Table 5-1. Age Summary of the Longhorn Pipeline, Kemper to Galena Park Station (Length in Miles)

Year of Construction:	1947	1950	1974	1980-1989	1990-1999	Total	Percent of Line
Miles of Pipeline:							
Kemper-McKavett		97.76		0.02	0.02	97.8	23.5
McKavett-Eckert		91.24			2.56	93.8	22.5
Eckert-Bastrop		85.88		0.05	0.13	86.1	20.6
Bastrop-Warda		28.67	0.06		0.03	28.8	6.9
Warda-Satsuma		75.24		1.01	0.37	76.6	18.4
Satsuma-Galena Park	19.30			5.49	9.11	33.9	8.1
Kemper-Galena Park Total	19.3	378.8	0.1	6.6	12.2	416.9	100.0
Percent of Total	**4.6**	**90.9**	**0.027**	**1.6**	**2.9**		**100.0**

Table 5-2. Pipe Characteristics

Location	Segment Length (mi)	Year Built	Type	Diameter (in)	Wall Thickness (in)	Coating
Galena Park to Valve J1	9.1	1998	API 5L X-52	20	0.312 0.344/0.375 at crossings	FBE 14-16 mils Lilly 2040 abrasion coating (40 miles at crossings
Valve J1 to Satsuma	26.8	1949	Grade B	20	0.312 0.375	Coal tar with asbestos and glass fiber
Satsuma to Kemper	370.3	1950	AP1 5L X-45, -52, -65	18	0.284 0.312 0.395	Coal tar
Kemper Bypass	0.64	1998	API 5L X-65	18	0.281	FBE
Kemper to Crane	53.1	1957	AP1 5L X-45, -52, -65	18	0.281, 0.375	Coal tar
James River	0.011	1998	X-65	18	0.375	FBE
Crane	0.011	1998	API 5L X-65	18	0.281	FBE
Crane – El Paso	236.9	1998	API 5L X-65	18	0.281 0.375	FBE 14-16 mils Lilly 2040 abrasion coating at crossings
El Paso Lateral – Fort Bliss Option						
• Chevron	8.3	N/A	API 5L X-60	8	0.188 0.250	FBE 14-16 mils Lilly 2040 abrasion coating at crossings
• Kinder Morgan #1	8.3	N/A	API 5L X-60	8	0.188 0.250	FBE 14-16 mils Lilly 2040 abrasion coating at crossings
• Kinder Morgan #2	8.3	N/A	API 5L X-65	12	0.203 0.250	Lilly 2040 abrasion coating at crossings
• Return line	8.3	N/A				
El Paso Laterals – Montana Ave. Option						
• Chevron	8.5	N/A	API 5L, X42	8	0.344 0.438	FBE 14-16 mils Lilly 2040 abrasion coating at crossings
• Kinder Morgan #1	8.5	N/A	API 5S, X42	8	0.312 0.312	FBE 14-16 mils Lilly 2040 abrasion coating at crossings
• Kinder Morgan #2	8.5			12		
• Return line	8.5	N/A				
Odessa Lateral	28	N/A	API 5L, X60	8	0.188 0.250	FBE 14-16 mils Lilly 2040 abrasion coating at crossings

Table 5-3. Overview of Longhorn Pipeline Construction Specifications

Section	1949, Humble Oil Kemper (Crane) – Satsuma	1993, Williams CS4 Galena Park Station - Satsuma, Station (9.1 miles) Refurbishing Satsuma Station-Kemper Station, Odessa Lateral, Crane Station - El Paso Terminal	49 CFR Part 195
Minimum Depth of Cover (inches)			
Normal Excavation			
Industrial, Commercial, Residential	24	36	36
Water body > 100 ft (high water marks)	24	48	48
Drainage Ditches	24	36	36
Other	24	30	30
Rock Excavation			
Industrial, Commercial, Residential	12	30	30
Water body > 100 ft (high water marks)	4 (concrete)	18	18
Drainage Ditches	12	36	36
Other	12	18	18
Crossings			
Hard-surfaced road (cased)	Vented casing, Kapco rock shield in addition to coating, seal bushings	Vented casing, 1.25 inch reinforced concrete jacket, seal bushings; 4 ft clearance to road foundation, 3 ft to bottom of drainage ditch.	Installation must withstand traffic loads.
Railroad	Same as hard-surfaced road	Cased: 5 ft 6 inch clearance to top of RR ties, 3 ft to bottom of drainage ditch; Uncased: 10 ft to top of ties, 6 ft to bottom of drainage ditch.	Installation must withstand traffic loads.
River	Weighted so it will not float when empty (2-inch concrete sheaths), split offset weld sleeves over welds, Kapco Rock shield over ends.	With riprap: rock plugs (typ. 50 ft to each side, 3 ft clearance from top of pipe to base of rock plug, 8 ft to river bottom; w/o riprap min 4 ft to river bottom; concrete weights as required.	Cover specified as 48 inches for normal excavation and 18 inches for rock excavation.
Irrigation canal		Open cut, 5 ft of cover	Covered under general depth of cover or drainage ditches.
Bar ditch		30-inch clearance, including 6-inch concrete slab	Covered under general depth of cover or drainage ditches.
Other Pipe	12-inch clearance, pass below	24 inch normal, 12 inch in rock	Clearance of 12 inches from other underground structures.

Table 5-3. (Continued)

Section	1949, Humble Oil Kemper (Crane) – Satsuma	1993, Williams CS4 Galena Park-Satsuma, (9.1 miles) Refurbishing Satsuma-Kemper, Odessa Lateral, Crane - El Paso	49 CFR Part 195
Coating and Wrapping			
Regular	Weld, clean, prime (coal tar base), dry, coal tar enamel & asbestos PL felt machine-applied to 94 mils, cool.	GATX-Crane: Fusion bond epoxy; Crane-El Paso: weld, clean, hot enamel (94 mil min.yard applied, 18 mil glass mat wrapped and embedded, poured molten enamel, coal tar PL felt wrapped.	Specified in general terms
River Crossings	Weld, clean, prime (coal tar base), dry, double coat coal tar enamel, glass mat wrapper, coat coal tar enamel, asbestos PL felt and Kraft paper, yard-applied in Houston.	Same as regular	Specified in general terms
Welds	AWS Class E-6010 electrodes or similar	API Standard 1104 (17th Ed. Sep 88), Sect. IX of ASME Boiler and Pressure Vessel Code	API Standard 1104 and Section IX of ASME Boiler and Pressure Vessel Code
Hydrostatic Testing	1000 psi, 4 hours	1525-1575 psi, 8 hours	§195.303
Cathodic Protection	Not mentioned	Specified in detail	§195.414

