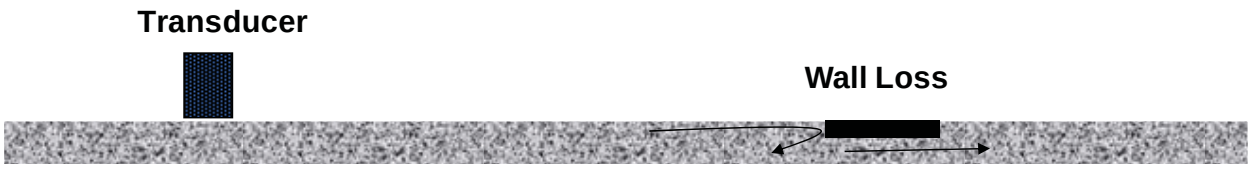

Figure 2.7: The nature of a guided wave reflection from a change in cross sectional area

Figure 2.8 shows the test results of a test loop. The peaks are from girth welds in the pipe. Note that the peaks are symmetrical with only a small red trace corresponding to them. This indicates that the change in cross sectional area is uniform around the pipe circumference.

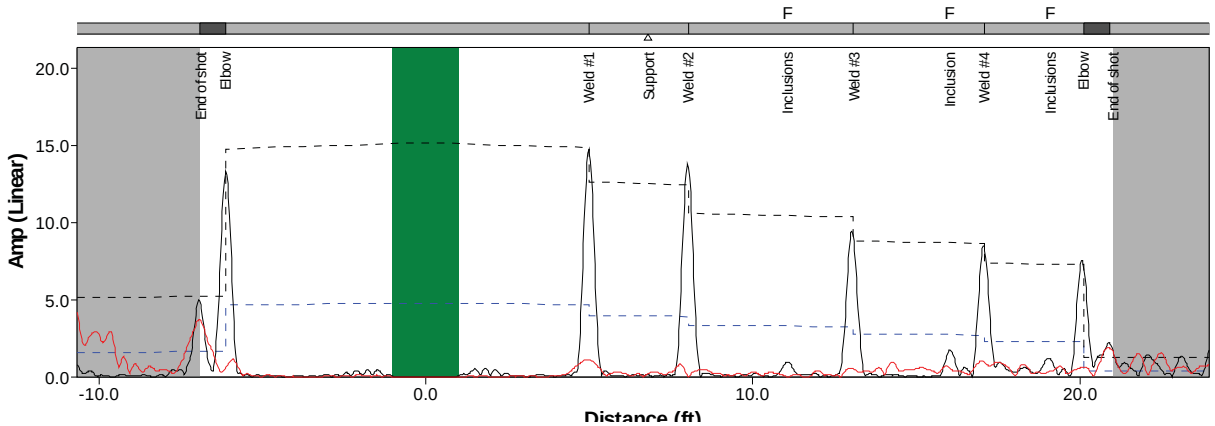

Figure 2.8: Test results of a test loop showing the responses from girth welds

Unlike girth welds, a non-symmetric feature is wall loss or gain that is not uniform around the major axis of the pipe as shown in Figure 2.9. It is important to understand the responses for

these types of features since most degradation is not symmetric and the understanding can assist in the interpretation of the test results.

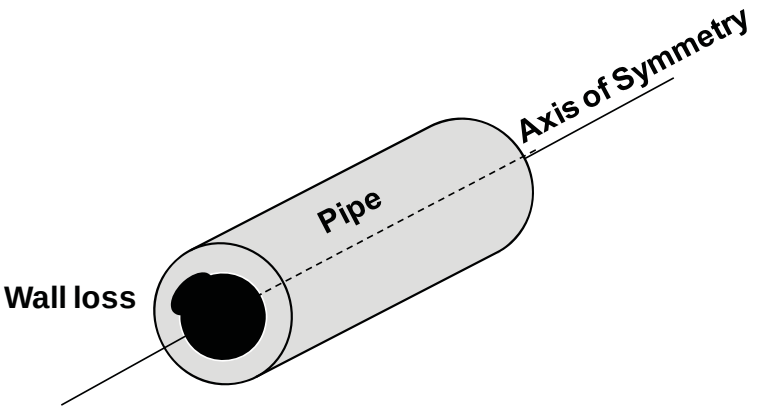

Figure 2.9: Depiction of non-symmetric wall loss of a pipe

Reflections from such features are typically composed of both a torsional symmetric wave and a flexural wave as shown in Figures 2.10 and 2.11.

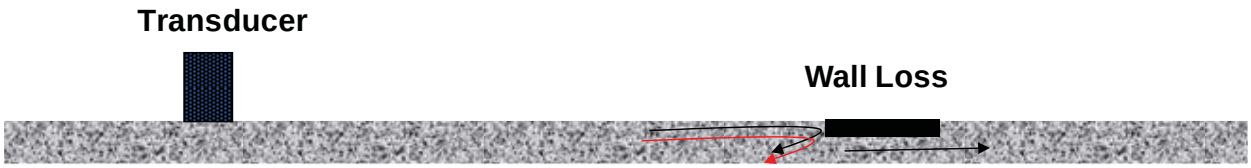

Figure 2.10: Symmetric (black) and non-symmetric (red) responses from a non-symmetric reflector

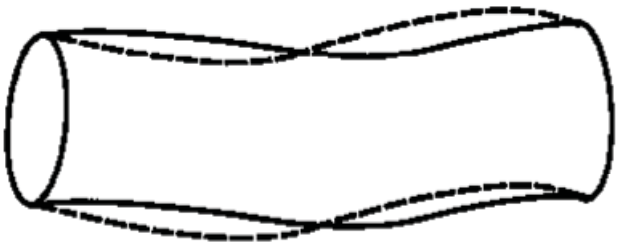

Figure 2.11: Depiction of a flexural wave from a non-symmetric reflector

Typically, the greater the non-symmetry of a feature, the greater the amplitude of the flexural response. The flexural response is depicted by a red trace. Figure 2.12 shows a comparison between a response from a symmetric girth weld and the response from a non-symmetric area of wall loss from corrosion. Note that the amplitude of the flexural response is much greater from the non-symmetric reflector.

The ratio of amplitudes is sometimes used to estimate the percent wall loss of a feature or the severity of the indication.

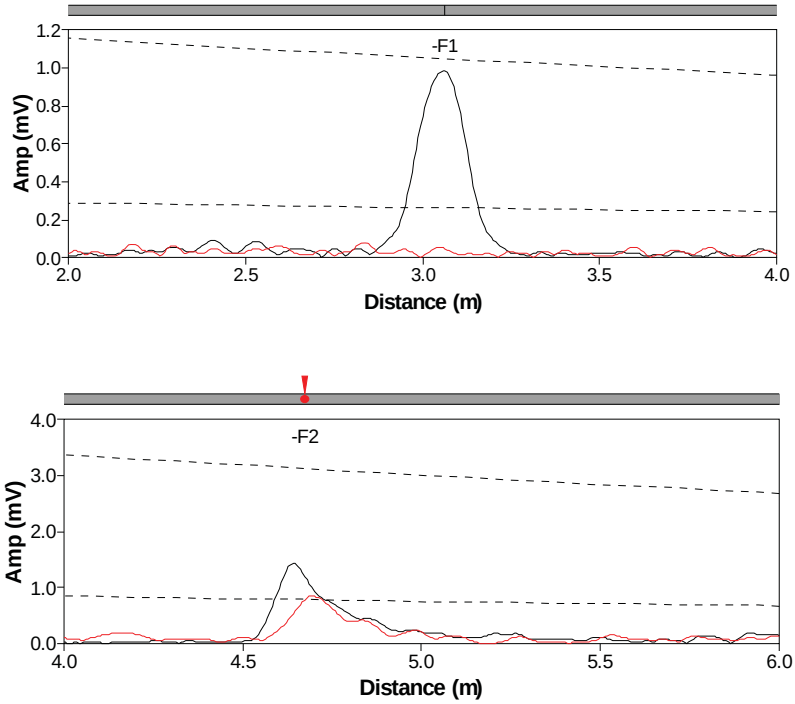

Figure 2.12: Example of responses from symmetric and non-symmetric reflectors.

The upper graph is a symmetrical response from a girth weld and the lower graph is non-symmetrical response from wall loss caused by corrosion.

2.2.3 Pipe Appurtenances Effects on Guided Waves

Pipe appurtenances such as elbows, branch connections, socket welded fittings and couplings, valves and flanges have an effect on guided wave propagation that influences the interpretation, detectability, and distance of a given test. Some of those effects are discussed in the following paragraphs.

Guided waves can propagate through elbows. Figure 2.13 shows part of a trace from a test done on an above ground piece of pipe. The first peak is from the girth weld of the elbow and is the expected amplitude from the weld. The second peak is from the second girth weld of the elbow. Note the significant decrease (approximately 9 dB) in the amplitude of the weld caused by the guided wave propagating around the elbow. Also note the high flexural response (red line) at the second weld. This is caused by the guided wave no longer being axi-symmetric on the pipe as a result of the different metal path lengths between the intrados and extrados of the elbow. Hence guided waves can go through elbows but the strength and symmetry of the guided wave is lessened reducing the distance and detectability of the test. As a general rule of thumb a guided wave can go through two elbows on above ground pipe and one elbow on below ground pipe. However the guided wave analyst will be able to determine the distance of the inspection based on the actual test results.

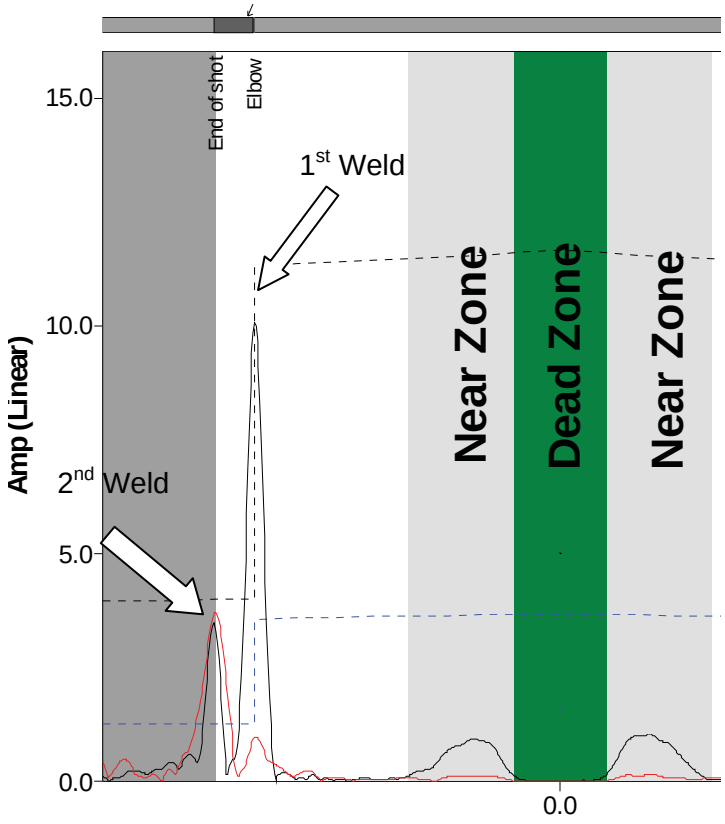

Figure 2.13: A trace of an elbow showing the attenuation effects on the guided wave

Other appurtenances can have a greater or lesser effect on test results depending on the size and location of appurtenances. Table 2.2 summarizes the general affects of various pipe appurtenances. However, it is important to understand that these are generalizations and the actual test results maybe different than what is presented in this table.

