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

Appendix 7 Olympic responses to WDOE order

OLYMPIC PIPE LINE COMPANY
2319 LIND AVE. S.W.
P.O. BOX 1690
RENTON, WASHINGTON 98057
(206) 235-7736

October 15, 1996

Paul O'Brien
Department of Ecology
Northwest Regional Office
3190 160th Avenue S.E.
Bellevue, WA 98008-5452

RE: Administrative Order No. DE 96CP-N269

Dear Paul:

Olympic Pipe Line Company submits the following in response to the administrative order dated September 17, 1996.

Item #1

Within 30 days of receipt of this Order, Olympic Pipe Line must submit a schedule satisfactory to Ecology for a review and analysis of pipeline magnetic flux tool data for the entire pipeline system for potential anomalies similar to those found after the Ebey Slough spill. In order to accomplish this analysis, Olympic Pipe Line must run the magnetic flux tool through those pipeline sections for which data does not exist.

Olympic Pipe Line Company voluntarily runs a magnetic flux tool for the inspection of possible corrosion and other forms of metal loss abnormalities, generally on a five year cycle. The history of the various line segments and Olympics proposed schedule for testing are as follows:

Line Segment	Length (miles)	Last Inspected	Prior Inspections	Future Inspection
Ch Pt. to Fe 16"	5.1	1996	1992	2001
Fe to Al 16"	37.4	1996	1991,1981	2001
Ana to Al 16"	8.4	1996	1992,1981	2001
Al to Re 16"	75.6	1996	1991,1982	2001
Al to Re 20"	76.1	1996	1991	2001
Re to Se 12"	12.4	1992	1981	1997
Re to ST 12"	6.6	1992	none	1997
Re to Po 14"	148.0	1996	1992	2001
Ta Jct to Ta 8"	3.9	1992	none	1997
Oly Jct to Oly 6"	15.0	1993	none	1998
Va Jct to Va 12"	4.5	1992	1981	1997
Total Miles	391.9			

The magnetic flux tool is not effective for the detection of dents and buckled pipe because these anomalies do not involve metal loss. This tool works on the principle of sending out a magnetic flux and measuring changes in the force field caused by fluctuations in the metal thickness around it. The tool very effectively pinpoints corrosion, scratches, gouges, and welds. Early after the Ebey release, we believed the tool might also be able to infer metal deformities, but this has since proven not to be the case.

As discussed with the Northwest Regional Office, we have conducted one or more of the magnetic flux tool runs on each of the pipelines in Olympic's system. However, we have also confirmed that this tool is not effective in identifying potential anomalies such as the one which caused the release at Ebey Slough in June, 1996.

Olympic also uses another type of internal inspection tool. What was not detected by the magnetic flux tool can be detected by a geometry inspection tool, otherwise known as a *caliper pig*. The caliper pig is very effective in locating pipe deformities, even those located at elbows and other bends. Our current and previous data and future plans for this tool are discussed in Item #3.

Item #2

Olympic Pipe Line must submit to Ecology a report of the magnetic flux data analysis within 30 days of completion. The report must explain the cause of all identified anomalies. Significant anomalies that can not be excused by examination of data must be verified by field inspection of the pipeline sections involved. Olympic Pipe Line must provide a schedule satisfactory to Ecology for conducting any necessary inspection work.

As noted above, the magnetic flux tool will not be useful in finding buckled or dented pipe. However Olympic aggressively uses the data analysis to find and eliminate other metal anomalies before they become serious, and jeopardize the integrity of the pipeline. The data is interpreted by analysts employed by Tubescope, the manufacturer of the inspection tool. The length and depth of any anomaly is measured, then calculated in accordance with the ASME B31.4 piping codes. Olympic's policy is to excavate and expose any anomaly, which by code would not meet the criteria of the rated design. This is done regardless of the actual operating pressure at the location. We are in the process of exposing all suspect anomalies which meet the above criteria, from the 1996 internal inspection. In accordance with Olympic's Risk Reduction policy, we have started with the highest indicated de-ratting potential. If any pipe exposed indicates an anomaly which is out of code, repairs will be made to restore the pipe to design standards.

We plan to excavate between 11 - 25 indicated anomalies on the 20" Allen to Renton line, 1 - 2 on the 16" Allen to Renton line, and 11 - 14 on the 14" line Renton to Portland line. We expect to have this work complete by the end of 1996. The completion of this project will confirm compliance with initial design specifications.

Our prior inspection and repair history has shown that approximately one in five anomalies have required repair. Metal loss defects are most often repaired by installing a welded full encirclement sleeve.

Items #3

Within 30 days of receipt of this Order, Olympic Pipe Line must submit a schedule satisfactory to Ecology for a comparative analysis of caliper tool data and construction drawings for the entire pipeline system to identify any discrepancies between the two. In order to accomplish this analysis, Olympic Pipe Line must run the caliper tool through those pipeline sections for which data does not exist.

The function of the Geometry Inspection tool, or caliper pig, is to determine the geometrical shape of the pipeline. It produces information indicating dents, buckles, ovality, weld penetration, pipe expansions, valves, pipewall changes, debris deposits and pipeline footage.

Prior to the Ebey Slough release, we had never experienced a failure attributed to a buckle or dent in our 30 years of operating history. Previous caliper pig runs had been made for very specific reasons. They were as follows:

1990 - Renton to Portland 14" - A ship had anchored directly over our pipeline, in the Columbia River, which could have potentially damaged the pipeline. We ran the caliper tool to make that determination and found no damage to the crossing. However, we did investigate other locations identified as ovalities and sharps. Excavation of these areas reduced or relieved the ovality.

1991 - Allen to Renton 20" - Prior the running a the magnetic flux tool, we were required to run a caliper pig to insure the pipeline had nothing less than a three pipe diameter internal bend. The caliper pig confirmed that we could safely run the magnetic flux tool. As it turns out, the caliper run "recorded" the Ebey Slough buckle. However it was so close to the fabricated fitting that it could not be correctly identified with the technology available in 1991..

1996 - Renton to Portland 14" - Following landslides and pipeline movements the decision was made to verify that landslides had not created any damage. We did this in conjunction with our geological survey work . We found no indications of pipe buckling.

After the June 1996 incident we went back to Enduro, the service company, who provided the caliper pig and analysis. Their 1991 report indicated that we had a 45 degree elbow on the south side of the North Ebey Slough crossing, which had failed. What we found was a 30 degree elbow next to a 7 degree buckle in the pipe. After several attempts, we were able to learn in late August that in 1993, Enduro improved their technology so that they could differentiate and locate buckles immediately adjacent to bends and fittings.

We asked them to review the 1991 data and provide an updated interpretation. They came back identifying four recorded elbows which were suspect based on this analysis.. The most critical was at the north side of the south Ebey Slough crossing. The second most critical one was the buckle that failed on the south side of the north Ebey Slough crossing The third most critical was at the south side of the south crossing. The fourth at the north side of the north crossing. All were anomalies in the lower outside elbow.Olympic Immediately worked to expose the three other identified fittings with anomalies and found that the tool indication proved to be correct in its

Interpretation of buckles near the elbows. A buckle was found, that was in fact larger than the one which had failed. A small buckle was also found on the south side of the south crossing. The fitting at the north side of the north crossing was not buckled. The damaged areas were removed and replaced in late September.

We have reviewed the rest of the line data, and comparing it to the new criteria, feel that we have found and removed all buckles on the 20" line like the ones found in the Ebey crossings. Olympic will be excavating portion of pipe near Fisher Slough to confirm that the an anomoly reported earlier as internal debris is not a dent. This should complete investigation and repairs on the 20" line. We also reviewed the 14" line data and found no reason to suspect any buckling.

It should be noted that .250" wall 20" pipe is the most susceptible pipe in Olympic's system to buckling, denting, and other ovality problems because of its high diameter over thickness ratio. As this ratio decreases, the susceptibility to damage during construction and other mechanical decreases. The diameter over thickness ratio for the 20" pipeline is 80, while the 16" and 14" lines are near 50.

In addition to looking for buckles by direct indication, we have also completed our review comparing the construction "as-built" drawings on the 20" and 14" lines with the caliper pig data. We have identified the following discrepancies, some of which have already been confirmed to support the accuracy of the "as-build" drawings.

Stationing	Pipeline	Planned Action
	North Ebey Slough 20"	Angles incorrect - Need to re-run the caliper pig to confirm.
	South Ebey Slough 20"	Angles incorrect - Need to re-run the caliper pig to confirm.
	Snohomish River, S. bank 20"	River survey - Need to run the caliper pig to confirm.
Stationing 2623+67	20"	Angle differs from pig run - Need to re-run the caliper pig to confirm.
Stationing 2629+69.6	20"	Need to field verify geometry
Stationing 2680+09	20"	Need to field verify geometry
Stationing 2669+42	20"	Need to field verify geometry
Stationing 3425+63	20"	Need to field confirm the alignment.
	Cedar River 20"	Need to run the caliper pig to confirm angles.
Stationing 4022+52	20" Renton Station	Angles on caliper pig run was off by 25 degrees. Dug up and confirmed the drawing was correct on 10/9/96.
Stationing 298+19	Green River 14"	No need to review, pipe to be replaced. with new bore of Green River in spring of 1997.
Stationing 1951+85	14"	12' of different W.T. pipe, need to review.
Stationing 6712+74	14"	Possible fitting, need to review.

We will re-run the caliper pig in the 20" line in the first four months of 1997, using a new tool feature which can detect and measure all changes in direction. Previously the caliper pig could only record a change in detect those where there was a change in diameter. This coupled with some field survey work will allow us to correct any errors in our pipeline alignments drawings on the 224.1 miles for which we have data.

