Analysis of Current Field Data
Technical Topical Report

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ABSTRACT

This report provides a concise summary of the information collected and analyzed regarding the leak characteristics which define them as applicable candidates for pressure activated sealant technology. This information covers Office of Pipeline Safety reported incidents from 1985 to 1997 and was collected from existing data sources as well as operator and service company input.

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EXECUTIVE SUMMARY

The purpose of this collection and analysis of existing data regarding the cause, type and severity of leaks most commonly experienced in natural gas transmission systems is twofold: first, to develop a database on information gathered and provide a summary of leak characteristics which define them as applicable candidates for pressure activated sealant technology; and secondly, utilize this database as a basis in constructing applicable sealant test modeling.

The period from 1985-1997 was chosen because this was the time frame with the most complete data. Starting with "Analysis of DOT Reportable Incidents for Gas Transmission and Gathering System Pipelines, 1985 through 1997" and adding additional data from Office of Pipeline Safety reports as well as operator and service company input, we were able to identify 205 incidents from a possible 1,084 that would have been candidates for pressure activated sealant technology.

EXPERIMENTAL

This report contains no experimental methods.

RESULTS AND DISCUSSION

Collection of Data

Our collection of existing data started with the "Analysis of DOT Reportable Incidents for Gas Transmission and Gathering System Pipelines, 1985 through 1997"[1]. This report covers 1,084 incidents on 523,000 kilometers (325,000 miles) of natural gas transmission and gathering pipelines that were reported to the DOT's Office of Pipeline Safety. In this report the authors classified the incidents into 22 distinct causes (Table 1).

Table 1. PRCI Report, All Reportable Incidents, 1985 - 1997

		Number	%
Cold Weather	CW	9	0.8%
Defective Fabrication Weld	DFW	20	1.8%
Defective Girth Weld	DGW	23	2.1%
Defective Pipe	DP	15	1.4%
Defective Pipe Seam	DPS	24	2.2%
External Corrosion Related Failure	EC	109	10.1%
Earth Movement	EM	24	2.2%
Gasket or O-Ring Failure	GF	15	1.4%
Heavy Rains or Flood	HRF	58	5.4%
Internal Corrosion Related Failure	IC	130	12.0%
Incorrect Operation by Carrier Personnel	IO	79	7.3%
Lightning	LIGHT	14	1.3%
Malfunction of Control or Relief Equipment	MCRE	27	2.5%
Miscellaneous	MISC	73	6.7%
Previously Damaged Pipe	PDP	40	3.7%
Stress Corrosion Cracking	SCC	11	1.0%
Seal or Pump packing Failure	SPPF	4	0.4%
Third Party Inflicted Damage	TP	308	28.4%
Threads Stripped, Broken Pipe, or Coupling Failure	TSBPC	34	3.1%
Unknown	UNK	54	5.0%
Vandalism	V	6	0.6%
Wrinkle Bend or Buckle	WBB	7	0.6%
		1,084	100.0%

In focusing on leak characteristics that define incidents as applicable candidates for sealant technology we first chose to examine leak severity. Data for actual leak size and rate being unavailable we filtered the incidents based on the data in the Rupture/Leak column (R/L)[2], as shown in Table 2.

Table 2. Rupture/Leak

Input	Number	Percentage
"Blank"	6	0.6%
Leaks	354	32.7%
None	10	0.9%
Other	206	19.0%
Puncture	160	14.8%
Rupture	293	27.0%
Tear	55	5.1%
	1,084	100.0%

For the purpose of this analysis we eliminated all incidents that were not classified as Leaks (…an unintentional escape of gas from the pipeline). The inputs of "Blank", None and Other were too vague to make a determination of their candidacy. The inputs of Rupture (…a complete failure of any portion of the pipeline), Puncture (…damage from an externally applied force) and Tear (…an extension of the original opening in the pipeline resulting from an externally applied force) indicated conditions that may be too severe for pressure activated sealant technology. This analysis resulted in 354 incidents remaining in our database.

At present, for pressure activated sealant technology to be successful, a working pressure of plus or minus 1.38 MPa (200 psi) or greater is required. After eliminating incidents that were in environments less than 1.38 MPa (200 psi) MAOP, 328 incidents remained. At this stage, without having leak rate or size data available, the assumption could be made that "a leak is a leak" and thus all 328 remaining incidents were applicable candidates for pressure activated sealant technology. That being said, we also looked at the data from the viewpoint where a pressure activated sealant repair would have an economic advantage over traditional repair methods.

To achieve this we took a broad view of the causes that were associated with the remaining incidents, and then eliminated causes that, as a group, did not appear to have a distinct economic advantage for utilizing sealant repair technology. These causes are listed below in Table 3[3].

Table 3. Causes Eliminated

Cause Eliminated	Reason for Elimination
Cold Weather	All incidents occurred onshore, on surface components and facilities that could easily be accessed for repair.
Gasket or O-Ring Failure	These types of leaks have historically been successfully cured by utilizing pressure activated sealant technology. Often, there are alternate methods of repair that possess an economic advantage.
Incorrect Operation by Carrier Personnel	All but one occurred onshore, mainly above ground, and usually resulted in damages that were too severe for sealant technology.
Lightning	All onshore and easily accessible.
Malfunction of Control or Relief Equipment	Either easily accessible, sealant technology not suitable for system or damage too severe.

Miscellaneous	Assorted failures on tees, ball valves and flanges, mainly at surface.
Stress Corrosion Cracking	All incidents resulted in ruptures.
Seal or Pump Packing Failure	Both incidents were compressor related.
Third Party Inflicted Damage	Mostly onshore, on exposed pipelines and damage too severe for sealant technology.
Threads Stripped, Broken Pipe or Coupling Failure	Mostly onshore and easily accessible.
Vandalism	All incidents were classified as ruptures.

We then examined the "OPS Natural Gas Transmission Incident Data – mid 1984 to 2001", eliminating data prior to 1985 and after 1997, and merged the two databases, matching incident per incident. A final filtering was done through closer examination of each individual incident, with a focus on damage severity, accessibility, incomplete and conflicting information.

The remaining base of 205 incidents and their causes are reflected in Table 4.

Table 4. Incident Base - Sealant Candidates

		Number of Leaks by Cause	% of Incident Base	% of all 354 Leaks	% of all 1,084 Incidents
Defective Fabrication Weld	DFW	9	4.4%	2.5%	0.8%
Defective Girth Weld	DGW	16	7.8%	4.5%	1.5%
Defective Pipe	DP	5	2.4%	1.4%	0.5%
Defective Pipe Seam	DPS	12	5.9%	3.4%	1.1%
External Corrosion	EC	41	20.0%	11.6%	3.8%
Earth Movement	EM	7	3.4%	2.0%	0.6%
Heavy Rains or Flood	HRF	13	6.3%	3.7%	1.2%
Internal Corrosion	IC	77	37.6%	21.8%	7.1%
Previously Damaged Pipe	PDP	6	2.9%	1.7%	0.6%
Unknown	UNK	17	8.3%	4.8%	1.6%
Wrinkle Bend or Buckle	WBB	2	1.0%	0.6%	0.2%
		205	100.0%	57.9%	18.9%

The remainder of this report will focus on our analysis of this remaining incident base and how these incidents will be represented in our test modeling.

Analysis of Data

Leak Cause Analysis

An analysis of the incident base by cause (Table 5) shows that weld and corrosion causes account for 75.6% of the 205 incidents.

Table 5.

	Number of Leaks by Cause	% of Incident Base
DFW	9	4.4%
DGW	16	7.8%
DPS	12	5.9%
EC	41	20.0%
IC	77	37.6%
	155	75.6%

We also looked at causes by "Operator Judgment" versus "Damage Greater Than $50K", since by definition, the incidents that were classified under "Operator Judgment" are considered more of a minor, or lesser leak.