Table 2.2: General Effects of Appurtenances on Guided Wave Testing[3]

Appurtenances	Effects		# that can be tested through[4]
	Attenuation	Symmetry	
Long Seam Welds	None	None	Indefinite
Girth Welds	Low	Usually none or minor	Many
Supports - Resting	None to low	None to Low	Indefinite
Supports - Welded	Moderate to High	Moderate to High	Several
Branch Connections – 10% of Diameter	Low to Moderate	Low to Moderate	Several
Branch Connections – 100% of Diameter	High	Very High	None
Bends-90's	Moderate	High	Two
Bends – 45's	High	High	None
Socket Fittings	Very High	Depends on fitting	Usually none
Valves and Flanges	100%	N/A	None

2.3 G-Scan Analysis

Once the test is conducted, all of the results from a single G-Scan shot are compiled into a single file that can be analyzed with assistance of the special software. The software presents the data. However it's the technician that integrates interpretation of patterns, past experience, and physical features of the test situation to conduct the actual analysis. This analysis is best performed at the test site and may take ten minutes or an hour or longer depending on the complexity of the test situation.

The following sections explain the tools and methods for the analysis.

2.3.1 Analysis Screen

Figure 2.14 shows the analysis screen with the various features of the screen labeled which are further described here.

The Dead Zone is the area directly beneath the transducer collar and is approximately a couple of feet wide. Pipe features such as internal wall loss cannot be detected within the dead zone.

[3] General guidance only. Actual test results will vary from test to test
[4] For above ground pipe. Below ground pipe divide by two for general guidance

The light grey area on each side of the dead zone is the near zone. Its width varies with frequency and pipe diameter and is usually on the order of three to five feet from the centerline of the transducer collar. Features that can be detected within the near zone though their amplitudes are not as reliable as outside the near zone and there is more likely to be false echoes in this zone.

The software determines and labels the location of the dead and near zones on each shot.

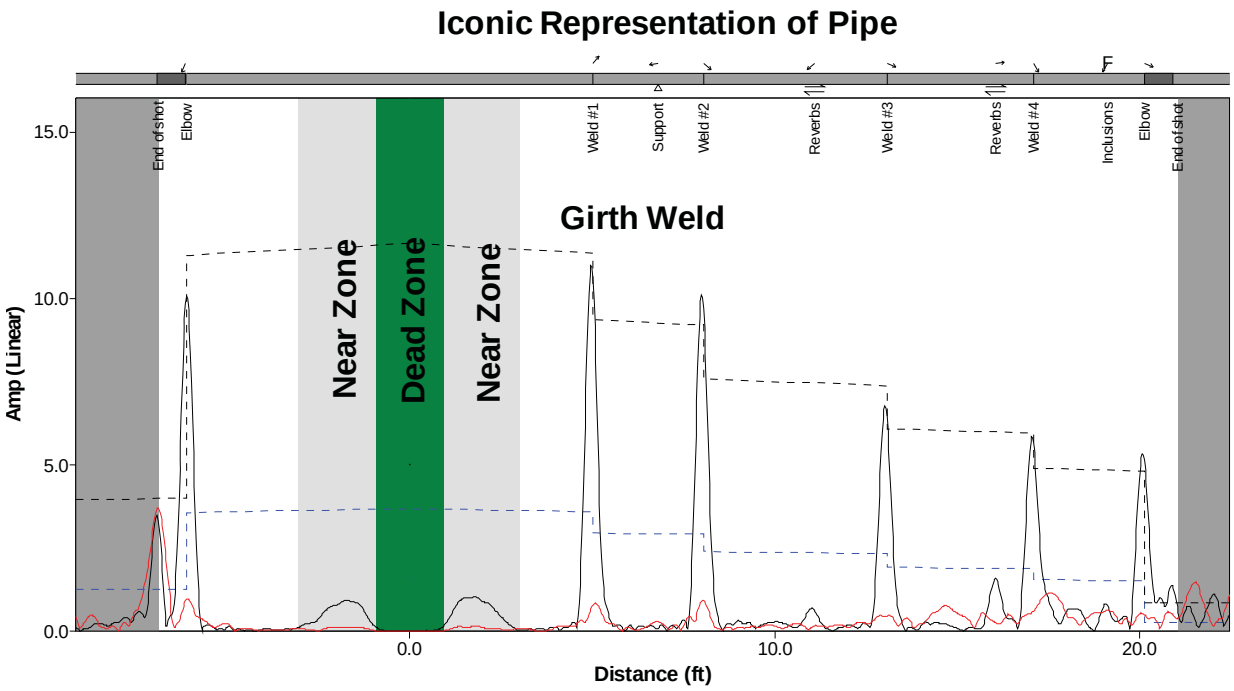

Figure 2.14: Typical G-Scan trace

At the top of the screen is an iconic bar that shows the icons for the identified features. These features can be welds, bends, area of wall loss, etc. The features are identified and placed by the technician in the analysis process

The grey areas on each end of the shot signify the end of the shot and are identified by the technician.

2.4 Test Distance

The pipe characteristics have significant effect on the distance of any given test. In the piping that was tested at Indian Point the coating types both internal and external had effect on the

distance of the tests as well as elbows and other pipe fittings. Mortar and coal tar type of coatings are both very attenutive and combined together shorten the distance of the test.

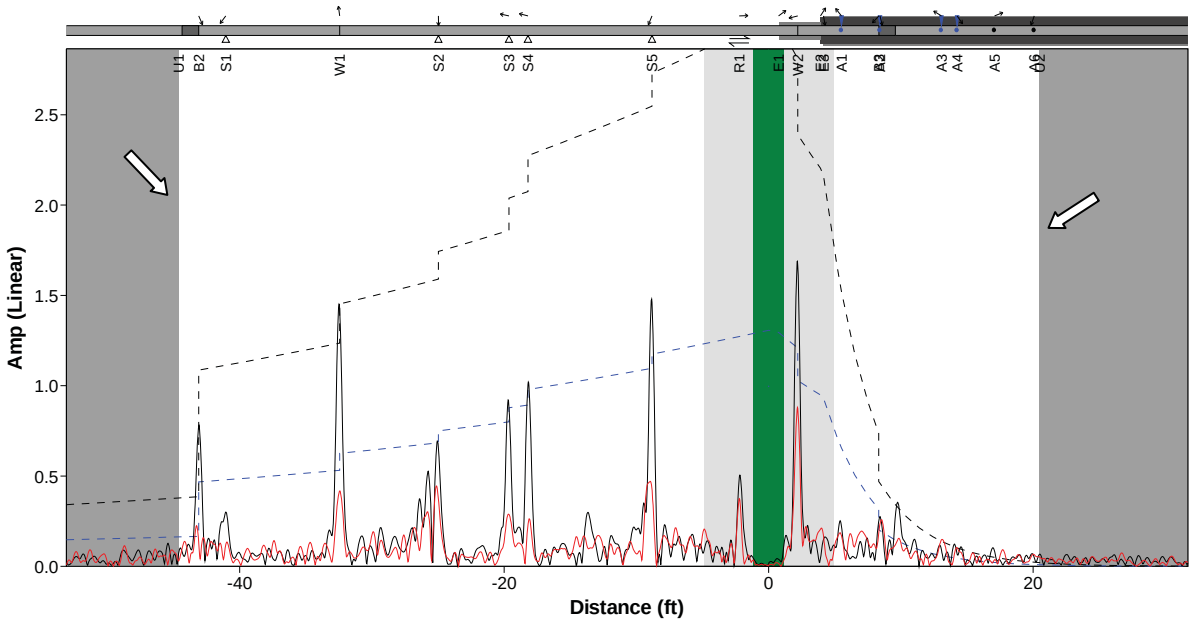

Figure 2.15: Depiction of the end of test on G-Scan trace(arrows)

The distance of each test can vary dramatically depending upon the acoustic characteristics of the pipe, coating, and the amount of features that reflect energy back to the collar. For these tests the coating and soil greatly attenuated the sound and shortened the distance of the tests.

2.5 Test Direction

Guided waves travel both upstream and downstream from the transducer collar and in many cases the pipe can be evaluated in both directions. For these tests the focus of the analysis was in the buried sections of the pipe.

2.6 G-Scan as a Survey Tool

G-Scan is best used as a pipe survey tool. Estimates of the wall thickness change can be derived from the data, but accurate measurement of flaw dimensions require that the anomaly be inspected using a technique capable of more accurate quantitative measurements of wall thickness. SI uses B-Scan ultrasonic inspection to perform detailed examination of anomalies

detected by G-Scan on accessible pipe segments. ID versus OD corrosion cannot be distinguished with the G-Scan system.

2.7 Equipment Checks

The G-Scan system performs equipment checks before each G-Scan shot is taken. There are no onsite calibrations that SI performs on this equipment. SI does periodically verify the proper operation of the G-Scan equipment using test loops at SI's offices.

3.0 INSPECTION RESULTS

The results of G-Scan testing from each test area are reported separately in the following sections.

3.1 Data Description

The following is the description of the individual data elements used to describe the test results.

3.1.1 Line Name

The line names were provided by Indian Point staff.

3.1.2 G-Scan Shot #

Each G-Scan test has a unique sequential number that is assigned to the test results by the equipment software. This number is reflected in the test data file name.

3.1.3 End of Test

The end of test was determined by the last identified feature or in the determination of the analyst where presence of reliable data ended.

3.1.4 Feature

Anomalies and pipe features are labeled by the G-Scan software. The minus sign in front of the alpha numeric number indicates that the feature is on the negative side of the transducer collar and vice versa for features without the minus sign.

3.1.5 Category

The G-Scan software has three categories of indications relating to wall loss. These categories are 1, 2 and 3 where 1 is an estimate of the greatest wall loss. Assignment of these categories to indications is performed by the G-Scan analyst based principally on the signal traces. The indication criteria described takes into account not only the category of the indication but other relevant piping information such as location in the shot, level of confidence in the indication, previous piping conditions etc.

3.1.6 Location

Location is the distance the feature is from the transducer collar. A minus sign indicates that the feature is in the negative direction from the collar.

3.1.7 Level Criteria

As described in Section 3.2 the anomalies are categorized as Level 1 through 4.

3.1.8 Notes

Comments to provide further explanation of the test results are reported in the note section of the report.

3.2 Level Evaluation Criteria

SI performed the tests and compiled the data in the report according to the criteria shown in Table 3.1. This criteria is not only based on the category of the indication in the signal trace, but also on the level of confidence in the indication, location of the indication in the trace, previous corrosion history of the piping, coating conditions, etc.

Table 3.1: Level Evaluation Criteria

Level	Category Name	Description	Recommended Action
1	Substantial Area of Interest	Area is unique and indicative of indications that may reduce pressure carrying capacity or leak tightness of the pipe	Evaluate with other another NDE technique and or perform a direct examination
2	Moderate Area of Interest	Area is somewhat unique and indicative of a level of degradation and/or better understanding of the area may improve the overall assessment understand of the condition of the subject pipe	If reasonably accessible, explore with another NDE technique or perform direct examination
3	Minor Area of Interest	Area where it is not clear that the indication is degradation or other pipe feature such as coating irregularities. Relatively low in amplitude and if degradation does not pose an immediate threat of leakage	Monitor the area with periodic subsequent tests to look for growth
4	Minimal Area of Interest	Feature likely not related to degradation of the pipe but is sufficiently unique to note.	No need to monitor on its own. However if subsequent tests are performed, the feature should be evaluated for changes.

3.3 Use of Criteria

The criteria developed for this analysis provide relative ranking of indications and assist plant staff in prioritizing follow up activities at various locations. None of these results should be used

to make operability determinations since G-Scan is used as a screening tool that identifies potential areas of degradation. Because results are influenced by number of factors other than reduction of wall loss, they are insufficient to be used as the basis of a structural analysis.