Table 5-4. Basic Inspection and Test Methods

Inspection or Test Type	Purpose	Attributes
Hydrostatic Testing (Hydrotesting)	Serves as a pre-service integrity validation of the pipe and components by pressurizing to a level above the maximum operating pressure. Destructively eliminates defects so they do not subsequently fail while in service. Allows the establishment of the real minimum strength of the pipeline and components, as opposed to the mill tensile test, which are based on a sample of pipe.	A regulatory requirement for new pipe sections, to uprate existing pipe sections, and conversion from vapor to liquid service. Done by sectioning line according to terrain elevations. One or more valve sections can be included within test segment. Requirements and procedures defined in regulations and industry standards. Hydrotesting service usually provided by a specialty contractor overseen by operating company staff.
Cathodic Protection (CP) Inspections and Surveys	Determines the adequacy of cathodic protection voltages and currents for protecting the pipeline against corrosion and to detect areas of potentially defective coating.	Rectifier inspections are done to ensure that the rectifiers are in service and providing the required impressed current for cathodic protection. Station tests or surveys are done to measure CP voltages at test station locations. This also includes readings taken at pipe casings under roads and railway crossings. Close interval surveys (CIS) are taken at intervals of 2 to 10 ft along a pipeline to provide a profile along the line to greater resolution than can be obtained with a station survey.

Table 5-4. (Continued)

Inspection or Test Type	Purpose	Attributes
In-Line Inspection (ILI)	Detects areas of anomalies, such as metal loss, deformations, cracks, etc..	Automated internal inspection tools or "smart pigs" vary in anomaly types that can be detected and terms of degree of resolution. Services are provided by a specialty pigging contractor. Results often require expertise in interpreting data. Either part or all of a pipeline is pigged depending on the location of pig launching and receiver equipment and the size and geometry of the pipeline system.
Manual Ultrasonic Wall Thickness Measurement	Determines wall thickness and identifies areas of possible corrosion by direct measurement of pipe wall.	Manually held instrument used in conjunction with exposed pipe inspections. Requires coating removal.
Visual Surveys	Identifies any adverse conditions associated with coating or pipe, such as corrosion, dents, scrapes, gouges or deteriorating or damaged coating.	Done in conjunction with finding exposed pipe or exposing pipe for inspection by digging at various pipe locations. The bare pipe can only be examined when the coating is removed.
Ground Patrols and Aerial Surveys	Identifies external conditions that might adversely affect the pipeline, such as third party activity and right-of-way (ROW) encroachments. Also used as a means of detecting leaks.	These apply more to the effects of external factors on the pipeline and the detection of leaks than to factors associated with the conditions of the pipe itself. They complement visual surveys.

Table 5-5. Summary of Hydrostatic Tests (1995 - 1998)

Valve Section Name	Date of Testing	Beginning Test Section (ft)	End Test Section (ft)	Diameter (in)	Min Pressure (psig)[b]	Pipe Grade
Galena Park Station to Valve J1	1998	0	38,547	20	Note a	X-52
Valve J1 to Valve F1	12/13/1995	38,547	53,299	20	861	Gr B
Valve F1 to Satsuma Station	12/13/1995	53,299	180,010	20	822	Gr B
Satsuma Station to West Side Brazos River	12/5/1995	180,263	337,925	18	1235	X-45
West Side Brazos River to Cut Pipe Spool	12/4/1995	337,925	461,973	18	1309	X-45
Cut Pipe Spool to Valve A1 (Warda Station)	12/4/1995	461,973	595,983	18	1293	X-45
Valve H1 (Warda Station) to Bastrop Station	12/5/1995	596,428	748,330	18	1266	X-45
Bastrop Station to Valve E1	11/19/1995	748,330	880,018	18	1326	X-45
Valve E1 to Valve K1	11/17/1995	880,018	926,671	18	1206	X-45
Valve K1 to Valve B1	11/18/1995	926,671	1,118,844	18	1373	X-45
Valve B1 to Valve A1 (Eckert Station)	11/20/1995	1,118,844	1,202,756	18	1254	X-45
Valve E1 (Eckert Station) to Valve C1	11/20/1995	1,203,938	1,460,647	18	1263	X-45
Valve C1 to Stopple Cut	11/9/1995	1,460,647	1,487,944	18	1216	X-45
Stopple Cut to Valve B1	11/9/1995	1,487,944	1,525,453	18	1353	X-45
Valve B1 to Cut Pipe Spool	11/12/1995	1,525,453	1,614,630	18	1324	X-45
Cut Pipe Spool to Valve A1 (Ft. Mc Kavett Station)	11/9/1995	1,614,630	1,699,238	18	1236	X-45
Valve C1 (Ft. Mc Kavett Station) to Valve B1	11/10/1995	1,699,911	1,893,966	18	1280	X-45
Valve B1 to Kemper	11/10/1995	1,893,966	2,135,340	18	1249	X-45
Kemper Station to Station 299064	8/23/1995	2,138,780	2,333,459	18	1260	X-52
Station 299064 to Crane Station	8/22/1995	2,333,459	2,406,181	18	1325	X-52
Crane Station (between designated valve locations)	10/25/1998	2,406,181	2,644,179	18	1970	X-65
	10/26/1998	2,644,179	2,845,660	18	1898	X-65
Utica Station (between designated valve locations)	10/28/1998	2,845,660	2,950,481	18	1833	X-65
	11/11/1998	2,950,481	2,997,191	18	1915	X-65
Cottonwood Station (between designated valve locations)	11/12/1998	2,997,191	3,061,177	18	1857	X-65
	11/12/1998	3,061,177	3,088,288	18	1839	X-65
	11/12/1998	3,088,288	3,106,951	18	1850	X-65
	11/12/1998	3,106,951	3,129,840	18	1859	X-65
	11/13/1998	3,129,840	3,140,682	18	1858	X-65
	11/13/1998	3,140,682	3,162,448	18	1843	X-65
	11/14/1998	3,162,448	3,188,535	18	1861	X-65
	11/14/1998	3,188,535	3,278,569	18	1832	X-65
	11/15/1998	3,278,569	3,399,663	18	1840	X-65
	11/22/1998	3,399,663	3,486,115	18	1835	X-65
	11/12/1998	3,486,115	3,524,735	18	1831	X-65
El Paso	11/21/1998	3,524,735	3,662,671	18	1837	X-65

Four leaks were reported during the 1995 hydrostatic testing (From Kemper to Crane):

Origin of Leak	Station No. (ft)	Mileage	Repairs
Hydrogen blister	2,146,607	406.6	Replaced 43' of 18" pipe
Leak in pipe body	2,160,888	409.3	Replaced 45' of 18" pipe
Hydrogen blister	2,190,051	414.8	Installed full wrap 18" long
ERW seam failure	2,242,311	424.7	Replaced 60' of 18" pipe

[a] Tested to 90% of SMYS (1460 psi).
[b] Final qualifying test pressure after any repairs.