We will also run caliper tools in the remaining line segments during the first four months of 1997. We would expect to receive the tool run data back no later than June 15, 1997. Olympic will therefore provide an analysis similar to the above, for the discrepancies noted in the 1996 run, by July 15, 1997. When the results are received, we would propose to meet with Ecology and mutually agree to a schedule for any investigation and field verification work required. In any case, discrepancies which indicate a safety or spill risk will be investigated immediately.

Item #4

Within 30 days of completion of the scheduled analysis in Item 3 above, Olympic Pipe Line must submit a report to Ecology. This report must identify where there are any discrepancies between the caliper tool data and the pipeline construction drawings. Significant discrepancies must be investigated and verified by field inspections of the pipeline. Olympic Pipe Line must provide a schedule satisfactory to Ecology for conducting any necessary inspection work.

Please see #3 above. Olympic will submit a report to Ecology within 30 days of completion of the scheduled caliper pig analysis. Field inspection and investigation will follow on a schedule which is mutually satisfactory to Ecology and Olympic.

Item #5

Olympic Pipe Line must continually monitor and record data from the two strain gauges recently placed on the 16" and 20" pipelines at the south Ebey Slough crossings after the spill. Within 180 days of receipt of this Order, Olympic Pipe Line must submit a report on the results of this monitoring effort including any findings that might affect the integrity of the pipeline or pipeline operations in a manner that may result in future releases to waters of the state. The report must also contain specific recommendations for follow-up and/or corrective actions.

Olympic installed a continuous recording device to record data monitored on the north Ebey Slough crossing, however, the lack of security does not make this a viable answer for long term continual monitoring. Strain gauges have been installed on the pipelines, which will measure any fluctuation of stress on the pipe during tidal action or high water flow conditions. Preliminary data have shown that there is a measurable fluctuation of stress on the pipe during tidal activity, but they are extremely low and well within the elastic range of the steel pipe. At Paul O'Brien's request, we will periodically repeat these recordings at intervals of near flood levels and extreme low tides over the coming winter and submit a final report by March 17, 1997.

It should be emphasized that the information gathered to date confirms our initial analysis that tidal effects on the dike do not contribute to the formation or distortion of

the pipe, which would result in a defect resembling that which caused the spill in June 1996.

Item #6

Within 60 days of receipt of this Order, Olympic Pipe Line must provide a written report on the cause of the second pipeline buckle discovered at the Ebey Slough river crossing south of the spill site including its relationship to the first buckle at the original spill site. As part of this analysis, Olympic Pipe Line must contact the city of Everett regarding the reported buckling that occurred in their water lines near Ebey Slough and report any information or conclusions that might be relevant to the buckling of the oil pipeline.

The second and third buckles found and replaced in September tend to confirm our conclusion that the pipe buckles developed during original construction. This was probably caused during the backfill operation. As noted above, the buckle on the north side of the south crossing was actually larger than the one at the failure site.

Information learned from the pipe replacements where buckles were confirmed include the following:

- The north side of the south crossing was not made perpendicular to the dike. This crossing was at about a 60 degree angle to the dike.
- The axis of all three buckles was the same. If settlement forces or hydraulic forces on the dike caused the buckling, the axis of the buckle should have been perpendicular to the dike. At the south crossing of Ebey Slough, this was not the case.
- In all three cases, when the pipe buckle was cut out, the pipeline rebounded to the non-buckled geometry. This indicates that the force which caused the buckles was no longer acting on the pipe. If natural soil transmitted forces caused the pipe deformation, the rebounding would not have taken place.
- The 16" and 20" line crossings at the Ebey Slough are unique in the Olympic system. The elevation of the land outside the levee is lower than normal high tide, so an up and over design was used. Unlike other crossings, fabricated elbows were used on both sides of the slough. The 20" pipeline on the outside of the dikes had a high outside diameter to thickness ratio, which indicates a higher degree of susceptibility to buckling and other damage.

We made contact with Mr. John Thetford of the Everett water department in September 1996. From that discussion, he relayed that the failures on the water lines were more related to the advance age of the water line (1929 construction), and their size. A follow up call to the engineering group confirms the earlier discussion with Mr. Thetford. Their conclusion is that the age and construction methodology of the 1920's were the primary problem.

The sections of pipe which were removed and replaced are being held at our Renton facility. Olympic is considering which independent laboratory to use in examination of the buckles of the pipe. They will be asked for an opinion as to any factors which may

have been involved in the formation of the anomalies. Depending on our ability to find a laboratory with the expertise required for this testing, we may need to ask for an extension of the time for the final report.

Note: In conjunction with the discovery of the buckles which we believe stem from original construction, we will review the feasibility of running the caliper pig in the new Cross-Cascades pipeline following the hydrotest as a final check that the new pipeline is at the highest quality construction and integrity.

Item #7

Within 90 days of receipt of this Order, Olympic Pipeline must submit a detailed map(s) illustrating the pipeline location at all major river and stream crossings. The map(s) must also verify that the pipeline markers at all of the crossings are properly located.

We have included the latest river crossing survey drawings for the major river and stream crossing on the system. As you know, Federal DOT requirements have always required that we re-survey each of these crossings every five years. Because of the heavy flooding last winter in the Columbia River drainage, we re-surveyed each of those rivers this past summer, regardless of the their survey schedule.

In the past seven years we have added high precision line locator tools which we use to locate and mark the pipeline. We do this to place line markers or when excavation is required near our pipeline. In most cases our pipeline markers are very close to the correct alignment for the pipe, however, it is important that contractors and landowners contact us for locate information as opposed to relying on these markers. Olympic's strongest ally are the state underground utility laws and the one-call centers. Notifications require Olympic personnel to respond to the location, locate the pipeline, and remain on site with communications to our control center during any excavations near our lines.

Olympic will verify that all pipeline locations are properly marked on both sides of rivers or other waterway crossings along the entire route, by December 17, 1996. This will put Olympic in compliance with the 90 day order discussed above.

Summary of Open Action Items from the Administrative Order

- By January 31, 1997, Olympic will submit a summary of all significant magnetic flux tool anomaly inspections and repairs.
- By July 15, 1997, Olympic will complete caliper pig inspection of all lines (including a re-running of 20" Allen to Renton line) and will submit a report analyzing any discrepancies at river crossings or to the "as-built" drawings. A schedule acceptable to Ecology and Olympic will be developed to resolve any outstanding inspection work.
- By March 17, 1997, Olympic will provide a final report on strain gauge results from the Ebey Slough crossing pipe with a report on any indicated corrective actions required.

- By November 17, 1996, Olympic will provide a final report on the cause of the Ebey Slough release. Olympic may request an extension if it is determined that an outside testing laboratory cannot satisfy the schedule outlined in the order.

- We will confirm in writing that all river crossings shown on the enclosed drawings are properly marked. It is understood that this verification of line location at these crossings do not relieve contractor or landowner of the requirements under Washington State law to first notify the One-Call center prior to digging. We would welcome the Department of Ecology's support in extending this requirement to all government agencies.

Olympic Pipe Line Company is committed to employing the best available technology and practices to provide the safest petroleum product transportation system possible. We are also committed to working with the Departments of Ecology, the US Department of Transportation - Office of Pipeline Safety, and the Washington Utilities and Transportation Commission to learn from incidents and "near miss" incidents to make further improvement the safety of the system.

It should be noted that even with the two unfortunate product releases in 1996, Olympioc has lost only one gallon to the environment for every 2,400,000 gallons transported since January 1, 1995. These figures are based on the Department of Ecology calculations of spilled volumes. (Olympic has transported 8.4 billion gallons of product since 1-1-95.)

It is important to note that we have been able to achieve this record by employing the best available technology and practices and aggressively acting to reduce risk. When we have a spill or incident we diligently work to learn and eliminate the cause from the system. While the Spencer Creek and Ebey Slough incidents were unfortunate what we have learned will make Olympic Pipe Line an even safer transportation system in the future. We acknowledge and appreciate the Department of Ecology's involvement and support in this improvement process. We look forward our continuing working relationship in the betterment of both the existing pipeline system and on the proposed Cross-Cascades pipeline extension.

Very truly yours,

Frank Hopf, Jr.
Vice President / Manager
Olympic Pipe Line Company

Olympic Pipe Line Company River Crossings				
Line Segment	Dwg.#	Name of River	Pipe Ø	County
Anacortes to Allen	D-112	Swinomish Slough	16"	Skagit
Seatac Lateral	D-108	Green River (Seatac)	12¾"	King
Olympia Lateral	D-169	Deschutes River	6"	Thurston
Allen to Renton	D-177	Skagit River	20"	Skagit
	D-178	Pilchuck Creek	20"	Snohomish
	D-180	Stillaguamish River	20"	Snohomish
	D-181	Ebey Slough-North Crossing	20"	Snohomish
	D-182	Ebey Slough-South Crossing	20"	Snohomish
	D-183	Snohomish River	20"	Snohomish
	D-184	Sammamish River	20"	King
	D-185	Cedar River	20"	King
Ferndale to Renton	D-114	Nooksack River	16"	Whatcom
	D-115	Samish River	16"	Skagit
	D-116	Skagit River	16"	Skagit
	D-117	Pilchuck Creek	16"	Snohomish
	D-118	Stillaguamish River	16"	Snohomish
	D-119	Ebey Slough-North Crossing	16"	Snohomish
	D-120	Ebey Slough-South Crossing	16"	Snohomish
	D-121	Snohomish River	16"	Snohomish
	D-122	Sammamish River	16"	King
	D-123	Cedar River	16"	King
Renton to Portland	D-133	Green River	14"	King
	D-129	Puyallup River	14"	Pierce
	D-130	Deschutes River	14"	Thurston
	D-132	Skookumchuck River	14"	Thurston/Pierce
	"	Nisqually River	14"	Thurston
	D-109	Newaukum River	14"	Lewis
	D-126	Cowlitz River	14"	Lewis
	D-134	Toutle River	14"	Cowlitz
	D-124	Coweman River	14"	Cowlitz
	"	Kalama River River	14"	Cowlitz
	D-131	Lewis River	14"	Lewis/Clark
	D-127	Lake River	14"	Clark
	D-110	Columbia River	14"	Clark/Multnomah
	D-111	Multnomah Channel	14"	Multnomah

OLYMPIC PIPE LINE COMPANY
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(206) 235-7735

December 23, 1996

CERTIFIED MAIL

Mr. Paul O'Brien
Department of Ecology
Northwest Regional Office
3190 160th Avenue S. E.
Bellevue, Washington

Re: Administrative Order #DE96CP-N269

Dear Paul:

As an update to our letter dated October 15, 1996 and specifically to address the listing of Open Actions from the Administrative Order, we offer the following:

1) Work on the inspection of the significant magnetic flux tool anomaly inspections and repairs is going slower than originally forecasted because of the early wet weather and the unusually high number of areas to be inspected that are subject to problems with wet weather. We have also found that the tool calibration was too sensitive. Consistently the recorded depths of the anomalies is much greater than actually found. Therefore, even though we have started with the worst cases we have yet inspect an anomaly which required repair. This consistency gives us great confidence that when we do expose the remaining anomalies that we may not find any requiring repair.