3.3.1 Other Actions

There are other alternatives to respond effectively to G-Scan indications. These include but are not limited to:

- Integrate and monitor groundwater monitoring data with G-Scan data
- Pressure test of the piping system
- Above ground indirect monitoring surveys
- Future G-Scan monitoring
- Mitigating further corrosion

3.4 Pipe Test Results

The following sections provide the test results of each test location. They are sequenced in the order of when the test was taken.

3.5 Location 1, Unit 2 Service Water Supply Header

3.5.1 Location Description

General Info						Pipe Data					
Loc. #	Unit	Line Name	Line #	Location	G-Scan Test #	OD (inches)	Schedule	External Coating	Internal Lining	Material	Design Temperature
1	2	Service Water Supply Header	408	Yard Area	2979 2982	24	.375"	Coal Tar Enamel w/saturated asbestos	Mortar Lined	A-53 Seamless Gr. B	150 psig / 160°F

Figure 3.1 shows Location 1 on a 24-inch service water header. Tests were conducted above and below the 18-inch blind flange. This line is insulated at least down to ground level and may be insulated partially underground. As can be seen in Figure 3.1 and Figure 3.2, under insulation corrosion had occurred on the above ground section. The wall loss is estimated to be 0.070 to 0.080 inches deep.

Figure 3.1: Location 1, Service Water Header, Transformer Yard

Figure 3.2: Location 1, Service Water Header, Under Insulation Corrosion

3.5.2 G-Scan Results below 18-Inch Blind Flange

The detailed test results, trace and drawing of Location 1 is on the following pages. In summary there was an estimated 0.080 inches of wall loss from under insulation corrosion. Two indications were classified as Level 2 indications because of their pattern in the trace and because it would be helpful to understand if the mortar lining is causing the indications.

Table 3.2: Test Results of Location 1, Shot 2979

Test ID:	G3-76#2979		
Pipe:	24" SW 408	Ring:	R2B24(1102)
Site:	Indian Point Unit 2, 1,	Config:	14.6FR, T(0,1)
Location:	Transformer Yard Flange 25"	Calibration:	Automatic (8376.39 mV)
Size:	24 inch (.375")	Version:	3.97, Wavemaker G3-76
Tested:	22 Sept 2009	Client:	Indian Point
Tested by:	Craig Chaney	Procedure:	GU 1.1
		DACs:	Call=10%, Weld=23%

Summary:
Service water pipe that is reported to have a mortar lining. Above ground line is insulated and heat traced and had under insulation corrosion. Insulation appears to go below ground. Client reports a coal tar wrap but it could not be visually confirmed. Pipe to soil measurements -250mV which is consistent with no CP. B-Scan 0 to 90; 0.404", 90 to 180; 0.388", 180 to 270; 0.397", 270 to 0; 0.398" No internal wall loss detected from B-Scan.

Feature	Location	Class	Notes
E2	-0'5"	Earth	Visually confirmed
E1	-1'8"	Bitumen	Assumed from trace and normal design practice
A4	-2'5"	Cat 2	Corrosion like indication. Could be start of coating also. Excavation would be necessary to confirm
R1	-3'1"	False Echo	From large branch connection
B1	-4'0"	1D Bend	Assumed from information provided by plant staff. It may be shorter than a 1 D
A3	-15'9"	Cat 1	Indications are corrosion like. Could be location of mortar failure or coating failure, Level 2
A2	-16'11"	Cat 1	Indications are corrosion like. Could be location of mortar failure or coating failure, Level 2
A1	-23'9"	Cat 1	Indications are corrosion like. Could be location of mortar failure or coating failure, Level 3
U1	-24'11"	End	
F1	-36'5"	Branch	Estimated location of 3" to instrument air compressor from drawing 9321-F-2700
F2	2'10"	Y	Visually confirmed
A5	5'0"	Cat 3	Visual confirmed pitting. Approximately 0.080 inches deep or 20% wall loss.
U2	8'8"	End	

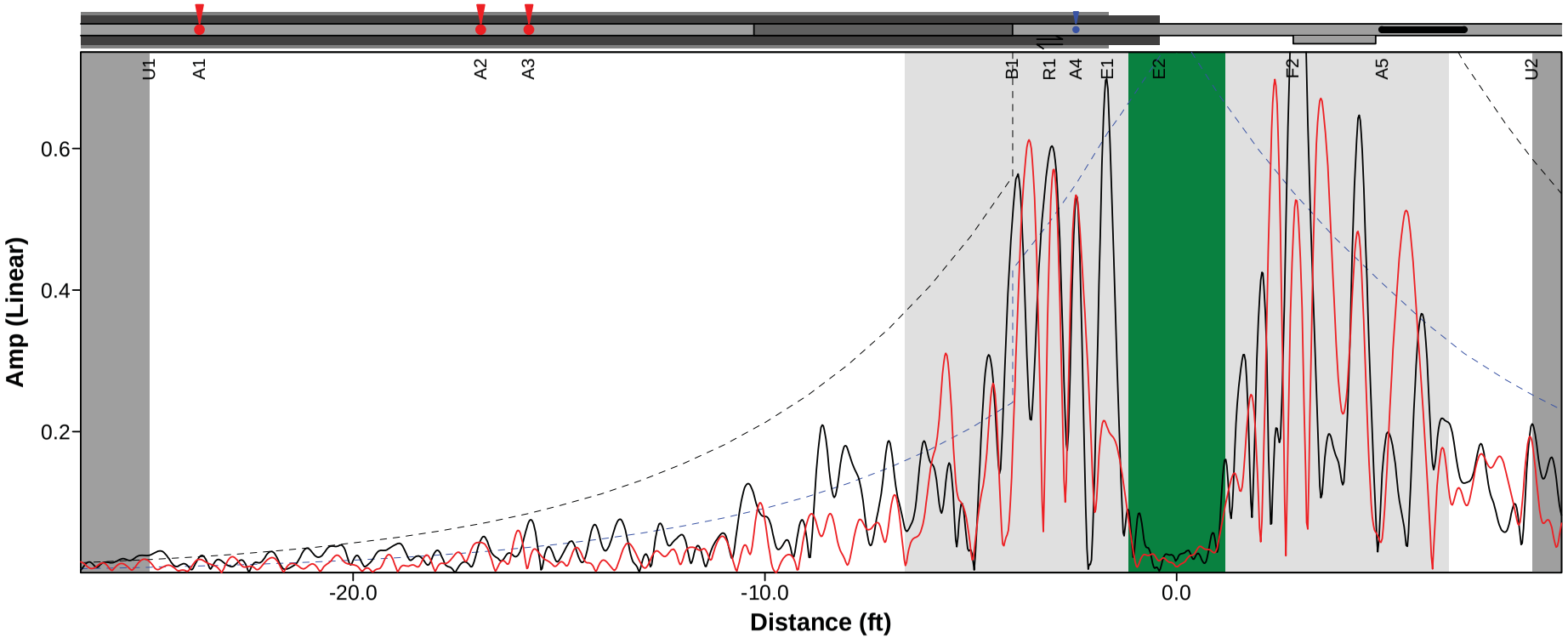

Figure 3.3: Shot 2979 Trace

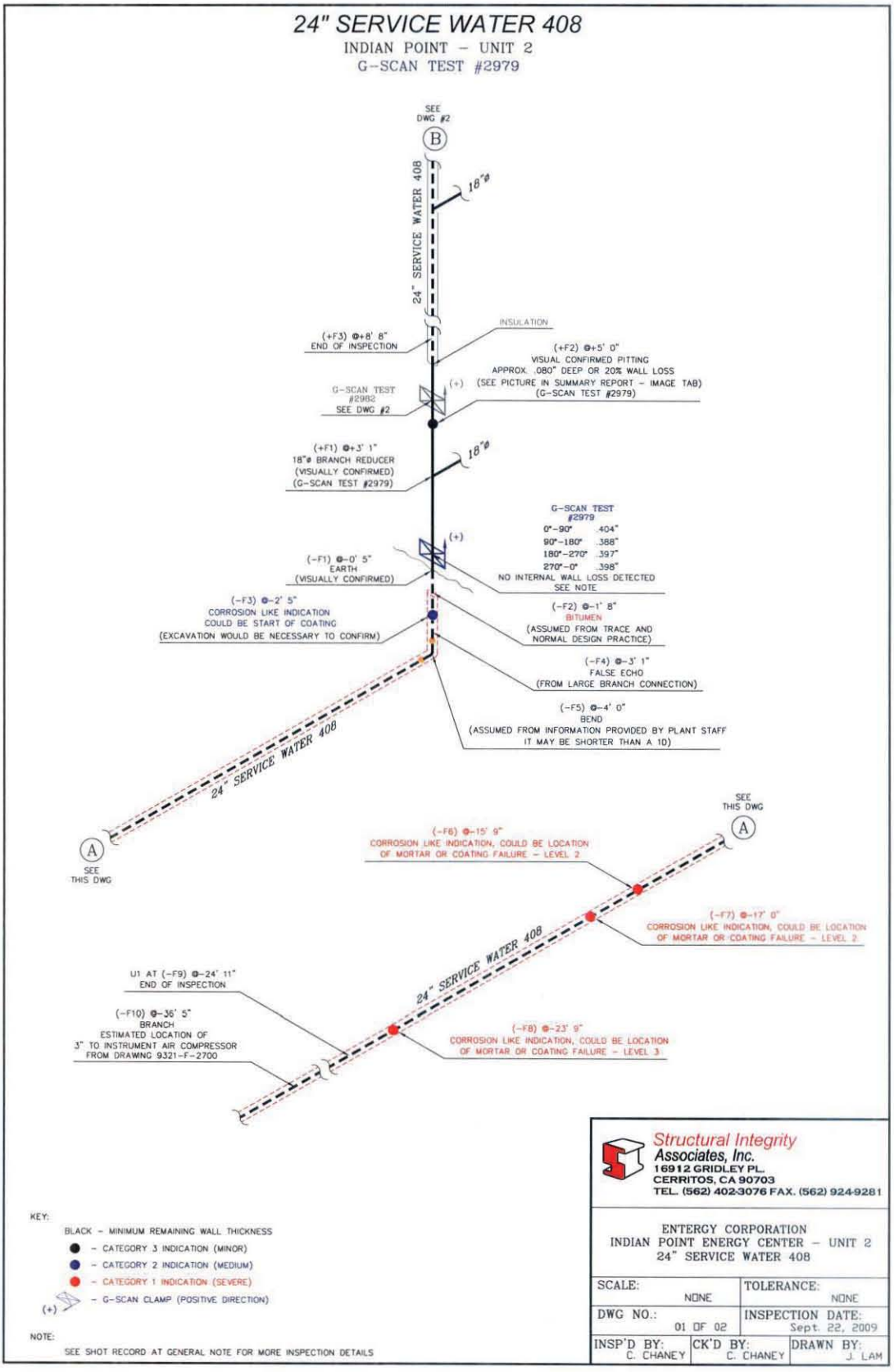

Figure 3.4: Location 1, Test Results of 2979

3.5.3 G-Scan Results above the 18-Inch Blind Flange

The following table, figure, and drawing are of the test performed on the above ground portion of the service water header. Level 4 indications were identified further up the line.

Table 3.3: Test Results for Location 1, Shot 2982

Test ID:	G3-76#2982		
Pipe:	24" SW 408	Ring:	R2B24(1102)
Site:	Indian Point, Unit 2	Configuration:	12.0FR, T(0,1)
Location:	1, Transformer Yard Flange -26"	Calibration:	Automatic (2007.36 mV)
Size:	24 inch (.375")	Version:	3.97, Wavemaker G3-76
Tested:	22 Sept 2009	Client:	Indian Point
Tested by:	Craig Chaney	Procedure:	GU 1.1
		DACs:	Call=10%, Weld=23%

Summary:
Service water pipe that is reported to have mortar lining. Above ground line is insulated and heat traced. Under insulation corrosion visually confirmed. Reported noise problem in the shot is due to poor coupling of transducers on the corroded surface. No B-Scan readings were taken in this area due to the external corrosion and the inability to couple the transducer to the corroded surface. Shot distance and confidence level is low after shooting through the 18 inch branch connection. Under insulation corrosion is also expected above branch connection.