Table 5-6. 1995 In-Line Inspection Summary

Section Name	Beginning Station (ft)	End Station (ft)	Anomaly Type[a]	Pipe Length with Anomolies[b]
Galena Park – Satsuma	0	180,263	Note c	Note c
Satsuma – Warda	180,263	596,447	EC IC NCF	300 feet 100 feet 300 feet
Warda – Bastrop	596,447	748,915	EC NCF	1320 feet 200 feet
Bastrop – Cedar Valley	748,915	959,232	EC NCF	3062 feet 300 feet
Eckert - Kimble County	1,203,937	1,558,907	EC IC NCF	1584 feet 200 feet 300 feet
Kimble County - Big Lake	1,558,907	1,971,811	EC NF NCF	2270 feet 200 feet 300 feet
Big Lake - Crane	1,971,811	2,415,839	EC IL NF NCF	2482 feet 500 feet 400 feet 400 feet
Crane - Cottonwood	2,415,839	3,043,013	Note c	Note c
Cottonwood - El Paso	3,043,013	3,666,496	Note c	Note c

[a] EC = External Corrosion; IC = Internal Corrosion; IL = Internal Lamination; NCF = Non-Corrosion Flaw.
NF = Nothing found after extensive inspection.
[b] Length is total in section and not necessarily contiguous.
[c] New pipe not installed as of 1995.

Table 5-7. Summary of Dig-Outs Performed in 1995

Section Name	Beginning Station (ft)	End Station (ft)	No. of Dig-Outs	No. Requiring Repair	Repairs Complete
Galena Park – Satsuma	0	180,263	Note a	Note a	Note a
Satsuma – Warda	180,263	596,447	8	6	6
Warda – Eckert	596,447	1,203,937	78	51	51
Eckert – Ft McKavett	1,203,937	1,699,911	26	22	22
Ft McKavett – Kemper	1,699,911	2,135,352	54	11	11
Kemper – Crane	2,135,352	2,415,839	21	8	8
Crane – Cottonwood	2,415,839	3,043,013	Note a	Note a	Note a
Cottonwood – El Paso	3,043,013	3,666,496	Note a	Note a	Note a
TOTAL	0	3,666,496	187	98	98

[a] New pipe not installed yet in 1995.

Table 5-8. Test Lead Readings Summary (1992-1998)

Section Name	Beginning Station (ft)	End Station (ft)	Year	No. of TL Stations with -0.85 V criterion not met	No. of TL Stations with -0.85 V criterion met	No. of TL Stations with No Data[a]
Galena Park - Satsuma		180,263	98	1	58	23
			97	0	79	3
			96	1	59	22
			95	0	0	84
			94	1	41	42
			93	0	39	45
			92	0	39	45
Satsuma – Warda	180,263	596,447	98	10	86	1
			97	2	95	0
			96	1	96	0
			95	0	0	97
			94	0	1	96
			93	0	1	96
			92	1	97	0
Warda – Bastrop	596,447	748,915	98	0	25	3
			97	0	27	1
			96	0	27	1
			95	0	0	28
			94	1	26	1
			93	0	27	1
			92	0	26	2

Table 5-8. (Continued)

Section Name	Beginning Station (ft)	End Station (ft)	Year	No. of TL Stations with -0.85 V criterion not met	No. of TL Stations with -0.85 V criterion met	No. of TL Stations with No Data[a]
Bastrop – Cedar Valley	748,915	959,232	98	2	44	2
			97	3	44	2
			96	0	46	2
			95	0	0	48
			94	0	47	2
			93	0	48	0
			92	0	47	1
Cedar Valley – Eckert	959,232	1,203,937	98	0	58	0
			97	0	58	0
			96	1	57	0
			95	0	0	58
			94	0	21	37
			93	0	21	37
			92	0	21	37
Eckert – Kimble County	1,203,937	1,558,907	98	0	90	1
			97	0	91	0
			96	0	87	5
			95	0	0	91
			94	0	0	91
			93	0	0	91
			92	0	0	91

Table 5-8. (Continued)

Section Name	Beginning Station (ft)	End Station (ft)	Year	No. of TL Stations with -0.85 V criterion not met	No. of TL Stations with -0.85 V criterion met	No. of TL Stations with No Data[a]
Kimble County – Big Lake	1,558,907	1,971,811	98	0	109	2
			97	4	107	1
			96	0	109	2
			95	0	0	111
			94	0	0	111
			93	0	0	111
			92	0	0	111
Big Lake – Crane	1,971,811	2,415,839	98	0	126	3
			97	1	126	2
			96	0	129	1
			95	0	0	129
			94	0	0	129
			93	0	0	129
			92	0	89	40
Crane – Cottonwood	2,415,839	3,043,013		Note b	Note b	Note b
Cottonwood – El Paso	3,043,013	3,666,496		Note b	Note b	Note b

[a] No data indicates missing or defective test lead. Number of stations with no data are reduced by 1998.
[b] New pipe with no survey yet.

Table 5-9. Close Interval Survey Conducted in 1998

Section Name	Beginning Station (ft)	End Station (ft)	Length of pipe with -0.85 V criterion not Met[a]	Length of pipe with -0.85 V criterion Met[a]	Length of pipe with No Data[a]
Galena Park – Satsuma	0	180,263	75 ft	30.3 miles	3.2 miles
Satsuma – Warda	180,263	596,447	476 ft	76.9 miles	2.5 miles
Warda – Bastrop	596,447	748,915	1.2 miles	27.6 miles	1025 ft
Bastrop – Cedar Valley	748,915	959,232	0.9 miles	37.8 miles	1.8 miles
Cedar Valley – Eckert	959,232	1,203,937	2.7 mile	43.5 miles	2.0 miles
Eckert – Kimble County	1,203,937	1,558,907	22 mile	54 miles	2002 ft
Kimble County – Big Lake	1,558,907	1,971,811	26 miles	49.1 miles	3.3 miles
Big Lake – Crane	1,971,811	2,415,839	26.7 miles	55.1 miles	2.5 miles
Crane – Cottonwood	2,415,839	3,043,013	Note b	Note b	118.8 miles
Cottonwood – El Paso	3,043,013	3,666,496	Note b	Note b	118.1 miles
TOTAL	0	3,666,496	78.8 miles	374.7 miles	251.8 miles

[a] Length is total in section and not necessarily contiguous.
[b] New pipe with no survey.