2) The caliper pig inspection program is expected to start the week of January 13, 1997. We expect to complete all field work associated with the inspections of the 20", 16" and 12" lines by end of July 1997.

3) Attached are strain gauge results from the 20" and 16" lines at the Ebey Slough pipe crossing taken during a week of high water in November 1996. While there is a measurable correlation between level and strain on the pipelines, the resulting stress and strains on the pipeline is so low relative to elastic and ultimate strength of the line pipe that it is not an issue. The maximum recorded stress is less that than 4% of the minimum allowable working stress of the pipeline and therefore insignificant. We therefore see no need to take any action relative to the stresses resulting from the tidal effects. We propose to drop further testing after this spring and submit only the attached graphs rather than a full report.

4) Attached is a final report on the cause and proposed prevention activities resulting from the Ebey Slough release and subsequent discovery of similar buckles at the south Ebey Slough crossing. I prepared the report personally. I am a Registered Professional Engineer in the State of Texas.

You will note that all of our findings since our October 16, 1996 letter confirm that the buckles and the failure were caused during original construction . We also confirm that the caliper pig inspection tool to be run next month will allow us to find and replace any other such defects on the existing and all future pipeline extensions.

The report also includes Pacific Testing Laboratories failure analysis report which indicates that there was nothing metallurgically wrong with the pipe.

5) We confirm that the marking of all river crossing shown on the river crossing drawings submitted to you with our October 16th letter have been verified in the field. As noted in our previous correspondence, this check does not relieve contractors or landowners of the requirement under Washington state law to first notify the One-Call Center prior to any excavation.

If you have an questions on any of the above, please contact me at 206-235-7738.

Very truly yours,

Frank Hopf
VP-Manager

cc W. N. Harris
W. A. Mulkey
D. Madenwald
A. Sanstra
P. J. McHugh

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December 11, 1996
Certificate No. 9611-9045

Mr. Frank Hopf
OLYMPIC PIPE LINE COMPANY
PO Box 1800
Renton, WA 98057

Subject: Failure Analysis of 20 inch Diameter Pipe

Dear Mr. Hopf:

Pacific Testing Laboratories was requested to analyze a cracked section of pipe that was removed from the Allen Station to Renton pipe line. According to a report produced by Olympus Environmental, the subject pipe line was found leaking by a City of Everett employee on June 17, 1996. Upon excavation by a contractor of Olympic Pipe Line Company, a buckle in the pipe was discovered above the bottom elbow on the south side of the Ebey Slough levee. A crack was located at the top of the buckle which was determined to be the source of the leak. Pacific Testing Laboratories was to determine if the crack was a result of the buckle or if it was preexisting.

SITE VISIT

A site visit to Olympic Pipe Line Company's facility in Renton, Washington was conducted by a Pacific Testing Laboratories representative on November 6, 1996. Mr. Richard Klasen of Olympia Pipe Line Company was present at the site visit to assist in our investigation. Large sections of pipe line inclusive of the crack had been removed and was being stored at their Renton facilities. Mr. Richard Klasen reported that the buckled portion was removed from the south face of the south side of the North Ebey Slough. Mr. Klasen also noted that during excavation and cutting of the pipe, the pipe sprung upwards approximately 7° and the interior surface of the pipe was shiny.

The cracked section and sections adjacent to it were visually examined, measured for nominal dimensions and photographed. The pipe was 20 inches in nominal diameter. The straight section of pipe, which had buckled and cracked, had a wall thickness of 0.25 inches. The adjacent 30° elbow section had a wall thickness of 0.375 inches.

It was reported by Mr. Richard Klasen that the pipe was constructed to API specification 5LX grade X52. The pipe line is typically used for transmission of gasoline, jet fuel, or diesel. Average operating pressure is 550 pounds per square inch (psi) with maximum pressure of 930 psi. Mr. Klasen was directed by the Pacific Testing Laboratories representative on what portions of the pipe to remove for further analysis (see Figures 1 and 2).

Saltwood Office Building, Suite 105
910 SE Spokane Street, Portland, Oregon 97202

Tel (503) 232-7852
Fax (503) 232-7886

MECHANICAL PROPERTIES

Two specimens were removed from the subject pipe near the buckle. Specimen No. 9611-9045-0002 was removed from pipe in the transverse direction and 9611-9045-0003 in the longitudinal direction. Tensile tests were then conducted to determine the ultimate tensile and yield strength and percent elongation. It was found that the specimens conformed to API specification 5LX grade X52 (see Table 2 for test results).

FRACTURE EVALUATION

The crack in the subject pipe was opened by sectioning to facilitate examination of the fracture surface topographical features that would identify the fracture mode. The fracture was heavily corroded indicating it had been exposed to the environment for an extended period of time. The exact amount of time could not be determined. The corrosion product was removed and the fracture surface viewed under low powered optics (see Figure 3). The topographical features consisted of a rough featureless surface with no shear lip or chevron marks pointing to the origin. The fracture length on the outer diameter (O.D.) was approximately 0.80 inches compared to a length of 0.12 inches on the inner diameter (I.D.). This indicates the fracture initiated on the O.D. and propagated inward. This crack initiation and propagation direction is consistent with the loading condition at the fracture location due to buckling. It is also consistent with secondary surface cracks/tears found adjacent to the subject crack. It appears that the initial crack did not propagate completely through the pipe wall but may have grown as the buckling progressed.

METALLURGICAL EVALUATION

A spectrochemical analysis was conducted on a specimen (Specimen No. 9611-9045-0001) removed from the pipe near the subject crack. It was found that the specimen conformed to API specification 5LX grade X52 for carbon steel pressure pipe (see Table 1 for test results).

A section of pipe, inclusive of the fracture, was removed for metallurgical evaluation. The sample was mounted in epoxy, polished and viewed at low and high magnification to evaluate the microstructure. Our examination revealed a microstructure consisting of fine pearlite grains in a matrix of grains (see Figure 4). Several sulfide stringers were noted but none were found in the vicinity of the fracture (see Figure 5). Sulfide stringers are a brittle intermetallic an in some circumstances can reduce the strength of the material. The density and size of the stringers found in the subject pipe were not sufficient to reduce the material strength and did not contribute to the ultimate failure.

DISCUSSION

The buckle which contained the crack formed at the transition from the 0.25 inch thick wall to the 0.375 inch thick wall sections (see Figures 6 through 10). The wall of the 0.25 inch thick section bulged outward in such a manner that the pipe diameter increased locally at the buckle. As the diameter increased, the pipe's material was stressed in the transverse direction. The deformation at the buckle location stressed the material beyond it's ultimate strength which resulted in cracking.

CONCLUSIONS

Based on the above analysis and the information available at this time, we conclude the following:

> The crack located on the buckle of the subject pipe was a result of the buckle. The buckle in the pipe stressed the material in the transverse direction, at the location of the buckle, beyond it's ultimate strength resulting in failure. No anomalies in the pipe material or environmental affects contributed to the failure.

Tests have been made and report prepared based upon the specific sample provided to us by the client for testing. We assume no responsibility for variations in quality of samples made by persons or under conditions over which we have no control.

Thank you for using Pacific Testing Laboratories. If you have any questions, or if we can be of further assistance to you, please contact us at (503) 232-7852.

Reviewed by : Alan Topinka, P.E., General Manager

Sincerely,

Gregory A. Marbett
Senior Project Engineer
Manager, Portland Division

DEPARTMENT OF ECOLOGY
NORTHWEST REGIONAL OFFICE
FACSIMILE COVER SHEET

WASHINGTON STATE DEPARTMENT OF ECOLOGY

DATE: 10/22/99

TIME: 1:24 pm

Number of Pages: 15 Plus Cover Sheet

TO: Allen Beshore
NTSB

FAX #: 202-314-6482

FROM: Paul O'Brien

PHONE: 425-649-7130 SECTION:

Department of Ecology
Northwest Regional Office
3190 - 160th Avenue S.E.
Bellevue, WA 98008-5452
Phone: (425) 649-7000
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COMMENTS: Allen - Here's everything we have in our files for 1997.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office, 3190 - 160th Ave S.E. • Bellevue, Washington 98008-5452 • (206) 649-7000

March 13, 1997

CERTIFIED MAIL
P 115 525 458

Mr. Frank Hopf
Vice President/Manager
Olympic Pipe Line Company
2319 Lind Avenue Southwest
P.O. Box 1800
Renton, WA 98507

Dear Mr. Hopf:

Re: Administrative Order DE 96CP-N269

Thank you for your efforts to comply with Administrative Order DE 96CP-N269 (the Order) issued after the Ebey Slough oil spill incident. As a result of several meetings Ecology has had with Olympic Pipe Line Company (OPLC), we have determined that the magnetic flux tool referenced in items #1 and #2 of the Order will not be useful in identifying potential anomalies similar to the buckle found at Ebey Slough. Therefore, it is no longer necessary to complete the requirements of items #1 and #2 of the Order.