Feature	Location	Class	Notes
F1	-2'11"	Y	Visually confirmed
E1	1'6"	Sleeve	Insulation
R1	2'8"	False Echo	From 18 inch branch connection
W1	6'0"	Weld	From signal trace
A1	9'8"	Cat 0	
A2	11'2"	Cat 3	From trace. Level 4
F2	12'11"	Y	18" branch connection and reducer that goes into Aux Building
A3	18'5"	Cat 3	From trace. Level 4
A4	19'9"	Cat 3	From trace. Level 4
A5	23'6"	Cat 3	From trace. Level 4
B1	47'5"	Bend	Visually verified
U2	54'5"	End	
U1	-6'1"	End	

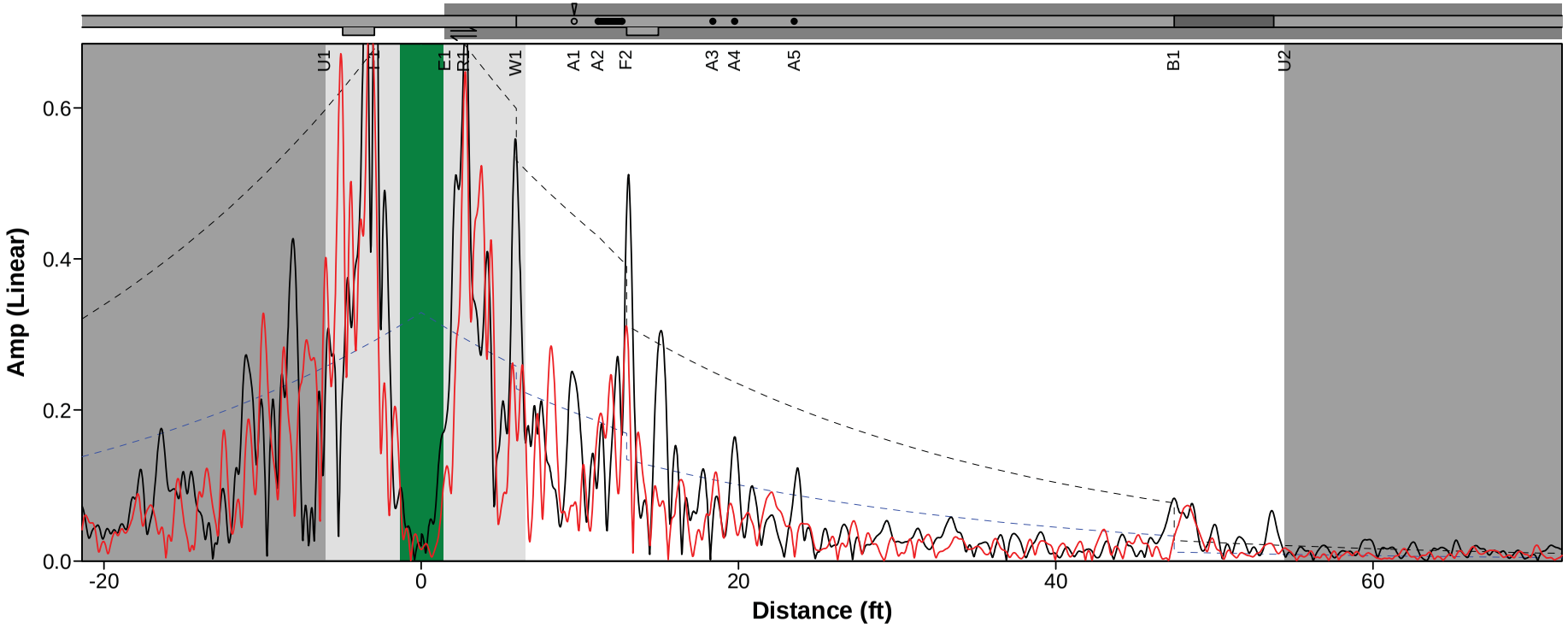

Figure 3.5: Trace of Shot 2982, Location 1

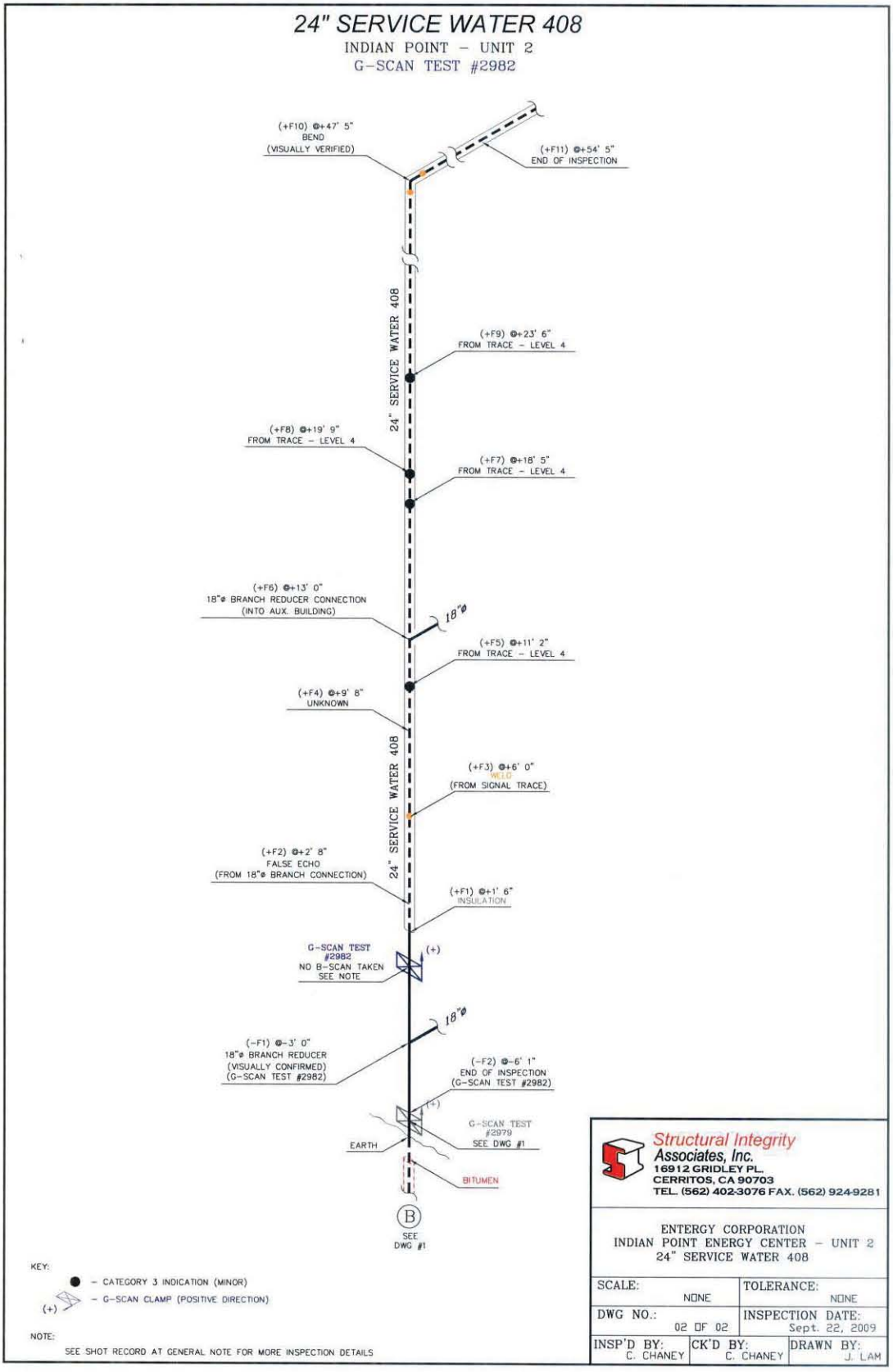

Figure 3.6: Location 1, Test Results from Shot 2982

3.6 Location 2, Unit 3 Service Water Header Supply, Service Valve Pit

3.6.1 Location Description

Figure 3.7 shows Location 2, a 24-inch service water header that was in the service water valve pit.

General Info						Pipe Data					
Loc. #	Unit	Line Name	Line #	Location	G-Scan Test #	OD (inches)	Schedule	External Coating	Internal Lining	Material	Design Temperature
2	3	Service Water Supply Header	408	Service Water Valve Pit	2983	24	.375”	Coal Tar Enamel w/saturated asbestos	Mortar Lined	A-53 Seamless Gr. B	150 psig / 160°F

Figure 3.7: Location 2, Service Water Valve Pit

Table 3.4: Test Result of Location 2, Shot 2983

Test ID:	G3-76#2983		
Pipe:	24" SW 408	Ring:	R2B24(1102)
Site:	Indian Point, Unit 3	Configuration:	14.6FR, T(0,1)
Location:	2, SW Piping Vault, Wall 9"	Calibration:	Automatic (2599.73 mV)
Size:	24 inch (.375")	Version:	3.97, Wavemaker G3-76
Tested:	22 Sept 2009	Client:	Indian Point
Tested by:	Craig Chaney	Procedure:	GU 1.1
		DACs:	Call=10%, Weld=23%

Summary:
This shot was taken in the service water valve pit at Unit 3. The pipe ran through a concrete wall and then into soil. The piping is reported to have a mortar lining. At the location of the collar the pipe had paint. A bitumen coating that was 1/4" thick was noted as the pipe entered the vault wall. B-Scan readings are 0 to 90; 0.388", 90 to 180; 0.393", 180 to 270; 0.393" 270 to 0; 0.389" No internal wall loss was detected from the B-Scan tests.

Feature	Location	Class	Notes
A6	19'1"	Cat 2	Level 3
A5	7'4"	Cat 0	Appears to be a change in mortar coating
A4	6'2"	Cat 2	Level 3
A3	5'2"	Cat 0	Appears to be a change in mortar coating
A2	2'9"	Cat 0	Appears to be a change in mortar coating
A1	-2'8"	Cat 0	Variation caused by the mortar lining
B1	9'7"	1D Bend	The location of the bend does not correspond with the drawing but was selected here due to the initial weld response of the bend
E4	2'0"	Earth	Assumed location of earth
E3	1'0"	Wall	Assumed wall thickness from partial details shown on drawings.
E2	0'5"	Bitumen	0.25" Thick
E1	-2'2"	Entrance	Insulation visibly verified
F2	-6'2"	Branch	
F1	-8'5"	T	
R1	-1'8"	False Echo	
S1	1'8"	Support	Welded ring to seal the vault from water and soil shown on drawings.
U2	19'7"	End	
W1	17'5"	Weld	From trace