Table 5-10. Visual Inspection of the Pipe in the Last Ten Years

Section Name	Beginning Station (ft)	End Station (ft)	Length of Pipe with Good Coating Condition[a]	Length of Pipe with Fair Coating Condition[a]	Length of Pipe with Bad but Replaced Coating Condition[a]
Galena Park – Satsuma	0	180,263	2,006 ft	831 ft	631 ft
Satsuma – Warda	180,263	596,447	12,672 ft	1,373 ft	492 ft
Warda – Bastrop	596,447	748,915	935 ft	465 ft	0
Bastrop – Cedar Valley	748,915	959,232	474.2 ft	8,976 ft	0
Cedar Valley – Eckert	959,232	1,203,937	200 ft	0	0
Eckert – Kimble County	1,203,937	1,558,907	0	0	0
Kimble County – Big Lake	1,558,907	1,971,811	400 ft	0	0
Big Lake – Crane	1,971,811	2,415,839	2,006 ft	995 ft	300 ft
Crane – Cottonwood	2,415,839	3,043,013	NA[b]	NA[b]	NA[b]
Cottonwood – El Paso	3,043,013	3,666,496	NA[b]	NA[b]	NA[b]
TOTAL	0	3,666,496	22,704 ft	12,672 ft	1,584 ft

[a] Lengths refer to total length in section, not necessarily contiguous.
[b] New pipe with new coating.

Table 5-11. Pipe Repairs in the Last Ten Years

Section Name	Beginning Station (ft)	End Station (ft)	Length of Pipe with Corrosion Related Repairs	Length of Pipe with Leak Related Repairs	Length of Pipe with Upgrade Related Repairs [b]	Length of Pipe with Unknown Repairs [c]
Galena Park - Satsuma	0	180,263	0	0	200 ft	3,696 ft
Satsuma - Warda	180,263	596,447	400 ft	618 ft	202 ft	2,640 ft
Warda – Bastrop	596,447	748,915	2,112 ft	231 ft	0	0
Bastrop - Cedar Valley	748,915	959,232	2,112 ft	0	200 ft	801 ft
Cedar Valley – Eckert	959,232	1,203,937	0	0	0	3,168 ft
Eckert - Kimble County	1,203,937	1,558,907	0	0	435 ft	4,224 ft
Kimble County - Big Lake	1,558,907	1,971,811	200 ft	202 ft	882 ft	5,808 ft
Big Lake – Crane	1,971,811	2,415,839	1,056 ft	5,808 ft	400 ft	1,584 ft
Crane – Cottonwood	2,415,839	3,043,013	NA [a]	NA [a]	NA [a]	NA [a]
Cottonwood - El Paso	3,043,013	3,666,496	NA [a]	NA [a]	NA [a]	NA [a]
TOTAL	0	3,666,496	5,808 ft	2,112 ft	2,112 ft	22,704 ft

[a] No repair for the new section (Crane to El Paso).
[b] Equipment replaced (except pipe), instrumentation installed, etc.
[c] Purging, moving pipeline, pipe replacement with no cause shown.

Table 5-12. Multiple Alarm and Shutdown Devices

Pump Location – Emergency Shutdown Devices	Alarm Types
Power Fail Alarm	Local and Operations Control Center
Fire Alarm	Local and Operations Control Center
Seal Leak Sensor	Local
Loss of Flow	Local
High Unit Vibration	Local
High Bearing Temperature	Local
High Discharge Pressure	Local
Low Suction Pressure	Local
High Motor Temperature	Local
Motor Overload	Local
Low DC Voltage Level	Local
Low Lube Oil Pressure (Satsuma, Crane and El Paso stations)	Local

Notes:

"Local" shutdown devices initiate a pump shutdown and transmit a pump shutdown alarm to the Tulsa Operations Control Center. The alarm sent to the Control Center does not normally identify the cause of the shutdown (e.g., motor overload, low suction pressure, etc.), but it alerts the Control Center to the pump shutdown. A technician must go to the pump and correct the problem causing the shutdown before it can be restarted.

Table 5-13. Summary of 49 CFR Part 195 Topics Addressed Outside the Longhorn System of Operating Manuals

Regulatory Issue		Comments
195.4	Compatibility necessary for transportation of hazardous liquids	Compatibility of liquids transported and materials of construction was not addressed in the manuals reviewed. This topic is part of WES design/construction procedures.
195.410	Line markers	WES's Pipeline Marking Standard is dealt with outside the Operating Manual Longhorn markers are specified in the LMP.*
195.416(i)	Cleaning, coating, and maintaining protection for components in the pipeline system exposed to the atmosphere.	Explicit discussion of topic not found in manuals reviewed, but addressed in the LMP.
195.418(a)	Investigation of corrosive effects	Compatibility of liquids transported and materials of construction is a design and construction issue.

Note:
*LMP refers to the Longhorn Mitigation Plan, see Chapter 9.

Table 5-14. Some Key Industry Standards Incorporated by Reference in 49 CFR Part 195 (1998 Edition[a] and 1999 Amendments)

Standard Organization	Standard Title
American Petroleum Institute (API)	Specification 5L "Specification for Line Pipe" (41st edition, 1995)
	Specification 6D "Specification for Pipeline Valves (Gate, Plug, Ball, and Check Valves) (21st edition, 1994)
	Standard 1104 "Welding of Pipelines and Related Facilities" (18th edition, 1994)
	Standard 650 – "Welded Steel Tanks for Oil Storage" (9th edition, July 1993)
	Standard 651 – "Cathodic Protection of Aboveground Petroleum Storage Tanks" (2nd edition, December 1997)
	Standard 653 – "Inspection of Aboveground Storage Tanks" (2nd edition, December 1997)
	Standard 2000 – "Venting Atmospheric and Low Pressure Storage Tanks" (4th edition, September 1992)
	Standard 2003 – "Protection Against Ignitions Out of Static, Lightning, and Stray Currents" (6th edition, December 1998)
	Standard 2350 – "Overfill Protection for Storage Tanks in Petroleum Facilities" (2nd edition, January 1996)
American Society of Mechanical Engineers (ASME)	B16.9 "Factory-Made Wrought Steel Buttwelding Fittings" (1993)
	B31.4 "Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols" (1992 edition)
	B31.8 "Gas Transmission and Distribution Piping Systems" (1995)
	B31G "Manual for Determining the Remaining Strength of Corroded Pipelines" (1991)
	Boiler and Pressure Vessel Code, Section IX "Welding and Brazing Qualifications" (1995)
	Manufacturers Standardization Society of the Valve Fittings Industry (MSS) SP-75 "Specification for High Test Wrought Butt Welding Fittings" (1993)
	Boiler and Pressure Vessel Code, Section VIII, Division 1 and 2 Pressure Vessels (1995)
American Society for Testing and Materials (ASTM)	A 53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded
	A 106 "Standard Specification for Seamless Carbon Steel Pipe for High Temperature
	A 333/A 333M "Standard Specification for Seamless and Welded Steel Pipe for Low-
	A 381 "Standard Specification for Metal-Arc Welded Steel Pipe for Use with High-Pressure Transmission Systems (1993)
	A 671 "Standard Specification for Electric-Fusion-Welded Steel Pipe for Atmospheric and
	A 672 "Standard Specification for Electric-Fusion-Welded Steel Pipe for High-Pressure Service at Moderate Temperatures" (1994)
	A 691 "Standard Specification for Carbon and Alloy Steel Pipe, Electric-Fusion-Welded for High-Pressure Service at High Temperatures" (1993)
American Gas Association (AGA)	Pipeline Research Committee, Project PR-3-805 "A Modified Criterion for Evaluating the Remaining Strength of Corroded Pipe," (December 1989)

