National Transportation Safety Board
Internal Inspection Factual
Bellingham, Washington
Accident DCA99-MP008

Appendix 1 Tuboscope Report - November 18,1991

OLYMPIC PIPE LINE COMPANY

LINALOG JOB #2703

Fcrndalc Station to Allen Station
Allen Station to Rcnton Station
Surveyed November of 1991

PREPARED
BY
MICHAEL MASCIOPINTO
TUBOSCOPE LINALOG INC.
2835 HOLMES ROAD
HOUSTON, TEXAS
713/799-5430

DECEMBER 17, 1931

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LIST OF FIGURES

TUBO 000221

SURVEY SYNOPSIS

SECTION — FERNDALE STATION to ALLEN *STATION*

Pipeline Description

rhis section **of** Olympic Pipe Line, **16"** gasoline line was survcycd by Linalog in November of **1991.** The section, located in Washington, begins in Fcrndalc and erminates in Allen.

rhis **37.41** mile section of **16"** diameter pipeline is composed of Grade **X-52, ERW** pipe. The section consists of .312" nominal wall pipe.

Survey History With Linalog

rhis pipeline was surveyed once previously by Tuboscope Linalog in Dcccmber of 1980, under job number **1083.**

Inspection Tool Run

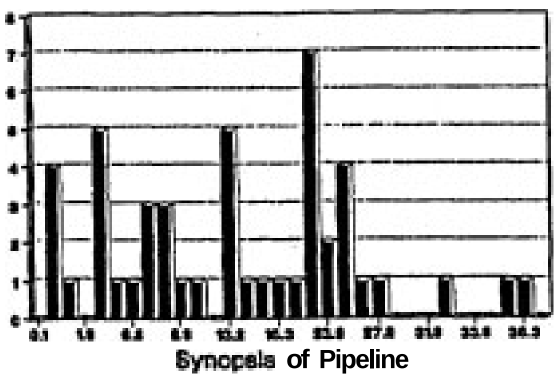
Two runs were necessary for a complete survey. The first survey run, launched November **13,** encountered problems with survey tool channel **16.** The second survey run, launched November **18,** was successful. The run lastcd approximately **8.48** hours with **a** flow rate averaging **4.4** miles per hour. Many of the Linacron marker stations were missed on this run and therefore were transferred from survey run number 1. No other major survey problems were rcportcd on this run.

Verification Dig Areas

No verification digs were conducted **by** Linalog on this section.

RESULTS

The completed Linalog survey of the 16" Ferndale Station *to* Allcn Station scction resulted in thc following findings:



Total Numbcr of:
- Gradc A Joints....................3
- Gradc 1 Joints..................43
- Gradc 2 Joints 4
- Gradc 3 Joints....................0

The results listcd above are thc total numbcr of graded joints on this scction of pipclinc. *For a more detailed listing* of *the graded joints, refer to appendix 2B.*

SECTION

ALLEN STATION to RENTON STATION

Pipeline Description

rhis section of Olympic Pipe Line, 16" gasoline line was survcycd by Linalog in November of **1991.** The section, located in Washington, bcgins in Allcn and erminates in Renton.

This **75.64** mile section of **16"** diameter pipeline is composcd of Gradc **X-52, ERW** pipe. The section consists of **312"** nominal wall pipe. Thc pipclinc also contains iome .500" nominal wall pipe.

Survey History With Linalog

This is an initial survey by Tuboscopc Linalog.

Inspection Tool Run

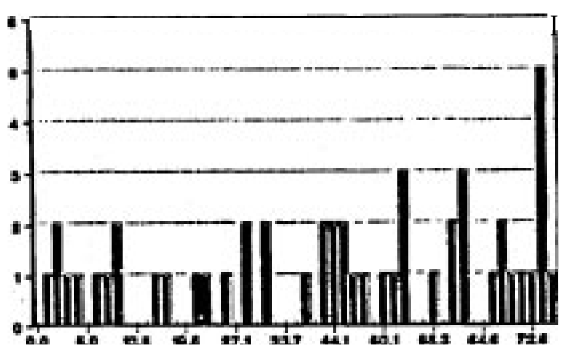
Two runs were necessary for **a** complete survey. The first survcy run, launched November **15**, lasted approximately 14.65 hours with a flow ratc of **5.16** milcs per hour. The run encountered problems with survey tool channel **17** and both markcr channcls damaged in the pipeline. The second survey run, launchcd Novcmbcr **18,** lasted approximately **17.05** hours with **a flow** rate averaging **4.4** milcs pcr hour. The run encountered problems with survey channels damagcd **as** thc tool passcd through Woodinville Station at wheel count **261,882.** Therefore, run numbcr I was used as the log of record, and run number **2** was used to aid and vcrify full survey coverage of the line. **No** other survey problems werc rcportcd on this run.

Verification Dig Areas

No verification digs were conducted by Linalog on this section.

RESULTS

The completed Linalog survey of the **16"** Allen Station to Rcnton Station scction resultcd in thc following findings:



Synopsis of Pipeline

Total Numbcr of: Gradc **A** Joints..................21
Grodc **1** Joints..................43
Gradc **2** Joints _____ 7
Gradc **3** Joints..................0

Thc rcsults listcd abovc nrc thc total numbcr of gradcd joints on this scction of pipclinc. *For a more detailed listing* **of** *the graded joints, refer to appendix 2B.*

CONCLUSION

The results listed here and in Appendix **2B** are Linalog's best evaluation of the ondition of these sections at the time of their surveys. This evaluation is based n information provided by the customer and data gathered from similar surveys.

Accompanying this report is one master log copy and one photocopy of cach'the urveys. This report is the final element of the the Linalog survcy process.

Thank you for your trust and confidence in Linalog. For clarification of any spect of the survey, please contact our office. We wclcomc the opportunity to rovide continued service lo Olympic Pipe Line Company.

SURVEY RESULTS

INTRODUCTION

The complete survey results can be examined by carefully studying the Linalog Survey log. However, often a summary of the results may be more helpful than the lengthy survey log. **Two** types of summaries are available: the Linalog Results Summary Spreadsheet or the Linalog Computer Enhanced Report **(LCER).** Each of these summaries includes a graph which illustrates the information listed on the summary.

Results Summary Spreadsheet

The Results Summary Spreadsheet, Figure 2.1, is the basic summary provided by Tuboscope **at no** additional cost. It is a simple listing of the markers, their locations, and the number of graded pints between the markers.

Computer Enhanced Report

The optional Computer Enhanced Report, is a comprehensive spreadsheet containing all of the key information about the graded anomalies on the pipeline. See Figure **2.2.**

Job 3000 Pipeline Company 16" Station 3 to Station 4 Run 1 January 1, 1989 Page 1

Pipeline Feature	Mile Post	Map Station	Map Distance	Wheel Count	Wheel Distance	Comments	Grade Tabulation U	1	2	3
Launch	0.00 *	0	0	18	0		0	1	0	1
Magnet	0.38 *	1782	1782	1838	1828		0	1	0	0
Magnet	0.63 *	3329	1557	3292	1554		0	1	1	0
Magnet	0.84 *	4424	1095	4478	1186		0	1	0	0
Valve	1.04 *	5492	1068	5553	1075		0	0	0	0
Valve	1.46 *	7714	2222	7778	2225		0	0	0	0
Magnet	2.17 *	11463	3751	11582	3724		0	0	0	0
Valve	2.74 *	14443	2978	14499	2957		0	0	0	0
Trap	3.09 *	16340	1897	16348	1849					
Feet of Line		16328								
Miles of Line		3.09					0	4	1	1

Figure 2.1. **Results Summary** spreadsheet Format

Job 3000 Pipeline Company 16" Station 3 to Station 4 - Run 1 January 1, 1989 Page 1

Pipeline Feature	Mile Post	Map Station	Map Distance	Wheel Count	Wheel Distance	Distance to Nearest * Marker Upstream	Distance to Nearest * Marker Downstream	1988 Grade	Distance from Upstream Weld	Distance from Upstream O'Clk	Comments	Grade Tabulation U	1	2	3
Launch	0.00 *	0	0	18	0	0	1828								
Grade 1 Joint	0.13	682	682	633	615	615	1205	1	6	12.09					
Weights	0.19	987	305	944	311	926	894				4 Weights				
Grade 3 Joint	0.25	1335	248	1198	254	1380	648	3	25	6.30					
Begin Casing	0.33	1621	466	1674	476	1656	164								
End Casing	0.36	1700	79	1754	80	1736	84					0	1	0	1
Magnet	0.38 *	1782	82	1838	84	1828	1554								
Grade 1 Joint	0.47	2329	547	2384	546	546	1008	I	8	4.83		0	1	0	0
Magnet	0.63 *	3329	1010	3292	1000	1554	1086								
Grade 1 Joint	0.67	3529	199	3582	198	198	876	1	16	5.03					
Grade 2 Joint	0.78	4133	604	4187	605	795	291	2	21	18.49		0	1	1	0
Magnet	0.84 *	4424	291	4478	291	1086	11878								
Grade 1 Joint	1.98	10442	6018	10473	5995	5995	5875	1	6	12.03					
Trap	3.09 *	16340	5898	16348	5875	11878	0					0	1	0	0
Feet of Line	16328														
Miles of Line	3.09							Total for Pipeline				0	4	1	1

Figure 2.2. Computer Enhanced Report Format

A more detailed analysis of each of the summaries and their accompanying graphs follows this brief comparison.

RESULTS SUMMARY SPREADSHEEJ PACKAGE

The Results Summary Package includes the Results Summary Spreadsheet and its accompanying graph. The Results Summary Spreadsheet lists a variety of information about the pipeline reference points and the approximate locations of the graded joints. The actual data for this survcy can be found in Appcndix 2B of this section of the report.

Results Summary Spreadsheet Columns

The listing is divided into 12 columns of information (see Figure 2.3). An explanation of each column follows:

Pipeline Feature. This column contains the above ground and below ground pipeline features ustd as reference markers during the survey. The reference markers are easily recognized by the blank line preceding them and the asterisk (*) appearing to the right of them Also listed in this column are the match points which occur between the consecutive rolls of the survey log.

Asterisk (*). This column provides a quick reference for distinguishing reference markers from temporary features, such as survey log match points Each reference marker will have an asterisk (*) appearing to the right of it.

Mile Post This column originates from the mile post numbers supplied by the pipeline company. Supplied numbers are usually listed for each reference marker. From these numbers, the mile post numbers for the match points are calculated. If the mile post number for a particular reference marker is not supplied, this column will be blank until the next reference marker with a supplied mile post number is reached. If no mile post numbers art supplied, this column will not appcar on the Results Summary Spreadsheet.

Map Station. This column originates from the map station numbers supplied by the pipeline company. Supplied numbers are usually listed for each reference marker. From these numbers, the map station numbers for the match points are generated. If the map station number for a particular reference marker is not supplied, this column will be blank until the next reference marker with a supplied map station number is reached.

Station numbcrs should only be ustd for locating general arcas. Specific mcasurcments should be based on the information supplicd on the distancc channcl of the log.

Map Distance. This column contains the distance from the previous pipeline feature to the current one, based on the supplied map station numbers.

Job 3000 Pipeline Company 16' Station 3 to Station 4 Run 1 January 1, 1989 Page 1

Pipeline Feature	Mile Post	Map Station	Map Distance	Wheel Count	Wheel Distance	Comments	Grade Tabulation U	1	2	3
Launch	0.00 *	0	0	18	0					
							0	1	0	1
Magnet	0.38 *	1782	1782	1838	1820					
							0	1	0	0

Figure 2.3. Results Summary Spreadsheet Column

Results Summary Spreadsheet Columns (continued)

Wheel Count. The wheel count is the cumulative number of feet traveled by the tool, as recorded by the tool's distance wheel and registered on the distance channel on the log. This information should be used for all detailed excavations. See Figure 2.4 below.

Wheel Distance. This Column lists the distance from the previous pipeline feature to the current one, based on the recorded wheel counts on the distance channel.

Comments. The use of this column is left to the discretion of the Log Analyst. It may contain such comments as "Calculated Mile Post" or "Transferred from Previous Survey". Pertinent data will be noted in this column as space permits.

Grade Tabulation. This section tabulates the number of graded joints (Us, 1s, 2s, and 3s) between reference markers. Subtotals of the number of graded joints in each category are given between reference markers.

At the end of the report, the length of the pipeline is listed and final grade **totals** are given for each classification (see Figure 2.4).

Job 3000 Pipeline Company 16' Station 3 to Station 4 Run 1 January 1, 1989 Page 1

Pipeline Feature	Mile Post	Map Station	Map Distance	Wheel Count	Wheel Distance	Comments	Grade Tabulation U	1	2	3
Launch	0.00 *	0	0	18	0					
							0	1	0	1
Magnet	0.35 *	1782	1782	1838	1828					
							0	1	0	0
Magnet	0.63 *	3339	1557	3392	1554					
							0	1	1	0
Magnet	0.84 *	4424	1085	4478	1086					
							0	1	0	0
Valve	1.04 4	5492	1068	5553	1075					
							0	0	0	0
Valve	1.46 4	7714	2222	7778	2225					
							0	0	0	0
Magnet	2.17 •	11465	3751	11502	3724					
							0	0	0	0
Valve	2.74 *	14443	2978	14499	2997					
							0	0	0	0
Trap	3.09 *	16340	1897	16348	1849					
Feet of Line		16330								
Miles of Line		3.09					0	4	1	1

Figure 2.4. Results Summary Spreadsheet Columns

Results Summary Graph

The Results Summary Graph is included with both the Results Summary Spreadsheet Package and the Computer Enhanced Report Package. It is a visual digest of the information on the Results Summary Spreadsheet The graph below, Figure 2.5, is only an example. The actual graphs for this survey can be found in Appcndix 2A of this section of the report. The graph is set up in the x/y format. The x-axis (horizontal axis) is a measure of distance in miles along the pipeline, with the marker locations listed. The distance is based on the wheel count recorded by the Linalog Tool. On the y-axis (vertical axis), a scale of the number of graded joints appears.

The body of the graph is set up in a stack format. The grading category subtotals are stacked between the reference marker locations to show the relative amounts of graded joints between the reference markers.

The legend below the graph explains the shading of the stacks. A different type of shading is assigned to each of the corrosion grading categories. (Grade U Joints are not listed.) BY relating the height of the stack to the scale on the y-axis, the total number of graded joints in each area can be determined.'

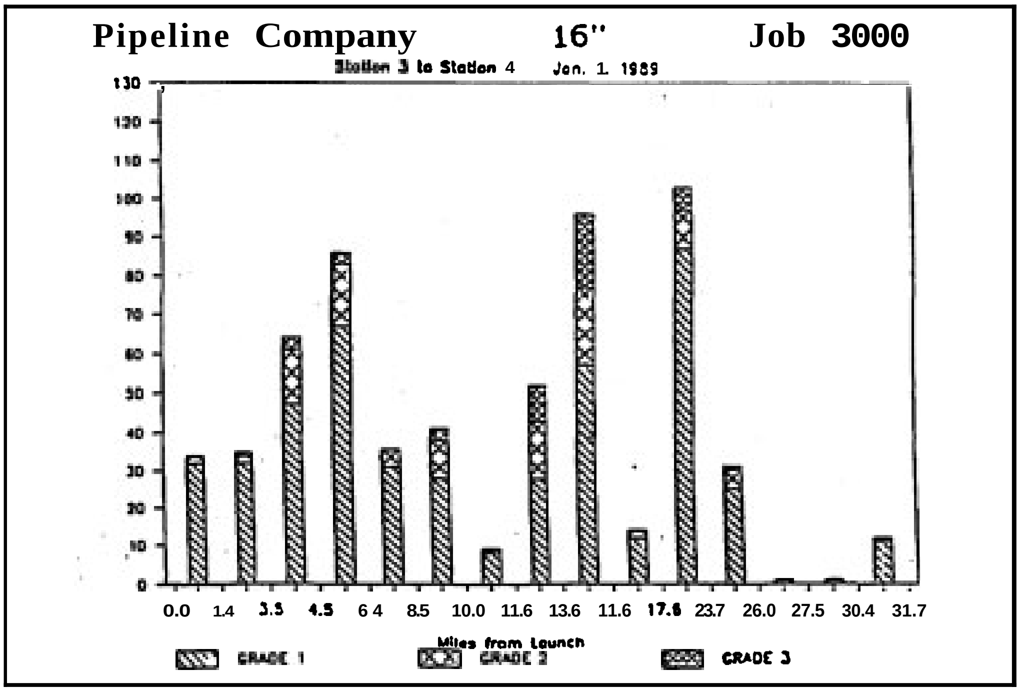


Figure 2.5. Results Summary Graph

The graph displays the cumulative graded joints between reference markers. The corrosion levels of the various segments of the pipeline can be easily compared. General areas of corrosion can be located rapidly. Marker placement for the next survey can be evaluated. The graph provides an easy way to view the overall condition of the pipeline.

COMPUTER ENHANCED REPORT PACKAGE

The Results Summary Spreadsheet and the Computer Enhanced Report are very similar in format However, the Computer Enhanced Report contains more detailed data than the Rcsults Summary Spreadsheet. Five additional columns of information for locating anomalies on the pipeline arc supplied on the Computer Enhanced Report. The example below, Figure 26, shows the format of the first 12 columns of information, as presented on the Computer Enhanced Report option The actual data for this survey can bc found in Appcndix 2B of this section of the report.

Job [illegible] Pipeline Company 16" Station 3 to Station 4 Run 1 January 1, 1389

Pipeline Feature	Mile Post	Map Station	Map Distance	Wheel bunt	Wheel Distance	Distance to Nearest Upstream	* Marker Downstream	1988 Grade	Distance from Upstream Weld	O'clk	Comments
Launch	0.00 *	0	0	18	0	0	1820				
Grade 1 Joint	1.13	602	602	633	615	615	1205	1	6	12.00	
Weights	1.19	907	305	944	311	926	894				4 Weights
Grade 3 Joint	0.25	1155	248	1190	254	1180	640	3	25	6.00	
Begin Casing	0.35	1621	466	1674	476	1656	164				

Figure 2.6. Computer Enhanced Report Columns

Computer Enhanced Report Columns

Clarification of each of the columns is given below:

Pioeline Feature. This column contains the above ground and bclow ground pipeline features which appear on the survey log (see Figure 2.6). All features, including the graded pipe joints, are listed in this column. Those features that can be located above ground, such as valves, magnets, taps, and tees, are used as pipeline reference markers.

Asterisk (*). This column provides a quick reference for distinguishing reference markers from other features, such as graded joints and casings. The reference markers are easily recognized by the blank line preceding them and the asterisk (*) appearing to the right of them.

Mile Post. This column originates from the mile post numbers supplied by the pipeline company. Supplied numbers are usually listed for each reference marker. From these numbers, the mile post numbers for the graded joints and pipeline features are calculated. If the mile post number for a particular reference marker is not supplied, this column will be blank until the next reference marker with a supplied mile post number is reached. If no milc post numbcrs are supplied, this column will not appear on the Results Summary Spreadshcct.

Map Station. This column originates from the map station numbers supplied by the pipeline company. Supplied numbers are usually listed for each reference marker. From these numbcrs, the map station numbers for the graded joints and pipeline features are generated. If the map station number for a particular reference marker is not supplied, this column will be blank until the next reference marker with a supplicd map station number is reached.

Calculatcd station numbcrs should only bc uscd for locating gcncral arcas. Spccific mcasurcmcnts should be bascd on thc information supplicd in thc distancc channcl of thc log.

Map Distancc. This column contains thc distancc from thc prcvious pipclinc feature to thc currcnt onc, bascd on thc supplied map station numbcrs.

TUBO 000231

Computer Enhanced Report Columns (continued)

Wheel Count. The wheel count is the cumulative number of feet traveled by the tool, as recorded by the tool's distance wheel and registered on the distance channel on the log. This information should be used for all detailed excavations. See Figure 2.7 below.

Wheel Distance. This column lists the distance from the previous pipeline feature to the current one, based on the recorded wheel counts on the distance channel.

Distance to Nearest * Marker Upstream/Downstream. These columns refer to the distance, in feet, from a "Pipeline Feature" to its nearest upstream reference marker (*) and its nearest downstream reference marker (*).

1987 Grade. All of the previous grades, except those associated with joints in excessive tool speed areas, are listed in this column.

1989 Grade. This column replicates the graded joint entries listed in the "Pipeline Feature" column. It is provided to facilitate easier location of the graded joints on the Computer Enhanced Report.

Distance From Uostream Welds. This figure refers to the distance, in feet, from the upstream girth weld to the graded anomaly in the joint of pipe. This measurement comes directly from the distance channel on the log.

O'clk. This column gives the o'clock position (facing downstream) of the largest gradable anomaly indication in the pipe joint.

Comments. The use of this column is left to the discretion of the Log Analyst. It may contain such comments as' "Corrosion in Casing" or "Possible Tap".

Grade Tabulation. This section tabulates the number of graded joints (Us, 1s, 2s, and 3s) between reference markers. Subtotals of the number of graded joints in each category are given between reference markers. At the end of the report, the length of the pipeline is listed and final grade totals are given for each classification.