Ecology feels that the progress to date made by OPLC on items #3 and #4 or the Order is adequate. Ecology looks forward to the submission of an analytical report of the caliper pig runs by April 1, 1997, which includes any anomalies identified by the tool and a schedule of any necessary follow-up field work.

Ecology has looked at the data gathered by OPLC from the strain gauges placed at the spill location. While it appears that the strain is minimal compared to the overall pipe strength, Ecology will still need to have item #5 of the Order satisfied through the submission of a report interpreting the data collected by the strain gauges. Of particular interest to Ecology is the long term effects of strain on the large diameter pipes.

Ecology accepts the report submitted by OPLC on the cause of the spill at Ebey Slough, thereby satisfying item #6 of the Order.

OPLC submitted a series of maps to satisfy item #7 of the Order. However, Ecology will still need to have OPLC describe what methods were used to locate the pipeline at all major river and stream crossings.

We look forward to meeting with you on April 10, 1997. If you need clarification on any of the above issues, please contact me a (206) 649-7130. Thank you for your continued cooperation in this matter.

Sincerely,

Paul S. O'Brien
Regional Supervisor

cc: Elin Storey - NWRO
Eric Heinitz - SWRO
Dave Lundstrom - HQ
Steve Hunter - HQ

OLYMPIC PIPE LINE COMPANY
2319 LIND AVE. S.W.
P.O. BOX 1800
RENTON, WASHINGTON 98057
(206) 235-7736

May 22, 1997

Certified Mail

Paul O'Brien
Department of Ecology
Northwest Regional Office
3190 160th Ave. SE
Bellevue, WA 98008-5452

RE: Administrative Order #DE 96CP-N269

Dear Paul:

As we discussed at our May 16th meeting at your offices, Olympic Pipe Line Company submits the following in response to the administrative order dated September 17, 1996 and follow up letter dated March 13, 1997. For reference, the remaining open items covered by this letter are described below:

Original Order September 17, 1996

Item #3
Within 30 days of receipt of this Order, Olympic Pipe Line must submit a schedule satisfactory to Ecology for a comparative analysis of caliper tool data and construction drawings for the entire pipeline system to identify any discrepancies between the two. In order to accomplish this analysis, Olympic Pipe Line must run the caliper tool through those pipeline sections of which data does not exist.

Item #4
Within 30 days of completion of the scheduled analysis in item 3 above, Olympic Pipe Line must submit a report to Ecology. This report must identify where there are any discrepancies between the caliper tool data and the pipeline field inspections of the pipeline. Olympic Pipe Line must provide a schedule satisfactory to Ecology for conducting any necessary inspection work.

Item #5
Olympic Pipe Line must continually monitor and record data from the two strain gauges recently placed on the 16" and 20" pipelines at the south Ebey Slough crossings after the spill. Within 180 days of receipt of this Order, Olympic Pipe Line must submit a report on the results of this monitoring effort including any finding that might affect the integrity of the pipeline or pipeline operations in a manner that may result in future releases to waters of the state. The report must also contain specific recommendations for follow-up and/or corrective actions.

Item #7
Within 90 days of receipt of this Order, Olympic Pipe Line must submit detailed map(s) illustrating the pipeline location at all major river and stream crossings. the map(s) must also verify that the pipeline markers at all of the crossings are properly located.

From follow up letter dated March 13, 1997:

Item #3 and #4 additions *"Ecology looks forward to the submission of an analytical report of the caliper pig runs by April 1, 1997, which includes any anomalies identified by the tool and a schedule of any necessary follow-up field work."*

Item #5 additions "... Ecology will still need to have item #5 of the Order satisfied through the submission of a report intsrpreting the data collected by the strain gauges. Of particular interest to Ecology is the long term effects of strain on the large diameter pipes."

Item #7 additions "OPLC submitted a series of maps to satisfy item #7 of the Order. However, Ecology will still need to have OPLC describe what methods were used to locate the pipeline at all major river and stream crossings."

Olympic Pipe Line Company's response to items 3 and 4

The following pipelines were internally inspected for internal geometry using technology supplied by Enduro Pipeline Services, Inc. This inspection of completed between January 12, 1997 and January 23, 1997.

1. Ferndale to Allen 16" pipeline	37.4 miles,
2. Anacortes to Allen 16" pipeline	8.5 miles,
3. Allen to Renton 16" pipeline	76.0 miles,
4. Allen to Renton 20" pipeline	76.2 miles,
5. Renton to Seattle 12" pipeline	12.0 miles,
6. Renton to Sea-Tac 12" pipeline	5.5 miles.
Total length of line inspected	215.6 miles

The final report from the Enduro Pipeline Service, Inc. was received by Olympic Pipe Line Company on March 26, 1997. After a review of the inspection report Olympic Pipe Line Company began the exposing various locations beginning in early April 1997.

The Enduro Pipeline Services, Inc. tool inspects pipe for internal geometric deformities and an attachment tool detects the approximate bend angle in pipe fittings, hot bends and all but the long radius field bends. Many of the bends in the Olympic Pipe Line system (and all cross-country pipelines) are long jointed cold bends which were field bent using techniques still favored today. The tool used to field bend pipe uses hydraulically rams and shaped shoes to carefully bend the pipe to conform to the required alignment. This process involves inelastically deforming the pipe in a controlled manner such that the roundness and ultimate strength of the pipeline is preserved. The smallest radius bend allowable is determined by the pipe diameter as per the American Society of Mechanical Engineers (ASME) code 31.4 -1992 Edition, 406.2.1 - "Bends Made From Pipe".

In analyzing anomalies in pipelines, the ASME B31.4 - 1992 Code, Edition 451.6.2 "Disposition of Defects" is used to determine the limits of acceptability and disposition of imperfections of various size pipe. Under this section the guideline states:

(1) Gouges and grooves having a depth greater that 12.5 % of the nominal wall thickness shall be removed or repaired.

(2) Dents meeting any of the following conditions shall be removed or repaired:
   (a) dents which affect the pipe curvature at the pipe seam or at any girth weld;
   (b) dents containing a scratch, gouge, or groove; or
   (c) dents exceeding a depth of .250" (6 mm) in pipe with a nominal pipe size (NPS) 4" or smaller, or 6% of the nominal pipe diameter in sizes greater than NPS 4".

(3) The guideline also identifies the criteria for repair of areas of General Corrosion and Localized Corrosion and defines "Allowable Pipeline Repairs" and "Repair Methods For Corrosion Defects". These defects are generally detected with the magnetic flux inspection tool.

Olympic Pipe Line Company strictly follows ASME B31.4 - 1992 Edition 451.6.2 repair guidelines, and may also make repairs to lesser defects, depending on the individual anomaly. All lesser defects are evaluated for repair by a member of Olympic's Engineering group who consider location, sharpness and appearance of the defect, location of the seam or joint welds, and other factors that influence stress at the location of the defect. Data obtained from the current excavation locations will be used to make a decision whether to continue or discontinue excavation of lesser defects.

The attached chart shows the segments and location, the defect as identified by the inspection contractor, Enduro Pipeline Services, Inc., what we actually found, our scheduled or actual investigation date, actions planned or taken and planned or actual completion date. Actions alternatives include "Repair or replacement required," "Reinforcement (repair) recommended," or "Re-apply corrosion prevention coating and re-work trench bottom."

Olympic response to item #5

As we noted earlier, the measured strains induced on Olympic's 20" line at the Ebey Slough crossing are very low relative to both the elastic or yield strength and ultimate strength of the steel pipe. The strain is also cyclical with the tides and there is no evidence of permanent deformation of the levee that could cause a build up of strain in the entire levee system.

There are two terms which get used almost interchangeably which must be understood - *stress* and *strain*. *Stress is a measure of the intensity of the forces acting on a unit area of a material.* In English units it is measured in pounds per square inch or psi. All materials, including carbon steel, have an ultimate strength, an intensity of forces which exceeds intermolecular bond forces and the material breaks or ruptures. Steel is used for pipelines and many other structural members because it provides high, very uniform strength at relatively low costs.

Strain is a measure of the deformation of a material in response to forces trying to pull it apart, crush it, twist it, or blow it apart. Strain is usually measured in inches of change per inches of original length. We measure strain in micro-strain units, (millions or inches per inch of original length). At Ebey Slough we recorded strain as much as 30/1,000,000 inch per inch of length. The same level of strain would be induced by a five degree (F) temperature change in the pipeline to give some comparison. A more important comparison is that for our pipeline steel with an minimum tensile strength of 52,000 psi, the pipe can take 1700/1,000,000 inches per inch of strain without being permanently deformed or effected. Pipeline operations routinely induce hoop or circumferential strain of as high as 1200/1,000,000 inches per inch without permanently changing the inside diameter of the pipe.

Stress and strain in materials like steel have a relationship as graphed on the attached chart. As an increasing force acts on the material, the strain increases directly with the increase in stress or force acting. As long as the yield strength or tensile strength is not exceeded (for the OPL 20" line this is a minimum of 52, 000psi), then as the force is relaxed, the steel returns to its original length and shape. This is the so called elastic range which our pipelines and most structural steel members are designed to operate in. The design codes for liquid pipelines limit us to using no more than 72 percent of this yield strength to provide adequate safety factors.