Table 6 shows that weld and corrosion leaks account for 81.7% of the incidents classified as Operator Judgment and 70.5% of the incidents classified under Damage Greater Than $50K.

Table 6.

	Operator Judgment			Damage > $50K	
	Number of Leaks by Cause	% of Op Judg		Number of Leaks by Cause	% of Dam > $50K
DFW	5	5.4%	DFW	4	3.6%
DGW	10	10.8%	DGW	6	5.4%
DPS	3	3.2%	DPS	9	8.0%
EC	27	29.0%	EC	14	12.5%
IC	31	33.3%	IC	46	41.1%
	76	81.7%		79	70.5%

For our testing, we will focus on simulating and sealing leaks that are caused by Defective Fabrication Welds, Defective Girth Welds, Defective Pipe Seams, External Corrosion and Internal Corrosion.

Area of Incident

Table 7 illustrates the breakdown of offshore and onshore incidents.

Table 7. Area of Incidents

	Onshore	Offshore	Total	%
Above Ground	1	0	1	0.5%
Under Ground	92	1	93	45.4%
Under Pavement	8	0	8	3.9%
Above Water	0	5	5	2.4%
Under Water	14	83	97	47.3%
Other	1	0	1	0.5%
	116	89	205	100%

For the onshore incidents the 1 "Above Ground" is actually in a marsh area; the 1 "Other" is along the edge of a creek; and the 14 "Under Water" were under rivers and streams; all together making accessibility challenging.

The offshore incidents were represented by 1 "Under Ground" which was under water and then under a 4' burial layer. The 5 incidents classified "Above Water" were riser related. Obviously the vast majority were "Under Water". What we can conclude from this data is that based on accessibility, for all 205 incidents, internal sealant repair could have an economic advantage over traditional methods of repair which average $75,000 and $150,000 respectively for onshore and shallow offshore external repairs, with the costs soaring as water depths are increased.

Area of Failure

Referring to Table 8, 81.0% of the incidents occurred on transmission lines, 16.6% on gathering lines and 2.4% on transmission lines of distribution system.

Even though all of the 205 incidents were candidates for sealant technology, for testing purposes we will focus on simulating pipe body and weld leaks, which together account for 88.3%, of the total incidents.

Table 8. Area of Failure

	Branch	Fitting	Gasket	Mech Jt.	Pipe Body	Unk	Valve	Weld	WB	
Gathering Line		2			31			1		34
Transmission Line	1	6	1	3	103	8	1	42	1	166
Trans. Line of Distr.		1			2			2		5
	1	9	1	3	136	8	1	45	1	205

Pipe Size

Table 9 shows that 168.28 mm (6-5/8”), 323.85 mm (12-3/4”), 406.40 mm (16”) and 508.00 mm (20”) pipe accounted for 56.1% of the incidents. Since pipe size has no relevance for the success or failure of a sealant repair we will utilize 168.28 mm (6-5/8”) pipe for our test modeling in order to reduce cost and facilitate ease of handling.

Table 9. Pipe Sizes - by System of Failure

Pipe Size mm	Pipe Size inches	Gathering	Transmission	Trans. Line of Distribution	Totals	%
12.70	0.500		3		3	1.5%
60.33	2.375		2		2	1.0%
76.20	3.000	2	2		4	2.0%
101.60	4.000		1		1	0.5%
114.30	4.500	2	6		8	3.9%
128.02	5.040		1		1	0.5%
139.70	5.500		1		1	0.5%
168.28	**6.625**	**7**	**20**		**27**	**13.2%**
219.08	8.625	4	8		12	5.9%
273.05	10.750	1	12		13	6.3%
323.85	**12.750**	**7**	**30**	**2**	**39**	**19.0%**
355.60	14.000		3		3	1.5%
406.40	**16.000**	**4**	**22**	**1**	**27**	**13.2%**
450.85	17.750		1		1	0.5%
457.20	18.000		4	1	5	2.4%
508.00	**20.000**	**3**	**18**	**1**	**22**	**10.7%**
558.80	22.000	2	1		3	1.5%
609.60	24.000	2	11		13	6.3%
660.40	26.000		4		4	2.0%
762.00	30.000		10		10	4.9%
863.60	34.000		1		1	0.5%
914.40	36.000		4		4	2.0%
1066.80	42.000		1		1	0.5%
		34	166	5	205	100.0%

Pipe Material

Since incidents that occurred on systems rated less than 200 psi MAOP were already removed from our study, it comes at no surprise that the vast majority (204) of the incidents occurred on steel material. The one other incident was classified as weld material. We will utilize schedule 80 steel material for our test modeling, with 0.432” wall thickness and 12.36 MPa (1,793 psi) MAOP.

Pipe Pressures

Table 10 shows the number of incidents at reported pressure ranges for estimated incident pressure, maximum leak differential and maximum allowable operating pressure.

The leak differential pressure is calculated as MAOP less atmospheric (or hydrostatic) pressure. With pressure activated sealants there are two primary criteria: a minimum of around 1.38 MPa (200 psi) differential pressure and leak severity.

The one Leak Differential incident in the 0.69 – 1.37 MPa (100 – 199 psi) range is at 1.28 MPa (185 psi). The thirty-nine MAOP incidents in the 9.65 – 10.34 MPa (1400 – 1499 psi) range were all 9.93 MPa (1440 psi). In our testing we will achieve a low pressure seal at 1.28 MPa (185 psi) and increase pressure in various stages until obtaining a maximum pressure seal at 9.93 MPa (1440 psi).

Table 10. Number of Incidents at Each Pressure Range

Pressure, MPa	Pressure, psi	Est. Incident Pressure	Max. Leak Differential	MAOP
0 - 0.68	0 - 99	5	0	0
0.69 - 1.37	100 - 199	4	1	0
1.38 - 2.06	200 - 299	12	8	9
2.07 - 2.75	300 - 399	19	7	6
2.76 - 3.44	400 - 499	21	11	6
3.45 - 4.13	500 - 599	18	5	11
4.14 - 4.82	600 - 699	18	8	4
4.83 - 5.51	700 - 799	17	17	16
5.52 - 6.20	800 - 899	28	22	22
6.21 - 6.89	900 - 999	17	21	17
6.89 - 7.58	1000 - 1099	22	13	17
7.58 - 8.27	1100 - 1199	16	31	13
8.27 - 8.96	1200 - 1299	1	11	30
8.96 - 9.65	1300 - 1399	0	22	11
9.65 - 10.34	1400 - 1499	0	17	39
10.34 - 11.02	1500 - 1599	1	0	0
11.03 - 11.71	1600 - 1699	0	0	0
11.72 - 12.40	1700 - 1799	0	1	0
12.41 - 13.09	1800 - 1899	0	0	1
13.10 - 13.78	1900 - 1999	0	0	0
13.79 - +	2000 - +	0	3	3
		199	198	205

Pipe Corrosion States

It can be seen by the data in Table 11 that 68.3% of the externally corroded pipe and 64.1% of the internally corroded pipe is described as either "localized pitting", "pinhole" or "pinhole with localized pitting". This number for internally corroded pipe may actually be closer to the 80% range if not for the lack of data for 19 incidents under "Corrosion Description". We will simulate pinhole leaks with localized pitting in our test model when attempting to seal external and internal corrosion leaks.