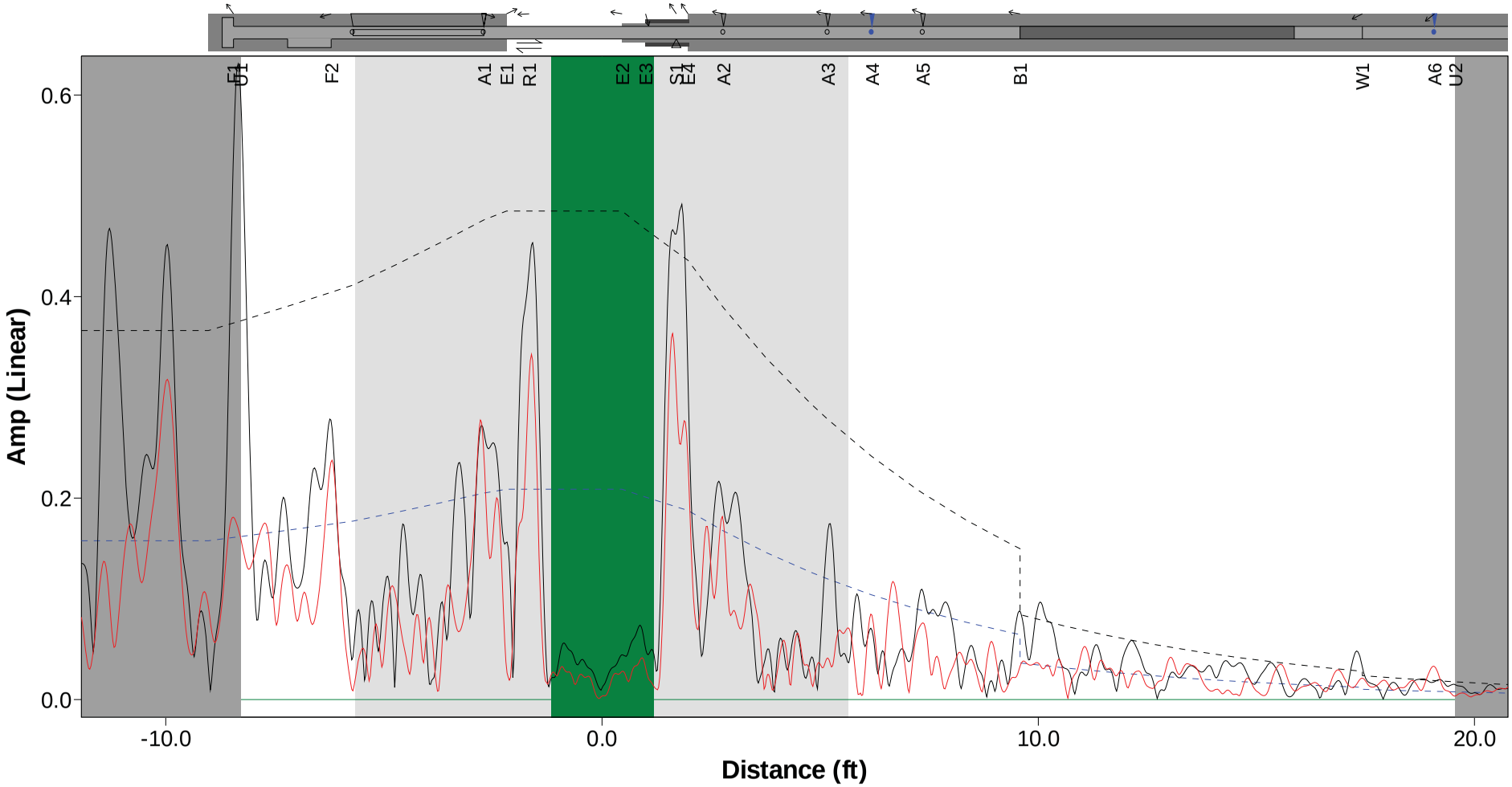

Figure 3.8: Trace of Shot 2983, Location 2

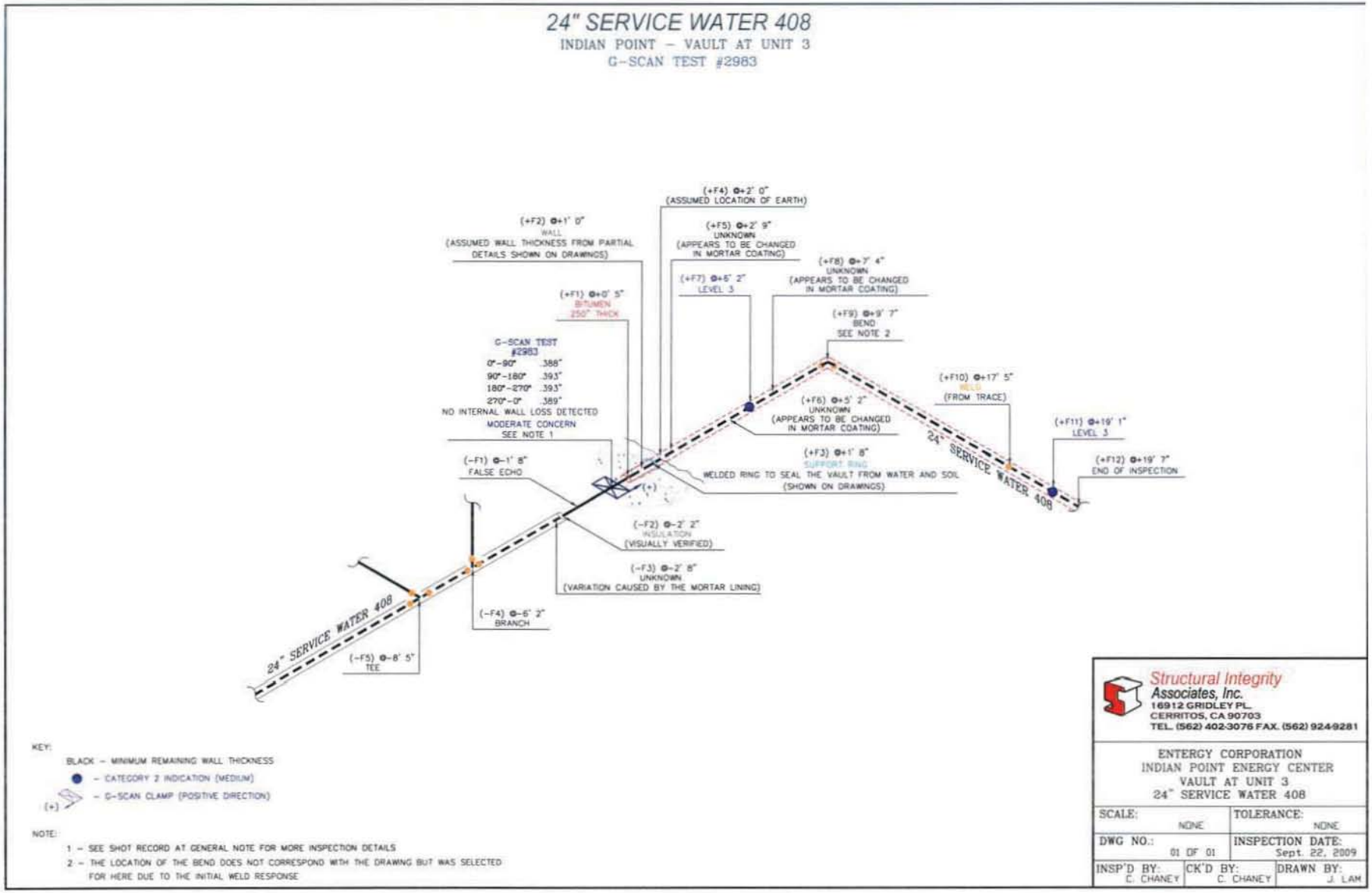

Figure 3.9: Location 2, Test Results from Shot 2983

3.7 Location 3, Unit 3 Condensate Return to CST, Bottom of Hill

3.7.1 Location Description

Figure 3.10 shows Location 3 on an 8-inch line from service water storage tank to the auxiliary feedwater building at the bottom of the hill.

Loc. #	Unit	Line Name	Line #	Location	G-Scan Test #	OD (inches)	Schedule	External Coating	Internal Lining	Material	Design Temperature
3	3	Cond. Ret. To CST	1080	Unit 3 AFW Building up to CST	2984	8	40	Coal Tar Enamel w/saturated asbestos	None	A-106 Gr. B	665 psig / 400°F

Figure 3.10: Location 3, 8-inch Line from the AFW Building up to CST

Table 3.5: Test Result of Location 3, Shot 2984

Test ID:	G3-76#2984		
Pipe:	IP3 - 8" CST Return	Ring:	R2B08(900)
Site:	Indian Point	Configuration:	3.3FR, T(0,1)
Location:	3, Bottom of Hill, Earth -45"	Calibration:	Automatic (1398.09 mV)
Size:	8 inch (.322")	Version:	3.97, Wavemaker G3-76
Tested:	23 Sept 2009 10:28	Client:	Indian Point
Tested by:	Craig Chaney	Procedure:	GU 1.1
		DACs:	Call=10%, Weld=23%

Summary:
Pipe #1080. This line runs up the hillside at a 65 degree angle on welded supports. In the other direction it runs into the earth and has a 65 degree bend approximately four feet below ground. Minor corrosion was observed in the trace above and below ground. This location has Level 3 indications.

Feature	Location	Class	Notes
W1	-21'10"	Weld	Identified from trace
W2	27'4"	Weld	From Trace
U1	-39'3"	End	
U2	-20'2"	Other	Possible coating problem or thickness change
U3	46'4"	End	
S1	8'6"	Weld. sup.	Visually verified
S2	25'3"	Support	Visually verified
S3	41'3"	Support	Visually verified
E1	-3'8"	Earth	Visually verified
E2	-0'5"	Entrance	Hardened foam insulation visually verified
E3	2'0"	Entrance	Hardened foam insulation visually verified
B1	-9'0"	Bend	Identified from trace and drawing. It is a 65 degree bend.
B2	42'5"	45 deg Bend	Visually verified, 45 degree bend.
B3	52'1"	45 deg Bend	Identified from trace and drawing.
A1	-39'1"	Cat 3	Level 3
A2	-26'2"	Cat 3	Level 3
A3	-13'2"	Cat 3	Level 3
A4	12'0"	Cat 3	Level 3
A5	13'4"	Cat 3	Level 3
A6	17'5"	Cat 3	Level 3