[a] A full listing is contained within 49 CFR 195 (1998 edition)

Table 5-15. Summary of ASME B31.4 and API 1129 Topics Not Explicitly Addressed in Longhorn System of Operating Manuals

Industry Standard	Issue	Comments[a]
ASME B31.4 – 437.6.2	Bending properties	Did not find explicitly addressed in the manuals reviewed.
ASME B31.4 – 437.6.4	Determination of weld joint factor for unknown weld joints	Did not find explicitly addressed in the manuals reviewed.
ASME B31.4 – 450.1 (b) and (c)	Operating and Maintenance procedures for specific facilities and local conditions	Longhorn pipeline system not specifically addressed in the current WES operating manuals. Manuals being modified to be specific to Longhorn.
ASME B31.4 – 451.7	Derating a pipeline to a lower operating pressure	Did not find explicitly addressed in the manuals reviewed.
ASME B31.4 – 460(e)	Training and equipping of coating crews and inspectors	Training and equipment associated with coating is a design and construction issue or handled through maintenance, coating contracts.
ASME B31.4 – 461.1.2(h)	Coating applied to attachments	Did not find explicitly addressed in the manuals reviewed.
ASME B31.4 – 461.1.3(b)	Installation of cathodic protection system	Did not find explicitly addressed in the manuals reviewed. This topic is discussed in WES design/ construction procedures.
ASME B31.4 – 461.1.3(d)	Notification of owners of underground structures which may be affected by cathodic protection	Did not find explicitly addressed in the manuals reviewed.
ASME B31.4 – 461.1.4	Electrical isolation	NACE RP-01-77 not referenced
ASME B31.4 – 461.1.6	Electrical interference	NACE RP-01-77 not referenced

Table 5-15. (Continued)

Industry Standard	Issue	Comments[a]
ASME B31.4 – 461.3(c)	Testing schedule based on specific conditions	Testing schedules provided in Longhorn Mitigation Plan (LMP).
API 1129 – 2.4	Pipeline routing based on formalized risk assessment /management	Pipeline route already established. Alternate route evaluations were based on a variety of factors, including environmental issues.
API 1129 – 4.3.1	Annual monitoring of cathodic protection levels	Isolation flanges not explicitly addressed. Other monitoring done on annual or semiannual schedule.
API 1129 – 5.2	Risk assessment	Qualitative Risk Assessment Model will be maintained with current information, as described in the LMP.
API 1129 – 5.3	Hydrostatic testing effectiveness, testing programs, and implementation	Did not find explicitly addressed in the manuals reviewed. Periodic hydrostatic testing is included in the Operational Reliability Assessment (ORA) of the LMP.
API 1129 – 5.4	Internal inspection – anomaly characterization, frequency of inspection, inspection capabilities, and operating considerations	Periodic inline inspection is included in the ORA of the LMP.
API 1129 – 5.5	Tank integrity	Addressed in construction documentation and commitments.
API 1129 – 5.6.2	Audits	Longhorn will conduct an annual self audit as part of the Longhorn Pipeline System Integrity Program (LPSIP).
API 1129 – 5.6.3	Failure analysis	Not explicitly addressed in the manuals reviewed. The LPSIP incorporates a formal Incident Investigation Program that includes root cause analyses.

[a] The manuals also incorporate various industry standards by reference, in which some of these topics would be explicitly addressed.
LMP refers to the Longhorn Mitigation Plan, see Chapter 9.

Table 5-16. Comparisons of Key Issues with Regulations, Codes, and Industry Practices

Topic	Issue	Industry Practice API 1129	ASME Code B31.4	49 CFR	Longhorn Manual Section[a]
General	Compliance Inspections	2.6, 5.6.2	Not Addressed	190.203	OP-19.1 to 19.9
	Records and Documentation	2.7, 3.4.6	437.7, 455, 465	195.266, 195.310, 195.404	OP-A.1
	Reviews and Analysis	5.2, 5.6	450.2(d)	195.402, 195.403	OP-18.22, OP-19.3
	Manpower Issues for O&M	Note c	Note c	Note c	Note b
	Contractor Management	2.5	Not Addressed	Not Addressed	LIMS
	Reporting Accidents and Safety Related Concerns	Not Addressed	Not Addressed	195.55, 195.56	OP-6.23, OP-20
Integrity Assessment	System Monitoring and Controls	3	434.20.6, 452.2, 461.3, 462.3, 463.3	195.402(c)(8,9) 195.426, 195.428	Operating Control Manual
	System Inspection and Review	5	VI	195.412, 195.414 (b),(c), 195.416, 195.418(c),(d), 195.428, 195.432	OP-4.1 to 4.2, OP-6.22 to 6.26, OP-19.2
	Risk Assessment	5.2	Note c	Note C	Mitigation Plan
	Failure Analysis	5.6.3	450.2(f)	195.50, 195.52, 195.54, 195.55, 195.402	Cause and Effect Diagram, Supervisors Accident Investigation Handbook, OP-20.1 to 20.21
	Fatigue Monitoring	Not Addressed	Note c	Note c	Mitigation Plan
	Hydrostatic Testing	5.3	437.4.1, 437.4.3	Subpart E	Note b
Design/ Construction	Design/Construction Issues for Integrity Assurance	2	Chapters II, III, IV and V	Subpart C	Addressed in construction project documentation.
	Welds and Welding Inspection: Standards of Acceptability	--	434.8.4, 434.8.5	195.214, 195.228, 195.230, 195.234	Welding Manual WPL 103, 104, MP, PT-1, UT-1, UT-2, UT-3
	Repair/Construction with specific regard to Environ-mental Protection	2.4	Note c	Note c	Note b
Leak Detection	Leak Detection	3.3	451.5	195.412	Note b
	Computational Pipeline Monitoring	3.3.1	Note c	195.444	Note b
	Station/Terminal Sensors	3.3.2	Note c	Note c	Note b

Table 5-16. (Continued)