Table 11. Pipe Corrosion States

Leak Cause	Corrosion Location	Corrosion Description	Corrosion Cause
1 – DP	1 – Internal	1 – Localized Pitting	1 – Bacteria
41 – EC	40 – External	8 – General Corrosion	1 – Coating Failure 4 – Galvanic 3 – "Blank"
		26 – Localized Pitting	1 – Atmosphere 1 – Coating Failure 18 – Galvanic 6 – "Blank"
		1 – Pinhole	1 – "Blank"
		1 – Pinhole, Localized Pitting	1 - Galvanic
		4 – "Blank"	4 – "Blank"
	1 – Internal*	1 – Localized Pitting	1 – Bacteria
77 – IC	76 – Internal	1 – ¼" Circular Hole	1 – "Blank"
		9 – General Corrosion	2- Bacteria 1 – Chemical 1 – Galvanic 1 – Microbiological 4 – "Blank"
		38 – Localized Pitting	2 – Liquid Accumulation 2 – Bacteria 2 – Chemical 9 – Galvanic 1 – H2S 22 – "Blank"
		7 – Pinhole	7 – "Blank"
		3 – Pinhole, Localized Pitting	1 – Galvanic 2 - Blank
		18 – "Blank"	1 – Liquid Accumulation 1 – Galvanic

	1 – “Blank”	1 – “Blank”	16 – “Blank” 1 – “Blank”
1 – PDP**	1 – External	1 – External Cracks	1 – Stray Current
*Leak was classified as External Corrosion, but leak location was designated as internal. May have been typographical error, but data remained unchanged to ensure accuracy of analysis. **Operator classified cause as Stress Corrosion Cracking and not Previously Damaged Pipe.			

Pipeline Piggability

Two operators and a service provider were queried about the ability to pig their pipelines. The service provider, through customer surveys, proclaimed that 40% of the onshore pipelines and 70% of the offshore pipelines were piggable. One operator generalized that only 20% of their onshore pipelines were piggable. Operator B examined 32 incidents that were part of our incident database and the results are outlined in Table 12.

Table 12.

	Piggable		
	Yes	No	Unknown
Offshore	6	6	16
Onshore	2	0	2
	8	6	18

Since the data is limited, these numbers are rendered inconclusive, and testing procedures will be developed for both non-piggable and piggable applications.

Conclusion

Candidates for pressure activated sealant technology were identified on the basis of several criteria: Accessibility/Economic Advantage, Leak Severity, Leak Geometry, Minimum Operating Pressure, and Leak Cause.

Starting with 354 leaks out of 1,084 incidents in a 13 year period we identified 205 leaks that were candidates for our sealant technology. This number affirms that pressure activated sealant technology is a viable option to traditional external leak repairs.

Accessibility/Economic Advantage: The more inaccessible the leak site, the greater the economic advantage. Our database focuses on leaks where accessibility is difficult, time-consuming and costly. 198 incidents (96.6% of our 205 incident base) were either underground, under pavement or underwater.

Leak Severity and Geometry: While no actual leak rates were collected, we know through previous field experience and testing that we can cure leaks in the range of 2.83 – 8.50 cubic meters per minute (100 – 300 scf per minute). Our incident base focused on cracks & pinholes, not ruptures, punctures or tears, which may be out of the range for sealant technology. Narrow leaks, which have more surface area to open area, are easier to seal and have longer seal longevity than circular leaks.

Minimum Operating Pressure: MAOP less hydrostatic (or atmosphere) needs to be near or greater than 200 psi for pressure activated sealant technology to be successful. Our testing will focus on curing leaks with differentials from 1.28 MPa (185 psi) to 9.93 MPa (1440 psi).

Leak Cause: Weld and corrosion leaks accounted for 75.6% of our incident base and 43.8% of all 384 leaks. By focusing our testing on weld and corrosion leaks we will be testing a representative sampling of the majority of leaks that are applicable candidates for pressure activated sealant technology.

[1 - 3] Report No. PR-218-9801 Published 2001 by Kiefner and Associates, Inc., J. F. Kiefner, R. E. Mesloh, and B. A. Kiefner