Station 3 to Station 4 Run I January 1, 1989

Wheel Count	Uheel Distance	Distance to Nearest * Marker Upstrean	Distance to Nearest * Marker Downstream	1987 Grade	1983 Grade	Distance from Upstream Weld	O'clk	Comments	Grade Tabulrtion U	1	2	3
18	0	█	1820									
633	615	615	1205	1	I	6	12.00					
944	311	926	894					. 4 Weights				
1198	254	1180	640	2	3	26	6.00					
1674	476	1656	164									
1754	80	1736	84						0	1	0	1
1838	84	1820	1554									
2384	546	546	1008	1	1	26	4.00		0	1	0	0
3392	1008	1554	1086									

Figure 2.7. Computer Enhanced Report Columns

Computer Enhanced Report Graph

The Computer Enhanced Report Package includes both the Results Summary Graph (see page **2.4)** and the Computer Enhanced **Report** Graph. The Computer Enhanced Report Graph is a pictorial representation of the overall condition of the pipeline. The graph below, Figure **2.8**, is only an example. **The** actual graphs for this survey can be found in Appendix 2A **of** this section of the **report** The graph is set up in the x/y format. The x-axis (horizontal axis) is a linear measure of distance along the pipeline. On the y-axis (vertical axis), some of the pipeline **features** appear. The pipeline measurement is the distance in feet from the launch, as measured by the tool's distance wheels. The pipeline features displayed on the graph are the reference markers and the graded pipe joints **(Us, Is, 2s,** and **3s).**

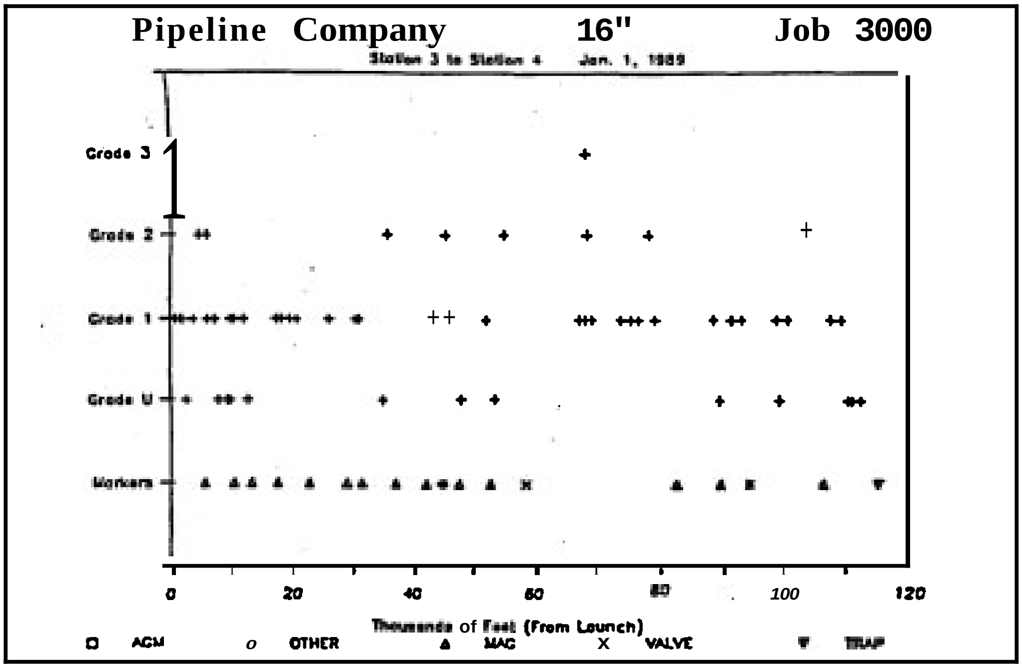


Figure 2.8. Computer Enhanced Report Graph

In the body of the graph, various symbols appear. Each plus symbol (+) represents **a** grade on the log at the corresponding distance location. **The** marker symbols represent the reference markers on the Computer Enhanced Report. **A** legend appears below the graph denoting the meaning of each marker symbol.

The graph illustrates pipeline characteristics which art otherwise difficult to observe. The corrosion levels of the various segments of the pipeline can **be** easily compared. The approximate location of each graded pint can be found. **The** approximate locations of all of the joints in a particular grading category, such **as** the Grade 3 Joints, can be determined. Corrosion problem spots **can be** located rapidly; and, marker placement for the next survey **can bc** evaluated. The graph is a clever tool for viewing the overall condition of the entire pipeline at a glance.

LOCATING ANOMALIES ON THE PIPELINE

By using the Linalog Survey **Log,** desired areas of interest can be accurately located on the pipeline. Typical areas of interest include corrosion, mashes, and unidentified anomalies.

The following steps should be taken to accurately locate an area of interest: Note: For customers choosing the Computer Enhanced Report option, the information needed in steps 1, **2**, ***5***, and **7** below appears **on** the Computer Enhanced Report (see Figure ***2.9*** below).

1. Choose an area of interest on the survey log.
2. Find the nearest marker upstream or downstream from the area of interest. Note the distance and direction from the marker to the area.
3. Go to the upstream or downstream marker (whichever applies) on the pipeline, and measure the distance determined above. Be sure to measure in the correct direction (upstream or downstream) from the specified marker.
4. Begin digging at this point to locate the upstream weld of the area of interest.
5. After locating the weld, determine the distance from the weld to the anomaly by referring to the survey log.
6. Measure this distance from the upstream weld to the anomaly.
7. To further aid in locating the area, note the anomaly's o'clock position on the log. (See the section entitled "Orientation Channel" for information on determining o'clock positions on the log.) O'clock positions on the pipeline are found by looking downstream, toward the receiver trap, and counting around the pipe circumference in a clockwise direction (Note: The top of the pipe is considered the **12** o'clock position.)

Locating Anomalies with the Computer Enhanced Report

Job 3000 Pipeline Company 16" Station 3 to Station 4 Run 1 January 1, 1989

Pipeline Feature	Mile Post	Map Station	Map Distance	Wheel Count	Wheel Distance	Distance to Nearest Marker Upstream	Distance to Nearest Marker Downstream	1988 Grade	Distance from Upstream Weld	O'clk	Comments
Launch	0.00 *	0	0	18	0	0	1820				
Grade I Joint	0.13	682	682	633	615	615	1205	1	6	12.00	
Weights	0.19	907	305	944	311	926	894				4 Weights
Grade 3 Joint	0.E	1155	248	1190	254	1180	640	3	26	6.00	
Begin Caring	0.35	1621	466	1674	476	1656	164				
End Casing	0.36	1700	79	1754	80	1736	84				
Magnet	0.38 *	1782	82	1838	84	1820	1554				
Grade I Joint	0.47	2329	547	2384	546	546	1008	1	26	4.00	
Magnet	0.63 *	3339	1010	3392	1008	1554	1086				
Grade I Joint	0.67	3529	190	3582	190	190	896	1	16	5.00	
Grade 2 Joint	0.78	4133	604	4187	605	795	291	2	21	10.00	
Magnet	0.84 *	4424	291	4478	291	1086	11870				
Grade I Joint	1.98	10442	6018	10473	5995	5995	5875	1	6	12.00	
Trap	3.09 *	16340	5898	16348	5875	11870	0				

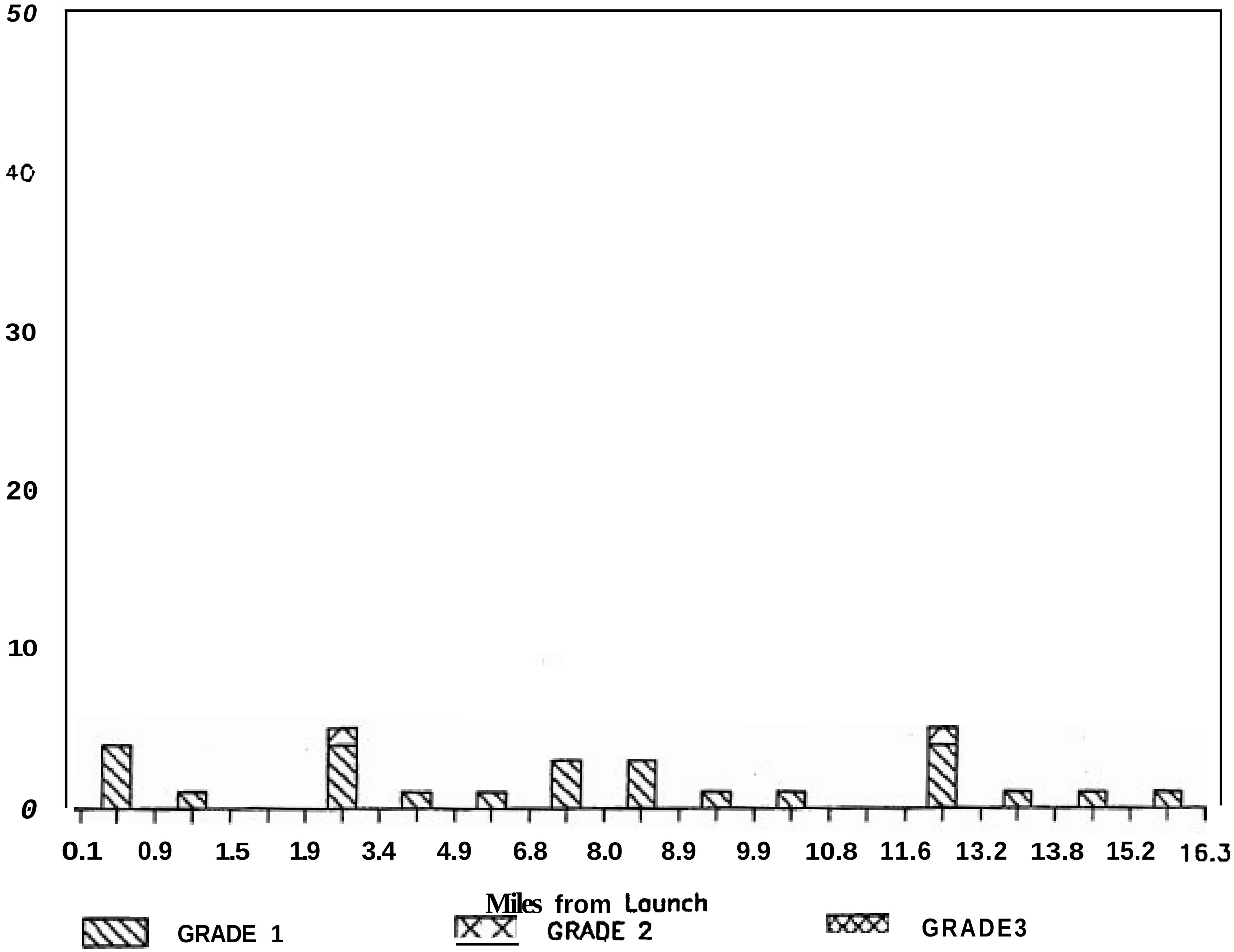
Figure 2.9. Locating Anomalies

APPENDIX 2A

Linalog Results Summary Graphs

Olympic Pipe Line Co. 16" Job 2703.01

Ferndale Sta. to Allen Sta. 11/18/91



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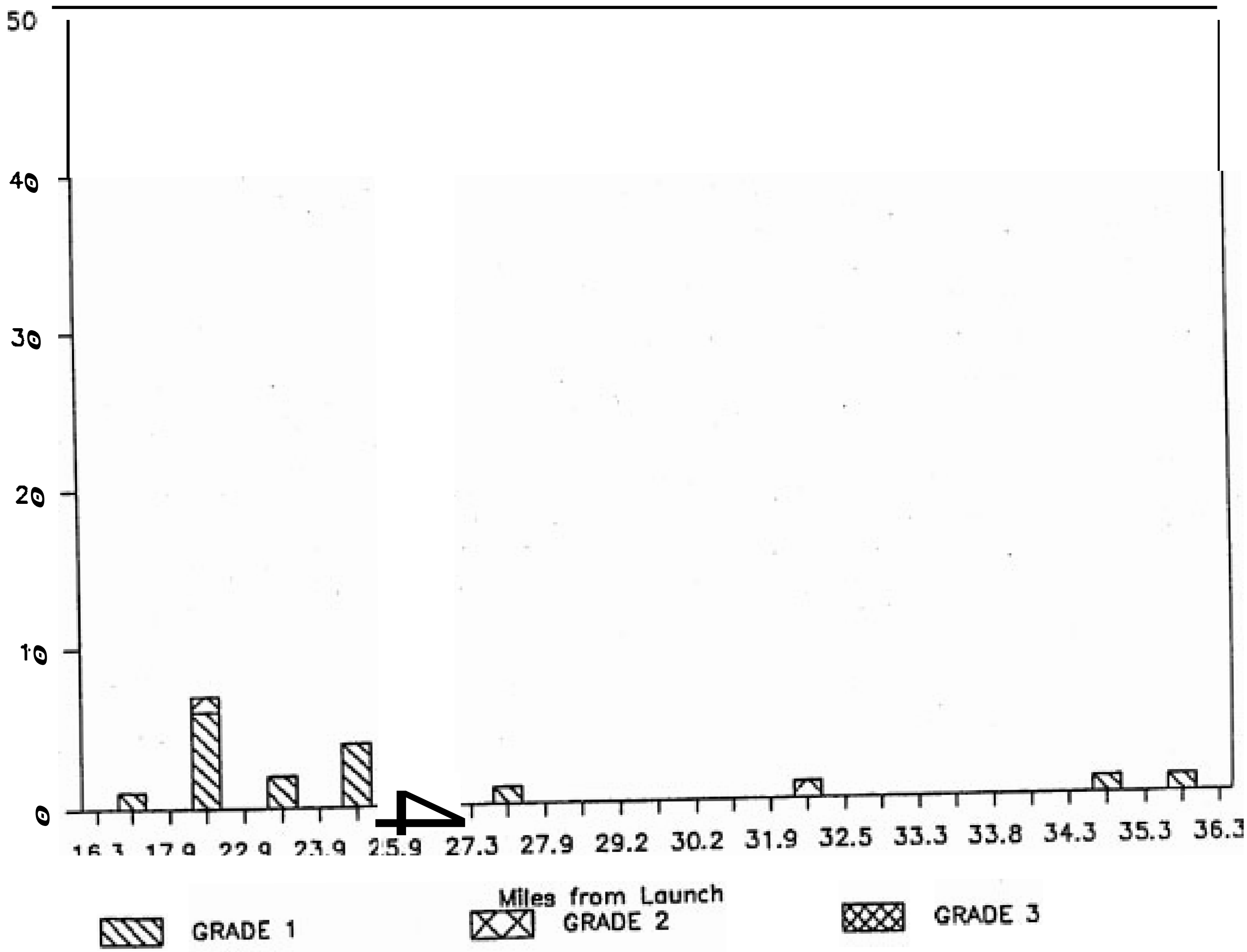
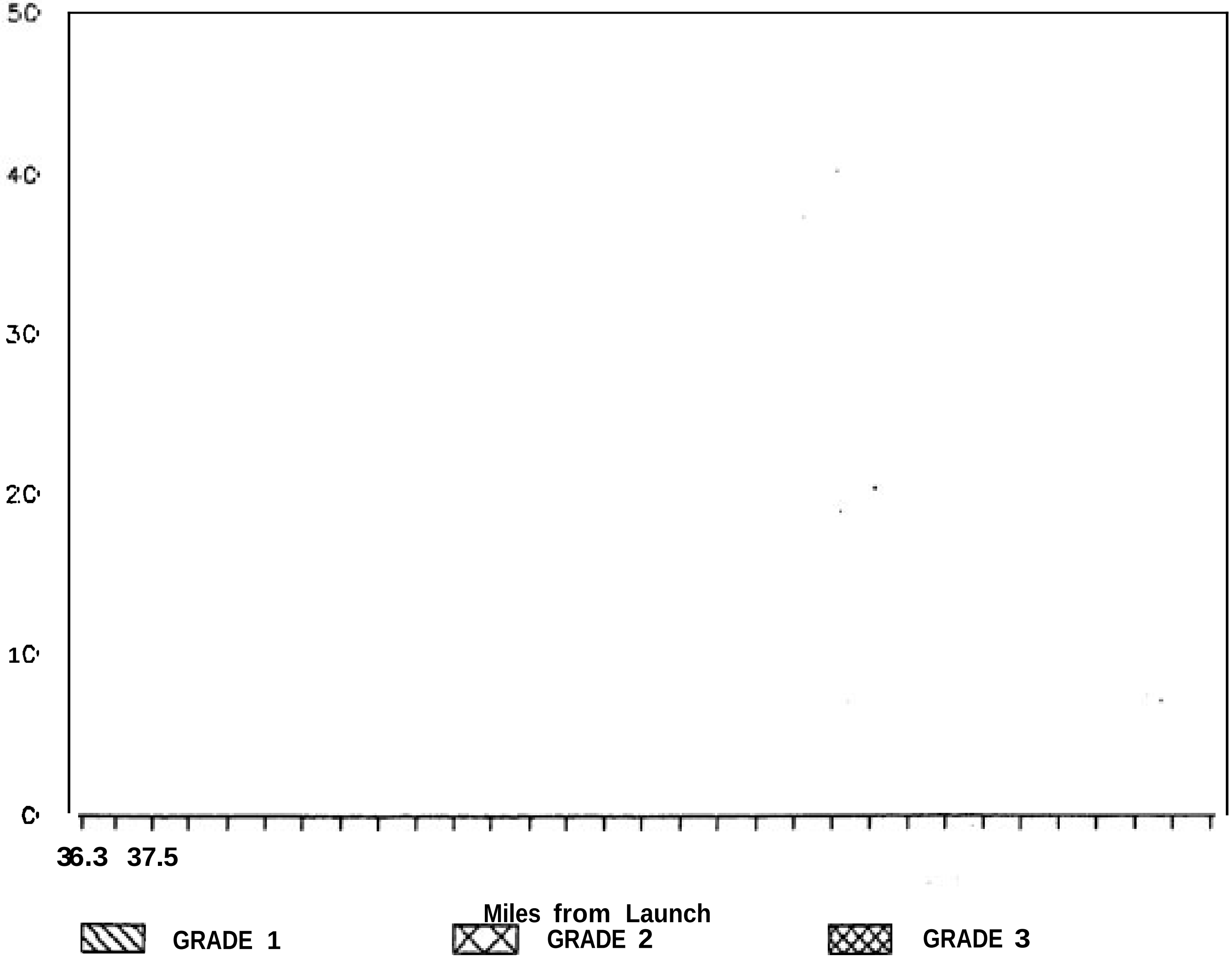
Olympic Pipe Line Co. 16" Job 2703.01