Topic	Issue	Industry Practice API 1129	ASME Code B31.4	49 CFR	Longhorn Manual Section[a]
Corrosion Control	Corrosion Control	4	453, Chapter VIII	195.414, 195.416, 195.418	OP-6.51 to 6.57, OP-15.1 to 15.16
	Coating Systems	4.1.4, 4.2	461.1.1(b), 461.1.2	195.238 195.416(i)	OP-6.54 to 6.56, MC-7.19
	Coating System Evaluations	4.2.1, 4.2.2	461.1.2(c)	195.416(e)	Incorporated within visual inspections and mitigation plan.
	Routine External Corrosion Control	4.3	461	195.236, 195.414, 195.416	OP-6.51
	Corrosion Monitoring	4.1.2, 4.3.1	461.3, 462.3, 463.3	195.416	OP-6.52, OP-6.54, OP-6.58
	Rectifier Inspection	4.3.2	461.3	195.416	OP-6.54, CBT Module #20
	Other Corrosion Inspections	4.3.3	461.3	195.416	OP-6.56
	Close Interval Survey (CIS)	4.3.4	461.3	195.414	OP-6.53, -6.54, MCOJT 2.03
	Internal Corrosion Monitoring/Control Methods	4.4	462	195.418	OP-6.58, OP-15.1 to 15.16
	Correlation of In-Line Inspection and Close Intervals Surveys	5.4.7	Note c	Note c	Note b
Corrosion and Mechanical Damage	Internal Inspection	5.4	Note c	195.120	OP-6.58, OP-6.76
	Anomaly Characterization	5.4.2	Note c	Note c	OP-6.58
	Frequency of Internal Inspection or Inspection Planning	5.4.3	Note c	195.418(c),(d)	OP-6.58
	In-Line Inspection Capabilities	5.4.4	Note c	195.120	OP-6.58
Damage Prevention	Damage Prevention	6	451.3, 451.5	195.442	OP-6.11,OP-6.22 to 6.25
	One-Call Systems	6.2.1	Note c	195.442	OP 6.13, MCOJT 2.18
	Aerial Surveillance	6.2.2	451.5	195.412	OP 6.13, OP-6.22 to 6-25, OP-19.5
	Ground Surveillance	6.2.3	451.5	195.412	OP 6.22 to 6-25
	Facility Marking and Maintenance	6.3	451.3, 451.4	195.410	SA 2.1 to 2.11, OP-10.2 to 10.5

Table 5-16. (Continued)

Topic	Issue	Industry Practice API 1129	Code ASME B31.4	49 CFR	Longhorn Manual Section[a]
Damage Prevention (continued)	Right of Way (ROW) and Facility Marking/Pipeline Markings	6.3.1	451.3	195.410, 195.434	OOJT; OP 6.34, 6.35; MCOJT 2.08
	Encroachment Mitigation	6.3.3	450.2(e)	195.442	MCOJT 2.17
	Public Education and Communication	6.4	450.2(e)	195.402, 195.440	OP 6.7 to 6.14, MCOJT 2.18
	Depth of Cover	Note c	434.6(a)	195.248, 195.410	OP 6.11, OP-6.13
	Response Time	Note c	454	Addressed through One-Call requirement	Note b
Maintenance Issues	Routine Maintenance	Note c	451	195.402	MC
	ROW Maintenance	6.3.2	451.4	Not directly addressed. Inspections called for in 195.412	MCOJT 2.16
	Exposed Pipe/Depth of Cover	Note c	463	195.416 (i)	Note b
	Pipe Crossings	Note c	451.9	195.412	Note b
	Pipe Casings	Note c	451.9	Note c	Note b
	Valves	Note c	451.8	195.42	Note b
	Pumps	Note c	Note c	195.262	Note b
	Instrumentation	Note c	Note c	Not directly addressed. Implied by reference to “safety devices” in 195.262.	Note b
	Tanks	5.5	452.3	195.264, 195.432	OOJT 6.21, O2-FAC-1009
Training	Control Room Staff Training	3.4	450.2(a)	195.403	Reference (Longhorn, 1999)
	Field Staff Training	3.4	450.2(a)	195.403	Reference (Longhorn, 1999)

[a] Key: WES Operations Manuals are as follows:

- OP - Operating Manual (RAD 20085)
- PM - Preventative Maintenance (RAD 20090)
- WM - Welding Manual (RAD 20102)
- SA – Safety (RAD 20127)
- OOJT - Operator On-the-Job Training Program (RAD 20139)
- MCOJT - Maintenance Crew On-the-Job Training Program (RAD 20143)
- CHC - Chemical Hazard Communication (RAD 20162)
- CH - Chemical Hygiene Plan (RAD 20168)
- MC - Maintenance and Calibration (RAD 20196)
- ME – Measurement (RAD 20200)

[b] Specific manual sections did not explicitly discuss topic as an entity. Issue is recognized by incorporation within other procedures or specific projects or programs. The latter applies, for example, to exposed pipe and depth of cover.

[c] Specific topic may be addressed indirectly in other topical area in some cases.

Table 5-17. Longhorn Partners Pipeline, Cathodic Protection Recommendations, April 20, 1999

Beginning Station (ft)	End Station (ft)	Total Length (ft)	Failing Length[1] (ft)	Required mA[2]	Rectifier/ groundbed system locations[3] (ESN/MP)	Stray Current Interference Testing Locations (ESNs)[4]	Magnesium Anode Installations and Reconditioning Locations (ESN From-To)
212,143	330,370	118,025	90	55	none required	none required	212,141 - 212,244, 330,320 - 330,370, 286,345 - 286,395
617,474	618,149	675	135	76	617,084	none required	none required
660,949	708,449	90,975	285	165	none required	none required	660,947 - 661,299, 7089,324 - 708,374
855,099	894,396	39,297	4,302	2,440	859,124	none required	none required
1,048,499	1,089,599	41,150	20	15	none required	none required	1,048,447 - 1,048,599, 1,089,524 - 1,089,599
1,183,799	1,392,924	209,125	2,080	1,180	1,282,324	1,200,615	none required
1,420,724	1,496,974	76,250	3,685	2,090	1,434,264	none required	none required
1,575,074	1,62,074	87,000	6,470	3,660	1,562,204, 1,640,224	none required	none required
1,688,824	1,752,649	63,825	1,765	1,000	none required	1,711,817, 1,727,988, 1,752,470	none required
1,765,124	1,839,873	74,750	6,505	3,680	1,835,923	1,811,313, 1,816,978, 1,818,133, l,818,973, 1,819,821	none required
1,840,973	1,862,223	18,375	10,685	6,050	1,843,423	1,842,913, 1,850,125, 1,851,025, 1,857,858, 1,857,975	none required
1,879,903	1,913,423	33,520	3,370	1,910	1,898,173	1,895,752	none required
1,916,321	1,965,372	49,052	1,020	580	1,949,702	1916320, 1926472	none required
1,992,822	2,066,196	73,375	1,990	1,125	2,000,865	none required	none required
2,086,346	2,096,346	10,000	1,035	590	2,097,221	2,086,578, 2,095,795	none required
2,096,796	2,131,121	34,325	4,773	2,700	2,116,600	1,687,774, 2,106,717[5]	none required

Notes: 1. Length that fails to meet the -0.85v criterion.
2. Amount of electrical current that would bring area to protective level.
3. Rectifier/groundbed system that would increase current levels between existing rectifiers and achieve adequate CP levels.
4. Testing to determine requirements of foreign bonds that would supply additional current to the Longhorn line or magnesium anode installations.
5. Station listed as testing location but outside area. Verify with Longhorn.