Pressure Activated Sealant Candidates, 1985-1997

2/25/2004

Leak No.	OPS Rpt ID	Op Judgement	Offshore Onshore	Area of Incident	Water Depth (ft)	Estimated Incident Pressure, psi	Max. Leak Differential Pressure, psi	MAOP, psi	Leak Cause	Leak Cause Detail	Corrosion Cause	Corrosion Location	Corrosion Description	Coated	CP	Incident Occurred on	Part of System Involved	Pipeline Piggable Yes/No	Failure Occurred on	Material Involved	Diameter (inch)	Wall Thickness (inch)	SMYS
1	19850003	Op Judge	Onshore	Under Ground		250	485	500	DGW	Leak in a Girth Weld						Tr of Dis	Pipeline		Weld	Steel	12.750	0.219	42,000
2	19850027	Op Judge	Onshore	Under Ground		500	492	507	PDP	Unknown Date of Damage						Trans	Pipeline		Pipe Body	Steel	10.750	0.250	24,000
3	19850029	Op Judge	Onshore	Under Ground		540	705	720	IC		Accumulation of Liquids	Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	2.375	0.250	60,000
4	19850043	Dam>$50K	Offshore	Under Water	187	969	1,116	1,200	IC		Galvanic	Internal	Pinhole Leak, Localized Pitting	Y	Y	Gath	Pipeline		Pipe Body	Steel	8.625	0.250	52,000
5	19850045	Op Judge	Onshore	Under Ground		550	1,140	1,155	IC		Chemical	Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	6.625	0.156	42,000
6	19850050	Op Judge	Onshore	Under Ground		80	235	250	EM	Subsidence/extreme Weather Caused Fillet Weld Failure						Trans	Pipeline		Weld	Steel	6.625	0.250	24,000
7	19850052	Op Judge	Onshore	Under Ground		240	285	300	EC		Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.250	35,000
8	19850068	Dam>$50K	Onshore	Under Ground		660	765	780	DFW	Hot Tap Connection, Fillet Weld Leaked in Haz						Trans	Pipeline		Pipe Body	Steel	30.000	0.312	52,000
9	19850080	Op Judge	Onshore	Under Ground		90	223	238	DFW	Branch Connection, Crack in Fillet Weld on Saddle						Trans	Pipeline		Weld	Steel	20.000	0.250	
10	19850089	Dam>$50K	Onshore	Under Ground		655	945	960	EM	Nipple (1/2") Failure Caused by Subsidence						Trans	Pipeline		Fitting	Steel	0.500	0.109	35,000
11	19850099	Op Judge	Onshore	Under Ground		410	612	627	EC	Cathodic Protection Breakdown	Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	3.000	0.312	60,000
12	19850104	Op Judge	Onshore	Under Ground		790	1,165	1,180	EC		Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.312	35,000
13	19850129	Op Judge	Onshore	Under Ground		240	705	720	DGW	Leak in a Girth Weld						Trans	Pipeline		Weld	Steel	6.625	0.188	
14	19850200	Op Judge	Onshore	Under Ground		550	1,140	1,155	IC			Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	6.625	0.188	42,000
15	19850204	Op Judge	Onshore	Under Ground		465	773	788	IC	Leak Was 250' from Well		Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	2.375	0.154	35,000
16	19850207	Dam>$50K	Offshore	Under Water		635		1,218	IC		Galvanic	Internal	General Corrosion	Y	Y	Trans	Pipeline		Pipe Body	Steel	16.000	0.500	52,000
17	19850214	Op Judge	Onshore	Under Ground		685	848	863	IC	Suspected Cause						Trans	Pipeline		Pipe Body	Steel	10.750	0.203	46,000
18	19850218	Op Judge	Onshore	Under Ground		400	545	560	DGW	Leak in a Girth Weld						Trans	Pipeline		Weld	Steel	6.625	0.219	35,000
19	19850228	Dam>$50K	Offshore	Under Water	185	1,000	1,357	1,440	EC	Occurred on Cad Weld of Anode to Pipeline Offshore		External	Pinhole Leak	Y	Y	Trans	Pipeline	Unk	Pipe Body	Steel	10.750	0.365	52,000
20	19850273	Op Judge	Onshore	Under Ground		200	1,185	1,200	IC		Chemical	Internal	General Corrosion	Y	Y	Trans	Pipeline		Pipe Body	Steel	10.750	0.203	35,000
21	19850306	Dam>$50K	Offshore	Under Water	215	996	1,344	1,440	UNK							Trans	Pipeline		Pipe Body	Steel	16.000	0.375	52,000
22	19860039	Dam>$50K	Offshore	Under Water	212	1,100	1,345	1,440	UNK	Power Gas Piping						Trans	Power Gas Piping		Fitting	Steel	0.500	0.147	
23	19860042	Op Judge	Onshore	Under Ground		950	960	975	DGW	Crack in a Girth Weld, Leak						Trans	Pipeline		Weld	Steel	30.000	0.344	60,000
24	19860067	Dam>$50K	Onshore	Under Ground		498	485	500	PDP	Contractor Damaged Pipe During Grading						Trans	Pipeline		Pipe Body	Steel	8.625	0.188	42,000
25	19860078	Dam>$50K	Onshore	Under Water		620	785	800	HRF	Heavy Water Run-off						Trans	Pipeline		Unknown	Steel	10.750	0.365	35,000
26	19860099	Op Judge	Onshore	Under Ground		1,000	2,537	2,552	IC	H2s In-line		Internal	Localized Pitting	Y	Y	Gath	Pipeline		Pipe Body	Steel	3.000	0.300	35,000
27	19860115	Op Judge	Offshore	Under Water		1,150		1,440	DFW	Flange Failed						Trans	Pipeline		Fitting	Steel	6.625	0.432	52,000
28	19860123	Dam>$50K	Offshore	Under Water	11	750	1,295	1,300	DPS	DSAW Leak, Construction Defect						Trans	Pipeline	Yes	Weld	Steel	20.000	0.406	52,000
29	19860126	Op Judge	Onshore	Under Ground		600	794	809	EM	Landslide Due to Soaked Ground; GW Failure						Trans	Pipeline		Weld	Steel	26.000	0.281	52,000
30	19860128	Dam>$50K	Onshore	Under Ground		418	485	500	DP	Leak in Pipe Wall						Trans	Pipeline		Pipe Body	Steel	6.625	0.188	35,000
31	19860143	Op Judge	Onshore	Under Ground		720	485	500	DPS	Lap Weld Leaked During MAOP Upgrade Test-fire						Trans	Pipeline		Weld	Steel	8.625	0.250	24,000
32	19860174	Dam>$50K	Offshore	Under Water	232	1,000	1,336	1,440	IC	Elbow, 90 Degree		Internal		Y	Y	Trans	Pipeline	Unk	Fitting	Steel	12.750	0.500	42,000
33	19860175	Dam>$50K	Onshore	Under Water		1,060	1,085	1,100	PDP	Dent and Gouge						Trans	Pipeline		Pipe Body	Steel	30.000	0.360	65,000
34	19860211	Dam>$50K	Onshore	Under Ground			885	900	DPS	EW (AOS) Leak, Incomplete Fusion						Trans	Pipeline		Weld	Steel	30.000	0.344	52,000
35	19870008	Dam>$50K	Offshore	Under Water	227	1,020	1,148	1,250	IC			Internal		Y	Y	Gath	Pipeline		Pipe Body	Steel	24.000	0.500	60,000
36	19870041	Op Judge	Onshore	Under Ground		940	1,330	1,345	IC	Release Occurred During Repair	Chemical	Internal	Localized Pitting	Y	Y	Gath	Pipeline		Pipe Body	Steel	6.625	0.188	42,000
37	19870089	Dam>$50K	Onshore	Under Water		582	1,295	1,310	EC	Poor Drainage Contributed to Excessive Standing Water		External	General Corrosion	Y	Y	Gath	Pipeline		Pipe Body	Steel	6.625	0.156	35,000
38	19870047	Dam>$50K	Offshore	Under Water	167	850	1,225	1,300	DGW	Leak in a Girth Weld, Construction Defect						Trans	Pipeline	No	Weld	Steel	12.750	0.375	46,000
39	19870050	Dam>$50K	Offshore	Under Water	227	930	1,148	1,250	IC			Internal		Y	Y	Gath	Pipeline		Pipe Body	Steel	24.000	0.500	60,000
40	19870072	Dam>$50K	Onshore	Under Ground		250	385	400	EM	Subsidence of Abandoned Coal Mine Caused Leak in Gas Storage Well Casing						Trans	Gas Storage Well		Pipe Body	Steel	5.500	0.244	
41	19870078	Dam>$50K	Offshore	Under Water	236		1,334	1,440	IC			Internal		Y	Y	Gath	Pipeline		Pipe Body	Steel	12.750	0.375	52,000
42	19870091	Dam>$50K	Onshore	Under Pavement		350	400	415	EC			External		Y	Y	Trans	Pipeline		Pipe Body	Steel	18.000	0.250	33,000
43	19870093	Op Judge	Onshore	Under Ground		700	1,048	1,063	EC		Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	16.000	0.281	42,000
44	19870094	Op Judge	Offshore	Under Water		125		200	EM	Erosion						Gath	Pipeline		Pipe Body	Steel	3.000	0.216	35,000
45	19870105	Op Judge	Onshore	Under Ground		320	549	564	IC			Internal		Y	Y	Gath	Pipeline		Pipe Body	Steel	6.625	0.188	
46	19870113	Op Judge	Onshore	Under Ground		510	794	809	DPS	DSAW Leak						Trans	Pipeline		Weld	Steel	26.000	0.281	52,000
47	19870124	Op Judge	Onshore	Under Ground		605	1,076	1,091	IC			Internal	General Corrosion	Y	Y	Trans	Pipeline		Pipe Body	Steel	6.625	0.156	42,000