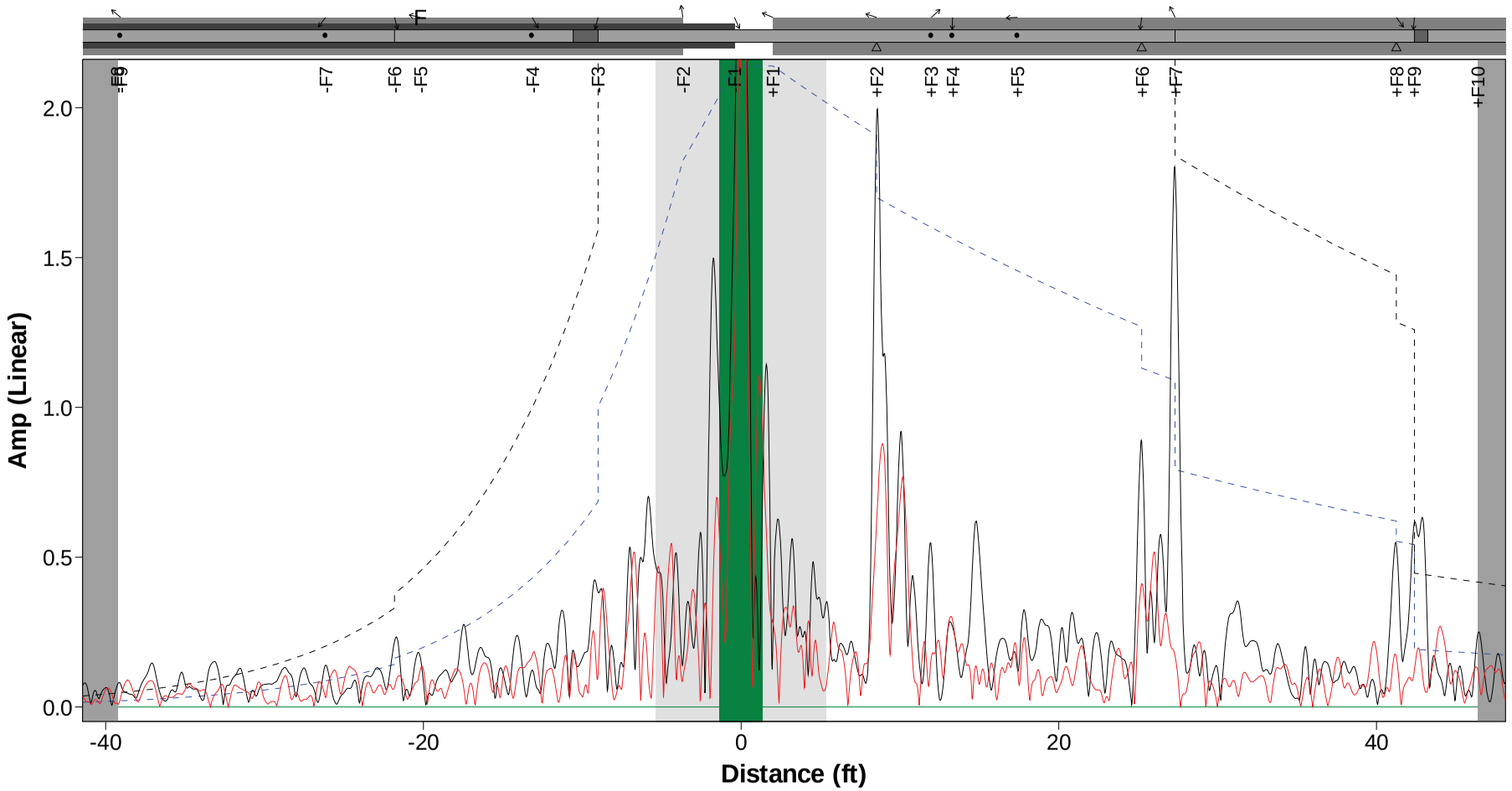

Figure 3.11: Trace of Shot 2984, Location 3

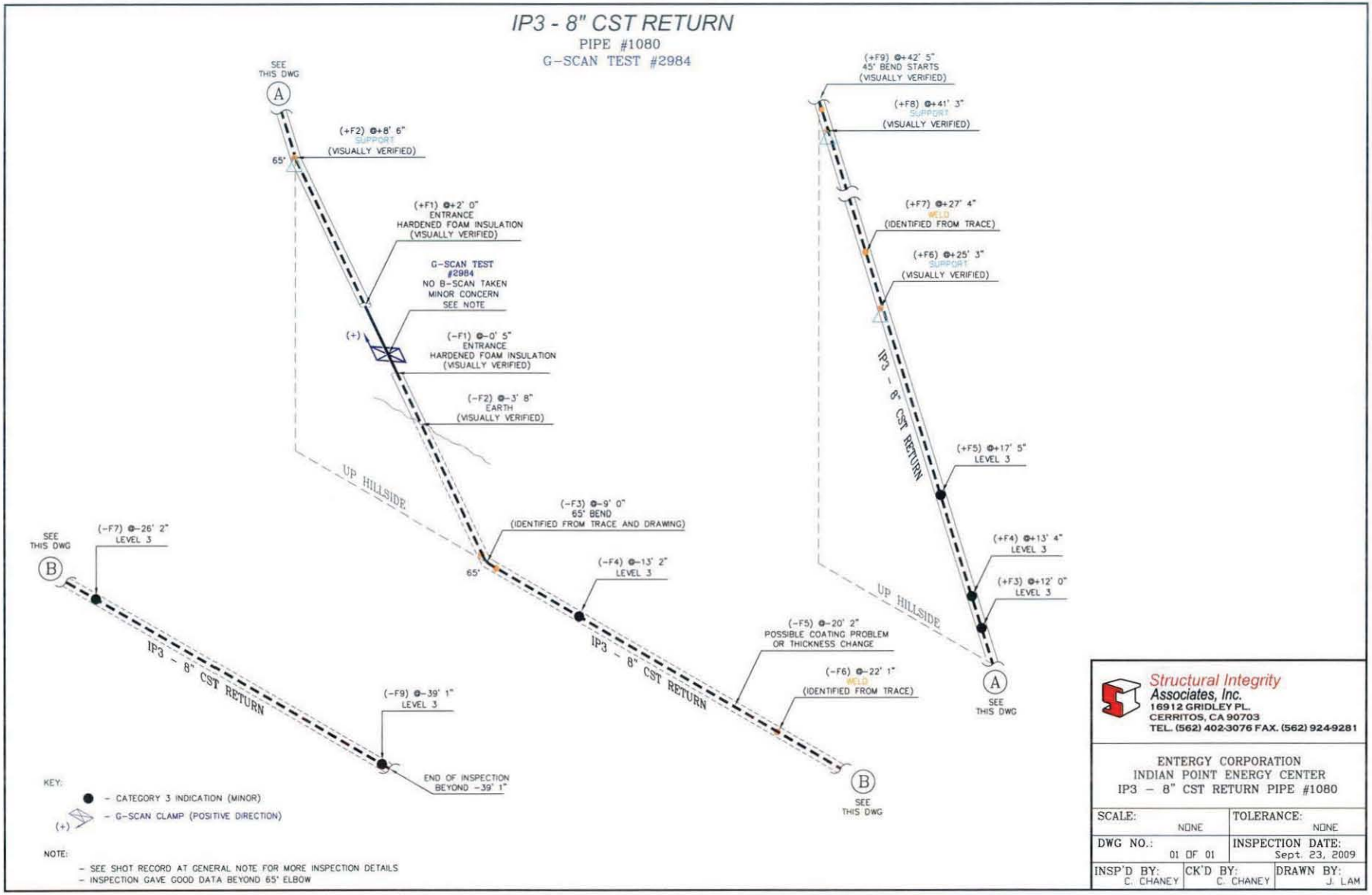

Figure 3.12: Location 3, Test Results from Shot 2984

3.8 Location 4, U2 8-Inch Condensate Return in FRV Building

3.8.1 Location Description

Figure 3.13 shows Location 4 on an 8-inch condensate return line to the condensate storage tank in an excavation in the feed regulator valve building.

General Info						Pipe Data					
Loc. #	Unit	Line Name	Line #	Location	G-Scan Test #	OD (inches)	Schedule	External Coating	Internal Lining	Material	Design Temperature
4	2	Cond. Ret. To CST	1509	FRV Bldg Excavation	2991	8	40	Coal Tar Enamel w/saturated asbestos	None	A-106 Gr. B	665 psig / 400°F

Figure 3.13: Location 4, 8-inch Line in an excavation in the FRV Building

Table 3.6: Test Result of Location 4, Shot 2991

Test ID:	G3-76#2991		
Pipe:	IP2 - 8" CST Return	Ring:	R2B08(900)
Site:	Indian Point, Unit 2	Configuration:	3.3FR, T(0,1)
Location:	Weld 1'5"	Calibration:	Automatic (2372.37 mV)
Size:	8 inch	Version:	3.97, Wavemaker G3-76
Tested:	23 Sept 2009 12:55	Client:	Indian Point
Tested by:	Craig Chaney	Procedure:	GU 1.1
		DACs:	Call=10%, Weld=23%

Summary: IP2-8" CST Return for Unit 2 in excavation that was in the feed regulator valve building. This section of line had through wall leaks in February 2009. This section of pipe was replaced in February 2009 and is the location of the transducer collar for this test. Minor corrosion indications were noted. This is a Level 3 test.

Feature	Location	Class	Notes
U1	-12'2"	End	
B1	-10'3"	Bend	Assumed from piping configuration
E1	-3'7"	Bitumen	Visually verified
B2	-3'0"	1D Bend	Visually verified
B3	-0'5"	1D Bend	Visually verified
W1	1'5"	Weld	Visually verified
W2	2'7"	Weld	Assumed from trace
E2	2'6"	Bitumen	Visually verified
E3	4'8"	Earth	Visually verified
A1	6'8"	Cat 3	Level 3 indication
A2	9'3"	Cat 3	Level 3 indication
A3	19'4"	Cat 3	Level 3 indication
U2	26'3"	End	
W3	33'3"	Weld	Assumed from trace.