Ferndale Sta. to Allen Sta. 11/18/91



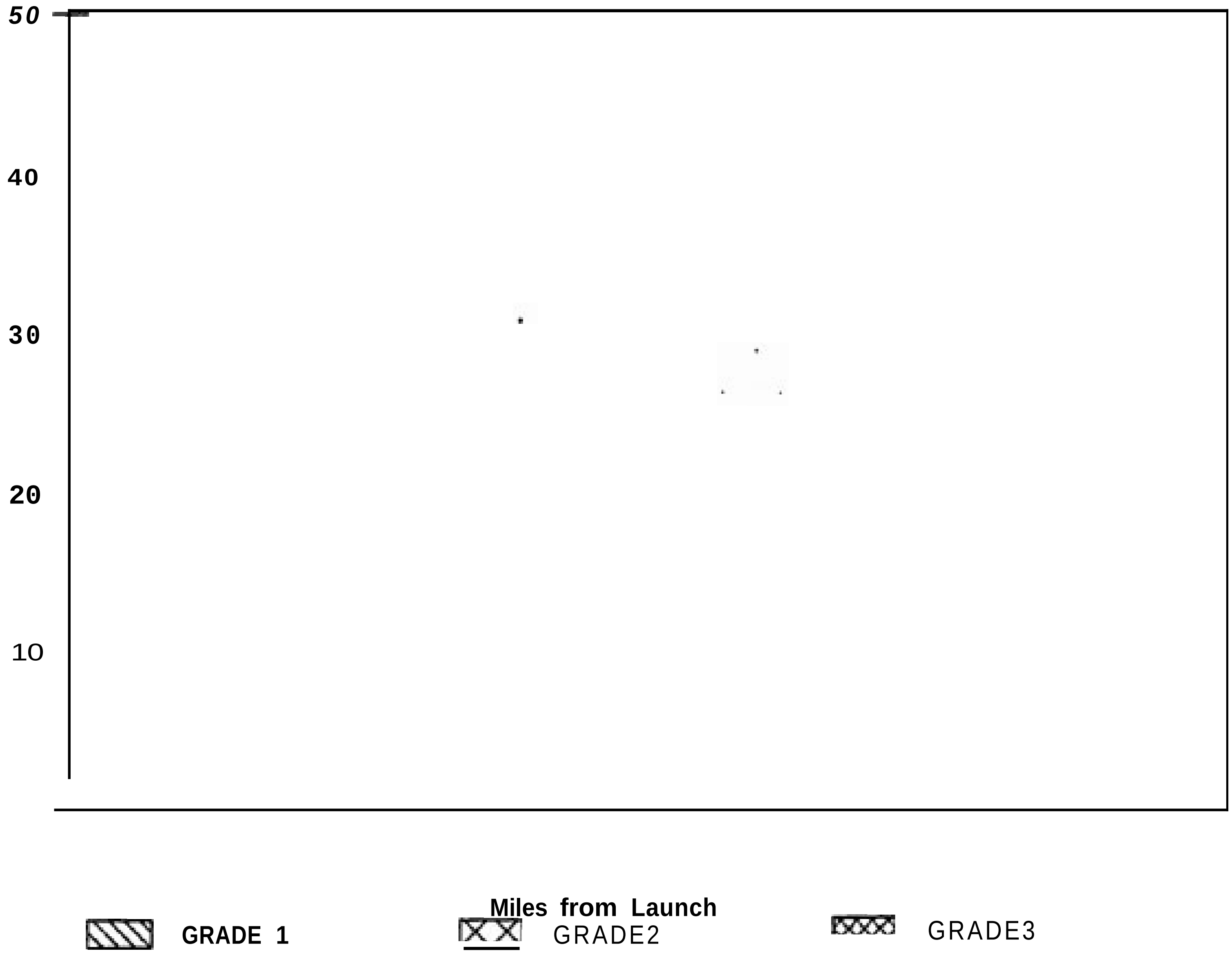
Olympic Pipe Line Co. 16" Job 2703.01

Ferndale Sto. to Allen Sto. 11/18/91



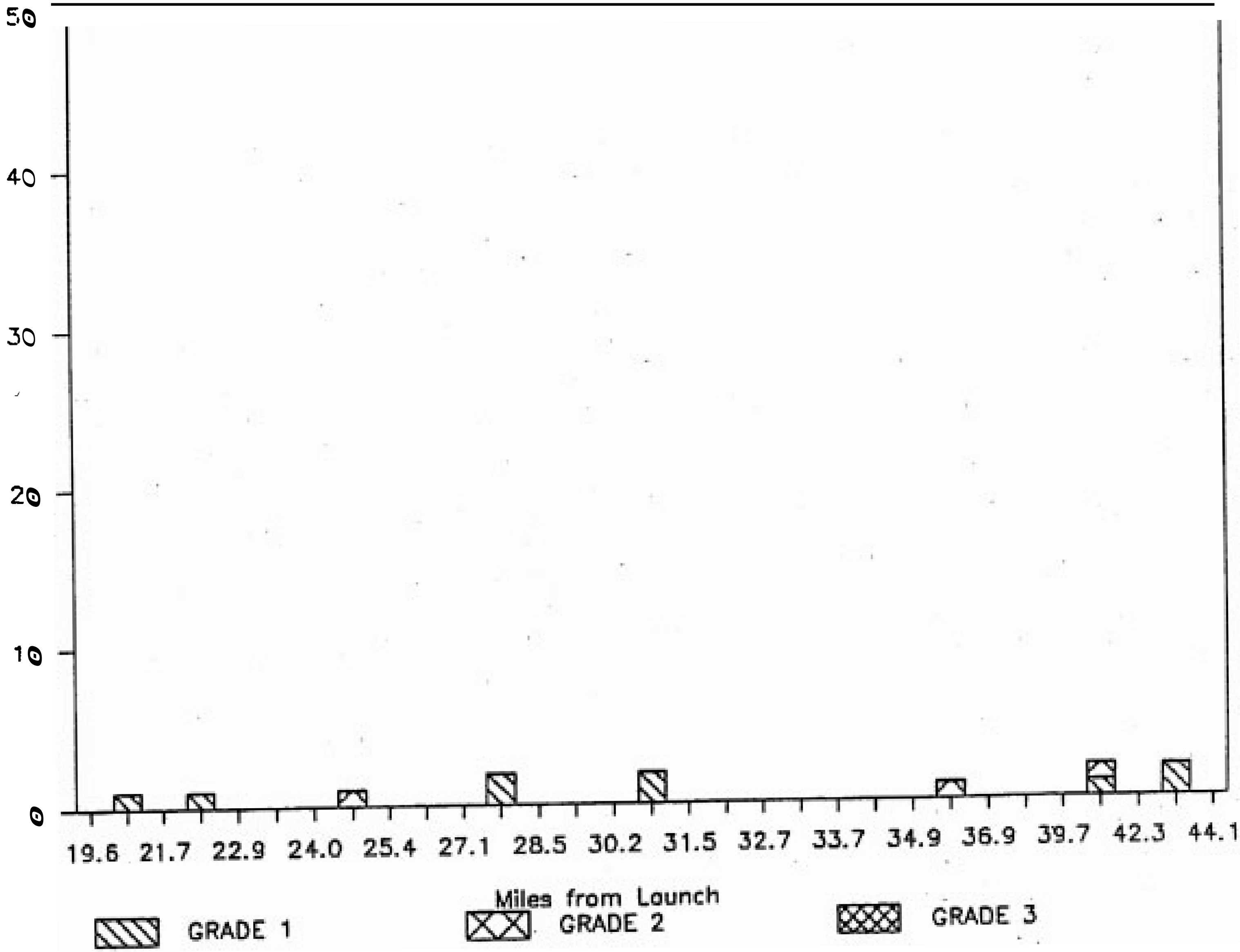
Olympic Pipe Line Co. 16" Job 2703.02

Allen Station to Renton Station 11/15/91



Olympic Pipe Line Co. 16" Job 2703.02

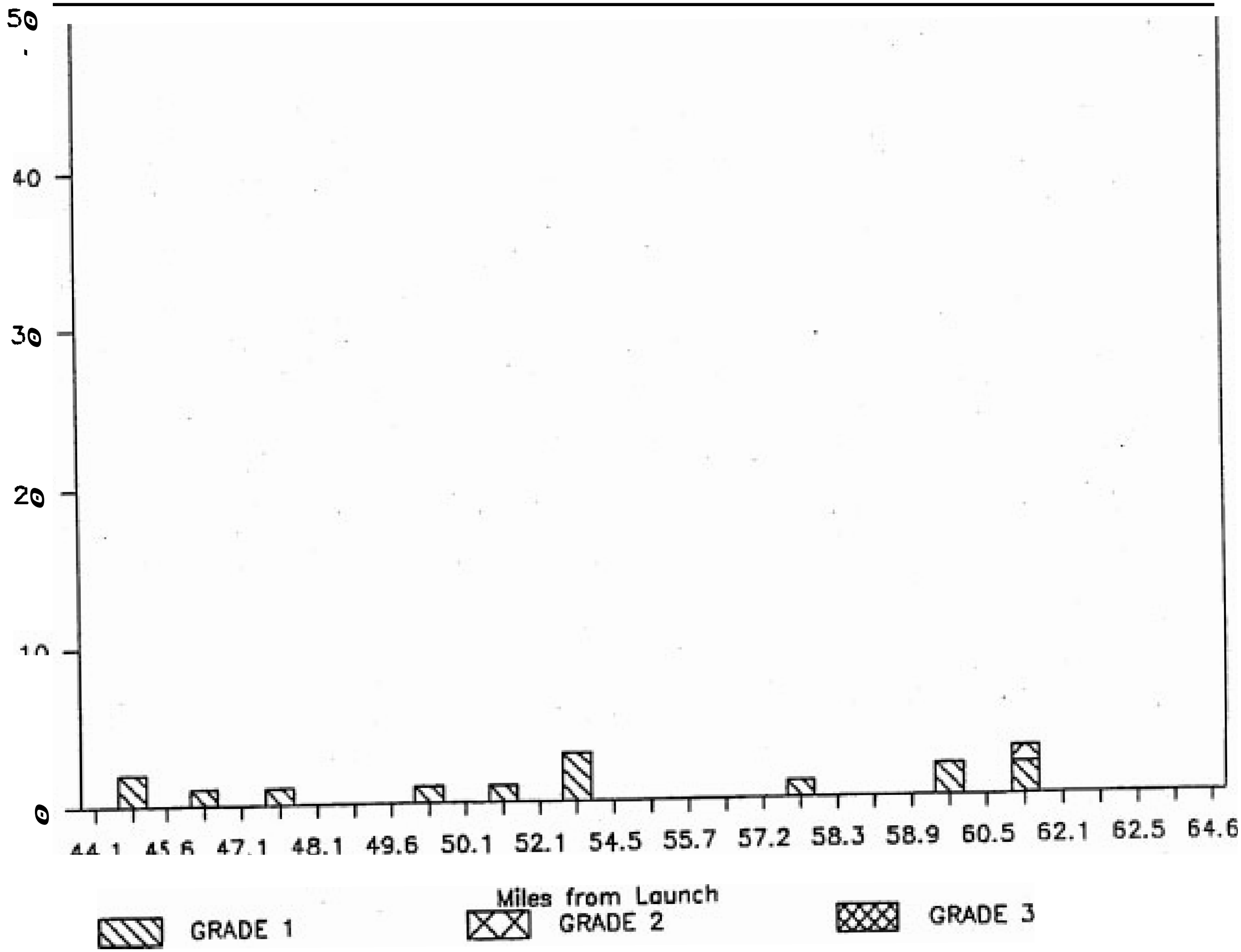
Allen Station to Renton Station 11/15/91



TUBO 000241

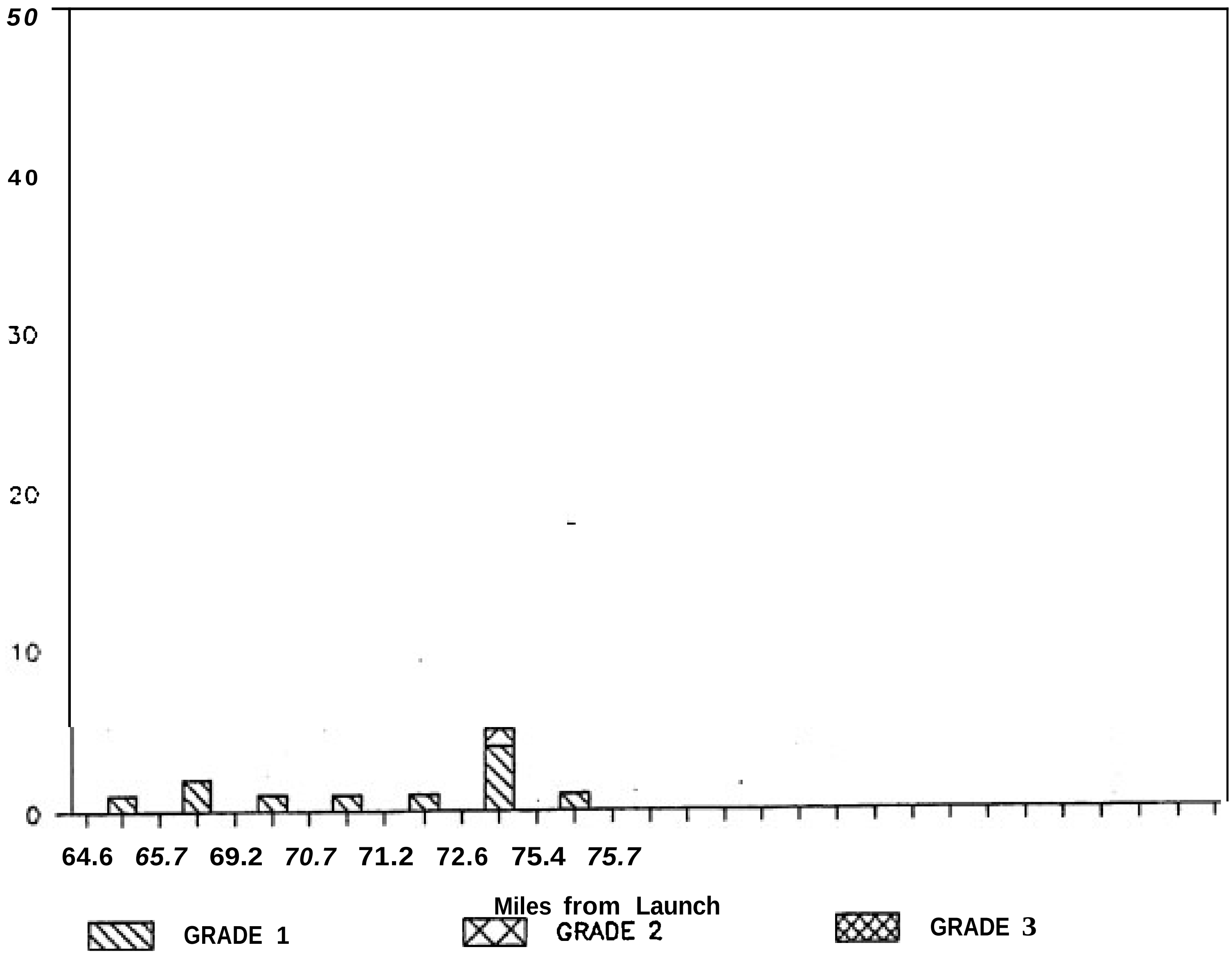
Olympic Pipe Line Co. 16" Job 2703.02

Allen Station to Renton Station 11/15/91



Olympic Pipe Line Co. 16" Job *2703.02*

Allen Station to Renton Station1 1/15/91



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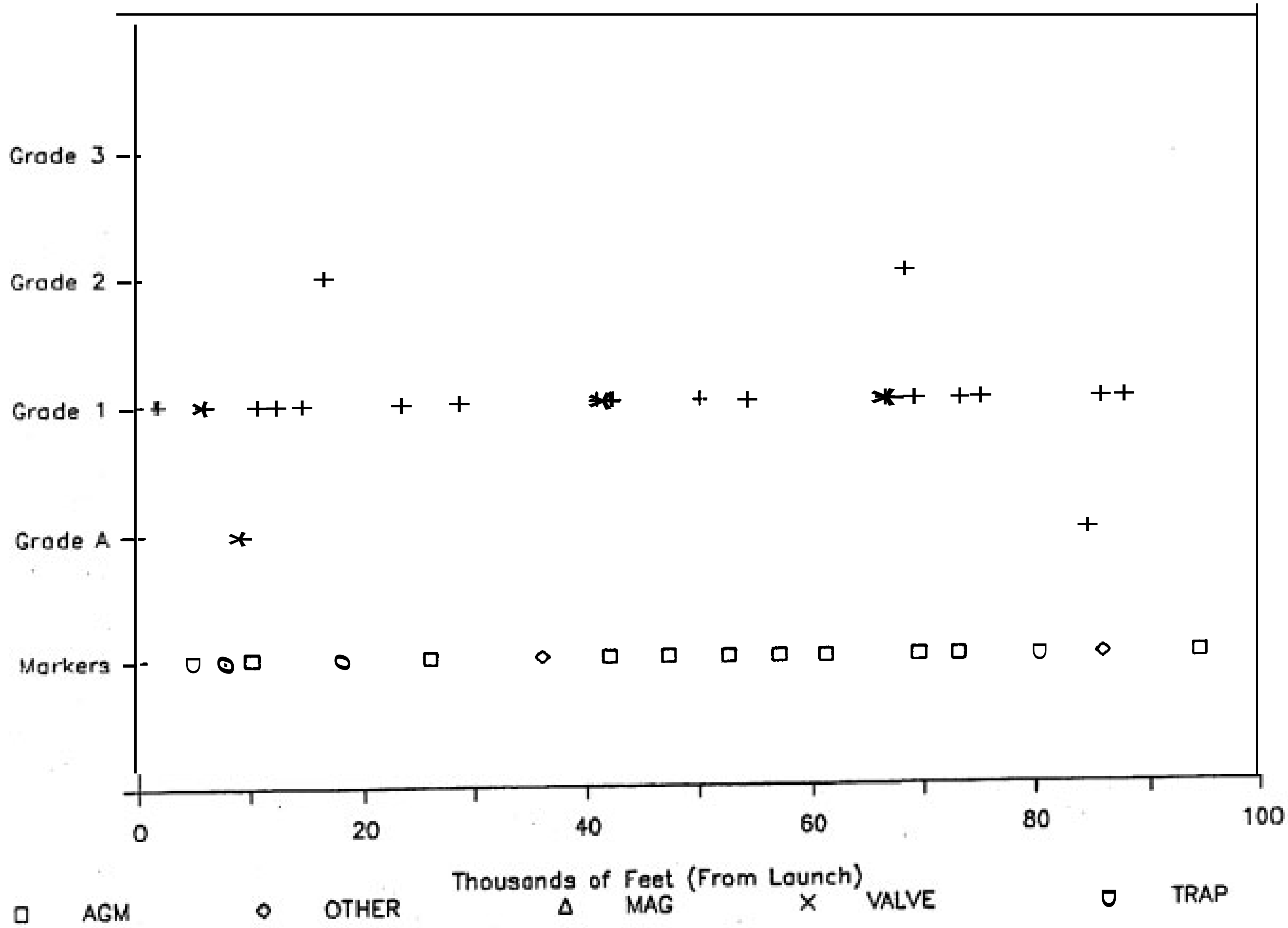
Linalog Computer Enhanced Report Graphs

TUBO 000244

Olympic Pipe Line Co. 16" Job 2703.01

Ferndale Sta. to Allen Sta. 11/18/91



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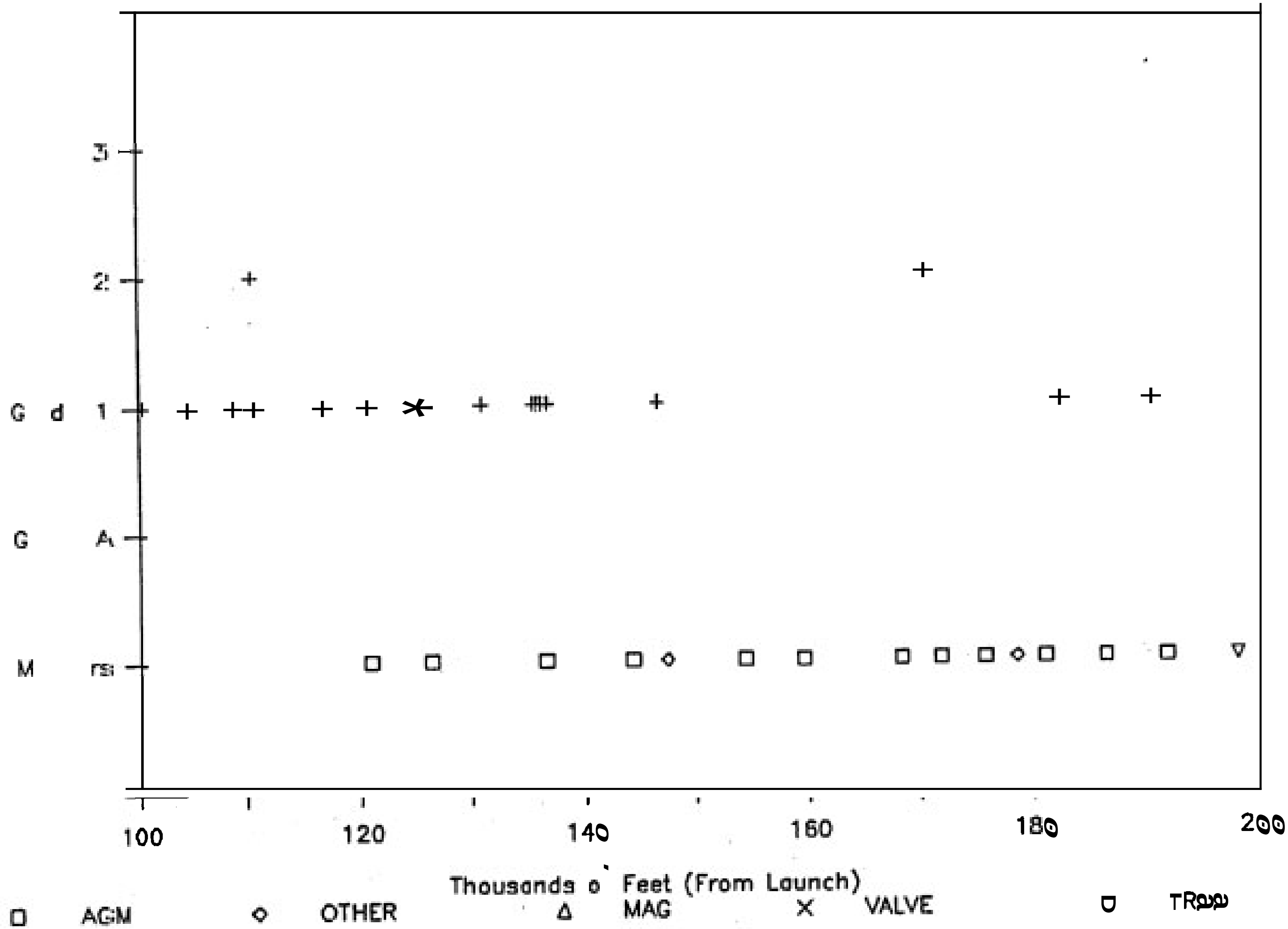
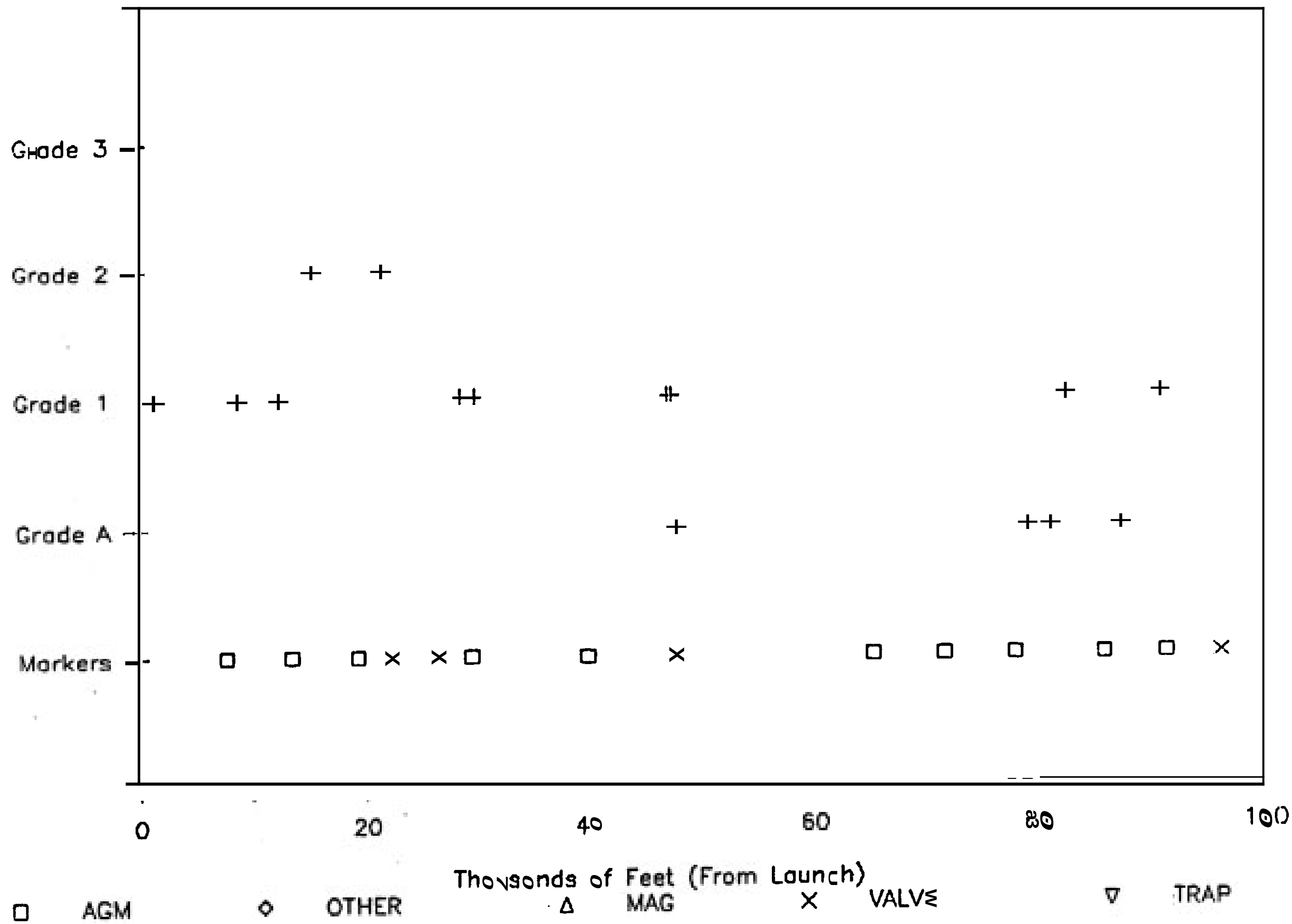
Olympic Pipe Line Co. 16" Job 2703.01