Leak No.	OPS Rpt ID	Op Judgement	Offshore Onshore	Area of Incident	Water Depth (ft)	Estimated Incident Pressure, psi	Max. Leak Differential Pressure, psi	MAOP, psi	Leak Cause	Leak Cause Detail	Corrosion Cause	Corrosion Location	Corrosion Description	Coated	CP	Incident Occurred on	Part of System Involved	Pipeline Piggable Yes/No	Failure Occurred on	Material Involved	Diameter (inch)	Wall Thickness (inch)	SMYS
48	19870128	Op Judge	Onshore	Under Ground		520	787	802	EC	Accumulation of Liquid under Coating	Galvanic	External	General Corrosion	Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.164	52,000
49	19870135	Op Judge	Onshore	Under Ground		370	575	590	PDP	Multiple Dents Found at Leak, Tension Failure of Girth Weld and Bending						Trans	Pipeline		Weld	Steel	3.000	0.156	42,000
50	19870142	Dam>$50K	Offshore	Under Water		850		955	IC			Internal	Localized Pitting	Y	N	Trans	Pipeline		Pipe Body	Steel	10.750	0.250	42,000
51	19870157	Dam>$50K	Offshore	Under Water	70	1,000	1,409	1,440	IC			Internal		Y	Y	Gath	Pipeline	Unk	Pipe Body	Steel	12.750	0.375	52,000
52	19870172	Op Judge	Onshore	Under Ground		82	185	200	DFW	Miter Weld (48 Degree) Broke						Trans	Compr Station		Pipe Body	Steel	16.000	0.250	
53	19870186	Dam>$50K	Onshore	Under Ground		850	885	900	EC			External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	36.000	0.375	60,000
54	19870225	Op Judge	Onshore	Under Pavement		600	697	712	EC	Cased Carrier Pipe, Coating Failure	Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	16.000	0.219	52,000
55	19880011	Op Judge	Onshore	Under Ground		800	895	910	IC	Sulfate Reducing Bacteria (Srb)	Bacteria	Internal	Localized Pitting	Y	Y	Gath	Pipeline		Pipe Body	Steel	12.750	0.250	
56	19880033	Dam>$50K	Onshore	Under Ground		805	843	858	DFW	Branch Connection Reinforcement Sleeve Weld Failure						Trans	Pipeline		Branch	Steel	30.000	0.344	52,000
57	19880068	Dam>$50K	Onshore	Above Ground		760	1,125	1,140	DPS	DSAW Leak, Construction Defect						Trans	Pipeline	Yes	Weld	Steel	20.000	0.375	52,000
58	19880079	Op Judge	Onshore	Under Water		450	845	860	HRF	Suspected - High Waters in Ms River Crossing						Trans	Pipeline		Unknown	Steel	18.000	0.725	35,000
59	19880080	Dam>$50K	Onshore	Under Ground		720	794	809	EM	Landslide Caused Buckle						Trans	Pipeline		Weld	Steel	26.000	0.344	52,000
60	19880112	Dam>$50K	Onshore	Under Ground		725	1,070	1,085	DPS	DSAW Leak, Construction Defect						Trans	Pipeline	Yes	Weld	Steel	20.000	0.375	52,000
61	19880124	Dam>$50K	Offshore	Under Water	191	1,066	1,355	1,440	IC			Internal	Pinhole Leak	Y	Y	Trans	Pipeline	Unk	Pipe Body	Steel	16.000	0.438	42,000
62	19880129	Op Judge	Onshore	Under Ground		650	785	800	HRF	Floodwater in Creek Caused Mech. Coupling Failure						Trans	Pipeline		Mech Jnt	Steel	24.000	0.281	48,000
63	19880143	Dam>$50K	Onshore	Under Ground		525	843	858	DP	Lamination 5-feet Long, Material Defect						Trans	Pipeline		Pipe Body	Steel	30.000	0.344	52,000
64	19880157	Op Judge	Offshore	Under Water	68	400	1,410	1,440	IC	Corrosion on Girth Weld	Galvanic	Internal	Localized Pitting	Y	Y	Trans	Pipeline		Weld	Steel	20.000	0.500	52,000
65	19880159	Dam>$50K	Offshore	Under Water	189		1,355	1,440	EM	Landslide Offshore, GW Failure						Trans	Pipeline		Weld	Steel	12.750	0.500	42,000
66	19880211	Dam>$50K	Offshore	Under Water	220	1,100	1,342	1,440	IC		Galvanic	Internal		Y	Y	Trans	Pipeline	Unk	Pipe Body	Steel	10.750	0.365	42,000
67	19880219	Op Judge	Onshore	Under Ground		800	1,425	1,440	EC	Stray Current	Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	6.625	0.250	35,000
68	19880225	Dam>$50K	Offshore	Under Water		1,180		1,440	DFW	Saddle Pad at (6") Side Valve, Weld Cracked						Trans	Pipeline	Yes	Valve	Steel	24.000	0.500	60,000
69	19880229	Op Judge	Onshore	Under Ground		450	685	700	EC	Cased Carrier Pipe	Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.219	52,000
70	19880269	Dam>$50K	Offshore	Above Water		1,000	1,425	1,440	EC	Platform Riser-water Beneath Concrete Coating in Splash Zone	Galvanic	External	Localized Pitting	Y	N	Gath	Pipeline		Pipe Body	Steel	20.000	0.625	52,000
71	19890022	Op Judge	Offshore	Under Water	197	1,014	1,112	1,200	UNK							Gath	Pipeline		Pipe Body	Steel	8.625	0.250	52,000
72	19890025	Op Judge	Onshore	Under Ground		610	1,090	1,105	EC	Improperly Installed Tape Coating	Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.203	
73	19890039	Dam>$50K	Offshore	Above Water		835	1,258	1,273	EC	Platform Riser Clamp	Galvanic	External	Localized Pitting	Y	N	Gath	Pipeline	No	Pipe Body	Steel	20.000	0.500	60,000
74	19890061	Op Judge	Offshore	Under Water	68	350	970	1,000	IC	Corrosion on Girth Weld	Galvanic	Internal	Localized Pitting	Y	Y	Trans	Pipeline		Weld	Steel	20.000	0.500	
75	19890063	Dam>$50K	Onshore	Under Ground		550	765	780	DPS	SAW Manufacturing Defect, Material Defect						Trans	Pipeline	Unk	Weld	Steel	30.000	0.312	52,000
76	19890066	Op Judge	Onshore	Under Ground		620	815	830	DFW	Stopple Fitting, Fillet Weld Crack						Tr of Dis	Pipeline		Fitting	Steel	16.000	0.375	52,000
77	19890107	Op Judge	Onshore	Under Pavement		240	809	824	IC	Sulfate Reducing Bacteria	H2S	Internal	Localized Pitting	Y	Y	Gath	Pipeline		Pipe Body	Steel	12.750	0.250	42,000
78	19890108	Op Judge	Onshore	Under Ground		410	973	988	EC	Shorted Casing	Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.250	42,000
79	19890111	Dam>$50K	Onshore	Under Water		300	973	988	HRF	Suspected - High Waters in Bayou						Trans	Pipeline		Unknown	Steel	12.750	0.375	42,000
80	19890114	Dam>$50K	Offshore	Under Water	215	990	1,344	1,440	UNK							Trans	Pipeline		Mech Jnt	Steel	6.625		
81	19890119	Op Judge	Onshore	Under Ground		420	973	988	EC			External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.250	42,000
82	19890120	Op Judge	Onshore	Under Pavement		426	485	500	DFW	Weld-o-let Fillet Weld From Construction Leaked						Trans	Pipeline		Weld	Steel	18.000	0.312	42,000
83	19890123	Op Judge	Onshore	Under Ground		470	985	1,000	EC		Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	6.625	0.156	42,000
84	19890154	Op Judge	Onshore	Under Ground		830	1,020	1,035	EC		Galvanic	External	General Corrosion	Y	Y	Trans	Pipeline		Pipe Body	Steel	16.000	0.250	52,000
85	19890155	Op Judge	Onshore	Under Ground		590	809	824	EC		Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	14.000	0.281	35,000
86	19890156	Op Judge	Onshore	Under Ground		350	814	829	EC		Galvanic	External	General Corrosion	Y	Y	Gath	Pipeline		Pipe Body	Steel	6.625	0.250	
87	19890164	Dam>$50K	Onshore	Under Ground		625	809	824	EC		Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	14.000	0.281	35,000
88	19890165	Dam>$50K	Onshore	Under Ground		740	945	960	EC		Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	24.000	0.312	52,000
89	19890173	Op Judge	Onshore	Under Ground		266	310	325	EC			External	General Corrosion	N	Y	Trans	Pipeline		Pipe Body	Steel	4.500		24,000
90	19890177	Op Judge	Onshore	Under Water		660	716	731	IC	River Crossing		Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	24.000	0.312	52,000
91	19890181	Op Judge	Offshore	Under Water	68	350	970	1,000	EC	Concrete Coating Missing at Location	Galvanic	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	20.000	0.500	52,000
92	19890188	Op Judge	Onshore	Under Ground		350	1,137	1,152	PDP	Dent Found near Leak						Trans	Pipeline		Pipe Body	Steel	4.500	0.237	35,000