Table 5-18. Leak Detection and Response Time

Flow Deviation Detected, % of Total Flow	Detection Method	Detection Time	Verification + Response Time	72,000 BPD Case		225,000 BPD Case	
				Leak Rate, bbl/min	Leak Volume, bbl	Leak Rate, bbl/min	Leak Volume, bbl
6 - 100	Alarm, notification that monitored pressures and flow rates are greater or less than 8% and/or 6%, respectively, of set points	5 seconds	5 minutes	3 - 50	15 - 254	9.4 - 156	47 – 795
<6 - 0.6	Mass balance/meter discrepancy	2 hours	30 minutes - 2 hours	0.3 - 3	72 – 720[1]	0.9 - 9.4	225 - 2,250[1]
<0.6 - 0.3	Mass balance/meter discrepancy	4 hours	2 hours	0.15 - 0.3	54 – 108[2]	0.47 - 0.9	169 – 338[2]
<0.3	Physical observation	---[3]	---[3]	<0.15	---[3]	<0.47	---[2]

[1] Assumes 4 hours to detect, verify, and respond to leak.
[2] Assumes 6 hours to detect, verify, and respond to leak.
[3] These items are not directly applicable to visual observation through patrolling, for example.
Note: See also Appendix 6D

Table 5-19. Number of Pumps, Valves, and Flanges at Longhorn Pipeline Stations

Station	72,000 BPD Case[1] Liquid Product Service				125,000 BPD Case[2] Liquid Product Service				206,000 - 225,000 BPD Case[3] Liquid Product Service			
	Mainline Pumps	Motor HP	Valves, >2-inches	Flanges, > 2-inches	Mainline Pumps	Motor HP	Valves, >2-inches,	Flanges, > 2-inches	Mainline Pumps	Motor HP	Valves, >2-inches	Flanges, > 2-inches
Galena Park	2	2@1000	17	86	2	2@1000	17	86	2	3000 total	17	86
Satsuma	1	3000	19	71	1	3000	19	71	1	4000	19	71
Buckhorn	---		---	---	---		---	---	---[5]	4500	10	48
Warda	---		---	---	---[5]	3000-4000	10	48	---[5]	4500	10	48
Bastrop	---		---	---	---		---	---	---[5]	4500	10	48
Cedar Valley	2	2@1000	10	48	2	2@1000	10	48		4500 total	10	48
Orotaga	---		---	---	---		---	---	---[5]	3500	10	48
Eckert	---		---	---	1	1 @ 4500	8	42	1	4000	8	42
Llano	---		---	---	---		---	---	---[5]	4500	10	48
Kimble County	2	2@1000	10	48	2	2@1000	10	48	2	4500 total	10	48
Cartman	---		---	---	---		---	---	---[5]	5000	10	48
Olson	---		---	---	---		---	---	---[5]	5000	10	48
Big Lake	---		---	---	---[5]	3000-4000	10	48	---[5]	5000	10	48
Crane (to El Paso)	2	4500	61	227	2	4500	61	227	2	5500	85	310
Crane (to Odessa)		1000				1000				1000		
Pecos	---		---	---	---		---	---	---[5]	5000	10	48
Utica	---		---	---	---		---	---	---[5]	5000	10	48
Cottonwood	---		---	---	---[5]	4000-5000	10	48	---[5]	5000	10	48
Harris	---		---	---	---		---	---	---[5]	5000	10	48
El Paso	3		346[4]	1256[4]	3		---[6]	---[6]	3	---[6]	---[6]	---[6]
El Paso/Chevron 8"		1500				1500				---[6]		
El Paso/Santa Fe 8"		1250				1250				---[6]		
El Paso/Santa Fe 12"		3000				3000				---[6]		

[1] Based on counts from P&ID Flow Schematics from WES.
[2] Extended from 72,000 BPD Case + description of new stations in Longhorn Pipeline Project Description.
[3] Estimated - based on projections from Longhorn Pipeline Project Description.
[4] Based on El Paso terminal permits.
[5] For fugitive emissions estimates in Chapter 7, two pumps were assumed for these stations. Number of pumps will be determined in final design.
[6] Will be determined in final design.

Table 5-20. Valve Locations and Types for the Longhorn Pipeline

Longhorn Mileage	Valve Location	Valve Type
0.0	Galena Park Station	Remote-Controlled Block Valve
5.34	GS-2	Manual Block Valve
7.46	GS-3	Manual Block Valve
11.99	Mesa Boulevard	Remote-Controlled Block Valve
21.3	GS-6	Manual Block Valve
34.09	Satsuma Station – Incoming	Remote-Controlled Block Valve
34.14	Satsuma Station - Outgoing	Remote-Controlled Block Valve
63.65	Brazos River – East	Remote-Controlled Block Valve
64.08	Brazos River – West	Check Valve and Manual Block Valve
112.88	Warda Station	Locally Motor-Operated Block Valve
112.88	Warda Station	Bypass Check Valve
112.96	Warda Station	Manual Block Valve
134.0	Colorado River	Remote-Controlled Block Valve
134.67	Colorado River	Check Valve and Manual Block Valve
166.66	Edwards Aquifer - East	Remote-Controlled Block Valve
175.5	Edwards Aquifer - West	Remote-Controlled Block Valve
181.6	Cedar Valley Station	Remote-Controlled Block Valve
181.6	Cedar Valley Station	Bypass Check Valve
181.67	Cedar Valley Station	Manual Block Valve
198.68	Pedernales River	Remote-Controlled Block Valve
198.94	Pedernales River	Check Valve and Manual Block Valve
211.90	SE-13	Manual Block Valve
227.79	Eckert Station	Remote-Controlled Block Valve
227.79	Eckert Station	Bypass Check Valve
228.02	Eckert Station	Manual Block Valve
276.48	Llano River	Remote-Controlled Block Valve
276.64	Llano River	Check Valve and Manual Block Valve
288.91	SE-18	Manual Block Valve
295.12	Kimble County Station	Remote-Controlled Block Valve
295.12	Kimble County Station	Bypass Check Valve
295.25	Kimble County Station	Manual Block Valve
321.95	Old Fort McKavett Station	Manual Block Valve
358.70	SE-22	Manual Block Valve
373.47	Big Lake Station	Manual Block Valve
373.47	Big Lake Station	Manual Block Valve

Table 5-20. (Continued)