Ferndale Sta. to Allen Sta. 11/18/91



Olympic Pipe Line Co. 16" Job 2703.02

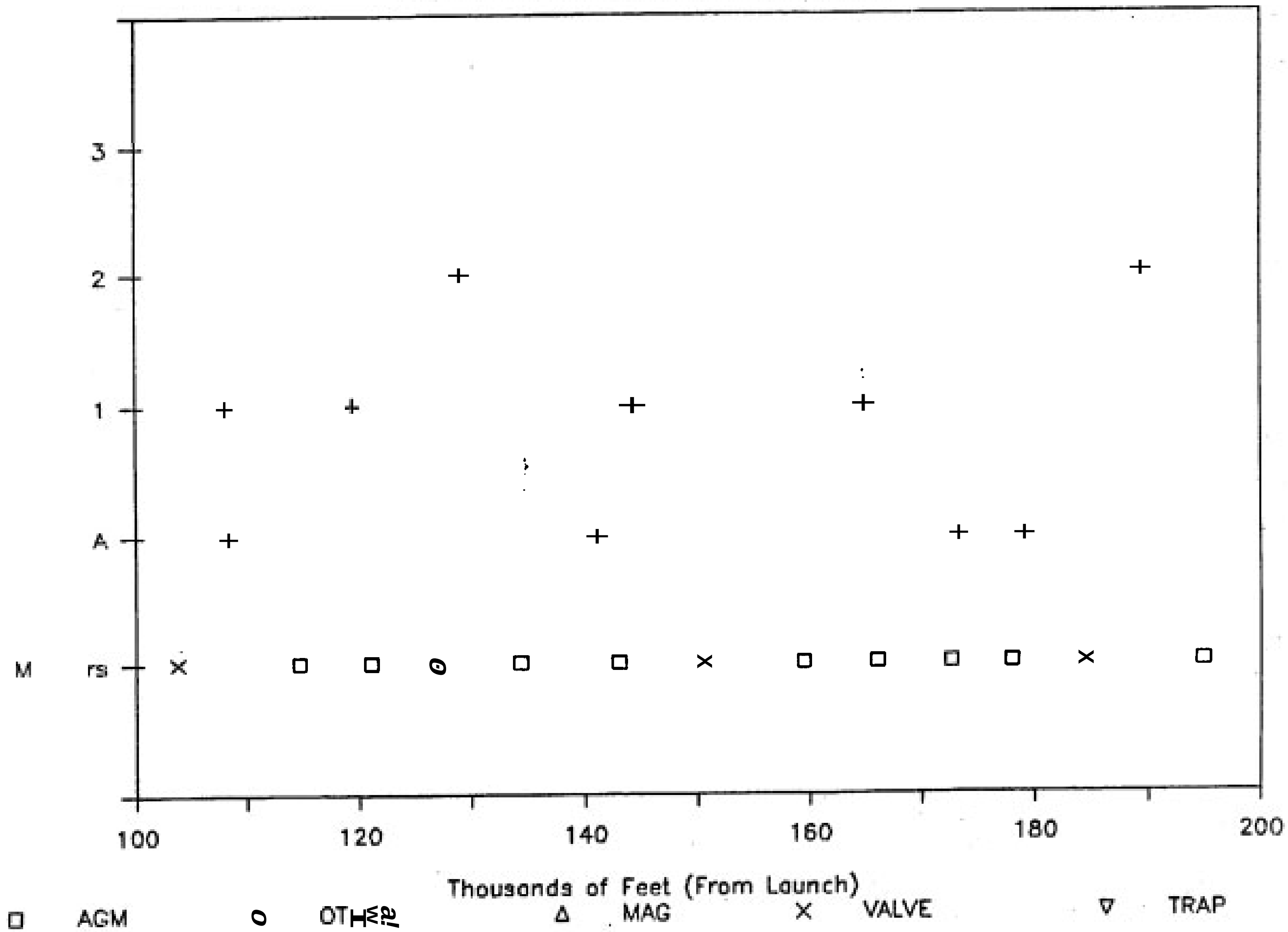
Allen Station to Renton Station 11/15/91



TUBO 000247

Olympic Pipe Line Co. 16" Job 2703.02

Allen Station to Renton Station 11/15/91



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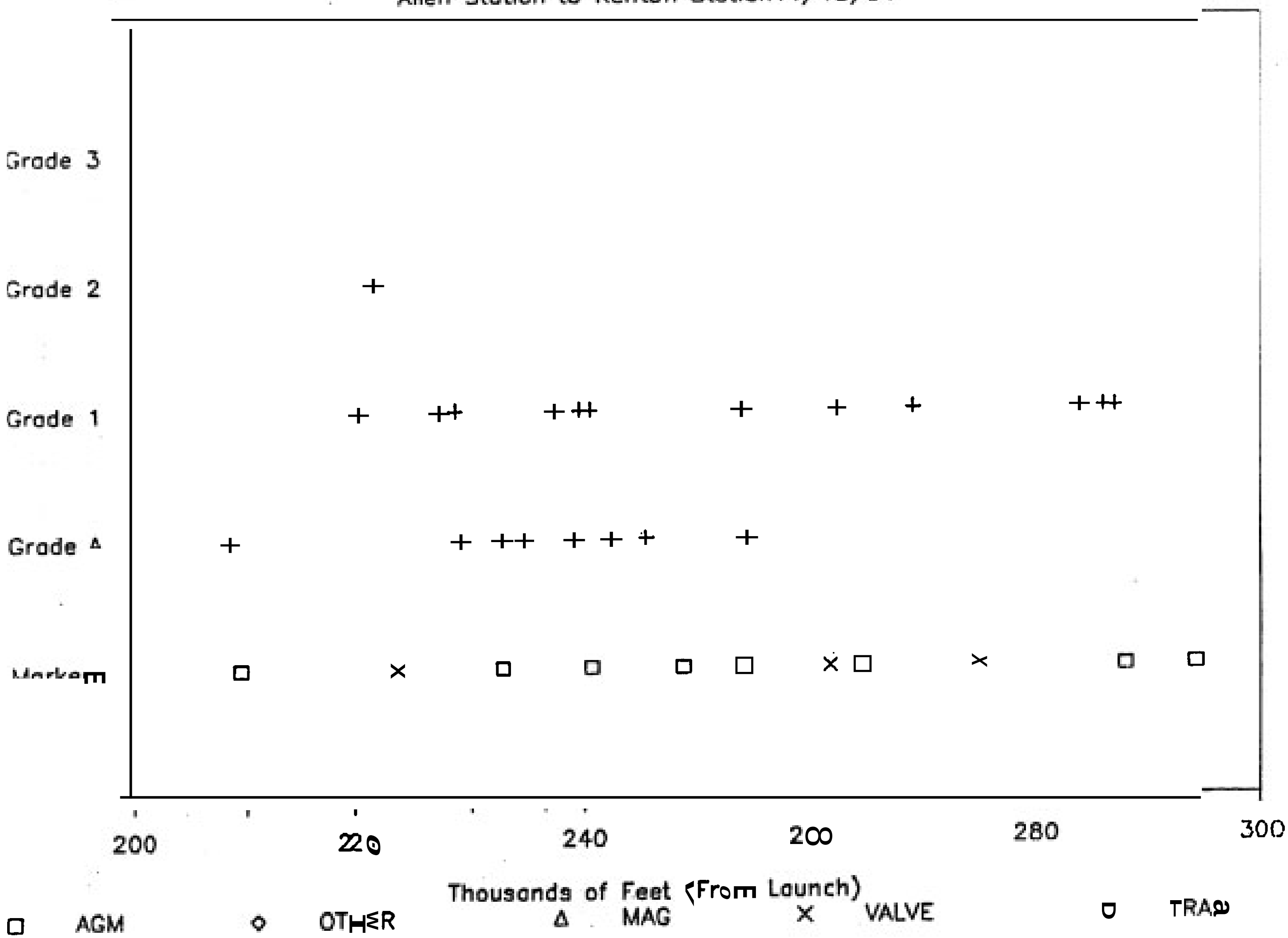
Olympic Pipe Line Co. 16" Job 2703.02

Allen Station to Renton Station11/15/91



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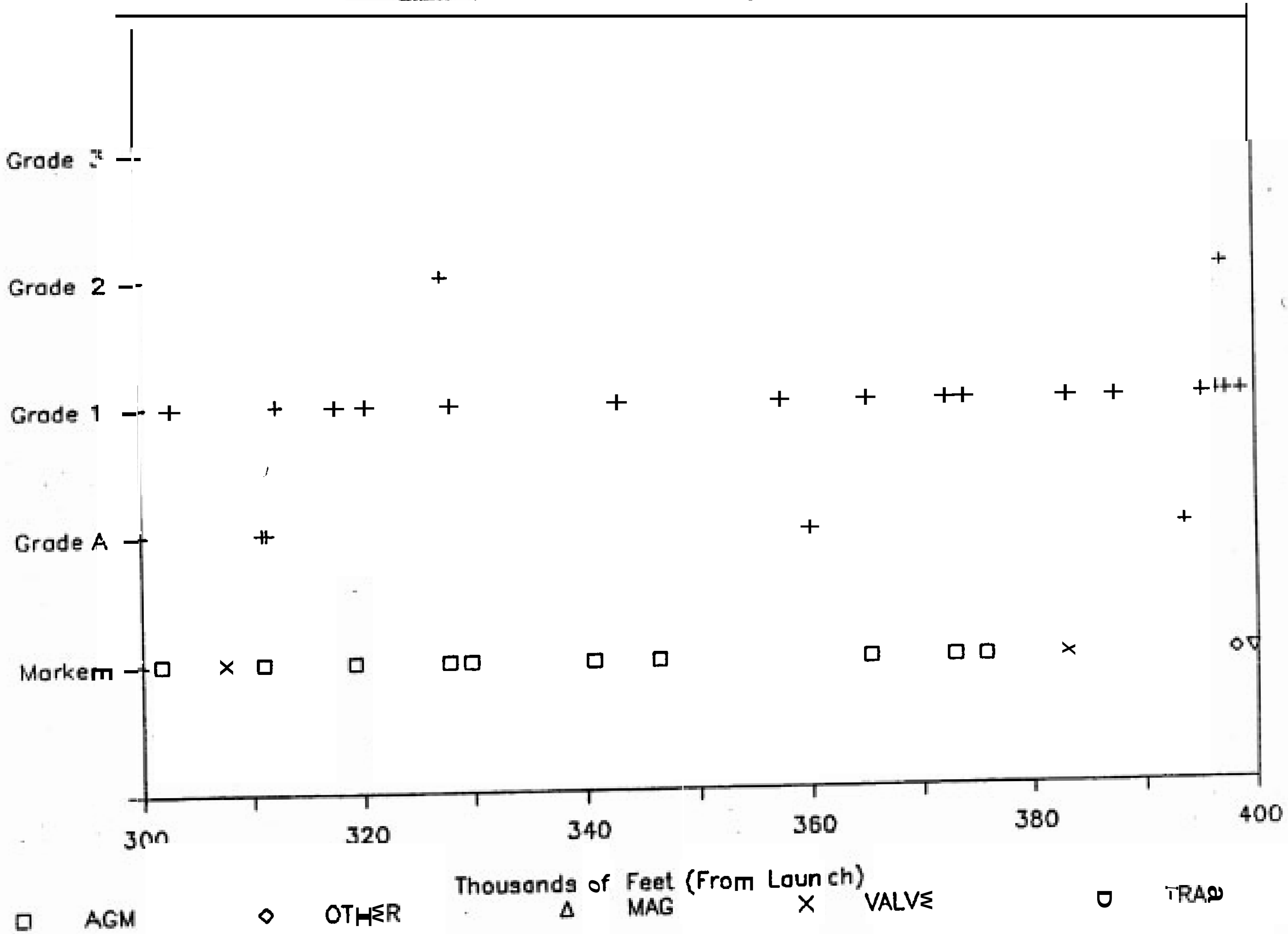
Olympic Pipe Line Co 16" Job 2703 02

Allen Station to Renton Station 11/15/91



TUBO 000250

APPENDIX 2B

Pipeline Feature	Calculated Mile Post	Map Station	Map Distance	Wheel Count	Wheel Distance	Distance to Nearest Upstream	* Marker Downstream	1991 Grade	Distance from Upstream Weld	O'clk	Comments	Grade Tabulation A	1	2	3
launch	0.00 I	0	0	282	0	0	4543								
Grade 1 Joint	0.31	1402	1402	1683	1401	1401	3142	1	25	30.00	Possible Mill Belated				
Grade 1 Joint	0.37	1666	264	1947	264	1665	2878	1	9	6.00	Possible Hill Related				
Grade 1 Joint	0.78	3539	1873	3819	1872	3537	1006	1	61	5.00	Possible Will Belated				
Grade 1 Joint	0.88	4022	403	4301	482	4019	524	1	2	4.00		0	4	0	0
Linacron	1.00 *	4546	524	4825	524	4543	2868								
Begin Casing	1.01	4582	36	4861	36	36	2832								
End casing	1.02	4636	54	4915	54	90	2778								
Grade 1 Joint	1.14	5364	728	5647	732	822	2046	1	23	6.00	Possible Hill Belated				
Grade A9 Joint	1.34	6479	1115	6768	1121	1943	925	A	2	6.00	Possible Hill Belated				
Grade A9 Joint	1.43	6989	510	7281	513	2456	412	A	53	9.00		2	1	0	0
Linacron	1.50 *	7399	410	7693	412	2868	2413				Waltine Boad	0	0	0	0
Linacron	2.00 *	9824	2425	10106	2413	2413	7996								
Begin Casing	2.00	9839	15	10121	15	15	7981								
End Casing	2.01	9890	51	10172	51	66	7930								
Grade 1 Joint	2.05	10069	179	10352	180	246	7750	1	2	9.00					
Grade 1 Joint	2.36	11724	1655	12010	1658	1904	6092	1	4	2.00					
Grade 1 Joint	2.37	11781	57	12067	57	[illegible]	6035	1	22	2.00					
Grade 1 Joint	2.79	14035	2254	14326	2259	4220	3776	1	46	5.00	Possible Hili Related				
Begin Casing	2.84	14296	261	14588	262	4482	3514								
End casing	2.85	14338	42	14630	42	4524	3472								
Begin Casing	3.01	15201	863	15494	864	5388	2608								
End Casing	3.01	15212	11	15505	11	5399	2597								
Grade 2 Joint	3.17	16057	845	16352	847	6246	1750	2	58	4.00	Poss Hill Belated	0	4	1	0
Linacron	3.50 *	17803	1746	18102	1750	7996	7867								
Begin Casing	3.50	17807	4	18106	4	4	7863								
End casing	3.51	17874	67	18173	67	71	7796								
Grade 1 Joint	4.45	22770	4896	23072	4899	4970	2897	1	3	4.00	Possible Hill Related				
Begin Casing	4.49	22993	223	23295	223	5193	2674								
End casing	4.50	23068	75	23370	75	5268	2599					0	1	0	0
Linacron	5.00 *	25666	2598	25969	2599	7867	10057								
Begin Casing	5.00	25683	17	25986	17	17	10040								
End Casing	5.01	25718	35	26020	34	51	10006								
Grade 1 Joint	5.48	28103	2385	28380	2360	2411	7646	1	32	11.00	Possible Hill %elated				
Begin Casing	6.43	32943	4840	33168	4788	7199	2858								
End casing	6.45	33056	113	33280	112	7311	2746								
Begin Casing	6.96	35650	2594	35846	2566	9877	180								
End casing	7.00	35826	176	36020	174	10051	6					0	1	0	0
Block Valve	7.00 *	35832	6	36026	6	10057	6069				Slater Road				
Begin Casing	7.15	36745	913	36951	925	925	5144								
End Casing	7.16	36800	55	37007	56	981	5088								
Begin Casing	7.17	36851	51	37058	51	1032	5037								
End Casing	7.26	37410	559	37625	567	1599	4470								
Begin Casing	7.27	37453	43	37668	43	1642	4427								
End Casing	7.30	37603	150	37820	152	1794	4275								
Begin Casing	7.31	37713	110	37932	112	1906	4163								
End Casing	7.32	37752	39	37971	39	1945	4124								

Pipeline Feature	Calculated Mile Post	Map Station	Map Distance	Wheel Count	Wheel Distance	Distance to Nearest * Marker Upstream	Distance to Nearest * Marker Downstream	1991 Grade	Distance from Upstream Weld	O'clk	Comments	Grade Tabulation A	1	2	3
Grade 1 Joint	7.40	38216	464	38441	470	2415	3654	1	36	3.00					
Grade 1 Joint	7.56	39208	992	39447	1006	3421	2648	1	13	7.00	Possible Mill Belated				
Grade 1 Joint	7.86	40964	1756	41226	1779	5200	869	1	7	5.00		0	3	0	0
Linacron	8.00 *	41822	858	42095	869	6069	5128								
Begin Casing	8.00	41837	15	42110	15	15	5113								
End casing	8.02	41907	70	42180	70	85	5043								
Grade 1 Joint	8.07	42167	260	42410	260	345	4783	1	51	5.00	DCI				
Grade 1 Joint	8.10	42338	171	42611	171	516	4612	1	1	6.00	DCI				
Grade 1 Joint	8.12	42458	120	42731	120	636	4492	1	59	7.00	Poss Hill Related	0	3	0	0
Linacron	9.00 *	46951	4493	47223	4492	5128	5303								
Begin Casing	9.00	46969	18	47241	18	18	5285								
End Casing	9.01	47016	47	47287	46	64	5239								
Grade 1 Joint	9.59	50137	3121	50369	3082	3146	2157	1	29	11.00	Poss Klll Belated	0	1	0	0
Linacron	10.00 *	52321	2184	52526	2157	5303	4541								
Begin Casing	10.00	52336	15	52541	15	15	4526								
End casing	10.02	52410	74	52617	76	91	4450								
Grade 1 Joint	10.25	53728	1318	53958	1341	1432	3109	1	51	6.00	Possible Kill Related				
Tap	10.43	54736	1008	54984	1026	2458	2083					0	1	0	0
Linacron	10.80 *	56783	2047	57067	2083	4541	4149								
Begin Casing	10.81	56839	56	57123	56	56	4093								
end Casing	10.83	56891	52	57175	52	108	4041					0	0	0	0
Linacron	11.80 *	60917	4026	61216	4041	4149	8379								
Grade 1 Joint	12.16	63071	2154	63369	2153	2153	6226	1	23	10.00	Possible Mill Belated				
Grade 1 Joint	12.36	64295	1224	64592	1223	3376	5003	1	4	1.00	Possible Mill Related				
Begin Casing	12.51	65171	876	65467	875	4251	4128								
End casing	12.54	65358	187	65654	187	4438	3941								
Grade 1 Joint	12.65	66008	650	66304	650	5088	3291	1	19	10.00	Possible Kill Related				
Grade 2 Joint	12.97	67932	1924	68227	1923	7011	1368	2	4	2.00	Possible Mill Belated				
Grade 1 Joint	13.08	68557	625	68851	624	7635	744	1	12	12.00		0	4	1	0
Linacron	13.20 *	69301	744	69595	744	8379	3523								
Begin Casing	13.20	69316	15	69610	15	15	3508								
end casing	13.24	69493	177	69787	177	192	3331								
Begin Casing	13.38	70091	598	70385	598	790	2733								
End Casing	13.38	70103	12	70391	12	802	2721								
Grade 1 Joint	13.97	72683	2580	72978	2581	3383	140	1	17	8.00		0	1	0	0
Llnacron	14.00 *	72823	140	73118	140	3523	7356								
Begin Casing	14.00	72036	13	73131	13	13	7343								
End Casing	14.01	72911	75	73206	75	88	7268								
Tap	14.15	73856	945	74151	945	1033	6323								
Grade 1 Joint	14.26	74561	705	74856	705	1738	5618	1	47	8.00	Possible Kill Eelated				
Begin Casing	15.03	79688	5127	79983	5127	6865	491								
End Casing	15.04	19772	84	80067	84	6949	107					0	1	0	0
linacron	15.10 *	80179	407	80474	407	7356	5438								
Begin Casing	15.31	81172	993	81499	1025	1025	4413								
End Casing	15.41	81647	475	91903	490	1515	3923								