Leak No.	OPS Rpt ID	Op Judgement	Offshore Onshore	Area of Incident	Water Depth (ft)	Estimated Incident Pressure, psi	Max. Leak Differential Pressure, psi	MAOP, psi	Leak Cause	Leak Cause Detail	Corrosion Cause	Corrosion Location	Corrosion Description	Coated	CP	Incident Occurred on	Part of System Involved	Pipeline Piggable Yes/No	Failure Occurred on	Material Involved	Diameter (inch)	Wall Thickness (inch)	SMYS
93	19890203	Dam>$50K	Offshore	Under Water	193	1,100	1,354	1,440	IC			Internal	Localized Pitting	Y	Y	Trans	Pipeline	Unk	Pipe Body	Steel	20.000	0.500	60,000
94	19890243	Dam>$50K	Offshore	Under Water	193	1,100	1,354	1,440	IC			Internal	Localized Pitting	Y	Y	Trans	Pipeline	Unk	Pipe Body	Steel	20.000	0.500	60,000
95	19890250	Dam>$50K	Offshore	Under Water	228	920	1,338	1,440	IC			Internal	General Corrosion	Y	Y	Trans	Pipeline	Unk	Pipe Body	Steel	10.750	0.365	42,000
96	19890253	Op Judge	Onshore	Under Ground		300	382	397	EC			External		Y	Y	Trans	Pipeline		Pipe Body	Steel	4.500	0.156	24,000
97	19890257	Op Judge	Onshore	Under Water		420	1,121	1,136	IC	Low Point in Creek Crossing		Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	6.625	0.188	35,000
98	19890270	Dam>$50K	Offshore	Under Water	197	1,000	1,112	1,200	IC			Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	8.625	0.250	52,000
99	19890274	Dam>$50K	Onshore	Under Ground		860	1,085	1,100	DP	Lamination in Pipe Wall Produced a Leak						Trans	Pipeline		Pipe Body	Steel	30.000	0.360	65,000
100	19900015	Dam>$50K	Onshore	Under Ground		310	455	470	WBB	Construct., Wrinkle Bend Started a Crack						Trans	Pipeline		Pipe Body	Steel	12.750	0.250	
101	19900056	Op Judge	Offshore	Under Water	67	585	1,410	1,440	IC		Accumulation of Liquids	Internal		Y	Y	Gath	Pipeline		Pipe Body	Steel	8.625	0.322	42,000
102	19900059	Op Judge	Onshore	Under Ground		511	602	617	HRF	Rains Caused Subsidence, in Area of Recent Adjacent Leak Repair						Trans	Pipeline		Pipe Body	Steel	14.000	0.250	30,000
103	19900035	Op Judge	Offshore	Under Water	65	350	971	1,000	IC		Galvanic	Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	20.000	0.500	52,000
104	19900046	Op Judge	Onshore	Under Ground		350	385	400	DGW	Possible Contribution by Axial Tension in Pipe						Trans	Pipeline		Weld	Steel	5.040	0.209	
105	19900057	Op Judge	Onshore	Under Ground		235	453	468	IC			Internal	General Corrosion	Y	Y	Trans	Pipeline		Pipe Body	Steel	8.625	0.322	35,000
106	19900068	Op Judge	Offshore	Under Water	65	335	971	1,000	IC			Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	20.000	0.500	52,000
107	19900088	Dam>$50K	Offshore	Under Water	175	880	1,172	1,250	IC	Small Leak		Internal	Localized Pitting	Y	Y	Trans	Pipeline	No	Pipe Body	Steel	12.750	0.375	46,000
108	19900100	Op Judge	Offshore	Under Water	40	460	1,422	1,440	IC	Pipeline Had Been Shut-in 2 Years		Internal		Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.344	52,000
109	19900109	Dam>$50K	Onshore	Under Water		800	1,118	1,133	HRF	Floodwater (Ms River) Caused Failure						Trans	Pipeline		Pipe Body	Steel	10.750	0.365	42,000
110	19900110	Dam>$50K	Onshore	Under Ground		750	960	975	WBB	Pigging Operation (Ili) Caused Failure of Wrinkle Bend						Trans	Pipeline		Wrinkle Bend	Steel	24.000	0.312	52,000
111	19900117	Op Judge	Onshore	Under Ground		900	896	911	DPS	ERW Seam Leaks Found During Survey						Trans	Pipeline		Weld	Steel	4.500	0.125	35,000
112	19900123	Dam>$50K	Offshore	Under Water	193	1,100	1,354	1,440	IC			Internal	Localized Pitting	Y	Y	Trans	Pipeline	Unk	Pipe Body	Steel	20.000	0.500	60,000
113	19900140	Dam>$50K	Offshore	Under Water	185	1,060	1,117	1,200	IC			Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	8.625	0.250	52,000
114	19900190	Dam>$50K	Offshore	Under Water	200	1,050	1,351	1,440	IC			Internal	Pinhole Leak	Y	Y	Trans	Pipeline	Unk	Pipe Body	Steel	16.000	0.438	42,000
115	19900210	Dam>$50K	Offshore	Under Water	60	1,030	1,173	1,200	IC			Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.375	52,000
116	19920125	Dam>$50K	Onshore	Under Water		325	370	385	HRF	Floodwater Washed out Crossing, Girth Weld						Trans	Pipeline		Weld	Steel	8.625	0.250	
117	19910052	Op Judge	Onshore	Under Ground		60	809	824	EC		Galvanic	External	Pinhole Leak, Localized Pitting	Y	Y	Gath	Pipeline		Pipe Body	Steel	6.625	0.156	35,000
118	19910056	Dam>$50K	Offshore	Under Water	187	970	1,116	1,200	IC			Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	8.625	0.250	52,000
119	19910058	Dam>$50K	Onshore	Under Water		650	843	858	DPS	Leak Caused by Penetrater in the Flash Weld						Trans	Pipeline		Weld	Steel	30.000	0.344	52,000
120	19910062	Dam>$50K	Onshore	Under Pavement		250	985	1,000	IC	Corrosion on Girth Weld		Internal	Localized Pitting	Y	Y	Trans	Pipeline		Weld	Steel	4.500	0.337	35,000
121	19910089	Op Judge	Offshore	Under Ground	68	500	970	1,000	IC		Galvanic	Internal	Localized Pitting	N	Y	Trans	Pipeline		Pipe Body	Steel	20.000	0.500	52,000
122	19910095	Dam>$50K	Onshore	Under Ground		750	843	858	IC	Pipeline Drip	Microbiological	Internal	General Corrosion	Y	Y	Trans	Pipeline		Pipe Body	Steel	24.000	0.375	42,000
123	19910133	Dam>$50K	Offshore	Under Water	167	830	1,175	1,250	IC			Internal	Pinhole Leak at 6 o'clock	Y	Y	Trans	Pipeline	Unk	Pipe Body	Steel	12.750	0.375	46,000
124	19910170	Dam>$50K	Offshore	Under Water	232	1,140	1,336	1,440	EC	Crack in Concrete Coating Possible Damaged Pipe	Coating Failure	External	Localized Pitting	Y	Y	Trans	Pipeline	Unk	Pipe Body	Steel	12.750	0.375	52,000
125	19910173	Op Judge	Onshore	Under Ground		210	277	292	EC	Cased Carrier Pipe		External		Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.250	24,000
126	19920073	Dam>$50K	Onshore	Under Ground		550	697	712	EC	Cased RR Crossing	Atmosphere	External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	26.000	0.250	52,000
127	19920082	Dam>$50K	Offshore	Under Water	230	850	1,097	1,200	IC			Internal	Pinhole Leak, Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	6.625	0.344	52,000
128	19920109	Dam>$50K	Onshore	Under Water		870	985	1,000	UNK	Material Defect						Trans	Pipeline		Gaskets	Steel	36.000	0.625	60,000
129	19920114	Dam>$50K	Offshore	Under Water	167	830	1,175	1,250	IC			Internal	Localized Pitting	Y	Y	Trans	Pipeline	Unk	Pipe Body	Steel	12.750	0.375	46,000
130	19920120	Dam>$50K	Offshore	Under Water	25	740	1,157	1,168	DGW	Leak in a Girth Weld						Trans	Pipeline		Weld	Steel	16.000	0.312	52,000
131	19920136	Dam>$50K	Offshore	Under Water	48	1,100	1,179	1,200	IC	Two Isolated Pits		Internal		Y	Y	Gath	Pipeline		Pipe Body	Steel	16.000	0.375	52,000
132	19920141	Op Judge	Onshore	Under Ground		334	410	425	DGW	Leak in a 30 Degrees Miter Girth Weld						Trans	Pipeline		Weld	Steel	20.000	0.281	35,000
133	19920149	Op Judge	Onshore	Under Ground		166	235	250	HRF	River Flooded (Hurricane Andrew) and Tree Hit 45 deg Elbow						Trans	Pipeline		Fitting	Steel	10.750	0.365	35,000
134	19920156	Op Judge	Onshore	Under Ground		90	985	1,000	IC		Accumulation of Liquids	Internal	Localized Pitting	Y	Y	Gath	Pipeline		Pipe Body	Steel	8.625	0.322	35,000
135	19920181	Dam>$50K	Onshore	Under Pavement		440	672	687	UNK	Leak in Cased Road Crossing						Trans	Pipeline		Pipe Body	Steel	34.000	0.375	52,000
136	19930042	Dam>$50K	Offshore	Under Water	70	1,000	1,409	1,440	IC			Internal		Y	Y	Gath	Pipeline	Unk	Pipe Body	Steel	12.750	0.375	52,000
137	19930029	Op Judge	Offshore	Above Water		1,000	1,425	1,440	EC	Platform Riser Coating Wore off	Coating Failure	External	General Corrosion	Y	N	Gath	Pipeline		Pipe Body	Steel	6.625	0.432	40,800