As the stresses exceed the yield strength of the pipe, the steel does not fail, but it does plastically deform. Plastic deformation is permanent so that when force is released and the stress is eliminated, the steel will not return to its original shape and size. If force is applied to the extent that the stresses go beyond the yield strength, the strain will increase in a non-direct relationship to stress until the ultimate stress is exceeded and the material fails or breaks. This plastic range of pipe strength is not considered in normal design of the a pipeline system but instead provides additional safety factor against failure.

It is important to note that once a pipe or structural member is plastically deformed that it retains its original ultimate strength and elastic strength. The formed steel bumper on a car or the pipe bent to follow the contour of the ground, while deformed, regains its elastic strength even though it is has been permanently elongated.

At any rate, the hydraulic forces acting on the levee and pipe cause extremely minor stresses which at the levels measured have no significance to the pipeline. It does produce measurable elastic strains but does not effect the safety of the pipeline in either the short term or long term (50 plus years).

We do think that the hydraulic forces created when the levee broke ten years ago at the north side of our south Ebey Slough crossing, did cause strains in the plastic range. These have the potential to cause a problem in the future, which is why we plan to re-install this crossing with a new bored installation at the cost of over $650,000.

Olympic response to item #7

The location methods used by Olympic Pipe Line Company personnel to accurately identify the pipeline at river and stream crossings are by the use of transmitter and receiver system and probe bar. The electronic transmitter system sends a signal to the pipe by either placing the device over the pipeline or connecting to wires at a test point station which is attached to the pipeline. The second device is a receiver that detects the location of the pipeline. The receiver has an indicator on a display that directs the user left or right. The result is the user end up directly over the pipeline. The most current model can give approximate depth of the pipeline. The electronic detection tool used is manufactured by MetroTech. The models are 810, 850 and 9860. Additionally the field technician can probe for the pipeline with a probe bar. The probe bar is always used when the pipeline is being excavated to confirm depth of burial.

We trust this satisfies your requirements. We will submit a final table showing the summary of anomaly investigation and disposition and soon as all work is complete, currently scheduled for August 1, 1997. If you and your staff would like to witness any of these activities, please advise Richard Klasen at (425) 235-7736.

Sincerely,

Frank Hopf, Jr.
Vice President/Manager

SUMMARY OF 1997 CALIPER PIG INSPECTION AND FIELD INVESTIGATION

Pipeline Segment - Stationing	Defect/Discrepancy	Finding	Scheduled or actual Investigation 1997	Repair / Replacement Required	Reinforcement Recommended (Full Encirclement Sleeve)	Recoat and Retrofitting Recommended	Completion Date 1997
FERNDALE	TO	ALLEN 16"					
16" 843+69	.45" Total Sharp**		May				
ANACORTES	TO	ALLEN 16"					
None	None						
RENTON	TO	SEATTLE 12"					
None	None						
RENTON	TO	SEA-TAC 12"					
None	None						
ALLEN	TO	RENTON 20"					
987+15	.70"Ttl, .49"Sharp		June				
1450+21	.59" Total Sharp**		June				
1724+53	.63" Ttl, .44"Sharp**		June				
3076+53	.70" Total Sharp		June				
ALLEN	TO	RENTON 16"					
783+45.5	1.12" Total Sharp	.75" Sharp	4/2	No	Yes	Yes	4/4
1783+64	1.02" Total Sharp	.625" Sharp	4/7	No	Yes	Yes	4/9
3549+50	.94" Ttl, .67" Sharp	Less than .50" Flat	4/3	No	No	Yes	4/5
3595+37	1.06" Ttl,.77" Sharp	Greater than .50" Sharp	4/7	No	Yes	Yes	4/16
1724+64	.59" Total Sharp	.75" Sharp	4/11	No	Yes	Yes	4/17
2141+66	.43" Total Sharp**		May				
2268+93	.63" Ttl, .50" Sharp	.375" Sharp	5/14	No	No	Yes	5/14
2278+98	.70" Ttl, .57" Sharp	.375" Sharp ***	5/12	No	***	***	***
2283+48	.54" Ttl, .37" Sharp	.56" Sharp	5/5	No	No	Yes	5/9
2319+41	.80" Total Sharp	.50" Sharp	5/15	No	No	Yes	5/15
2319+92	.74" Total Sharp	.375" Sharp	5/15	No	No	Yes	5/15
2340+35	.50" Ttl, .39" Sharp	.375" Sharp	5/1	No	No	Yes	5/2
2383+31	.78" Total Sharp	.344" Sharp	5/16	No	No	Yes	5/19
2416+49	.76" Total Sharp	.50" Sharp ****	5/20	Yes	Yes	Yes	5/22
2451+94	.84' Total Sharp	.562" Sharp ****	5/21	Yes	Yes	Yes	5/22
2587+82	.48" Total Sharp	.25" Sharp	4/28	No	No	Yes	4/29
3073+29	.84" Total Flat		May				
3084+00	.50" Total Sharp**		June				

SUMMARY OF 1997 CALIPER PIG INSPECTION AND FIELD INVESTIGATION

Pipeline Segment Stationing	Defect/Discrepancy	Finding	Scheduled or actual Investigation 1997	Repair/ Replacement Required	Reinforcement Recommended (Full Encirclement Sleeve)	Recoat and Retrenching Recommended	Completion Date 1997
3111+07	.80" Total Sharp		June				
3839+30	.69" Ttl, .37" Sharp**		June				
3992+23	.59" Ttl, .33" Flat**		June				
1956+51	1.06" Ttl, .65 Sharp		July				
2045+27	1.80" Ttl, 1.26" Sharp		July Bore Replacement				
2045+56	1.40" Ttl, .96" Sharp		July Bore Replacement				
2046+61	.94" Ttl, .35" Sharp		July Bore Replacement				

Definitions:

Total Is a measurement made from the baseline of the record to the peak.

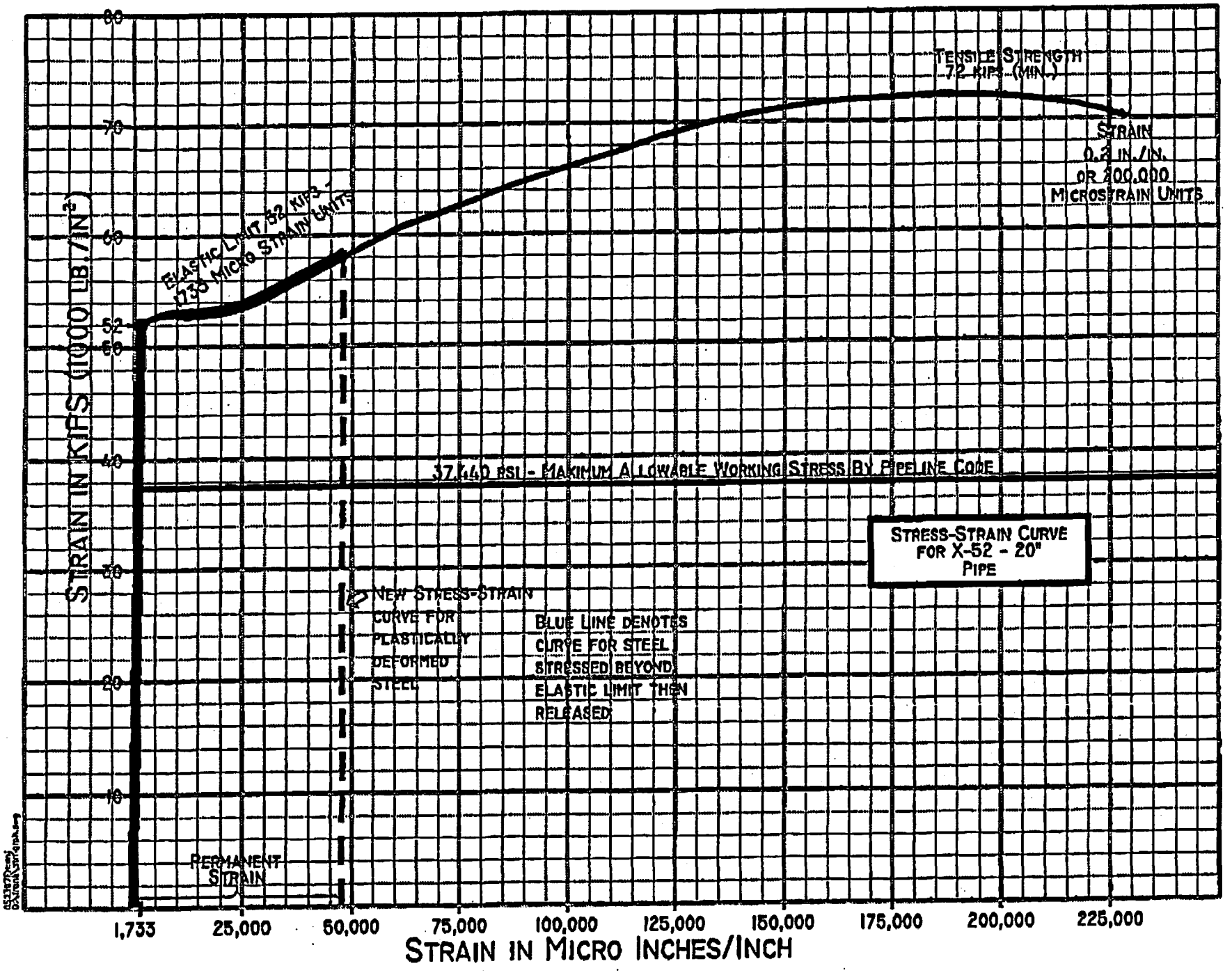
Sharp Anomaly as a reduction in pipe diameter, occurring within a span of 2 feet or less.

Flat Anomaly as a reduction in pipe diameter having a span exceeding 2 feet but, not greater than 5 feet.