Pipeline Feature	Calculated Mile Post	Map Station	Map Distance	Wheel Count	Wheel Distance	Distance to Nearest Upstream	* Marker Downstream	1991 Grade	Distance from Upstream Weld	O'clk	Comments	Grade Tabulation A	1	2	3
Begin Casing	15.51	82129	482	82486	497	2012	3426								
End Casing	15.54	82310	181	82673	187	2199	3239								
Grade A9 Joint	15.84	83742	1432	84151	1478	3677	1761	A	41	8.00					
Tap	15.91	84067	325	84486	335	4012	1426								
Grade 1 Joint	16.11	85013	946	85462	976	4988	450	1	28	3.00	Possible Mill Belated				
Begin Casing	16.16	85266	253	85723	261	5249	189								
End casing	16.17	85328	62	85707	64	5313	125					1	1	0	0
Block Valve	16.20 *	85449	121	85912	125	5438	8483								
Flange	16.20	85457	8	85920	8	8	8475								
Begin Casing	16.21	85515	58	85979	59	67	8416								
End casing	16.22	85578	63	86042	63	130	8353								
Grade 1 Joint	16.39	87070	1492	67546	1504	1634	6849	1	36	6.00		0	1	0	0
Linacron	17.20 *	93862	6792	94395	6849	8483	26557								
Tap		96885	3023	97390	2995	2995	23562								
Grade 1 Joint		99834	2949	100311	2921	5916	20641	1	12	12.00	Possible Mill Belated				
Begin Casing		101548	1714	102009	1698	7614	18943								
End casing		101705	157	102165	156	ND	18787								
Grade 1 Joint		103537	1832	103979	1814	9584	16973	1	13	9.00	Possible Hill Related				
Tap		106023	2486	106442	2463	12047	14510								
Begin Casing		106362	339	106778	336	12383	11174								
nd casing		106850	488	107261	b83	12866	13691								
gin Casing		106867	17	107278	17	12083	13674								
End casing		106949	82	107359	81	12964	13593								
Begin Casing		107346	397	107753	394	13358	13199								
End Casing		107352	6	107759	6	13364	13193								
Grade 1 Joint		107829	477	108231	472	13836	12721	1	3	8.00	Possible Kill Belated				
Tap		109429	1600	109816	1585	15421	11136								
Grade 1 Joint		109769	340	110153	337	15758	10799	1	41	8.00	Possible Will Related				
Grade 2 Joint		110137	368	110518	365	16123	10434	2	39	6.00					
Tap		110968	831	111341	823	16946	9611								
Tap		113391	2423	113741	2400	19346	7211								
Taps		115777	2386	116105	2364	21710	4847				Three Taps				
Grade 1 Joint		115986	209	116312	207	21917	4640	1	32	2.00					
Begin Casing		116059	73	116384	72	21989	4568								
End casing		116100	49	116433	49	22038	4519								
Flange		116112	4	116437	4	22042	4515								
Katch Point		117690	1578	118000	1563	23605	2952				Begin Poll 2				
Grade 1 Joint		119754	2064	120045	2065	25650	907	1	16	6.00					
Tap		119978	224	120266	221	25871	686					0	6	1	0
Linacron	a	120670	692	120952	686	26557	5336				Logging Road				
Grade 1 Joint		121579	909	121899	947	947	4389	1	17	7.00					
Grade 1 Joint		122431	852	122787	888	1835	3501	1	27	6.00	DCI	0	2	0	0
Llnacron	24.00 *	125790	3359	126288	3501	5336	10205								
Grade 1 Joint	24.85	130657	4867	130829	4541	4541	5664	1	36	5.00	Possible Mill Belated				
Tap	25.66	135368	4711	135224	4395	8936	1269								
ade 1 Joint	25.70	135561	193	135604	180	9116	1089	1	1	6.00					
Grade 1 Joint	25.77	135951	390	135768	364	9480	725	1	77	7.00	Possible Hill Related				
Grade 1 Joint	25.82	136280	329	136075	307	9787	410	1	77	7.00	Poss Hill Related	0	4	0	0

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Pipeline Feature	Calculated Mile Post	Map Station	Map Distance	Wheel Count	Wheel Distance	Distance to Nearest Marker Upstream	Distance to Nearest Marker Downstream	1991 Grade	Distance from Upstream Yeld	O'clk	Comments	Grade Tabulation A	1	2	3
Linacron	25.90 a	136728	448	136493	418	10205	7802								
Grade 1 Joint	25.92	136820	92	136595	102	102	7700	1	58	3.00	Possible Will Belated				
Tap	26.45	139700	2880	139797	3202	3304	4498					0	1	0	0
Linacron	27.20 *	143746	4046	144295	4498	7802	3082								
Grade 1 Joint	27.77	145933	2187	146498	2203	2203	879	1	63	6.00					
Tap	27.94	146592	659	147162	664	2867	215								
Begin Casing	27.98	146741	149	147313	151	3018	64								
End casing	28.00	146800	59	147372	59	3077	5					0	1	0	0
Block Valve	28.00 *	146805	5	147377	5	3082	7036				Wood Road				
Tap	28.92	152203	5398	152788	5411	5411	1625					0	0	0	0
Linacron	29.20 *	153824	1621	154413	1625	7036	5183								
Begin Casing	29.20	153838	14	154427	14	14	5169								
End Casing	29.21	153900	62	154489	62	76	5107								
Tap	29.25	154089	189	154678	189	265	4918					0	0	0	0
Linacron	30.20 *	159007	4918	159596	4918	5183	8599								
Begin Casing	30.21	159077	70	159666	70	70	8529								
end Casing	30.23	159143	66	159732	66	136	8463								
Begin Casing	31.17	163935	4792	164526	4794	4930	3669								
[illegible] Casing	31.20	164063	128	164654	128	5058	3541					0	0	0	0
Linacron	31.90 *	167602	3539	168195	3541	8599	3500								
Begin Casing	31.90	167617	15	168210	15	15	3485								
End Casing	31.91	167657	40	168250	40	55	3445								
Grade 2 Joint	32.08	169203	1546	169793	1543	1598	1902	2	8	10.00					
Begin Casing	32.14	169698	495	170287	494	2092	1408								
End Casing	32.14	169738	40	170327	40	2132	1368								
Begin Casing	32.26	170767	1029	171355	1028	3160	340								
End casing	32.27	170866	99	171453	98	3258	242					0	0	1	0
Linacron	32.30 *	171108	242	171695	242	3500	3945					0	0	0	0
Linawon	33.10 *	175019	3911	175640	3945	3945	2717								
Begin Casing	33.12	175098	79	175719	79	79	2638								
end Casing	33.14	175162	64	175783	64	143	2574								
Flange	33.15	175218	56	175838	55	198	2519					0	0	0	0
Block Valve	33.80 *	177743	2525	178357	2519	2717	2613					0	0	0	0
Linacron	34.20 *	180372	2629	180970	2613	2613	5271								
Begin Casing	34.20	180388	16	180986	16	16	5255								
End Casing	34.21	180442	54	181039	53	69	5202								
Grade 1 Joint	34.36	181198	756	181788	749	818	4453	1	3	12.00	Possible Hill Belated				
Begin Casing	34.75	183316	2118	183886	2098	2916	2355								
End Casing	34.76	183334	18	183904	18	2934	2337					0	1	0	0
[illegible]acron	35.20 *	185694	2360	186241	2337	5271	5375								
Begin Casing	35.21	185765	71	186313	72	72	5303								
End Casing	35.23	185845	80	186394	81	153	5222								
Grade 1 Joint	35.67	189270	3425	189853	3159	3612	1763	1	49	8.00					

Pipeline Feature	Calculated Mile Post	Map Station	Map Distance	Wheel Count	Wheel Distance	Distance to Nearest * Marker Upstream	Distance to Nearest * Marker Downstream	1991 Grade	Distance from Upstream Weld	O'clk	Comments	Grade Tabulation A	1	2	3
f a ~	36.19	190953	1683	191552	1699	5311	64					0	1	0	0
Linacron	36.20 *	191016	63	191616	64	5375	6180								
Begin Casing	36.20	191032	16	191632	16	16	6164								
End Casing	36.21	191087	55	191689	57	73	6107								
Tap	36.85	195907	4820	196611	4922	4995	1185				Three Taps				
Begin Casing	36.91	196377	470	197091	480	5475	705								
End Casing	36.91	196418	41	197133	42	5517	663								
Tap	36.99	197007	589	197735	602	6119	61								
Trap	37.00 *	197067	60	1977%	61	6180	3					0	0	0	0

Feet of Line 197514

Miles of Line 37.41

Total for Pipeline 3 43 4 0

A1.. .Possible Wash
A2...Possible Tap
A3...Possible Test Lead
14.. .Possible Support
A5...Possible Metallurgical Change
A6...Possible Patch
A7...Possible Debris
AB... Possible Anchors
A9...Other

DCI = Determined Circumferentially Influenced

INTERPRETATION OF THE SURVEY LOG

INTRODUCTION

Log interpretation is the process by which a determination is made concerning the nature of the indications appearing on the Linalog Survey Log (hereafter referred to as the "log").

The log is a multi-faceted source of information about a pipeline. It represents the cumulative output of all of the sensors on board the Linalog Tool. To fully decipher all of the information revealed on the log, years of interpretation training are necessary. Therefore Tuboscope employs analysts, with log interpretation training and experience, to evaluate the various indications displayed on the log. The following explanation has been prepared to facilitate the basic understanding of the information presented on the log.

The typic31 log produced in a Linalog Survey has many channels of information. The bottom channel on the log is the distance/orientation channel. The two channels appearing directly above the distance/orientation channel are the marker channels. The rest of the channels are the survey channels. See Figure 3.1.

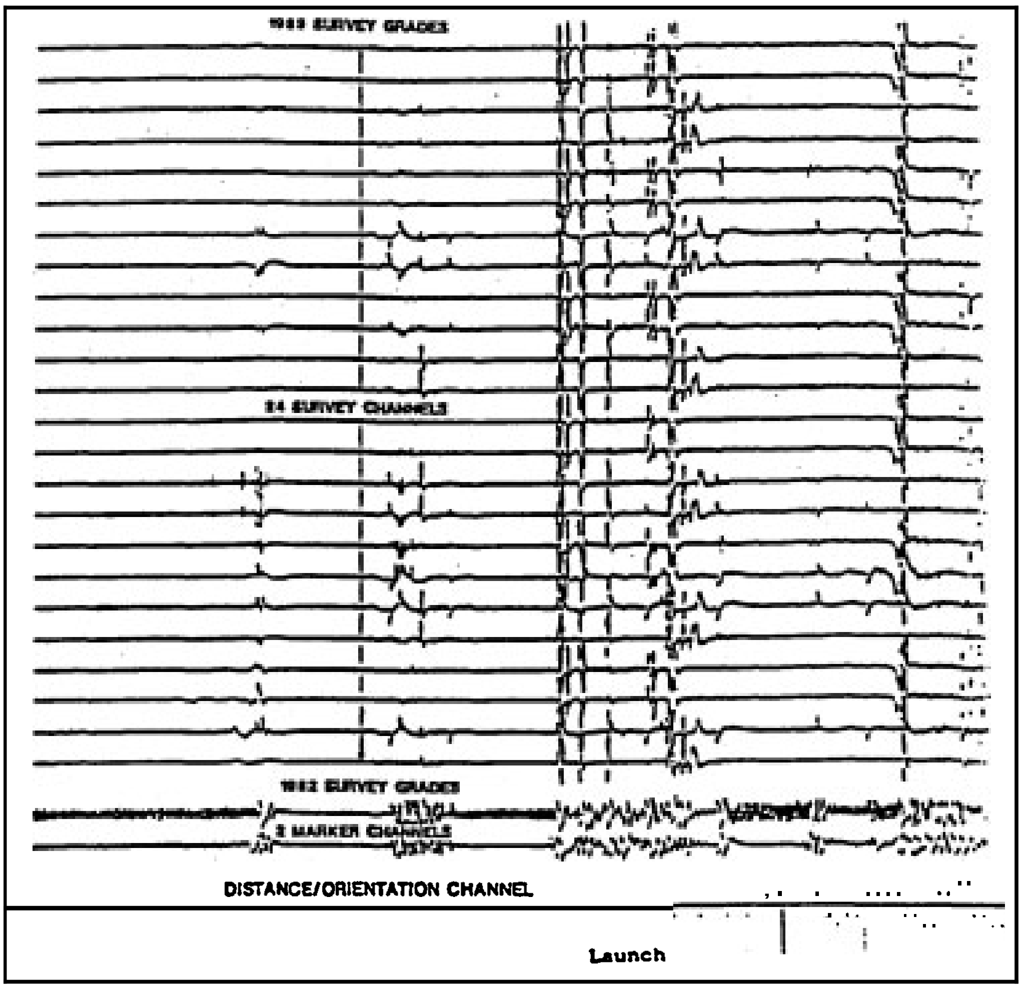

Figure 5.1. Survey Log Format

SURVEY CHANNELS

The survcy channels are the primary source of information relating to the pipeline's condition. Many types of anomalies can be identified through intense study of the indications rccordcd on these channels. See Figure 3.1.

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Pipeline Feature Indications

Pipeline Construction Features. Many of the construction features inherent to most pipelines can be identified on the survey log. The indications corresponding to valves appear on the survey channels of the log. These indications are unique and easily distinguished from other data recorded on the log. See Figure 3.2.

The indications corresponding to other full encirclement features, such as welds, tees, flanges, heavy wall pipe, and some taps, are also easily recognized. Some casings, however, are missed since the casing itself is not actually in contact with the pipe wall.

Many non-encirclement features also appear on the log. They may or may not be recognized. Examples are test leads, taps, anchors, and weights. The designation "Unknown Feature" is used to mark unidentified indications such as these. See Figure 3.2.

Pipeline features are referenced on the Computer Enhanced Report as follows:

Valves, tees, taps, and other fittings - referenced by the centerline of the fitting.

Casings - referenced by the actual beginning and ending points of the feature.

Sets of weights, supports, and other groups of pipeline features - referenced by the first and last indication of each group of features.

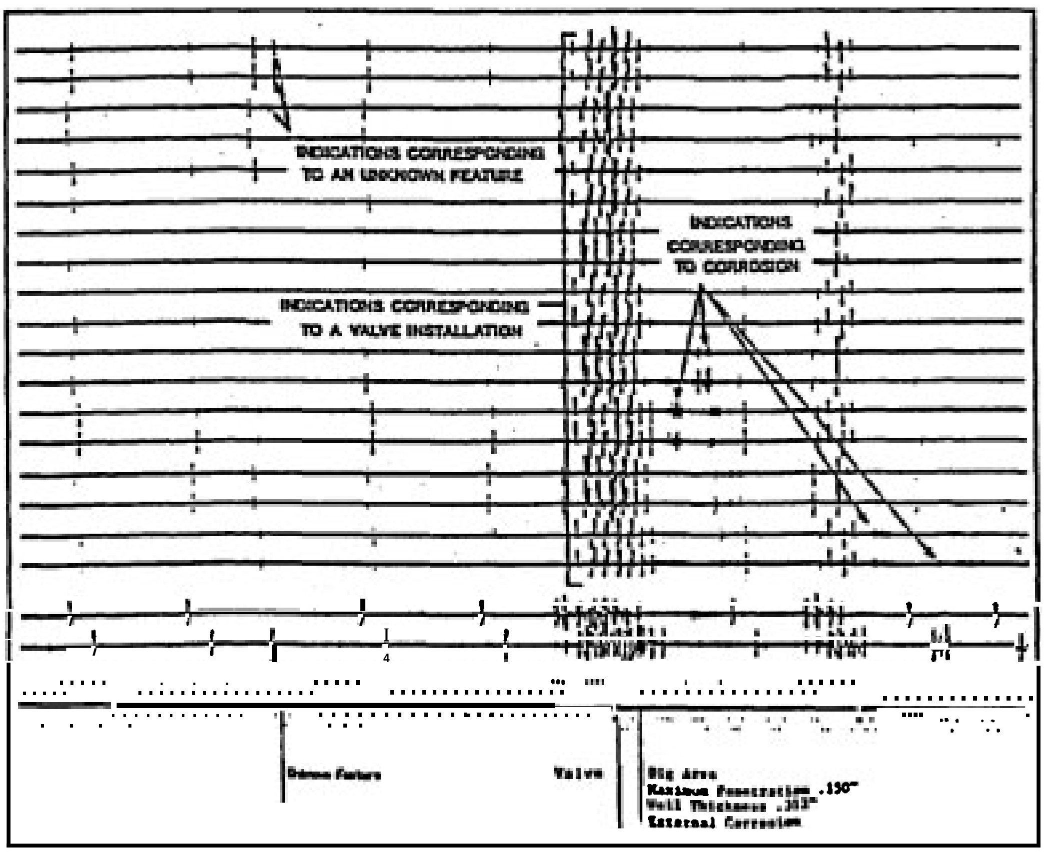

Figure 3.2. Pipeline Construction Features

Pipeline Feature Indications (continued)

Repairs. The indications which correspond to the various pipeline repair devices :an sometimes be identified on the log. Repairs are not listed on either summary.

The unique image corrosponding to a sleeve (see Figure 3.3) is almost always liscernible, even on initial surveys. This capability can be used to check the)roper placement of sleeves over anomalies.

'atches are also recognized with regularity. However, on surveys of especially :orroded lines, it can be very difficult to identify patches The use of a previous urvey can make the identification of patches somewhat easier, through a joint-to-oint comparison of the previous and new surveys.

The identification of replacement pipe is also usually possible on repeat surveys. n most cases, the change on the log is very obvious. Repeat surveys can assure hat detrimental anomalies have in fact been repaired. Reroutings of the pipeline :an also be distinguished by comparing joints on consecutive surveys.

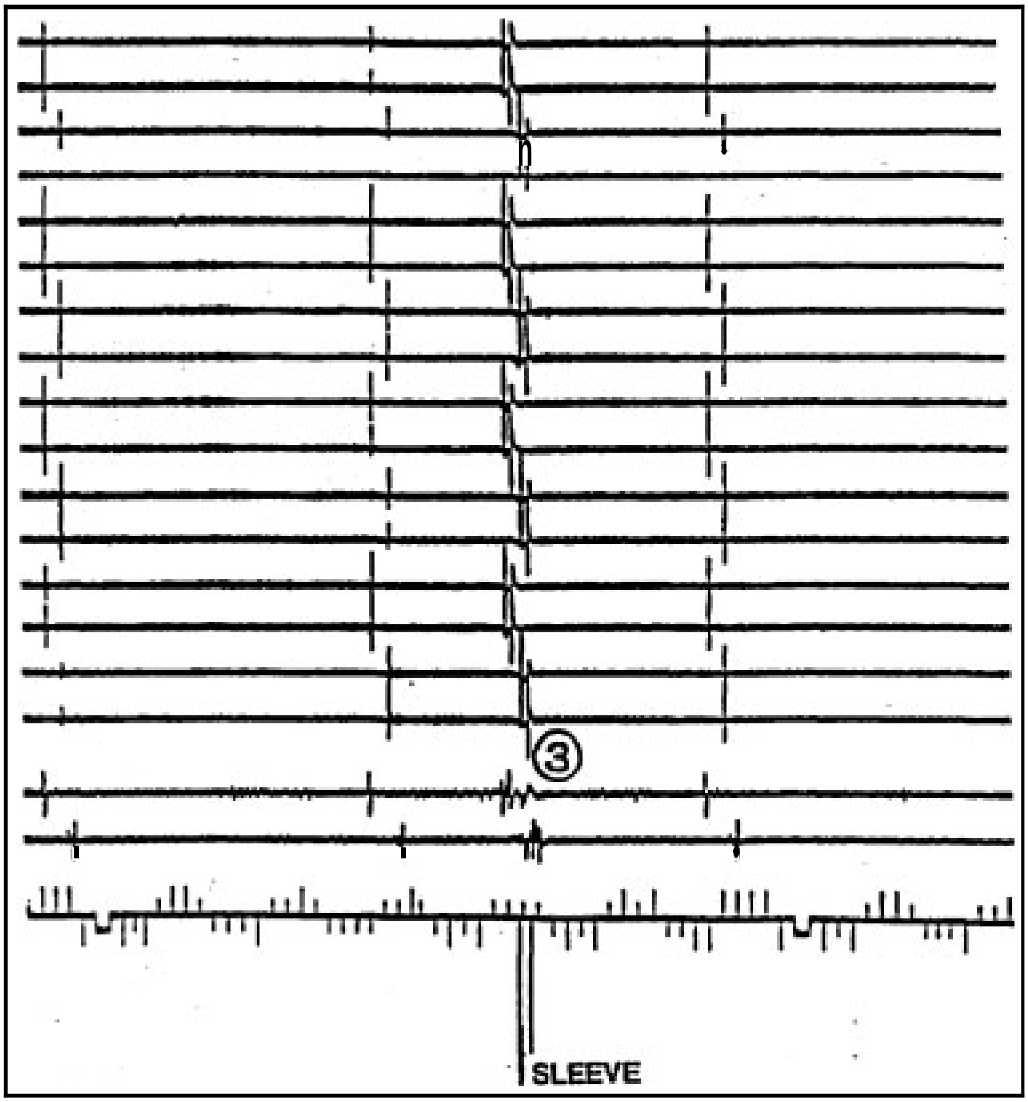

Figure 3.3. Repair Indications

Other Indications

Corrosion. Linalog's primary purpose is to locate pipeline corrosion. See Figure 3.4 below. This includes clustered, isolated, longitudinal, and circumferential corrosion. Both internal and external corrosion are detected by the Linalog Tool. In identifying corrosion, the following pipeline characteristics are considered: the pipeline product, the environment surrounding the pipeline, the type of pipe, and the history of the pipeline.