Pressure Activated Sealant Candidates, 1985-1997

Leak No.	OPS Rpt ID	Op Judgement	Offshore Onshore	Area of Incident	Water Depth (ft)	Estimated Incident Pressure, psi	Max. Leak Differential Pressure, psi	MAOP, psi	Leak Cause	Leak Cause Detail	Corrosion Cause	Corrosion Location	Corrosion Description	Coated	CP	Incident Occurred on	Part of System Involved	Pipeline Piggable Yes/No	Failure Occurred on	Material Involved	Diameter (inch)	Wall Thickness (inch)	SMYS
138	19930089	Dam>$50K	Onshore	Under Water		341	685	700	HRF	River near Flood Stage, Exact Cause Unknown						Trans	Pipeline		Unknown	Steel	24.000	0.344	60,000
139	19930093	Dam>$50K	Onshore	Under Ground		705	958	973	EC	Disbonded Coating		External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	24.000	0.312	52,000
140	19930102	Dam>$50K	Offshore	Under Water	195	1,100	1,219	1,306	UNK	Evidence Available Did Not Allow Determination of Cause						Trans	Pipeline		Pipe Body	Steel	20.000	0.438	60,000
141	19930105	Op Judge	Offshore	Under Water	160	1,050	1,178	1,250	IC			Internal	Pinhole Leak, Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	24.000	0.438	60,000
142	19930109	Dam>$50K	Onshore	Under Water		162	235	250	HRF	Strong (Ms River) Current Caused GW Haz Failure						Trans	Pipeline		Weld	Steel	10.750	0.500	35,000
143	19930169	Dam>$50K	Onshore	Under Ground		1,550	1,785	1,800	EC	Located on 65% Grade Rock - Ineff. Cp	Galvanic	External	General Corrosion	N	Y	Trans	Pipeline		Pipe Body	Steel	4.500	0.337	24,000
144	19930180	Dam>$50K	Offshore	Under Water	197	1,150	1,162	1,250	IC			Internal	Pinhole Leak			Trans	Pipeline		Pipe Body	Steel	12.750	0.406	52,000
145	19930197	Dam>$50K	Offshore	Under Water	51		1,224	1,247	UNK	Offshore Leak						Trans	Pipeline		Pipe Body	Steel	16.000	0.406	42,000
146	19940024	Op Judge	Onshore	Under Ground		368	580	595	DGW	Acetylene Girth Weld Failed						Trans	Pipeline		Weld	Steel	20.000	0.344	42,000
147	19940023	Dam>$50K	Offshore	Under Water	51	530	1,224	1,247	UNK	Suspected Int/ext Corrosion						Trans	Pipeline		Pipe Body	Steel	16.000	0.406	42,000
148	19940033	Dam>$50K	Offshore	Under Water	42	910	1,421	1,440	IC		Galvanic	Internal	Localized Pitting	Y		Trans	Pipeline	Yes	Pipe Body	Steel	16.000	0.375	52,000
149	19940057	Op Judge	Onshore	Under Ground		270	255	270	DGW	Leak in End Cap, Blew off						Tr of Dis	Pipeline		Weld	Steel	18.000	0.312	42,000
150	19940061	Op Judge	Onshore	Under Ground		270	335	350	EC	Leak on Dresser Coupling	Galvanic	External	Localized Pitting	N	Y	Trans	Pipeline		Mech Jnt	Steel	4.000	0.198	30,000
151	19940062	Op Judge	Offshore	Under Water	68	475	570	600	IC		Galvanic	Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	20.000	0.500	52,000
152	19940082	Dam>$50K	Offshore	Under Water	25	820	1,157	1,168	IC			Internal		Y	Y	Trans	Pipeline		Pipe Body	Steel	16.000	0.312	52,000
153	19940089	Dam>$50K	Onshore	Under Ground		775	975	990	DPS	ERW Lack of Fusion						Trans	Pipeline		Weld	Steel	20.000	0.312	52,000
154	19940102	Op Judge	Onshore	Under Ground		705	765	780	DGW	Leak in a Girth Weld, Construction Defect						Trans	Pipeline	Unk	Weld	Steel	24.000	0.250	52,000
155	19940111	Op Judge	Offshore	Under Water	63	410	1,412	1,440	UNK	Suspected Int/ext Corrosion						Trans	Pipeline		Pipe Body	Steel	16.000	0.375	52,000
156	19940115	Dam>$50K	Offshore	Under Water	230	815	1,097	1,200	IC		Bacteria	Internal	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	6.625	0.344	52,000
157	19940118	Dam>$50K	Onshore	Under Water		159	235	250	HRF	Strong (Ms River) Current Caused GW Haz Failure						Trans	Pipeline		Weld	Steel	10.750	0.500	35,000
158	19940121	Dam>$50K	Onshore	Under Ground		620	896	911	DGW	Leak in GW Between X65 and X70 Pipe						Trans	Pipeline		Weld	Steel	42.000	0.456	70,000
159	19940129	Dam>$50K	Offshore	Under Water	225	900	1,099	1,200	IC			Internal	Localized Pitting			Tr of Dis	Pipeline		Pipe Body	Steel	12.750	0.375	52,000
160	19940145	Dam>$50K	Offshore	Under Water	42	863	1,421	1,440	IC		Galvanic	Internal	Localized Pitting	Y		Trans	Pipeline	Yes	Pipe Body	Steel	16.000	0.375	52,000
161	19940146	Dam>$50K	Offshore	Under Water	200	1,108	1,161	1,250	IC			Internal		Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.406	52,000
162	19940153	Dam>$50K	Onshore	Under Pavement		608	697	712	UNK							Trans	Pipeline		Pipe Body	Steel	18.000	0.375	30,000
163	19940154	Dam>$50K	Offshore	Under Water	48	890	1,179	1,200	IC	Line Abandoned		Internal		Y	Y	Gath	Pipeline		Pipe Body	Steel	16.000	0.375	52,000
164	19940158	Dam>$50K	Offshore	Under Water	150	580	713	780	IC		Bacteria	Internal	General Corrosion	Y	Y	Gath	Pipeline		Pipe Body	Steel	22.000	0.500	52,000
165	19940176	Dam>$50K	Offshore	Under Water	150	580	713	780	IC		Bacteria	Internal	General Corrosion	Y	Y	Gath	Pipeline		Pipe Body	Steel	22.000	0.500	52,000
166	19940180	Dam>$50K	Offshore	Under Water	62	956	1,272	1,300	DP	Identified as Material Defect	Bacteria	Internal	Localized Pitting			Gath	Pipeline		Pipe Body	Steel	12.750	0.312	52,000
167	19940184	Dam>$50K	Offshore	Under Water	200	1,108	1,161	1,250	IC			Internal		Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.406	52,000
168	19940192	Op Judge	Onshore	Under Ground		400	735	750	EC			External	Localized Pitting	N	N	Trans	Pipeline		Pipe Body	Steel	6.625	0.280	
169	19940193	Op Judge	Onshore	Under Ground		390	735	750	EC			External		N	Y	Trans	Pipeline		Pipe Body	Steel	6.625	0.280	
170	19940203	Dam>$50K	Offshore	Under Water	42	910	1,421	1,440	IC		Galvanic	Internal	Localized Pitting	Y	Y	Trans	Pipeline	Yes	Pipe Body	Steel	16.000	0.375	52,000
171	19940216	Op Judge	Offshore	Above Water		850	1,300	1,315	EC	Platform Riser (3) Leaked		External	Localized Pitting	Y	Y	Gath	Pipeline		Pipe Body	Steel	16.000	0.281	52,000
172	19940229	Dam>$50K	Offshore	Under Water	140	1,100	1,377	1,440	UNK							Trans	Pipeline		Unknown	Steel	6.625	0.432	35,000
173	19950004	Dam>$50K	Onshore	Under Pavement		780	843	858	UNK							Trans	Pipeline		Unknown	Steel	30.000	0.340	52,000
174	19950021	Dam>$50K	Onshore	Under Ground		640	985	1,000	EC	Coating Damage During Construction		External	Localized Pitting	Y	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.250	46,000
175	19950042	Op Judge	Offshore	Under Water	468	800	1,171	1,380	DP	Small Split						Gath	Pipeline		Pipe Body	Steel	10.750	0.280	42,000
176	19950048	Op Judge	Offshore	Above Water		360	1,425	1,440	EC	Elbow (90-degree) next to Weld		External	General Corrosion	Y	N	Gath	Pipeline		Fitting	Steel	4.500	0.240	
177	19950060	Op Judge	Onshore	Under Ground		980	1,425	1,440	IC			Internal	Localized Pitting	Y	Y	Gath	Pipeline		Pipe Body	Steel	16.000	0.500	52,000
178	19950074	Dam>$50K	Onshore	Under Ground		890	896	911	DPS	Seam Split (3/4-inch)						Trans	Pipeline		Weld	Steel	16.000	0.230	46,000
179	19950106	Dam>$50K	Offshore	Under Water	164	1,073	1,367	1,440	IC			Internal	Pinhole Leak	Y	Y	Trans	Pipeline	Yes	Pipe Body	Steel	16.000	0.380	52,000
180	19950114	Dam>$50K	Offshore	Under Water	60	850	1,413	1,440	DFW	Fillet Weld on 6-inch Hot Tap Tie-in Weld						Trans	Pipeline		Weld	Steel	6.625	0.430	35,000
181	19950134	Dam>$50K	Offshore	Under Water	225	822	1,099	1,200	UNK	1/2" NPT Nipple						Trans	Pipeline		Fitting	Steel	0.500	0.280	25,000
182	19950136	Op Judge	Onshore	Under Ground		1,200	2,183	2,198	IC		Galvanic	Internal	Localized Pitting	Y	Y	Gath	Pipeline		Pipe Body	Steel	6.625	0.280	52,000
183	19950153	Op Judge	Onshore	Under Ground		569	1,048	1,063	DGW	Small Crack in Girth Weld						Trans	Pipeline		Weld	Steel	17.750	0.310	42,000
184	19960021	Op Judge	Onshore	Under Ground			335	350	UNK	Damage by Outside Force						Trans	Pipeline		Weld	Steel	12.750	0.219	35000
185	19960077	Dam>$50K	Offshore	Under Water	14	905	1,294	1,300	DGW	Construction Defect						Trans	Pipeline	No	Weld	Steel	6.625	0.312	35,000
186	19960092	Dam>$50K	Offshore	Under Water	36	980	1,184	1,200	DGW							Trans	Pipeline		Weld	Steel	16.000	0.312	52,000
187	19960094	Dam>$50K	Onshore	Under Ground		488	1,035	1,050	HRF	Buckle						Tr of Dis	Pipeline		Pipe Body	Steel	20.000	0.281	
188	19960101	Op Judge	Onshore	Under Ground		440	485	500	PDP	Stress Corrosion in Old Dent	Stray Current	External	External Cracks	N	Y	Trans	Pipeline		Pipe Body	Steel	24.000	0.250	52,000
189	19960129	Dam>$50K	Offshore	Under Water	175	1,065	1,362	1,440	IC			Internal	Pinhole Leak at 6 o'clock	N	Y	Trans	Pipeline	No	Pipe Body	Steel	16.000	0.381	52,000