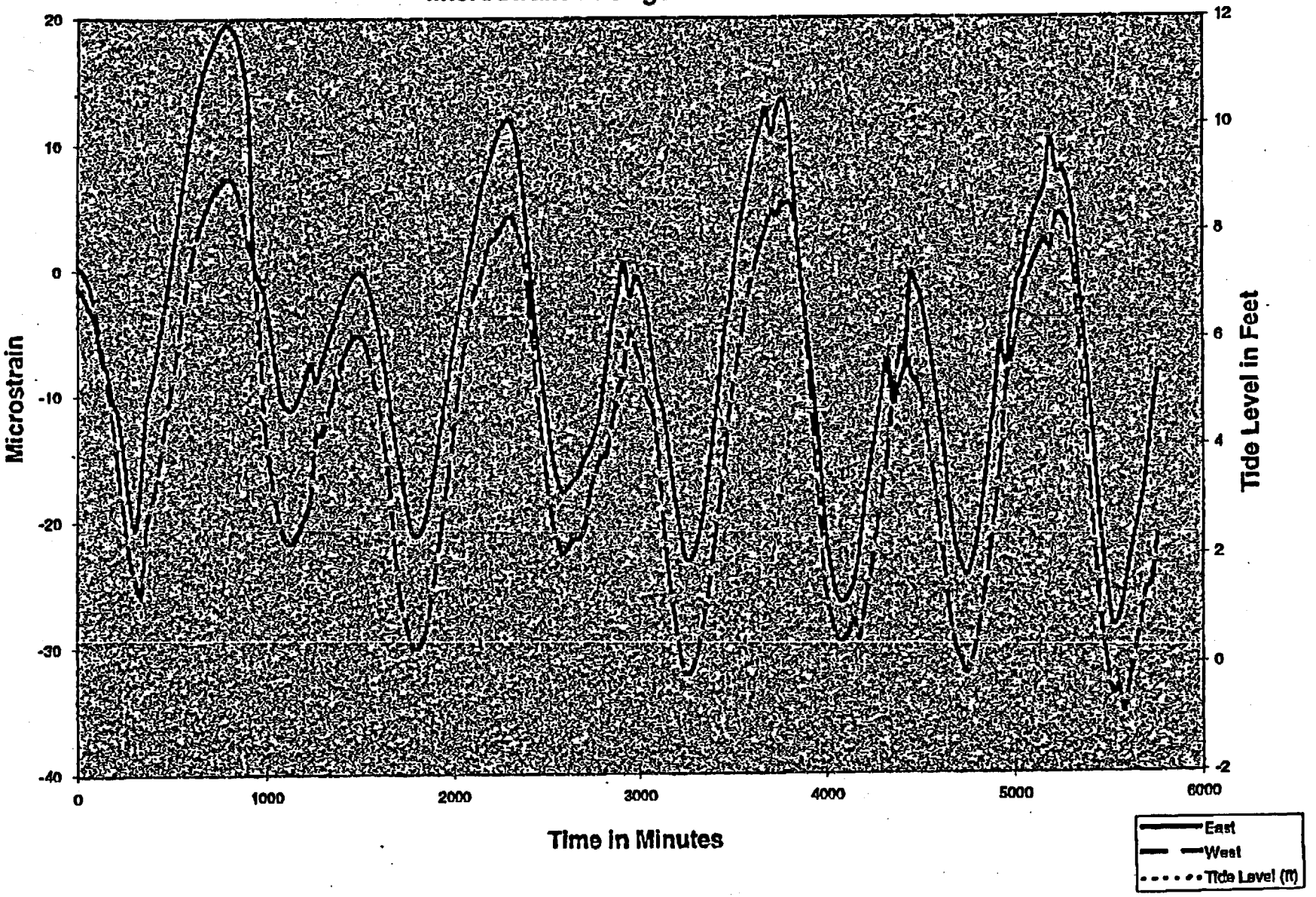
** May investigate if risk is justified by engineering opinion.

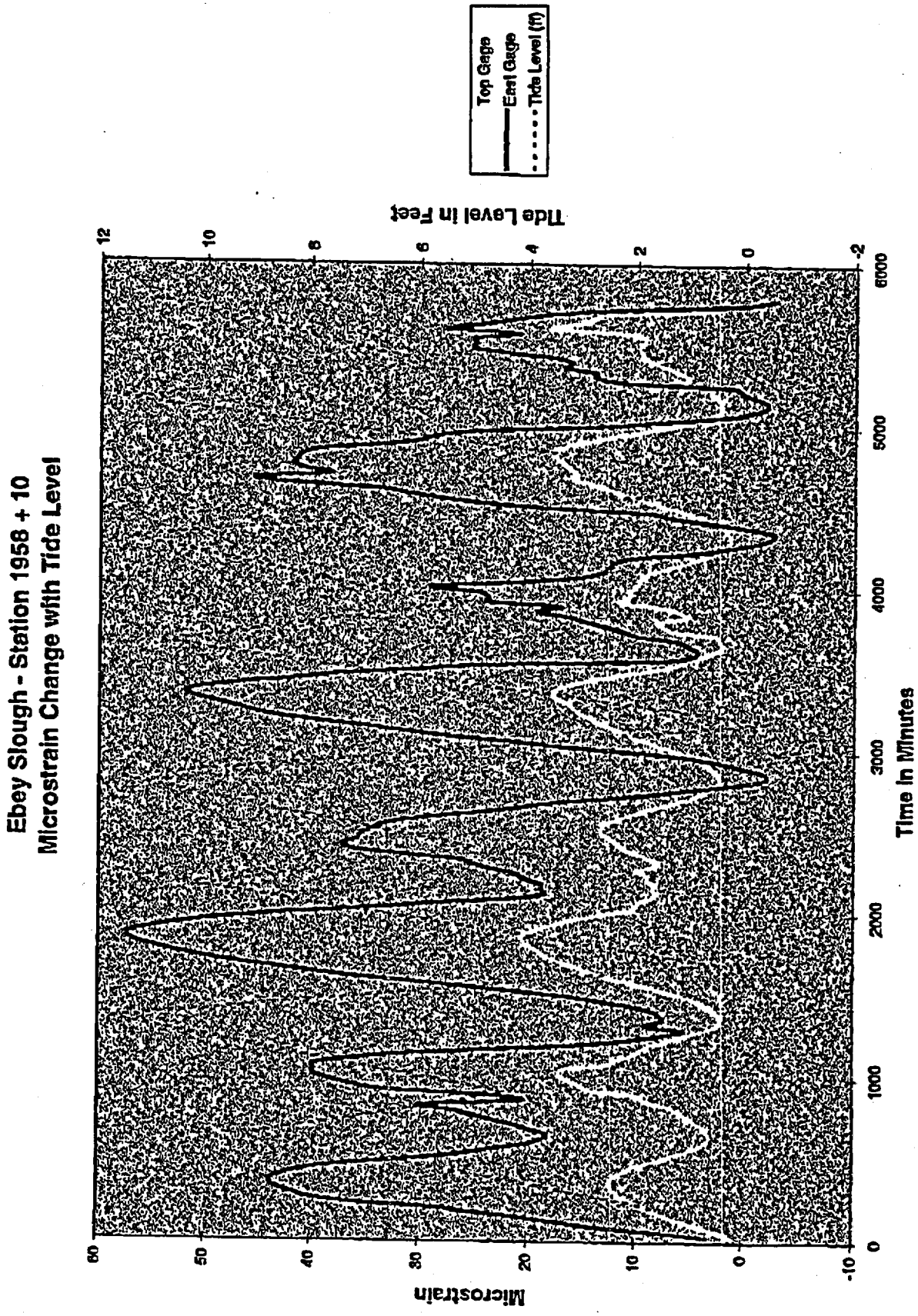
*** Also found localized corrosion near weld, while not technically requiring repair, this segment will be cut out and replaced during the installation of the new bored crossing of Ebey Slough.

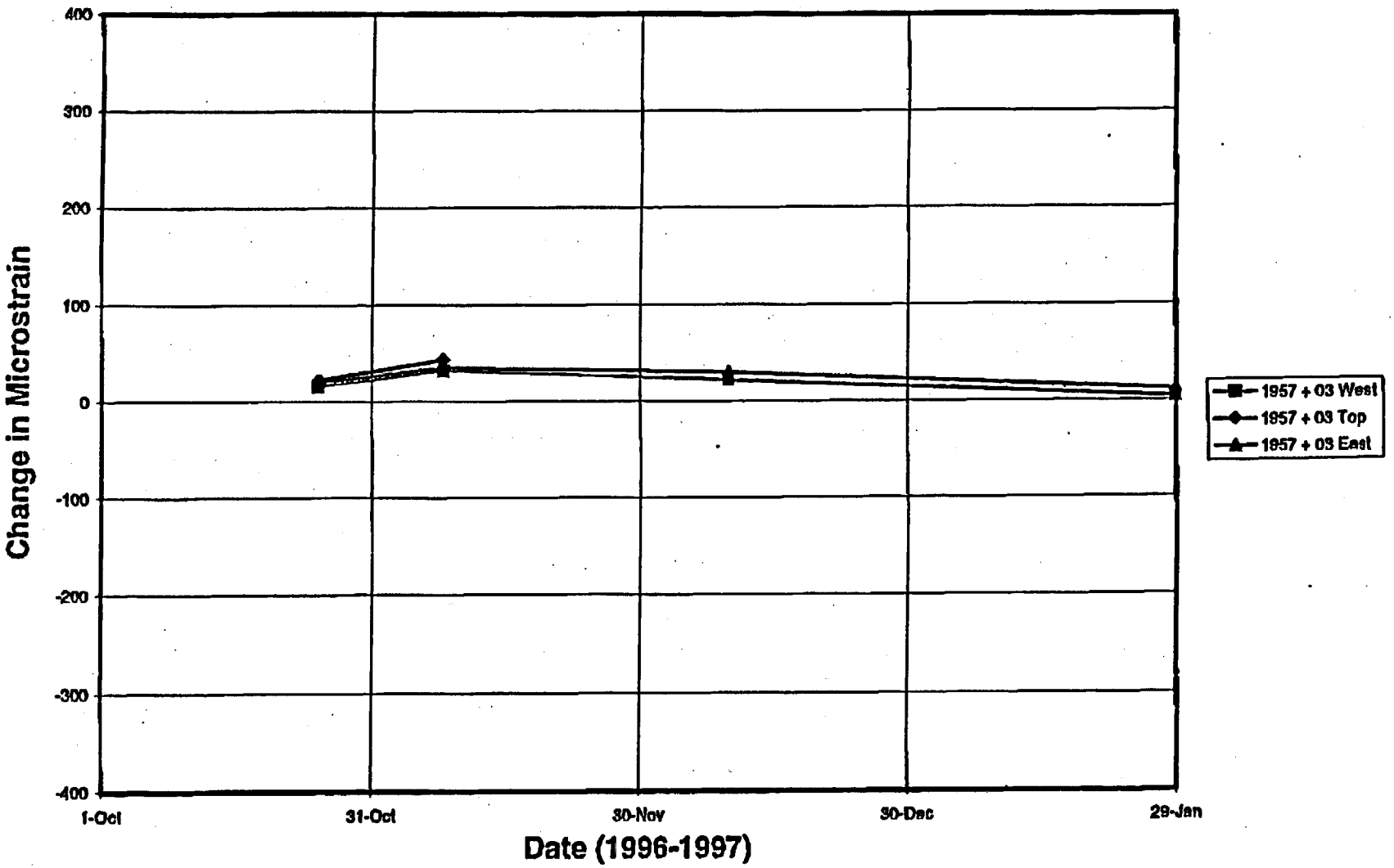
**** Small gouge found in pipe wall in the dent, requiring repair.