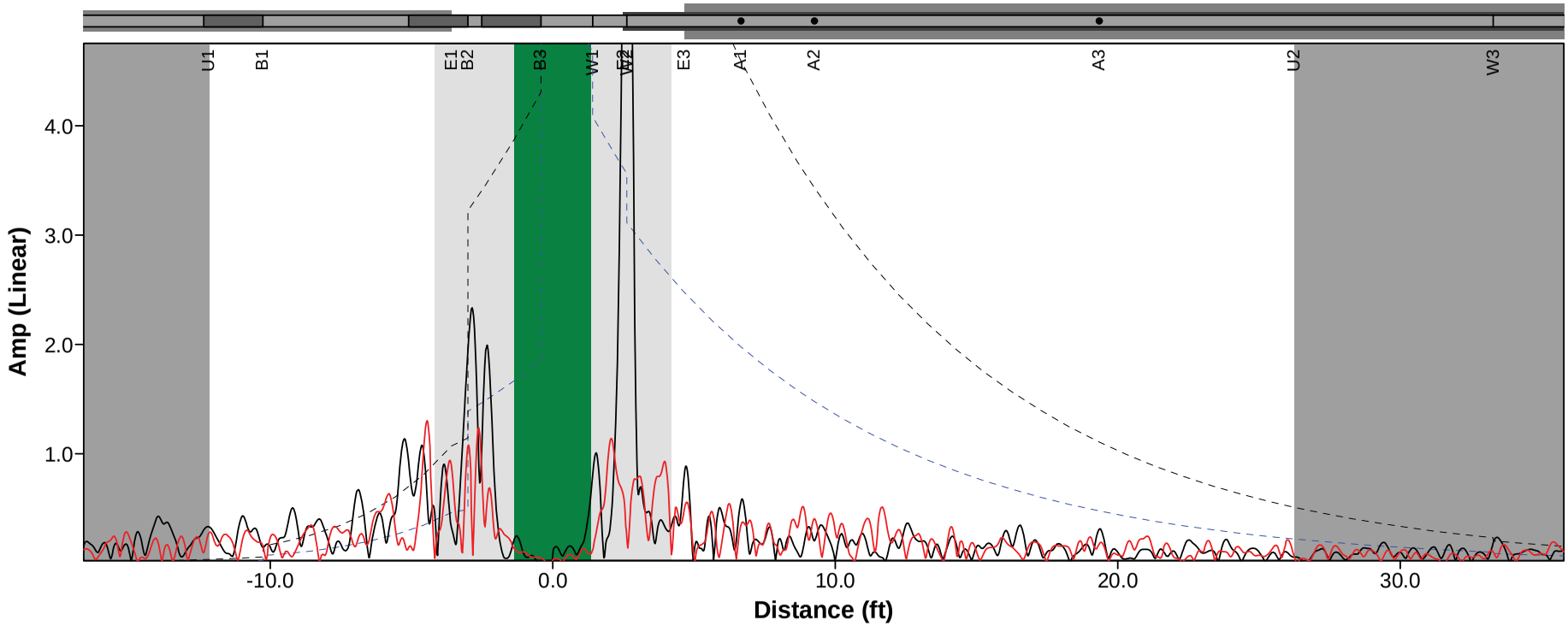

Figure 3.14: Trace of Shot 2991, Location 4

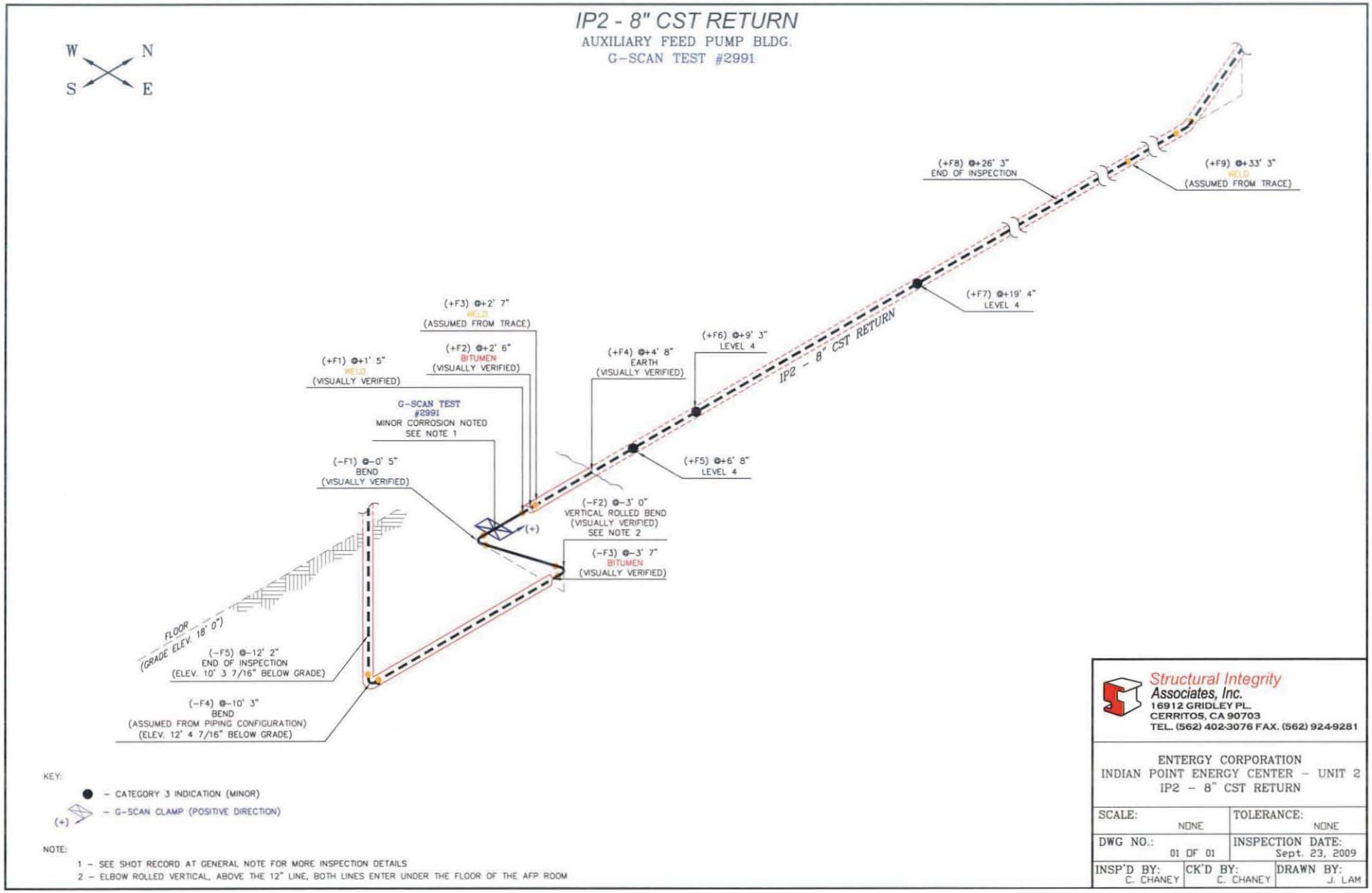

Figure 3.15: Location 4, Test Results from Shot 2991

3.9 Location 5, Unit 2 12-Inch Condensate Supply to AFP Building

3.9.1 Location Description

Figure 3.16 shows Location 5 on a 12-inch condensate supply line to the AFW pumps in an excavation in the auxiliary feed pump building.

General Info						Pipe Data					
Loc. #	Unit	Line Name	Line #	Location	G-Scan Test #	OD (inches)	Schedule	External Coating	Internal Lining	Material	Design Temperature
5	2	CST TO AFP	1505	AFP Bldg. Excavation	2993	12	40	Coal Tar Enamel w/saturated asbestos	None	A-53 Seamless or ERW, Gr. B	Full vacuum to 150 psig / 225 °F

Figure 3.16: Location 5, 12-inch Line in an excavation in the AFP Building

Table 3.7: Test Result of Location 5, Shot 2993

Test ID:	G3-76#2993		
Pipe:	IP2 - 12" AFP Suction	Ring:	R2B12(1368)
Site:	Indian Point	Configuration:	7.4FR, T(0,1)
Location:	Wall 3'0"	Calibration:	Automatic (6864.49 mV)
Size:	12 inch	Version:	3.97, Wavemaker G3-76
Tested:	23 Sept 2009	Client:	Indian Point
Tested by:	Craig Chaney	Procedure:	GU 1.1
		DACs:	Call=10%, Weld=23%

Summary: Unit 2 12" Aux Feed Pump Suction from CST in excavation. Several indications are observed in the piping towards the elbow. Because of the nature of these indications they are categorized as Level 2 indications.

Feature	Location	Class	Notes
E1	-3'7"	Earth	Visually verified
E2	-1'5"	Bitumen	Visually verified
E3	0'6"	Bitumen	Visually verified
E4	1'5"	Earth	Visually verified Partial earth coverage of pipe approximately 90 degrees
E5	3'2"	Earth	Visually verified Full coverage of pipe
A3	4'1"	Cat 2	Could be coating variation. Level 2
A4	5'1"	Cat 1	Could be coating variation. Level 2
A5	6'5"	Cat 3	Could be coating variation. Level 2
A6	7'4"	Cat 1	Could be coating variation. Level 2
B1	9'3"	Bend	Level 3
U2	11'3"	End	
W2	-8'8"	Weld	Weld has a high flexural response recommend follow-up UT examination, Level 3
A2	-22'11"	Cat 2	Level 3
A1	-25'2"	Cat 2	
W1	-28'2"	Weld	Level 3
U1	-28'7"	End	