Pressure Activated Sealant Candidates, 1985-1997

Leak No.	OPS Rpt ID	Op Judgement	Offshore Onshore	Area of Incident	Water Depth (ft)	Estimated Incident Pressure, psi	Max. Leak Differential Pressure, psi	MAOP, psi	Leak Cause	Leak Cause Detail	Corrosion Cause	Corrosion Location	Corrosion Description	Coated	CP	Incident Occurred on	Part of System Involved	Pipeline Piggable Yes/No	Failure Occurred on	Material Involved	Diameter (inch)	Wall Thickness (inch)	SMYS
190	19960146	Dam>$50K	Offshore	Under Water	220	856	1,102	1,200	IC			Internal	1/4" Circular Hole at 6 o'clock	N	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.381	52,000
191	19960169	Op Judge	Offshore	Under Water	130		3,622	3,680	HRF	Break-Away Joint						Gath	Pipeline		Fitting	Steel	4.500	0.438	35,000
192	19960174	Op Judge	Offshore	Under Water	200	890	1,351	1,440	UNK	Unknown Pipe Leak						Trans	Pipeline		Unknown	Steel	16.000	0.438	42,000
193	19960185	Dam>$50K	Offshore	Under Water	35	1,082	1,424	1,440	UNK	Unknown						Trans	Pipeline		Unknown	Steel	6.625	0.375	35,000
194	19970078	Dam>$50K	Onshore	Under Ground		765	835	850	DPS							Trans	Pipeline		Weld	Steel	22.000	0.250	52,000
195	19970083	Op Judge	Offshore	Under Water	64	1,100	1,199	1,228	IC			Internal	General Corrosion	N	Y	Gath	Pipeline		Weld	Steel	20.000	0.406	42,000
196	19970094	Dam>$50K	Onshore	Other		720	985	1,000	EC		Galvanic	External	Localized Pitting	N	Y	Trans	Pipeline		Pipe Body	Steel	8.625	0.281	24,000
197	19970095	Dam>$50K	Offshore	Under Water		848		1,100	IC			Internal		N	Y	Trans	Pipeline	No	Pipe Body	Steel	12.750	0.250	42,000
198	19970122	Op Judge	Offshore	Under Water	48	1,000	1,279	1,300	IC			Internal				Trans	Pipeline		Pipe Body	Steel	12.750	0.381	52,000
199	19970132	Op Judge	Offshore	Under Water	48	960	1,279	1,300	IC			Internal				Trans	Pipeline		Pipe Body	Steel	12.750	0.381	52,000
200	19970135	Op Judge	Onshore	Under Ground		650	843	858	IC			Internal	Pinhole Leak			Trans	Pipeline		Weld	Steel	36.000	0.438	60,000
201	19970140	Dam>$50K	Offshore	Under Water	74	1,170	1,407	1,440	IC			Internal	Localized Pitting	N	Y	Gath	Pipeline	Unk	Pipe Body	Steel	12.750	0.500	42,000
202	19970170	Op Judge	Onshore	Under Ground		450	830	845	EC		Bacteria	Internal	Localized Pitting	N	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.250	42,000
203	19970171	Dam>$50K	Onshore	Under Ground		850	959	974	DGW							Trans	Pipeline		Weld	Weld Mtl	36.000	0.381	65,000
204	19980022	Dam>$50K	Offshore	Under Water		1,050		1,250	IC			Internal	Localized Pitting	N	Y	Trans	Pipeline		Pipe Body	Steel	12.750	0.406	52,000
205	19980025	Dam>$50K	Offshore	Under Water	250	1,000	1,328	1,440	IC			Internal	Localized Pitting	N	Y	Trans	Pipeline	Unk	Pipe Body	Steel	16.000	0.438	52,000

Blue Text Represents Additional Operator Input

Red Text Designates Possible Error in Input