STRAIN IN KIPS (1000 LB./IN²)
60
70
52
60
40
30
20
10
TENSILE STRENGTH
72 KIPS (MIN.)
STRAIN
0.3 IN./IN.
OR 300,000
MICROSTRAIN UNITS
ELASTIC LIMIT 52 KIPS
1733 MICRO STRAIN UNITS
37,440 PSI - MAXIMUM ALLOWABLE WORKING STRESS BY PIPELINE CODE
STRESS-STRAIN CURVE
FOR X-52 - 20"
PIPE
NEW STRESS-STRAIN
CURVE FOR
PLASTICALLY
DEFORMED
STEEL
BLUE LINE DENOTES
CURVE FOR STEEL
STRESSED BEYOND
ELASTIC LIMIT THEN
RELEASED
PERMANENT
STRAIN
1,733
25,000
50,000
75,000
100,000
125,000
150,000
175,000
200,000
225,000
STRAIN IN MICRO INCHES/INCH

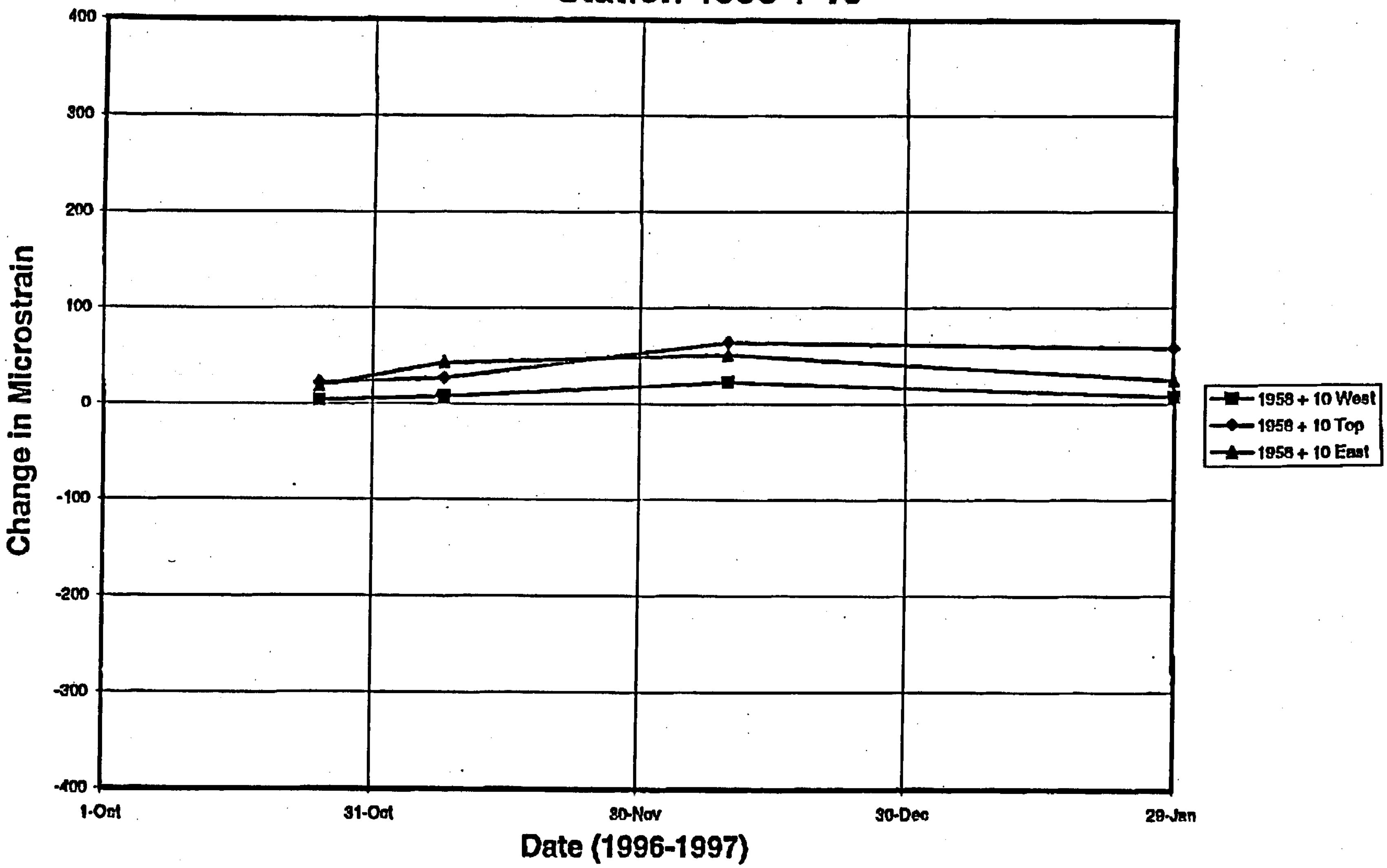
Ebey Slough - Station 1957 + 03
Microstrain Change with Tide Level