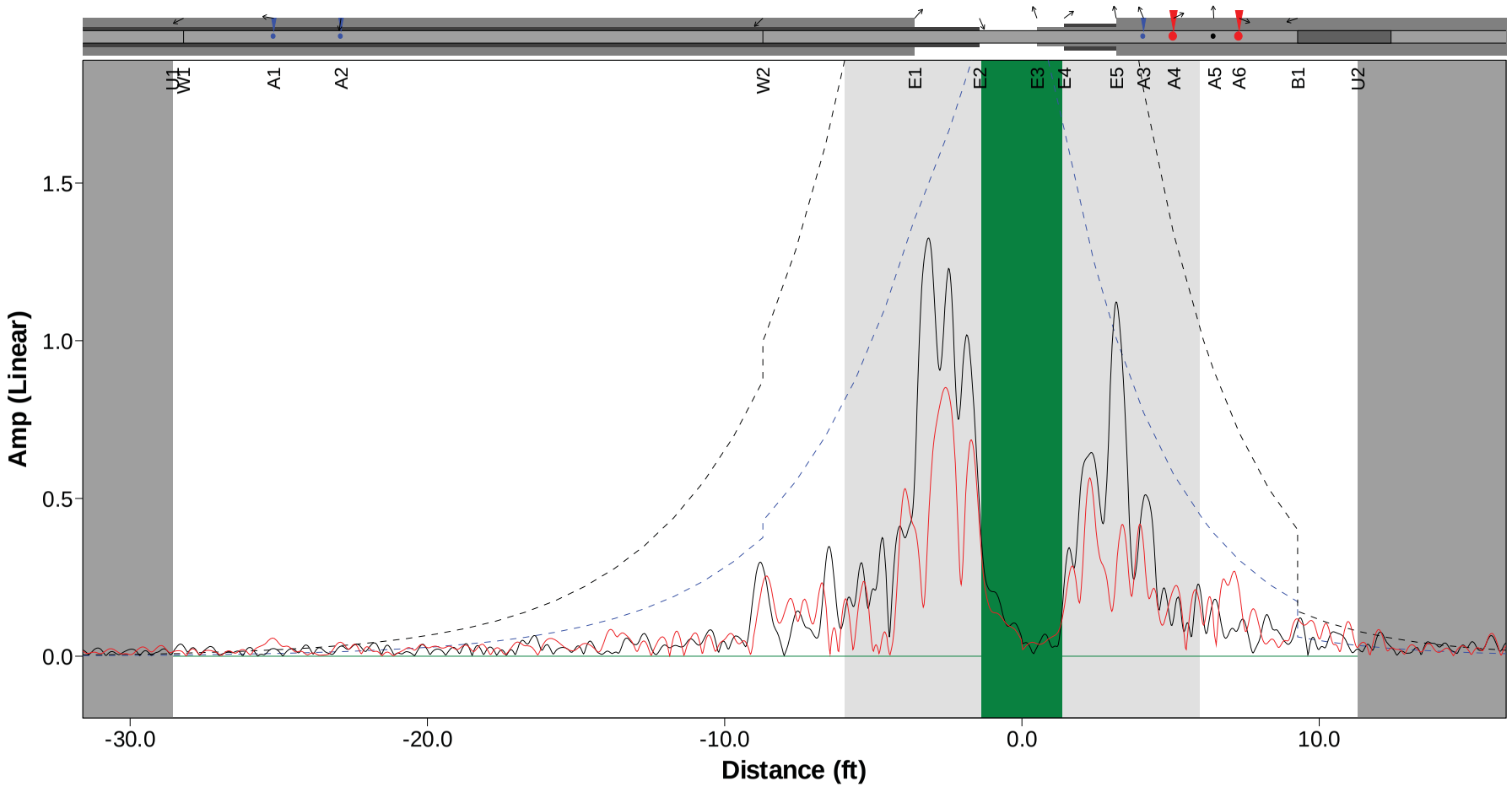

Figure 3.17: Trace of Shot 2993, Location 5

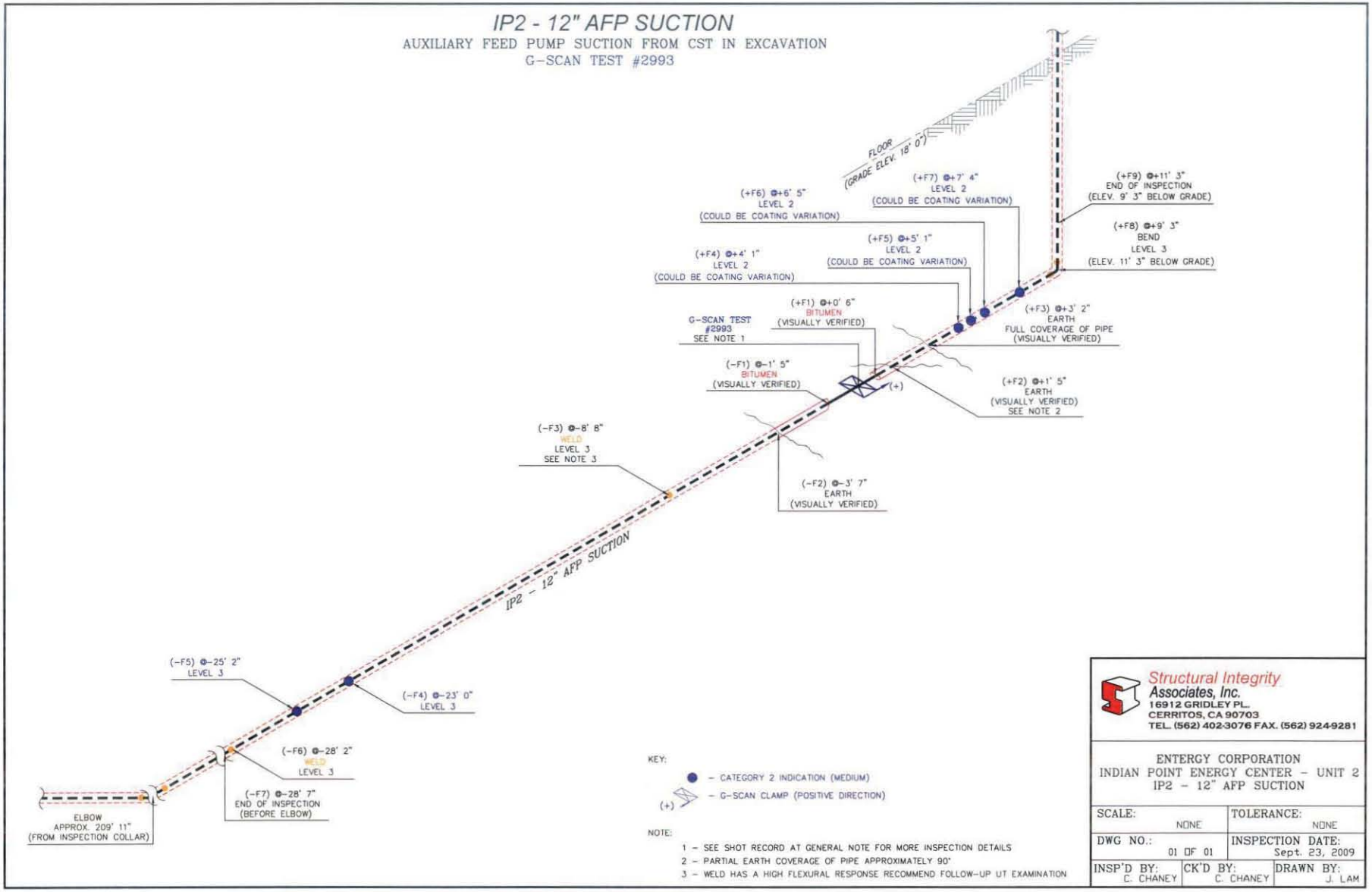

Figure 3.18: Location 5, Test Results from Shot 2993

3.10 Location 6, U3 CST to AFP Building, Bottom of Hill

3.10.1 Location Description

Figure 3.19 shows Location 6 on a 12-inch line from condensate storage tank to the AFP building at the bottom of the hill.

General Info						Pipe Data					
Loc. #	Unit	Line Name	Line #	Location	G-Scan Test #	OD (inches)	Schedule	External Coating	Internal Lining	Material	Design Temperature
6	3	CST to AFP	1070	Unit 3 CST to AFW Building at Bottom of Hill	2995	12	20	Coal Tar Enamel w/saturated asbestos	None	A-53 Seamless or ERW, Gr. B	Full vacuum to 150 psig / 225 °F

Figure 3.19: Location 6, 12-inch Line from CST to AFP Building

Table 3.8: Test Result of Location 6, Shot 2995

Test ID:	G3-76#2995		
Pipe:	IP3 - 12" AFW Suction	Ring:	R2B12(1368)
Site:	Indian Point	Configuration:	8.4FR, T(0,1)
Location:	Earth +3'11"	Calibration:	Automatic (2571.19 mV)
Size:	12 inch (.250")	Version:	3.97, Wavemaker G3-76
Tested:	23 Sept 2009	Client:	Indian Point
Tested by:	Craig Chaney	Procedure:	GU 1.1
		DACs:	Call=10%, Weld=23%

Summary: IP3 - 12" AFP Suction shot taken in the yard going up the hill. Minor corrosion noted under the collars of 0.025". Several corrosion like indications were identified in the buried section of the pipe. These indications are categorized as a Level 2.

Feature	Location	Class	Notes
U1	-44'7"	End	
B1	-59'3"	45 deg Bend	
B2	-43'1"	45 deg Bend	Visually verified
S1	-41'0"	Support	Visually verified
W1	-32'5"	Weld	From trace
S2	-25'0"	Support	Visually verified
S3	-19'8"	Support	Feature appears to be a support although no support was visible
S4	-18'2"	Support	Feature appears to be a support although no support was visible
R1	-2'3"	False Echo	From weld
S5	-8'10"	Support	Visually verified
E1	0'9"	Entrance	Insulation begins, visually verified
W2	2'2"	Weld	From trace
E2	3'11"	Earth	Visually verified
E3	4'2"	Bitumen	Assumed
A1	5'6"	Cat 2	Level 2 indications
B3	8'4"	45 deg Bend	Actually a 65 degree bend
A2	8'5"	Cat 2	Level 2 indications
A3	13'1"	Cat 2	Level 2 indications
A4	14'3"	Cat 2	Level 2 indications
A5	17'1"	Cat 3	Level 3 indications
A6	20'1"	Cat 3	Level 3 indications
U2	20'6"	End	

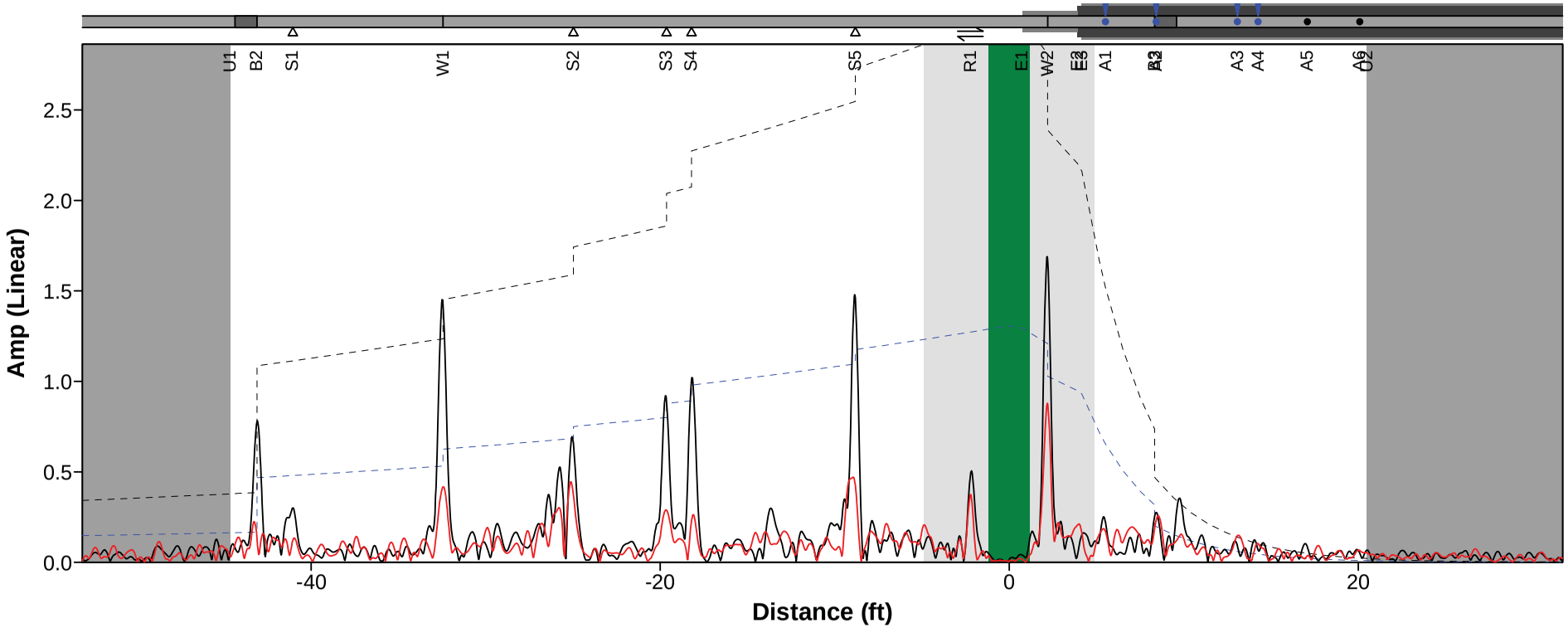

Figure 3.20: Trace of Shot 2995, Location 6

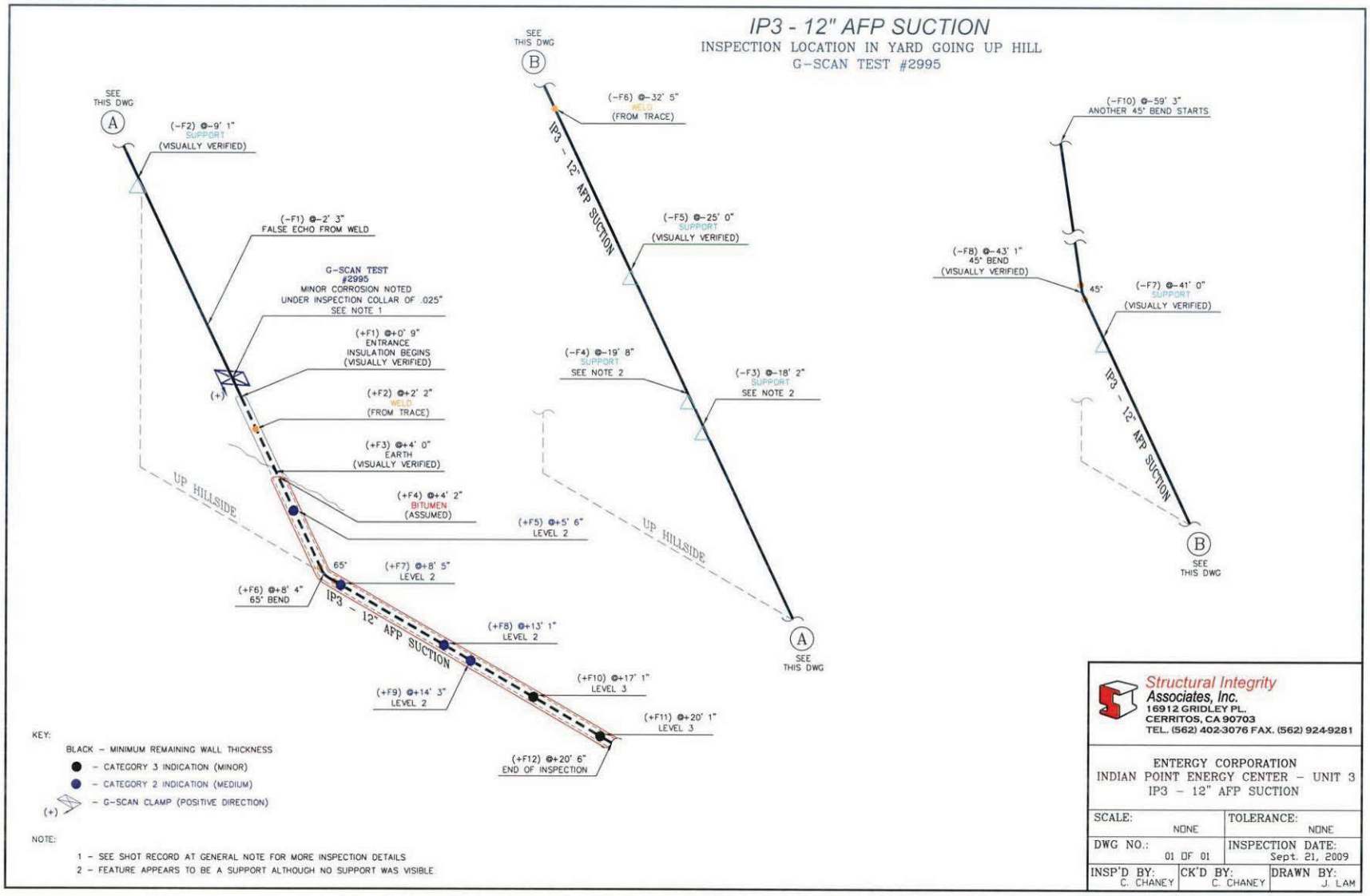

Figure 3.21: Location 6, Test Results from Shot 2995