Pipeline Debris. Pipeline debris, such as welding rods, causes erroneous indications on the log. When a pipe joint with such an indication is investigated, the debris is often no longer present The cause of such indications is normally very difficult to verify.

Mill-Related Defects. Indications corresponding to production-related defects also appear on the log. These indications will often be of a higher amplitude than their corresponding depth justifies. Some anomalies which produce exaggerated signals are expander marks, grinding marks, and laminations.

Other Anomalies Other anomalies, such as mashes, dents, cable burns, and gouges, often appear on the log. The unusual geometry and the circumstances which introduce these types of anomalies cause the tool to produce indications which are difficult to interpret accurately. Sometimes, with the we of additional digging, it is possible to identify the indications of a specific type of anomaly. When this is done, indications of the same type can be categorized similarly. This procedure can greatly increase the accuracy of the interpretation of the log.

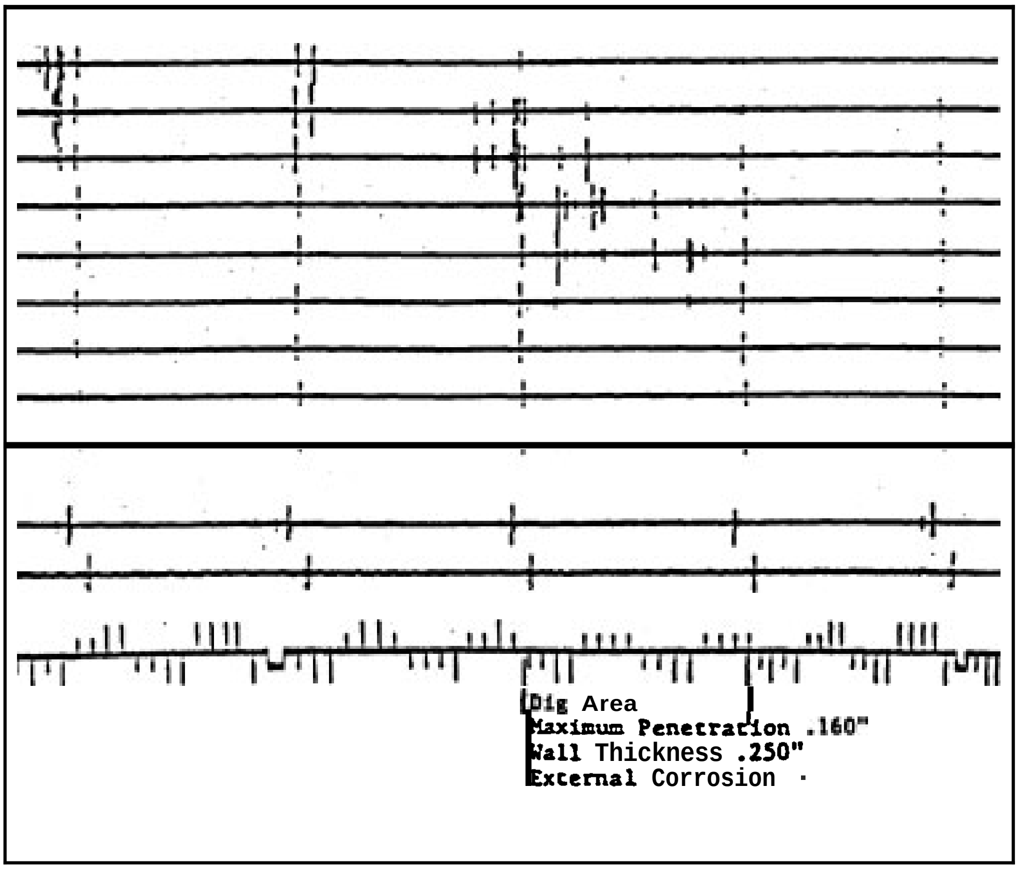

Figure 3.4. Corrosion Indications

MARKER CHANNELS

Most Linalog Surveys have one or two marker channels. Careful observation of both major and minor indications on the marker channels is essential to the correct interpretation of the log.

Anomaly Recognition

The primary function of the marker channels is to help distinguish corrosion indications from the indications of other recorded pipeline features. Certain anomalies, such as mashes, casings, and wrinkles, can be better defined if their effects on the marker channels are considered.

Marker Signals Identification

The marker channels are also used to aid in locating the markers used as reference points on the pipeline.

Magnet Markers. The magnets used in the Magnet Marking System will have corresponding indications appearing on both the survey channels and the marker channels on the log. See Figure 3.5.

Above Ground Markers. The Above Ground Markers produce indications which only appear on the marker channels on the survey log. See Figure 3.6. These indications are unique and easily distinguished from other data recorded on the marker channel. (For more information regarding the use of marker systems, refer to the section entitled "Linalog Pipeline Marking Systems".)

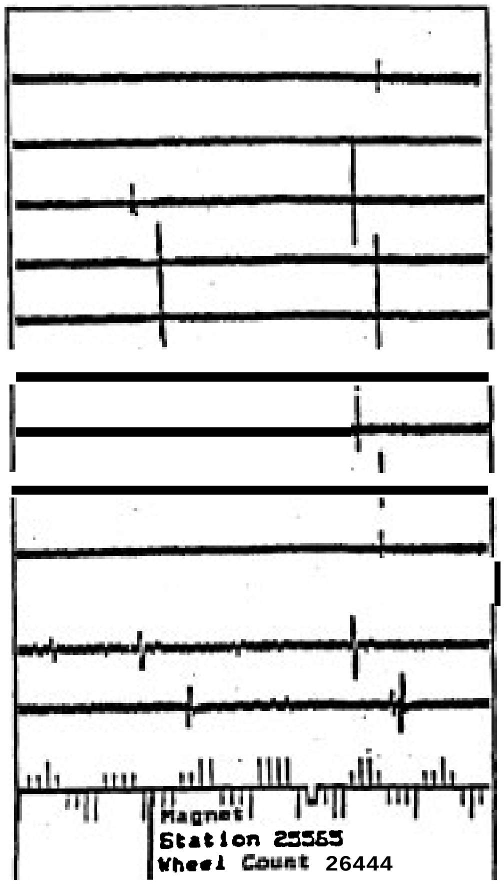

Figure 3.5. Magnet Marker

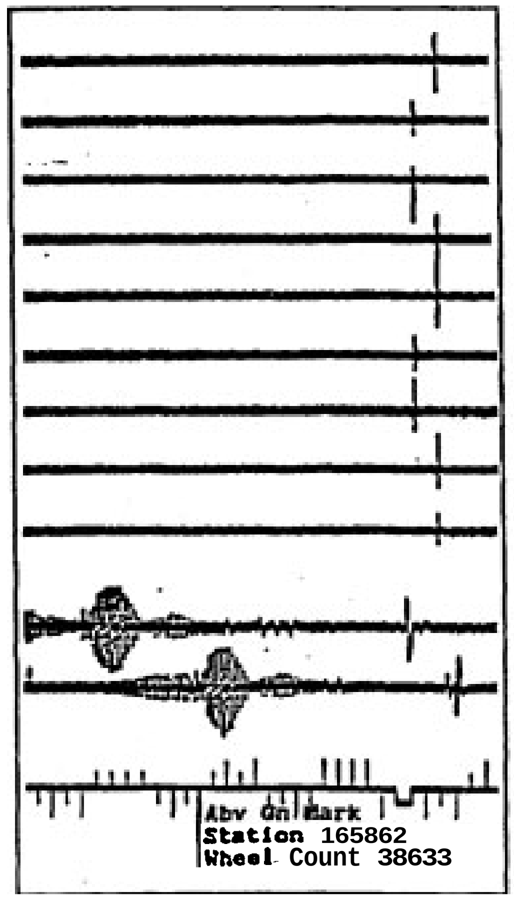

Figure 3.6. Above *Ground* Marker

DISTANCE/ ORIENTATION CHANNEL

The bottom channel is the coded distance/orientation channel. It shows, in coded form, four items of information about the log: the units of measurement (feet or meters), the wheel count at that point on the log, the tool speed, and the orientation of the tool.

Terminology

Several terms must be understood in order to use the coded distance/orientation channel effectively. An example of this channel is shown in Figure 3.7.

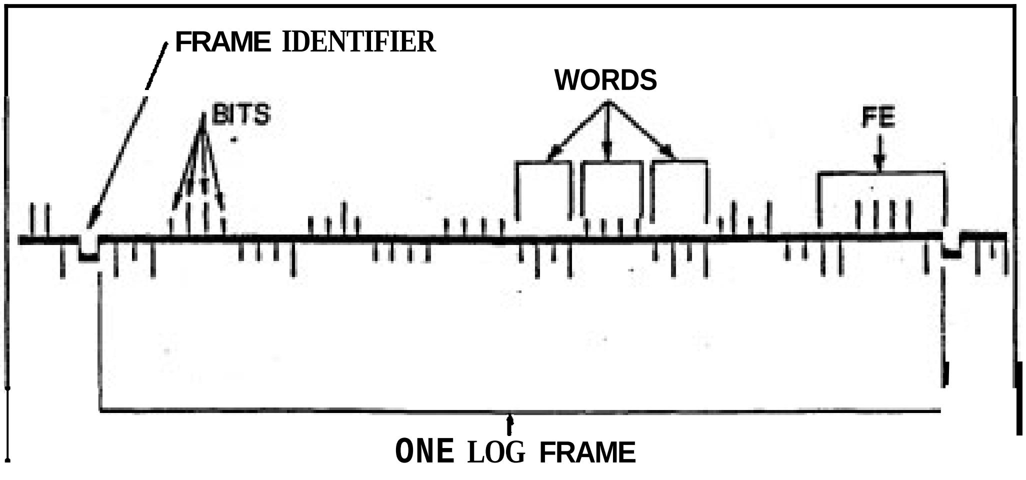

Figure 3.7. Coded **Distance/Orientation** Channel

Frame - A *"frame"* is an independent group of indications within the distance/ orientation channel.

Bit - Each vertical indication is called a *"bit"*. These indications are either long (binary "1") or short (binary "0"). The distance between each *bit* represents one foot of length along the pipeline.

Flag - A long *bit* normally has a binary value of 1. If it is assigned some meaning that does not follow the normal binary code, it is called a *"flag"*. If a *flag* is short, it will have an alternative meaning to a long *flag*. Further explanation of this follows.

Word - Each group of four *bits* on the same side of the baseline is called a *"word"*. A word may represent either a number, one or more *flags*, or some combination of a number and one or more *flags*. The first ten *words* in each *frame* arc alternated on opposite sides of the baseline to aid in differentiating them

Log Frame - Twelve *words* plus two extra bits make a "log *frame*". Since each log *frame* contains 50 *bits* and the distance between two *bits* is one unit of measurement (either 1 foot or 1/2 meters), each *log* frame represents 50 units of measurement of pipeline. All *bits* in the log *frame* are derived from the tool's distance wheel pulses.

Frame Identifier - This is a special signal to mark the beginning of each *frame*.

FE - This is a series of 8 *bits* which arc used to check the performance of the tool and signal the decoder electronics that a new *frame* is starting.

Coding System

A multi-purpose coding system is used to relate the various data displayed in the distance/orientation channel. Each word in a log frame represents a coded piece of information, about the log, defined by some combination of the long and short bits in that word. With the exception of flags, a long (high amplitude) bit has a positive value (binary "1"). A short (low amplitude) bit has no value (binary "0").

The numeric value of a bit depends on where the bit appears within the word. In a four bit word, the bit at the extreme right is the least significant bit and has a value of "1" if it is high. The next bit to the left has a numeric value of "2" if it is high. The next bit to the left has a numeric value of '4' if it is high. (Notice that the value doubles with each move to the left.) Finally, the first bit has a numeric value of 8 if it is high.

The numeric value of a word is the sum of the numeric values of the high bits. For example, if all four bits are low, the numeric value is *0.* If all four bits are high, the numeric value is 8 + 4 + 2 + 1 = 15. See Figure 3.8.

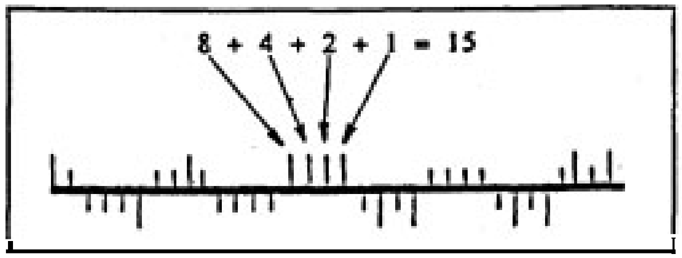

Figure 3.8. Binary Coding: System

Divisions of a Log Frame

The above explanation is of a simple binary numbering system. Although the distance/orientation channel makes extensive use of this system, it does not use it in its pure form. It uses, instead, three slight variations which follow similar rules. The variation used depends upon the location of the word within the frame. The following is an explanation of the function of each of the words in a Linalog frame (see Figure 3.9). The words are explained in the order in which they appear within the frame.

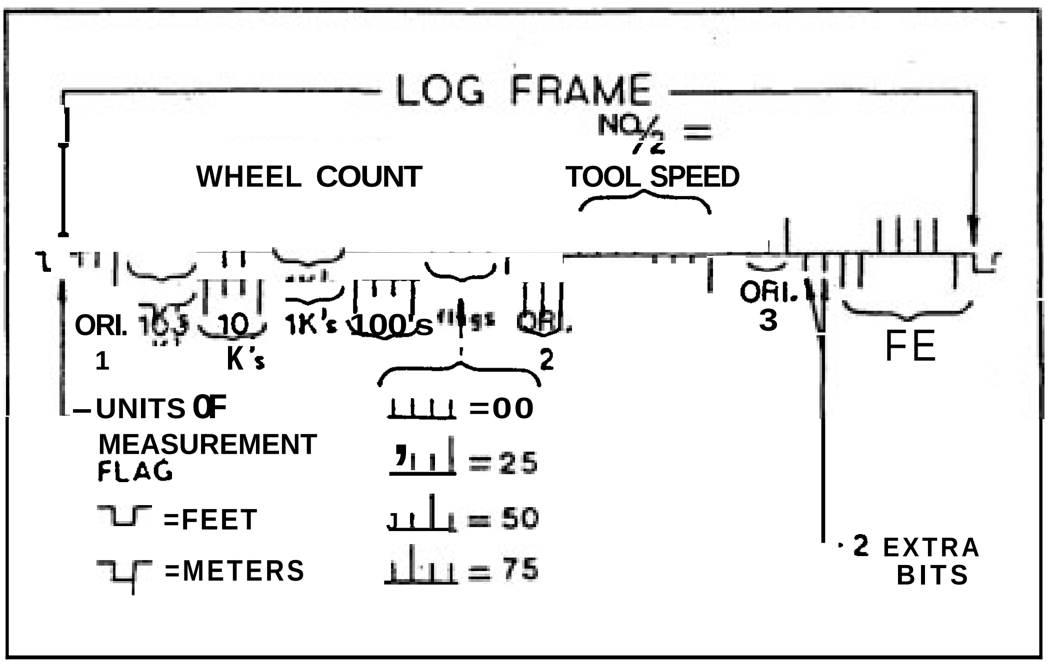

Figure 3.9. Divisions of a Log Frame

Divisions of a Log Frame (continued)

Orientation 1. The first word in a Log frame is the first of three orientation samples to be taken during a frame. See Figure 3.10 below. The first bit of the word is a flag. It indicates how the pipeline is being measured. A high bit indicates metric measurement (meters); a low bit indicates English measurement (feet). The next three bits in this word follow the binary code. These three bits indicate which of the quadrants the number 1 shoe appears in. For more information, see Calculating Orientation on page 3.11.

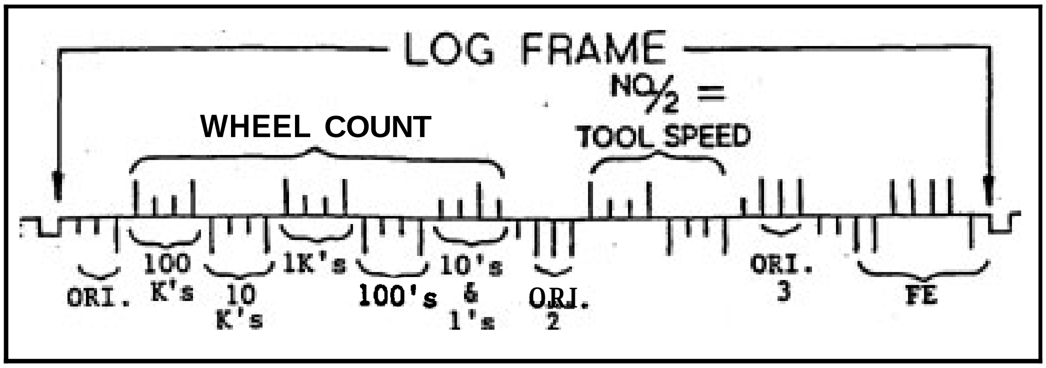

Figure 3.10. Divisions of a Log Frame

Wheel Count. Words 2-6 represent the Wheel Count at the end of the preceding frame. For Words 2-5, we use a code known as Binary Coded Decimal (BCD) in which each digit of a number is represented by a word. In this system, the numeric value of each word cannot exceed 9. Figure 3.11 shows an example of the number "14" in BCD.

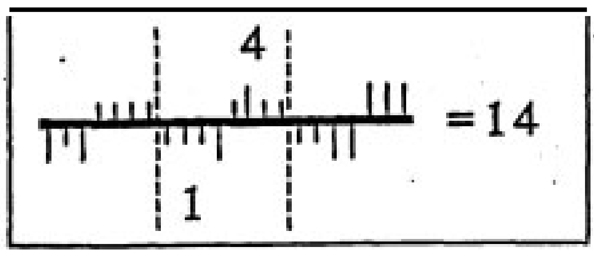

Figure 3.11. Binary Coded Decimal (BCD)

Word 2 is the Wheel Count hundred thousands digit, Word 3 is the ten thousands digit. Word 4 is the thousands digit, and Word 5 is the hundreds digit. The tens digit and ones digit are contained in Word 6 in flag form.

Since the Wheel Count starts at 0, and each frame is 50 units long, the last two digits repeat in a predictable sequence. Therefore, they can be represented by flags of known meaning in just one word (Word 6). Four values can be determined by the flags in Word 6: 0, 25, 50, 75 (see Figure 3.12). If all four bits are low, the number is 0; if only the fourth bit from the left is high, the number is 25; if only the third bit from the left it high, the number is 50; if only the second bit is high, the number is 75. These are the only conditions that are allowed to exist in Word 6. The results 25 and 75 are only used in metric surveys.

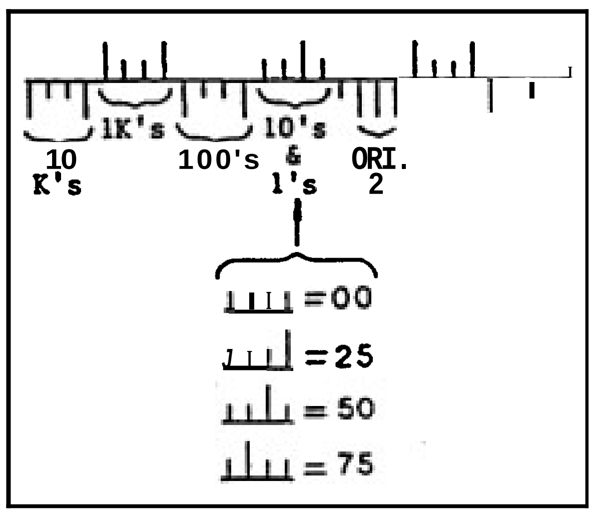

Figure 3.12. Wheel Count - Tens and Ones Digits

Divisions of a Log Frame (continued)

Orientation 2. Word 7 of a log frame is the second place that tool orientation is sampled during the frame. See Figure 3.13. It is similar to Word 1 except that the first bit is always low and has no meaning. Therefore, the numeric value of the last 3 bits will be between 0 and 7 indicating one of the 8 orientation sectors in the orientation calculator.

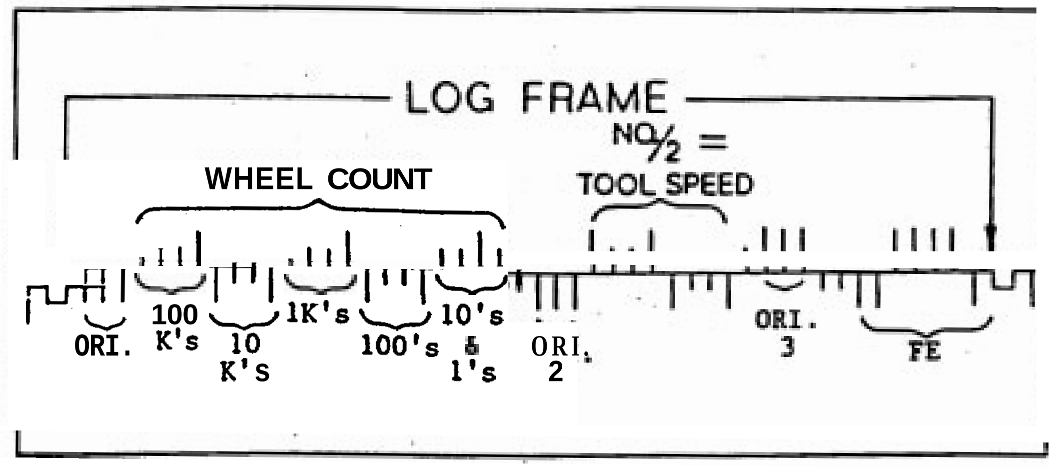

Figure 3.13. Divisions of a Log Frame

Tool Speed. The tool speed is checked during the 3 inches of pipe immediately preceding the first bit of Word 8. The tool speed is then doubled and recorded in BCD form in Words 8 and 9. See Figure 3.14.