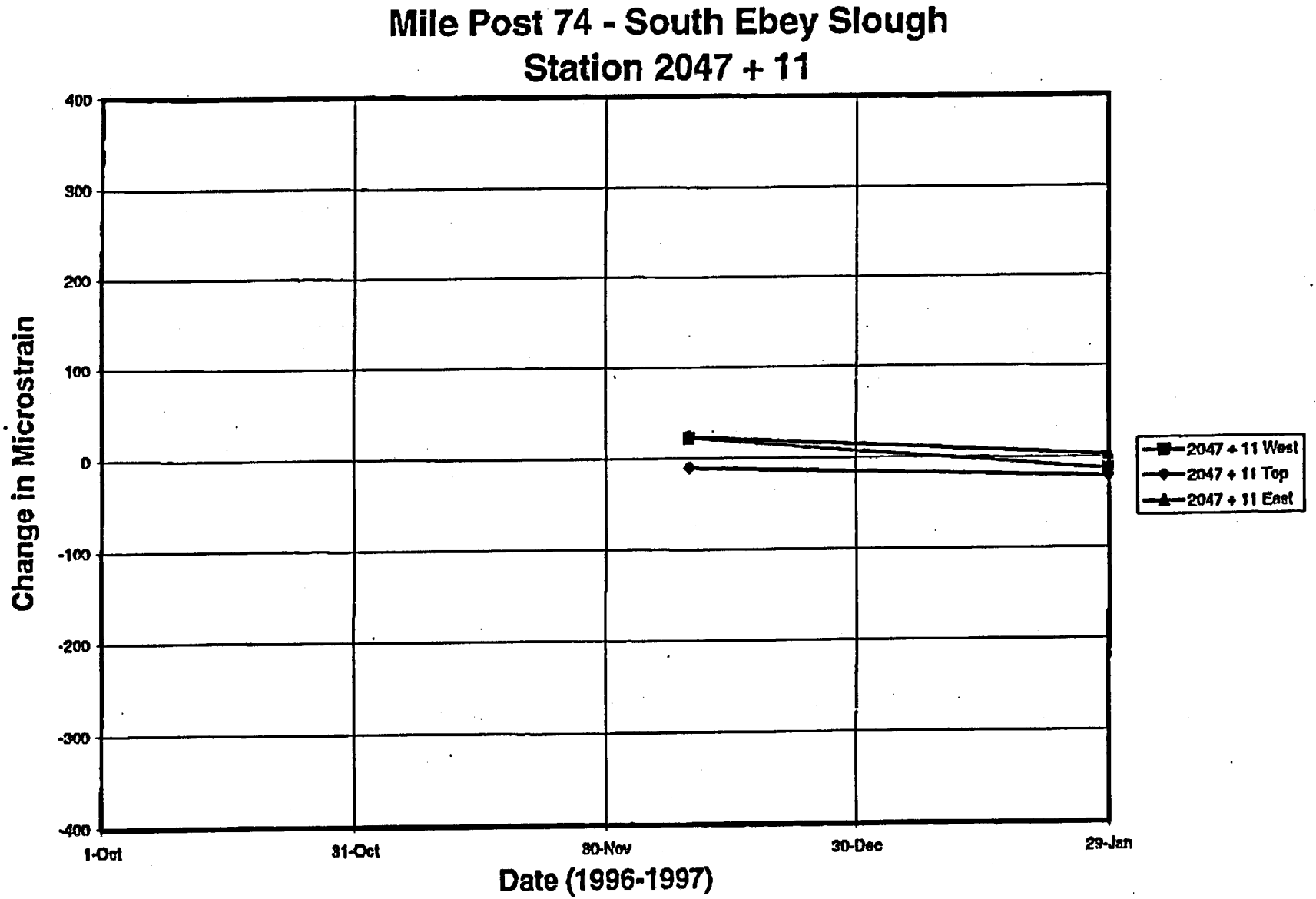


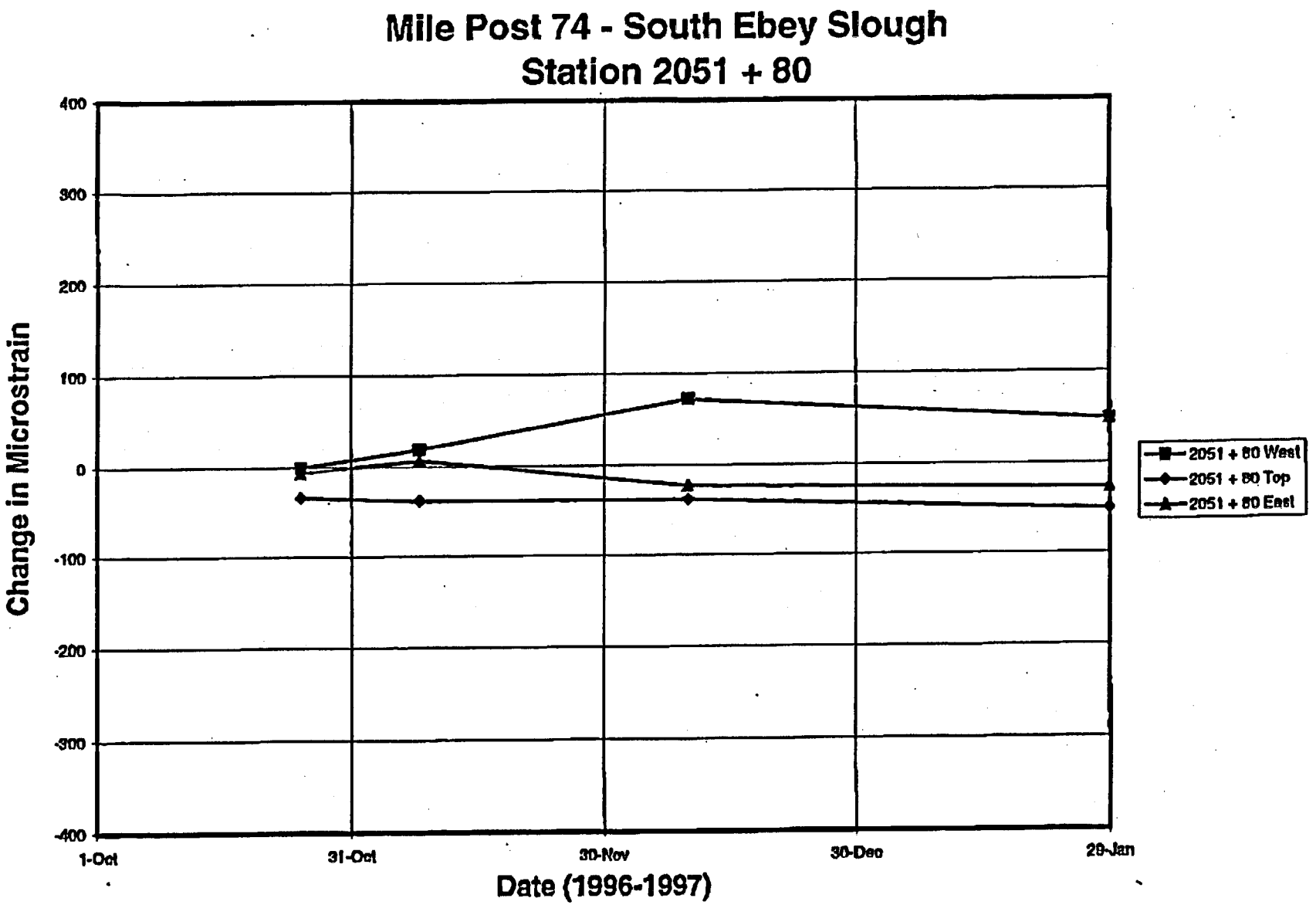

Ebey Slough - Station 1958 + 10
Microstrain Change with Tide Level
Top Gage
East Gage
Tide Level (ft)
Tide Level in Feet
Microstrain
Time in Minutes
12
10
8
6
4
2
0
-2
60
50
40
30
20
10
0
-10
0
1000
2000
3000
4000
5000
6000


Mile Post 74 - North Ebey Slough
Station 1957 + 03
Change in Microstrain
400
300
200
100
0
-100
-200
-300
-400
1-Oct
31-Oct
30-Nov
30-Dec
29-Jan
Date (1996-1997)
1957 + 03 West
1957 + 03 Top
1957 + 03 East

Mile Post 74 - North Ebey Slough
Station 1958 + 10




Mile Post 74 - South Ebey Slough
Station 2047 + 11
Change in Microstrain
400
300
200
100
0
-100
-200
-300
-400
1-Oct
31-Oct
30-Nov
30-Dec
29-Jan
Date (1996-1997)
2047 + 11 West
2047 + 11 Top
2047 + 11 East


Mile Post 74 - South Ebey Slough
Station 2051 + 80
Change in Microstrain
400
300
200
100
0
-100
-200
-300
-400
1-Oct
31-Oct
30-Nov
30-Dec
29-Jan
Date (1996-1997)
2051 + 80 West
2051 + 80 Top
2051 + 80 East

OLYMPIC PIPE LINE COMPANY
2319 LIND AVE. S.W.
P.O. BOX 1800
RENTON, WASHINGTON 98057
(206) 235-7736

We are sending 3 pages. INCLUDING this page. If you need confirmation or a resend of any page, please call (206) 235-7736 or fax (206) 271-5320.

DATE: 6-3-97

FROM: R.J. Klosen

TO: E. Story

LOCATION: WA DOE Bellevue

TELECOPY #: 649-7098

COMMENTS: UPDATE OF FIELD INVESTIGATIONS

SUMMARY OF 1997 CALIPER PIG INSPECTION AND FIELD INVESTIGATION

Pipeline Segment Stationing	Defect/Discrepancy	Finding	Scheduled or actual Investigation 1997	Repair & Replacement Required	Reinforcement Recommended (full Encirclement Sleeve)	Recoat and Retrenching Recommended	Completion Date 1997
FERNDALE	TO	ALLEN 16"					
16" 843+69	.45" Total Sharp**		May				
ANACORTES	TO	ALLEN 16"					
None	None						
RENTON	TO	SEATTLE 12"					
None	None						
RENTON	TO	SEA-TAC 12"					
None	None						
ALLEN	TO	RENTON 20"					
987+15	.70"Ttl, .49"Sharp		June				
1450+21	.59" Total Sharp**		June				
1724+53	.63" Ttl, .44"Sharp**		June				
3076+63	.70" Total Sharp		June				
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1724+64	.59" Total Sharp	.75" Sharp	4/11	No	Yes	Yes	4/17
2141+66	.43" Total Sharp**		May				
2268+93	.63" Ttl, .50" Sharp	.375" Sharp	5/13	No	No	Yes	5/14
2278+98	.70" Ttl, .57" Sharp	.375" Sharp	5/12	No	close to weld, cut out	Yes	5/12, July
2283+48	.54" Ttl, .37" Sharp	.56" Sharp	5/6	No	Yes	Yes	5/9
2319+41	.80" Total Sharp	.50" Sharp	5/14	No	No	Yes	5/15
2319+92	.74' Total Sharp	.375" Sharp	5/15	No	No	Yes	5/16
2340+35	.50" Ttl, .39" Sharp	.375" Sharp	5/1	No	No	Yes	5/2
2383+31	.78" Total Sharp	.3438" Sharp	5/18	No	No	Yes	5/19
2416+49	.76" Total Sharp	.500" Sharp	5/20	Yes	Yes	Yes	5/22
2451+94	.84' Total Sharp	.5625" Sharp	5/21	Yes	Yes	Yes	5/22
2587+82	.48" Total Sharp	.25" Sharp	4/28	No	No	Yes	4/29

Pipeline Segment Stationing	Defect/Discrepancy	Trending	Scheduled or Total Investigation Date	Repair/ Replacement Required	Reinforcement Recommended (Full Encirclement Sleeve)	Recoat and Retrenching Recommended	Completion Date 1997
3073+29	.84" Total Flat	In Gate Valve	6/30	No	No	No	5/30
3084+00	.60" Total Sharp**	.500" Sharp	5/28	Yes	Yes	No	5/29
3111+07	.80" Total Sharp		6/4				
3839+30	.69" Tll, .37" Sharp**		June				
3992+23	.59" Tll, .33" Flat**		June				
1958+51	1.06" Tll, .65 Sharp		July				
2045+27	1.80" Tll, 1.26" Sharp		July Bore Replacement				
2046+56	1.40" Tll, .96" Sharp		July Bore Replacement				
2046+61	.94" Tll, .36" Sharp		July Bore Replacement				

Definitions
Total - Is a measurement made from the baseline of the record to the peak.
Sharp - Anomaly as a reduction in pipe diameter, occurring within a span of 2 feet or less.
Flat - Anomaly as a reduction in pipe diameter having a span exceeding 2 feet but, not greater than 5 feet.
** - May investigate if risk is justified by engineering opinion.