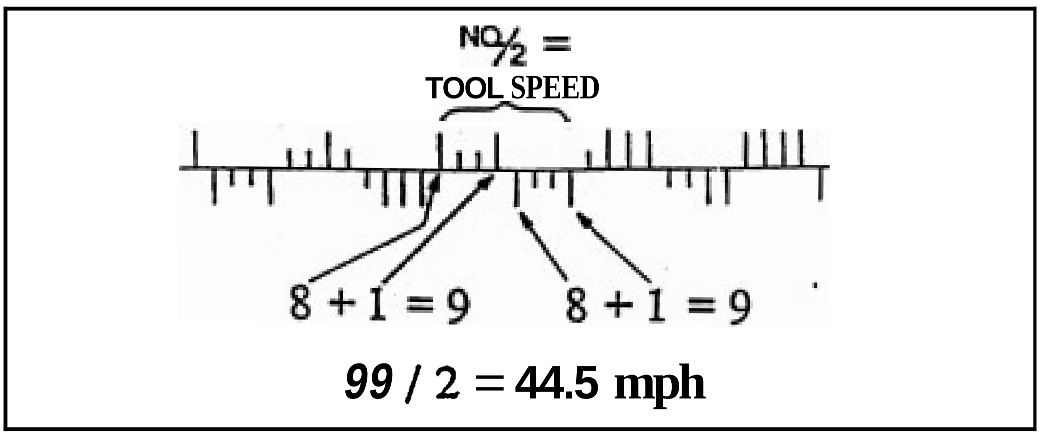

Figure 3.14. Determining Tool Speed

Orientation 3. Word 10 of a log frame is the third place the tool orientation is sampled during the frame. Word 10 is coded in the same manner as Word 7 (Orientation 2) described above.

Remainder of Frame. Following Word 10 are two extra bits which are inserted to make the frame 50 units of distance long (see Figure 3.13). These two bits cause the last two words in the frame not to alternate in the normal sequence. The last two words (7 high bits and 1 low bit) are a signal to alert the decoder electronics in the playback to start a new frame. This enables the playback system to be started anywhere within the log and still format data properly. It also prevents data errors from affecting any frame other than the one in which they occurred.

Reading the Wheel Count

To determine the Wheel Count at any anomaly indication or other point of interest on the log, follow these steps:

1. **Draw a** vertical line down **from** the anomaly indication to the distance/ orientation channei.
2. Locate the first frame identifier to the left (upstream) of the vertical line.
3. Using words **2-6,** determine the Wheel Count at the end of the preceding frame.
4. Count the number of bits between the end of the preceding frame and the vertical line at the indication.
5. Add this number ***to* the** Wheel Count at the end of the preceding frame. This **is** the Wheel Count at the anomaly indication.

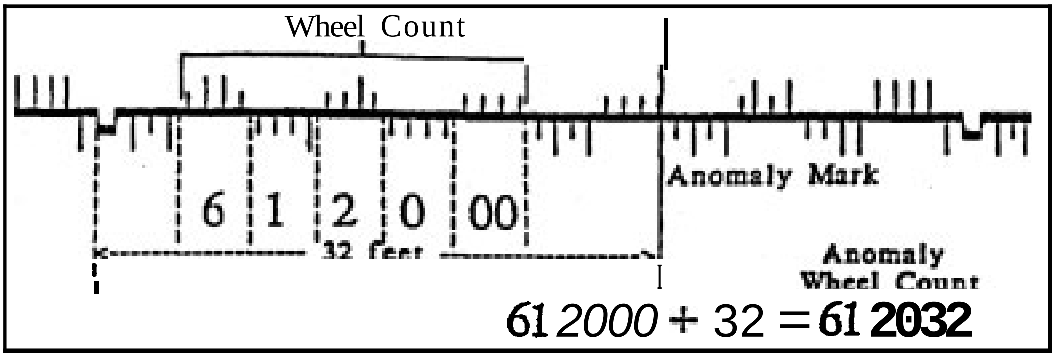

Figure 3.15. Reading the Wheel Count

This system provides the basis for all the Wheel Counts" shown **on** the log. The Wheel Count cannot **be** reset to 0 once the tool has been inserted into the launch barrel; therefore, the Wheel Count at the launch valve is not **0. FOP** this reason, a calculation is necessary **to** determine the distance from any point of interest on the pipeline to the launch valve.

Determining Tool Speed

Tool Speed is monitored at the beginning of Word **8** in each frame. **To** determine tool speed, decode Words **8** and ***9*** and divide the resulting **number by 2.** For example, if Word **8** is decimal **"2"** and **Word *9*** is decimal "5", **you** divide "25" by 2; and, the tool speed **was** 125 mph at the beginning of **Word 8.**

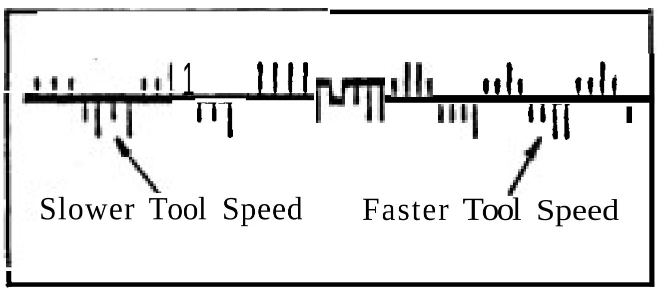

Figure S.16. Variable Tool Speed

Changes in tool speed are also indicated on the distance/orientation channel. **As** the tool's speed decreases, the individual bits appear farther **apart.** Similarly, as the tool's speed increases, the individual bits appear closer together. See Figure **3.16.** Changes in tool speed often indicate pipeline changes, such as the prcsencc of heavy wall pipe.

Calculating Orientation

The rotating design of the tool allows it to wear evenly and endure long runs. The distance/orientation channel records the rotation of the tool as it moves through the pipeline.

For purposes of determining the orientation of indications on the log, the pipe's circumference is divided into equal sectors. The sectors are numbered clockwise, looking downstream. See Figure 3.17. The orientation is recorded at the beginning of each orientation word in the frame.

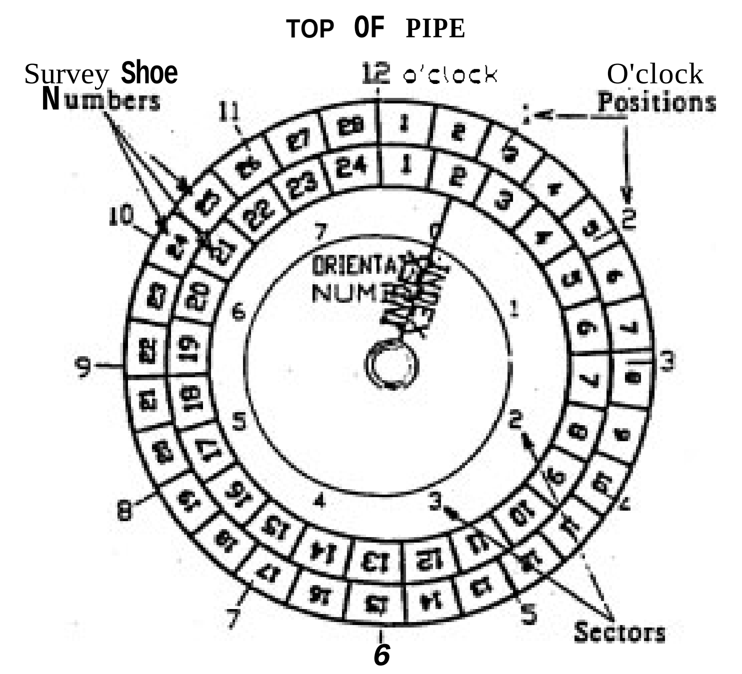

Figure 3.17. Calculating Orientation

Attached is an orientation calculator similar to the ones used by Linalog personnel. The orientation calculator allows the user to determine the o'clock position of an anomaly with greater ease. To use the calculator, follow these steps:

1. Draw a vertical line up from the first bit of an orientation word to the first survey channel. Do this for several orientation words on each side of the anomaly of interest.

2. Begin with the first orientation word. .Decode the last three bits. This will produce a decimal number. Rotate the clear plastic disk on the calculator until the Shoe 1 is centered in the sector numbered the same as you just decoded. With the calculator so aligned, read the o'clock position of each survey channel, Mark the 12 o'clock position and the 6 o'clock position on the log. Repeat this procedure for two more orientation words near the anomaly of interest.

3. Draw a solid line through the 12 o'clock marks and a dotted line through the 6 o'clock marks.

4. To dctcrmine the approximate o'clock position of the anomaly, compare the position of the anomaly to the positions of the 12 and 6 o'clock lines.

The oricntation channel is intended to locate the quadrant of the pipe whcrc the anomaly can bc located. Although an exact o'clock position can normally bc dcrcrmincd through the above steps, this channel is only designed to provide an approximate location.

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GRADING PROCESS

The survey log is examined to check for "significant" indications. An indication is considered significant if it is believed to represent an anomaly of greater than 15% pipe wall penetration. Using the weld indications to distinguish the individual joints, the analysis of the log is done on a joint-by-joint basis. Those joints containing significant indications are further studied to locate the largest indication in the joint. If the largest indication in a joint is believed to be corrosion, a number grade classification is assigned to that joint on the log. If the largest significant indication in a joint is not believed to be corrosion-related and cannot be otherwise identified, that joint is given in "A#" grade. Each number (1-9) represents an alteration encountered by the carrier pipe. The various numbers are as follows:

A1: Mash	A5 Metallurgical Change
A2 Tap	A6 Patch or Half Sole
A3: Test Lead	A7: Debris
A4 Supports	A8: Anchors
	A9 Others

Occasionally, the tool's speed will be in excess of Linalog's primary range of effectiveness (1 to 5 miles per hour). However, in order to point out all areas of corrosion for the customer's consideration, all legible areas of the log are graded. The graded joints, which appear in areas of excessive tool speed, are dignified on the log and Computer Enhanced Report (if applicable). A star is placed to right of the grade on the log; and, the statement "Excessive Speed" appears in the comments section of the Computer Enhanced Report.

Classifications

The definitions of the grading categories are as follows:

Grade 1 - From 15% to 30%
Grade 2 - From 30% to 50%
Grade 3 - Greater than 50%
Grade A - Alteration; not corrosion-related

Common Considerations

The following is a list of common considerations and rules of log interpretation. These rules are followed during the interpretation of most logs Certain indications and situations may lend themselves to variations in the prescribed procedures and rules.

- If the nature of the largest significant indication in a joint is not known, that joint is given a corrosion grade.
- Indications which are believed to represent anomalies with less than 15% pipe wall penetration are not given a grade classification.
- The decision as to the nature of some indications may be based on the indications appearing in the adjacent joints.
- Previous surveys are the most important source of information, other than the current survey log itself, for determining the nature of anomalies on the current survey log. For details, see "Repeat Surveys" on the following page.
- The verification digs are usually a reliable source of information about the pipeline. They are intensely reviewed during the interpretation process.
- The o'clock positions of anomalies from pint to pint and throughout the log . are compared.
- The number of indications within each joint is considered.
- The flow or lack of flow of indications across the welds is considered.
- Indications which follow patterns within a joint or throughout the log are studied.
- The type of pipe (seamless, spiral weld, etc.) is considered.
- Known repairs are marked and considered in the interpretation process.
- Known and verified mill-related patterns, such as expander marks, are considered.
- The environment of the pipeline (rocky terrain, swampland, etc.) can also affect corrosion patterns.
- The pipeline product is also an important consideration. Certain products create unique types of corrosion patterns.

These are some of the procedures used to make the interpretation process as accurate and consistent as possible.

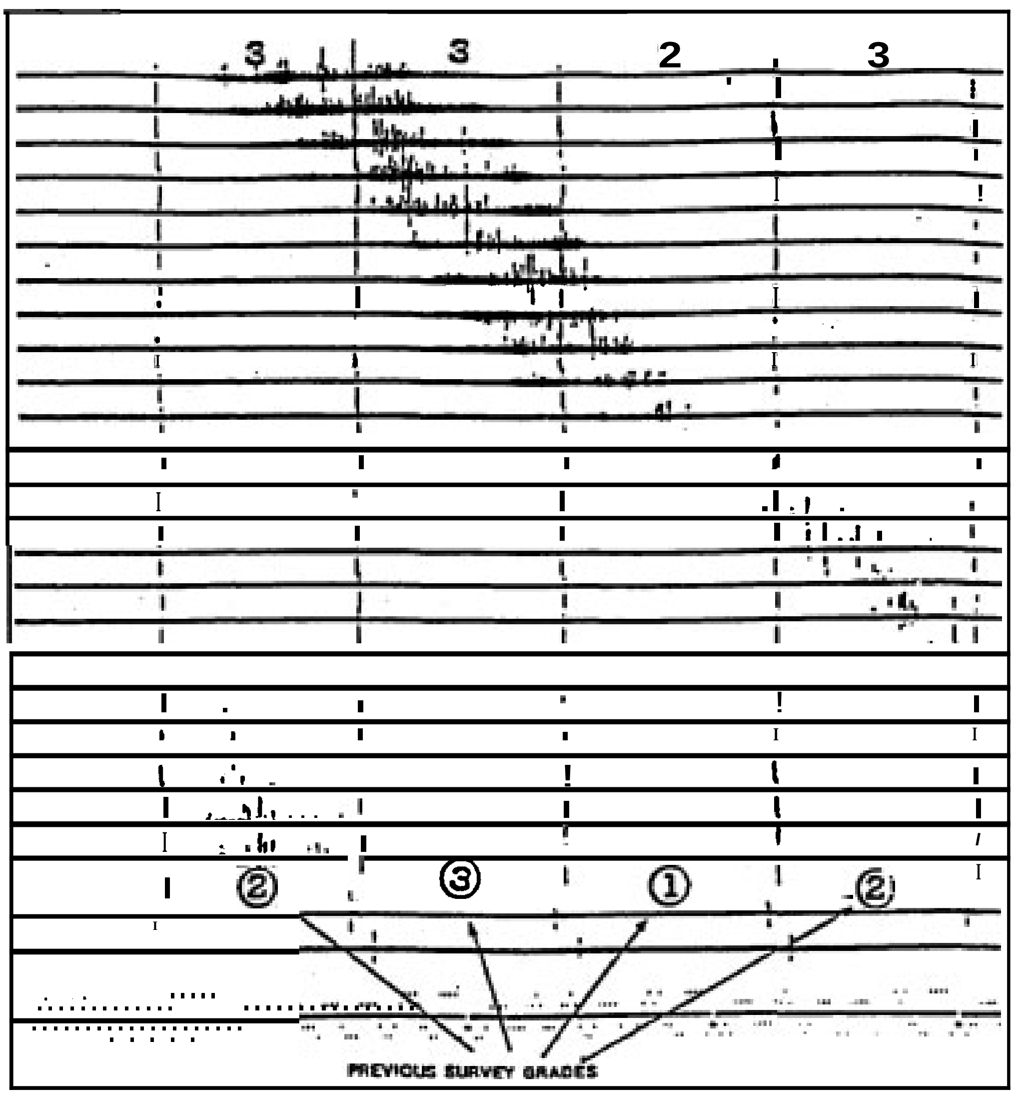
REPEAT SURVEYS

On repeat surveys, the previous survey is studied side-by-side with the current survey to reveal patterns of corrosion growth. The previous survey also helps to fine tune the current survey. The actual comparison involves several Steps:

- During the interpretation process, the grades on the previous survey are transferred to the current survey. See Figurc 3.18. If a star appears next to the grade on the previous survey log, it is transferred to the new survey log next to the appropriate previous survey grade. The star indicates excessive tool speed in the area of the graded indication.

- While transferring grades, a joint-to-pint, indication-to-indication comparison is done. This comparison provides important insight into the changes which have occurred during the span of time between the survey runs.

- Magnets, above ground markers, or other pipeline features can be transferred from the previous survey to .the current survey.



Figurc 3.11 Previous Survey Grades

SURVEY PREPARATION

INTRODUCTION

To accurately locate and grade pipeline defects by means of intelligent pigging, some preparation of the pipeline is necessary. Preparation includes two major aspects. The first is the placement of an applicable line marking system. The second is a test run of the "Dummy Tool" to identify problems which may affect the running of the Linalog Tool.

LINALOG PIPELINE MARKING SYSTEMS

The use of a pipeline marking system is essential to the success of a Linalog survey. Such a system establishes a relationship between distances on the pipeline and distances on the survey log. If accurate records are kept, marker placement is only necessary on the initial run of the Linalog Tool. On repeat surveys, marker locations can be transferred from the initial survey log to the new survey log. Two types of marker systems are available.

Placement

The sites chosen for marker placement are determined by the customer. Certain technical limitations and practical matters should be considered.

The interval between markers should be based on the relative ease of chaining distances. In rough terrain, where chaining is difficult, markers should be placed closer together. In smooth terrains, they may be spaced farther apart. We recommend placing a marker approximately every mile. It is not important to space them any particular distance apart.

Another important aspect to consider when choosing sites for markers is the amount of corrosion in an area. Areas known to have corrosion problems should be considered prime locations for markers This will greatly ease the locating of defects in those areas.

In areas where there are other permanent features (such as valves, taps, tees, or casings), proper spacing of the markers can maximize the number of useful reference points. Placing a marker near a permanent pipeline feature will result in having two valuable reference points showing on the log in proximate locations.

Importance of Accurate Records

Accurately recording the locations of the markers is as important as the placement itself. Without accurate records, the markers are of little or no use. Pipeline personnel must be able to return to the marker site, at a later date, and know exactly where that particular marker was located. There are two basic ways of doing this:

- placing some type of permanent landmark directly above the spot where the marker was located, such as a large post set in the ground that cannot be easily moved; or,
- keeping accurate records of how far and in which direction the marker was located from an existing geographical landmark, such as the centerline of a road.

Either method will allow the marker location to be reestablished whenever needed. It will also eliminate the need to place a new set of markers on the pipeline during future surveys.

Magnet Marking System

One optional pipeline marking system is the Magnet Marking System. The concept of the system is very easy to understand. See Figure 4.1.

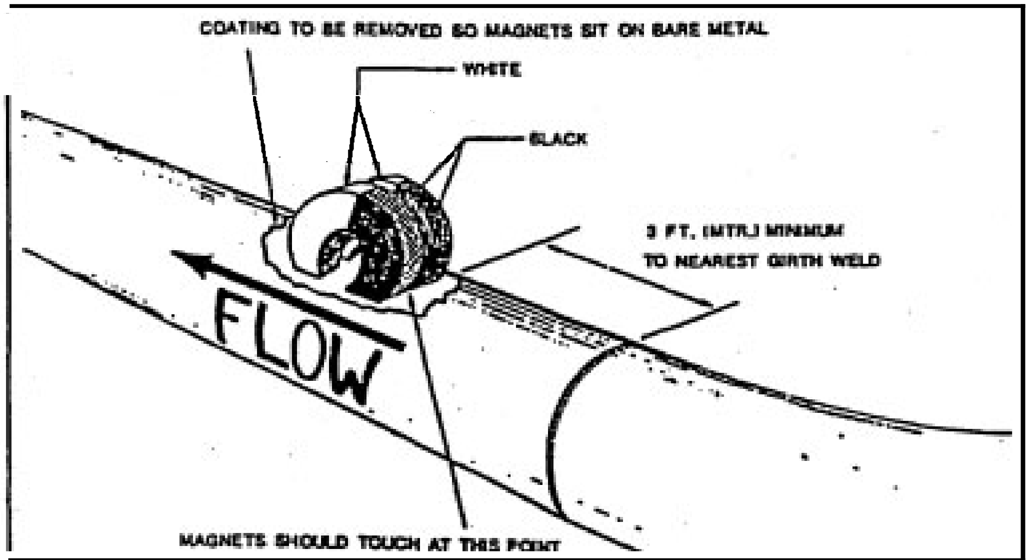


Figure 4.1 **Magnet Marking System**

Theory of Operation. The Magnet Marking System consists of a series of permanent magnets. These magnets are placed in pairs along the pipeline. The magnets are placed in direct contact with the pipe at the desired locations The magnetic field, induced into the pipe wall by the magnets, is detected by the tool as it passes through the pipeline. A corresponding signal is recorded on the magnetic tape. The result is an image on the log that is unique and easily recognized.

Criteria for Placement. The following criteria must be observed during placement of the magnets on the pipeline.

- The magnets must be placed at least 3 feet from the welds If the magnet is closer to the weld, its signal may be lost in the signal associated with the weld.
- The magnets must be placed on top of the pipe. This will aid in distinguishing the magnets from other signals on the log.
- The magnets must be in direct contact with the pipe. (Scrape off the coating to the bare metal.)
- The magnets must be placed parallel to the axis of the pipe, with the white edges towards the downstream end of the pipeline.

Applications. The Magnet Marking System is designed to work well under most conditions. Interference with the magnet's signal is very seldom a problem. The use of this system is most efficient in areas where excavation of the pipeline can be done fairly easily. The Magnet Marking System is the original marking system and has been used with success for many years.

Above Ground Marker System

The other pipeline marking system is the Above Ground Marker System. It provides the means to mark a pipeline without excavating and making direct contact with the pipe. Refer to Figure 4.2. Although this system is more convenient, it is not as foolproof as the Magnet Marking System.

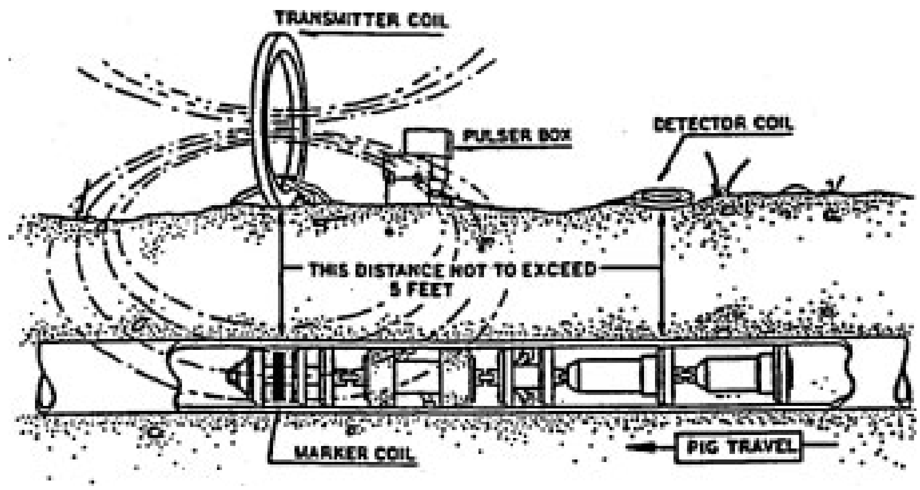


Figure 4.2. Above Ground Marker System

Theory of Operation. The Above Ground Marker System consists of two units: a transmitter unit, placed on the ground above the pipeline; and a receiver, mounted on the inspection tool. The transmitter unit consists of a detector coil, a larger transmitter coil, and a pulser box. The two coils connect to the pulser box. The detector coil senses the magnetic field of the approaching inspection tool and activates the pulser box. The pulser box, in turn, supplies the alternating current to the transmitter coil. The result is a time varying magnetic field which penetrates the surrounding medium and the pipeline. This field is detected by the inspection tool as it passes underneath. A corresponding signal is recorded on the magnetic tape. The end result is an image on the marker channels of the log, that is unique and easily distinguished from other pipeline features. This image provides a reference point for locating the anomalies revealed on the survey log.

Criteria for Placement. The following criteria must be observed during placement of the Above Ground Markers.

- The distance between the pipe and the surface on which the two coils sit must not exceed 5 feet. Probing the line is required to locate the pipeline and determine depth. Both coils must be placed directly above the pipeline.
- The detector (small) coil must be upstream of the transmitter (large) coil.
- The transmitter coil must not be placed closer than 10 feet upstream of the upstream end of a road casing.
- The detector coil must not be placed less than 200 feet downstream of the downstream end of a road casing. Explanation: When the Linalog magnetizer passes through a road casing, the magnetic field of the tool

Above Ground Marker System (continued)

extends well beyond the casing ends. The extended field will cause the detector coil to trigger the pulser box. If this happens, the pulsing cycle will be finished before the tool reaches the transmitter coil. On the upstream end of a casing, the above ground marker (AGM) has already done its job before the tool gets to the casing.

- Neither coil can be placed within 10 feet of metallic objects, such as vent pipes, right-of-way signs, aerial sign posts, or fences.

ications. The Linalog Above Ground Marker System is designed to work in many difficult situations. These markers have been utilized a great deal in areas where excavation of the pipeline is extremely costly. Many pipeline companies that transport high pressure fuels find it much safer to use a pipeline marking system that does not require direct contact with the pipe surface.

DUMMY TOOL

The dummy tool provides an important contribution to the success of the survey. The dummy tool's weight, length, and maneuverability are similar to that of the live tool; however, it does not contain the instrumentation of the live tool.

Purpose

The dummy tool is used to avert possible problems and provide a practice run for the live tool. The advantages of running the dummy tool include the following.

- Obstructions in the pipeline, such as mashes and tight bends, may be discovered.
- Necessary operating parameters, such as line pressure for optimum tool performance, can be determined.
- Personnel can be educated on the proper procedures for launching and trapping a Linalog Tool.
- Possible problems with debris in the line can be exposed. Also, much of the debris may be flushed out by the dummy tool.

Conclusion

The running of the dummy tool can help prevent problems during the running of the Linalog Tool. By making adjustments to resolve such problems, unnecessary expenses (such as tool damage costs and rerun costs) can be avoided. Taking advantage of the information obtained from the dummy run will enhance the success of the survey.

SURVEY EQUIPMENT

INTRODUCTION

The equipment used in producing a complete Linalog survey log includes the Linalog Survey Tool, any necessary adaptations to the tool, and the Linalog Playback System. The tool performs the actual inspection. The playback system transforms the data gathered by the tool into a readable scroll of information.

LINALOG SURVEY TOOL

Description

The Linalog Survey Tool (referred to as the "tool") is a self-contained unit which generates a complete, launch-to-trap, full circumferential inspection of a pipeline. See Figure 5.1. Normal pigging operations are used to launch, propel, and trap the tool. The standard 16 inch diameter tool consists of 4 sections connected by universal joints (U-joints). The multi-section design allows the tool to negotiate most pipeline bends. The Linalog Tool produces an indirect survey of the condition of the pipeline. The actual specifications of the tool used in this survey can be found in Appendix SA of this report.

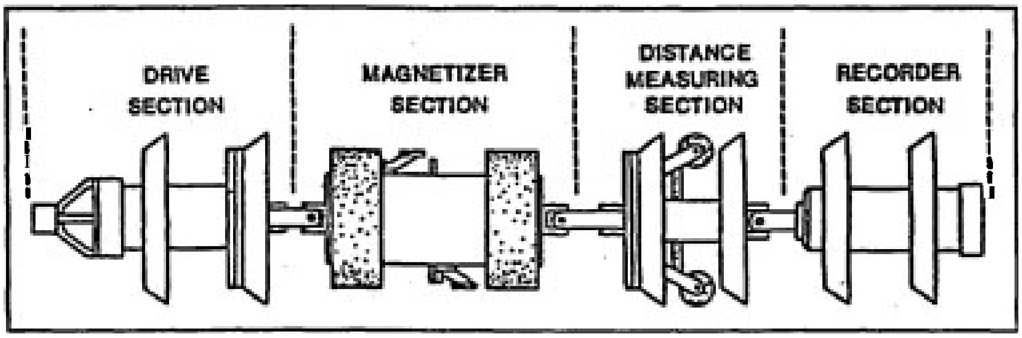


Figure 5.1. Linalog Survey Tool

Operating Principle

The Linalog System of pipeline inspection incorporates the principles of magnetic flux leakage technology. The inspection process involves two steps.

1. The pipe to be inspected is magnetized to an optimum inspection level.

   If the section of pipe is free of defects, then all magnetic lines of flux will be contained within the pipewall. See Figure 5.2.

   If the section df pipe contains a defect, the lines of flux will be redistributed around the defect The result will be that some of the lines of flux will "leak" out into the surrounding medium.

2. A magnetic field sensor, scanning along the surface of the pipewall, will detect the leakage field and output a corresponding electrical signal. This signal is a measure of the defect's size and shape.

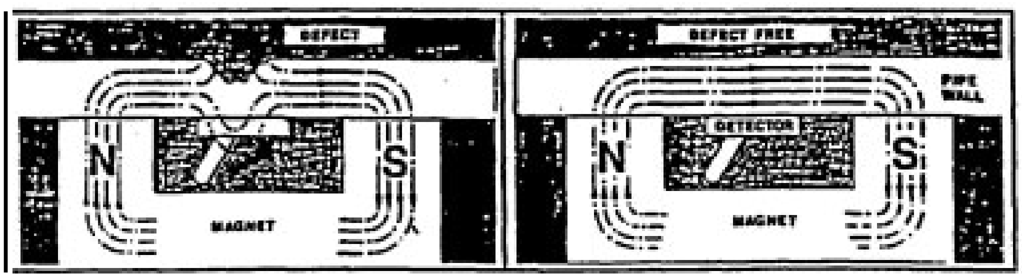


Figure 5.2. Flux-Leakage Principle

Drive Section

The drive section is located at the front of the tool. See Figure 5.3. Its main functions are to facilitate propulsion of the tool, and to provide electrical power. The primary components of the drive section are the drive cups and the battery. Also, a marker detector unit is often mounted on the drive section The remainder of the tool is pulled along behind the drive section. This eliminates the possibility of the tool jackknifing in the line.

Drive Cups. The drive cups form a positive seal on the internal surface of the pipe, allowing the tool to be propelled by the pipeline throughput.

Battery. The battery supplies the electrical current necessary to operate the tool's magnetizer and recorder. A pressure proof compartment protects the battery from the pipeline pressure and product.

Marker. The marker detector units are designed to create an image on the log at each Above Ground Marker (AGM) or Magnet location. The marker also provides other information about the pipeline, such as weld locations. Note: The marker units may be mounted on the drive section or the distance measuring section.

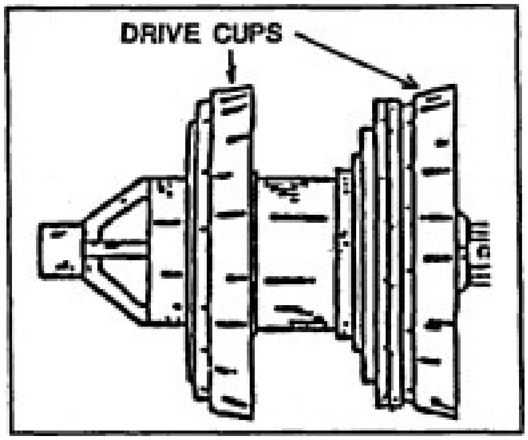


Figure 5.3. Drive Section

Magnetizer Section

The magnetizer section performs the actual inspection. The major components of this section are the electromagnet, the steel brushes, and the transducers. Refer to Figure 5.4. The electromagnet and the steel brushes are responsible for inducing a magnetic flux field into the pipe wall. The transducers ride along the pipe wall and detect leakage of the flux field.

Magnetizer. The electromagnet is powered by the battery. It provides the magnetic force which induces the flux field into the pipe wall.

Steel Brushes. Two sets of steel brushes are used as a path for the magnetic flux to enter the pipe wall. The constant contact between the brushes and the pipe insures uninterrupted flux field in the pipe wall with. The two sets of brushes become magnetic north and south poles. Twenty-four transducers are located between the brushes.

Transducers. The transducers (referred to as "shoes") are a circumferential group of detectors which overlap to provide a complete, 360 degree inspection of the pipe wall. When an anomaly is present in the bodywall of the pipe, these transducers detect the corresponding leakage of the magnetic flux field. Throughout the course of the survey, such information is dispatched to the recorder section.

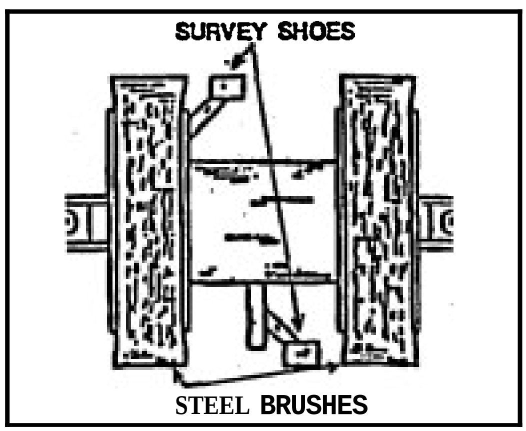


Figure 5.4. Magnetizer Section

Distance Measuring Section

The distance measuring section [Figure 5.5) supports the distance wheels, and may or may not carry one of the marker receiver units.

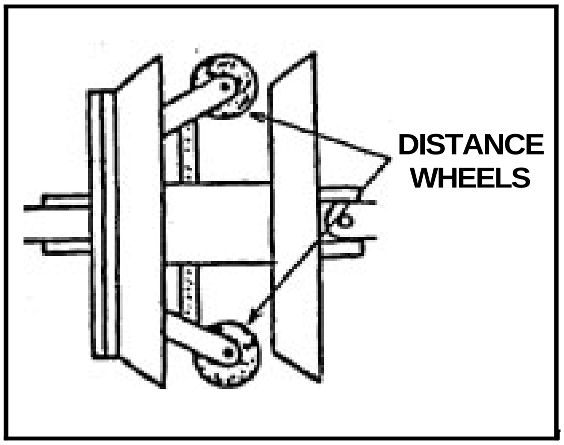


Figure 6.6. Distance Measuring Section

Distance Wheels. The distance wheels are responsible for measuring the progress of the tool as it moves through the pipeline. Throughout the survey, the data obtained from the distance wheels is recorded on magnetic tape along with the other information.

Marker. The marker detector units are designed to create an image on the log at each above ground marker (AGM) or magnet location. The marker also provides other information about the pipeline, such as weld locations. Note: The marker units may be mounted to the drive section or the distance measuring section.

Recorder Section

The recorder section, Figure 5.6, has many functions The primary function is to process and record the information detected by the transducers The orientation mechanism is also located this section.

Recorder. The recorder processes the data detected by the transducers and records it on magnetic tape. The recorder also houses the amplifiers and the Automatic Gain Control (AGC) circuits The AGC circuits work with the amplifiers to compensate for variations in tool speed.

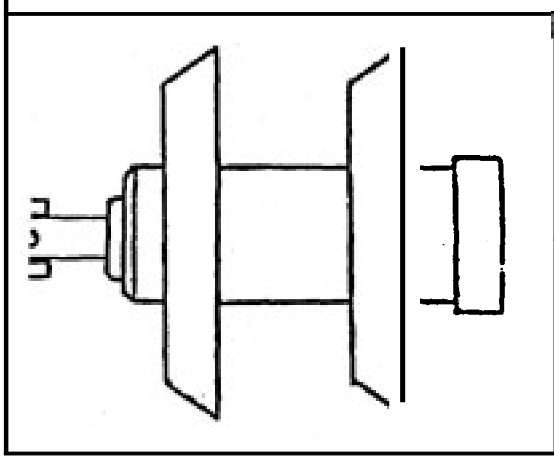


Figure 6.6. Recorder Section

Orientation Mechanism. The term orientation refers to the position of the tool, circumferentially, in the pipeline at any given time. The orientation mechanism adjusts the signal to the recorder that indicates the rotation of the tool. The recorder registers this signal on magnetic tape along with-the other data.

OPTIONAL TOOL ADAPTATIONS

Variations of standard equipment arc available to suit the needs of most pipclinc companies. Some of the more frequent adaptations arc described below.

Double U-Joints. For pipelines with tighter than usual bends, double U-joints are somctimcs available. They give the Linalog Tool added maneuvctability.

OPTIONAL TOOL ADAPTATIONS (continued)

Butterfly Cups. For pipelines with sections of slightly larger diameter Pipe, butterfly cups are available to keep the tool moving. Their unique design allows them to flex open in larger diameter pipe. When flexed open, they form an alternative seal between the pipeline and the front of the tool. This permits the pipeline product to continue propelling the tool.

Dual Battery Package. A dual battery package has been designed for especially long sections This option can considerably increase the tool's surveying capability.

Timer. A timer is available for lines that are too long to survey in one run. The timer is also used for surveys in which only the latter part of the section needs to be surveyed. In either case, the timer can be set to activate the tool a set number of hours after it is inserted into the pipeline.

Bolts and Wiring. The bolts and wiring on the tool can be replaced with specially made equipment designed for use in a hydrogen sulfide (H2S) environment. Special stainless steel bolts and Viton rubber insulated wiring have been designed for this purpose.

Shims. For lengthy sections, special carbide shims have been designed. They are much more resistant to wear than the standard shims.

Standard tools are often adapted to the needs of a particular customer. Many otherwise difficult situations can be resolved with an adaptation of the tool.

PLAYBACK SYSTEM

The end product of the Linalog Tool passage is a magnetic tape containing all of the recorded information about the pipeline. This information must be transformed into a visible form. This is the function of the playback system. The playback system converts the recorded signals on the magnetic tape into visible indications on a paper graph (known as the log).

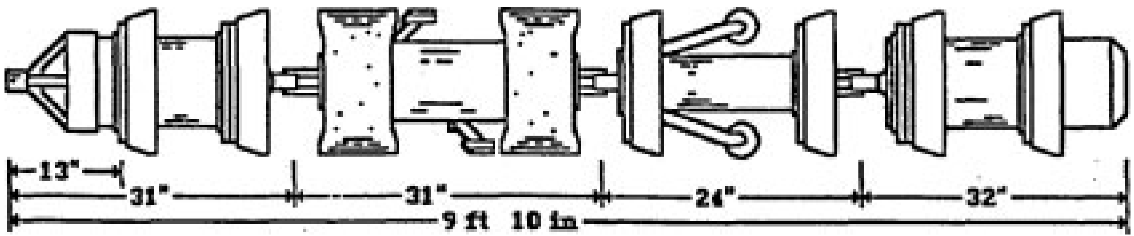
Results

Field Log. The log produced by the field playback system is a temporary, light-sensitive, paper graph called a 'field log''. It is used to check the performance of the tool. The field log is also used to locate areas for the verification digs, if required.

Permanent Log. After the survey run is completed, the magnetic tape is returned to the interpretation Center in Houston, Texas. The tape is placed on a more precise playback system for a second conversion. The information is once again converted to a paper graph form or 'log''. This log is the more precise, permanent record termed the "master log".

APPENDIX **5A**

16 INCH TYPE 4-2-2 LINALOG TOOL



INSPECTION CAPABILITY
Minimum Wall Thickness: 0.188 inch
Maximum Wall Thickness: 0.500 inch

OPERATXNG INFORMATION *
Maximum Pressure: 3000 psi
Temperature Range: 140 deg F max.
40 deg F min.
Tool Weight: 1276 lb / 1400 lb with tray
Speed Range: 1 to 7 mph
Tray Width: 26 inch
Tray Length 118 inch

RUN TIME
Standard Tool: 39 hrs

MINIMUM STRAIGHT PIPE DISTANCE BETWEEN BENDS
36 inch for 4 D
22 inch for 5 D
18 inch for 6 D
9 inch for 8 D
0 inch for 10 D and greater

BEND CAPABILITY

BEND RADIUS PIPE DIAMETERS	(inch)	MINIMUM I. D. IN BEND (inch)	TYPICAL WALL THICKNESS ** (inch)
4 D	64	15.49	0.219
5 D	80	15.23	0.312
6 D	96	15.13	0.375
8 D	128	14.89	0.469
10 D	160	14.80	0.500
12 D	192	14.62	0.562
Straight Pipe (Fittings)		14.25	0.750
Straight Pipe (Continuous)		14.50	0.625

* NOTE: Minimum Recommended Operating Conditions In Gas - 700 psi, 18.7 mmcfd and 2 mi/hr.

** NOTE: The Typical Wall Thickness is provided as a convenience only. Abnormal conditions in the pipe such as unusual ovality may make the Typical Wall Thickness value unusable. The value for the minimum I. D. is the most critical value.

This information is intended only for the use of Linalog customers. This data is subject to revision without notice, and is not to be construed as a warranty or guarantee of any nature. If you have any questions, please contact your local representative. or call (713) 799-5424.

Rev. 0/ 04-27-83

TUBO 000292

LIST O... ...R...RS

JOB #
2703
REPORT #
14111891A

0104 ACCEPT 4.3 mph
26067.6 12:13:43

LIST OF ALL MARKERS

SOB #
2703
REPORT #
14111591A

0103	ACCEPT	5.2 mph	
,39156.1		05:50:21	
8103	ACCEPT	4.9 mph	
39989.8		05:54:14	
0183	ACCEPT	4.9 mph	
40798.0		06:07:43	
8181	REJECT	0.6 mph	
41921.0		06:26:26	
0101	ACCEPT	4.5 mph	
42211.1		06:31:16	
0103	ACCEPT	4.9 mph	
43677.3		06:55:42	
0101	ACCEPT	4.9 mph	
47211.2		07:54:36	
0103	ACCEPT	5.2 mph	
48083.9		08:09:08	

TUBO 000295

0101	ACCEPT	4.9 mph	
48966.2		08:23:51	
0103	ACCEPT	4.9 mph	
50062.3		08:42:07	
0101	ACCEPT	4.5 mph	
50814.9		03:54:39	
0103	ACCEPT	4.9 mph	
54088.4		09:49:13	
0101	ACCEPT	4.5 mph	
54972.9		10:03:57	
0103	ACCEPT	4.9 mph	
55779.5		10:17:24	
0101	ACCEPT	5.2 mph	
56805.6		10:34:30	
0103	ACCEPT	5.7 mph	
57991.8		10:54:16	
0103	ACCEPT	5.7 mph	
60060.6		11:28:45	
0101	ACCEPT	5.7 mph	
60879.1		11:42:24	

0103 ACCEPT 5.7 mph
61688.4 11:55:53

0101 ACCEPT 5.2 mph
64455.4 12:42:00

0103 ACCEPT 5.2 mph
66313.2 13:12:58

0303 ACCEPT 5.7 mph
69225.8 14:01:36

0101 ACCEPT 5.2 mph
70219.9 14:18:04

8103 ACCEPT 5.2 mph
71218.5 14:34:35

'0181 ACCEPT 6.2 mph
71885.9 14:45:50

0101 ACCEPT 4.8 mph
73478.7 15:12:23

0101 ACCEPT 6.2 mph
76473.1 16:02:18

0103 ACCEPT 5.2 mph
77239.5 16:15:04

0181 ACCEPT 5.7 mph
78214.5 16:31:19

8181 ACCEPT 5.7 mph
79466.4 16:52:11

0103 ACCEPT 5.2 mph
80391.2 17:07:36

0101 ACCEPT 5.7 mph
81458.9 17:25:23

8183 ACCEPT 5.7 mph
81715.9 17:29:40

8183 ACCEPT 7.6 mph
83894.4 17:52:39

8161 ACCEPT 5.2 mph
83822.5 18:04:47

8181 ACCEPT 4.5 mph
86326.7 18:46:31

0103 ACCEPT 4.9 mph
87326.9 19:03:11

0101 ACCEPT 5.2 mph
87716.8 19:09:35