Longhorn Mileage	Valve Location	Valve Type
416.6	West of Kemper (SE-25)	Manual Block Valve
457.55	Crane Station - Incoming	Remote-Controlled Block Valve
457.55	Crane Station – outgoing to El Paso	Remote-Controlled Block Valve
457.55	Crane Station – outgoing to Odessa	Remote-Controlled Block Valve
492.26	SE-26A	Manual Block Valve
523.63	SE-27A	Manual Block Valve
526.07	SE-28	Manual Block Valve
555.1	SE-29	Manual Block Valve
576.32	Cottonwood Station	Manual Block Valve
576.33	Cottonwood Station	Remote-Controlled Block Valve
607.10	SE-32	Manual Block Valve
638.86	SE-33	Manual Block Valve
668.37	SE-34	Manual Block Valve
694.41	El Paso Station	Remote-Controlled Block Valve

Table 5-21. Emergency Response Compliance Summary

Regulation	Apparent Overall Compliance Status	Enhancement Opportunities
49 CFR Part 194	In compliance	1. Although covered generally in the FRP Vol. I, there are no specific sections covering training, equipment testing, or drills for each response zone in Vol. II. 2. A Plan Distribution List is referred to in the FRP, but it was not included in the copy reviewed.
49 CFR §195.402	In compliance	
OSHA HAZWOPER (29 CFR §1910.120)	In compliance	1. Safety Officer responsibilities do not specifically include the authority to stop or change work when facing an IDLH or imminent danger. 2. Responsibilities for the Repair and Environmental Group Leaders mention decontamination, but no procedures are documented.
TNRCC Spill Prevention and Control (Chapter 327)	In compliance	
Oil Pollution Act of 1990 33 USC 1321(j)	In compliance	
API Recommended Practice 1129	In compliance (with ER guidelines)	
ANSI B31.4 Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia and Alcohols	In compliance	The Facility Response Plan refers to participation in "One Call" services, but the specific numbers for those services are not included in notifications.

Table 5-22. Comparison of EPC Spill Counts History by Data Source

Sources	Mainline + Pump Station		Mainline Only		Pump Station Only	
	Any Size	≥ 50 bbls	Any Size	≥ 50 bbls	Any Size	≥ 50 bbls
FDWBC	170	57	26	10	144	46
Incident Report Forms	113	43	10	9	70	33
Kiefner	23	9	23	9	0	0
Deaver	0	26	0	8	0	18
RCT H-8	N/A	N/A	N/A	N/A	N/A	N/A
Cumulative Database	173	58	26	10 [a]	147	48[b]

[a] Of the 10 mainline leaks, 9 were referenced in the incident forms and 1 (1 of the 10 FDWBC leaks were not identified by forms) came from FDWB leaks table.

[b] Of the 48 pump station leaks, 33 were referenced in the incident forms and 15 (15 of the 46 FDW BC leaks were not identified by forms) came from FDWB leaks table.

Table 5-23. EPC Pipeline and Pump Station Spill Data

Leak or Spill Size (Barrels)	Pipeline and Pump Station Combined Spill Counts		Pipeline Spills		Pump Station Spills	
	Historical Number	Normalized Frequency (No./mile/yr)	Historical Number	Normalized Frequency (No./mile/yr)	Historical Number	Normalized Frequency (No./stn/yr)
> 5,000	4	3.07E-04	1	7.66E-05	3	1.29E-02
1,500 – 4,999	6	4.60E-04	2	1.53E-04	4	1.72E-02
500 – 1,499	11	8.43E-04	4	3.07E-04	7	3.02E-02
50 - 499	37	2.84E-03	3	2.30E-04	34	1.47E-01
0 - 49	115	8.81E-03	16	1.23E-03	99	4.27E-01

Table 5-24. EPC Pipeline System Spills ≥ 50 Barrels

No.	Spill Date	District	County Name	Location	Facility	Barrels Lost	Barrels Recovered	Net Barrels Lost	Cause of Loss	Remedy
1	2/22/1971	8	Crane	SEC 216,BLK F,CCSD, Crane Station	Pump Station	50	30	20	Cut station pipeline to revise system	Installed Revised system
2	6/29/1969	7C	Reagan	Sec.11 and 14, Univ. Lands, Kemper Station	Pump Station	60	Unknown	Unknown	Unknown	Unknown
3	5/1/1974	1	Bastrop	THOS.THOMPSON A-65,14591+20	Pipe Line	60	54	6	Corrosion	Repaired existing equipment
4	3/13/1980	8	Crane	216,F.CCSD&RGNG RR, Crane Station	Pump Station	65	60	5	Metal Fatigue	Repaired existing equipment
5	3/1/1988	8	Crane	SEC 201 BLK F, Crane Station	Pump Station	70	40	30	Corrosion	Repaired existing equipment
6	3/1/1970	7C	Reagan	Sec.11 and 14, Univ. Lands, Kemper Station	Pump Station	72	Unknown	Unknown	Oil loss due to cutting lines to connect new pump	Unknown
7	2/8/1971	8	Crane	SEC 216,BLK F,CCSD, Crane Station	Pump Station	80	0	80	4" strainer ruptured	Strainer replaced
8	9/8/1973	8	Crane	216,F,CCSD&RGNG RR	Pump Station	80	40	40	Corrosion	Repaired existing equipment
9	11/6/1981	7C	Reagan	BLK 11, SEC.14,UL, Kemper Station	Pump Station	80	65	15	Equipment failure (check valve body cracked)	Replaced check valve
10	10/3/1968	7C	Reagan	Sec.11 and 14, Univ. Lands, Kemper Station	Pump Station	86	Unknown	Unknown	Unknown	Unknown
11	7/8/1969	7C	Reagan	Sec.11 and 14, Univ. Lands, Kemper Station	Pump Station	100	Unknown	Unknown	Unknown	Unknown
12	2/24/1971	8	Crane	SEC 216,BLK F,CCSD, Crane Station	Pump Station	100	85	15	Cut station pipeline to revise system	Installed revised system
13	6/5/1982	3	Harris	Satsuma Station	Pump Station	100	97	3	Unknown	Unknown
14	6/10/1981	7C	Reagan	BLK 11, SEC.14,UL, Kemper Station	Pump Station	115	20	95	Incorrect Operation led to overpressure at dresser coupling	Replaced dresser coupling
15	6/24/1970	8	Crane	SEC 216,BLK F,CCSD, Crane Station	Pump Station	120	92	28	Unknown	Unknown
16	2/24/1987	8	Crane	SEC. 216, BLK. "F," Crane Station	Pump Station	125	85	40	Equipment failure (valve failure)	Repaired existing equipment

Table 5-24. (Continued)

No.	Spill Date	District	County Name	Location	Facility	Barrels Lost	Barrels Recovered	Net Barrels Lost	Cause of Loss	Remedy
17	3/1/1971	8	Crane	SEC 216,BLK F,CCSD, Crane Station	Pump Station	145	135	10	Drained line to replace gate valves and pipe	Gate valves and 170' pipe replaced
18	12/30/1969		Schleicher	Fort McKavett Station	Pump Station	150	0	150	Pump seal failure	Unknown
19	2/23/1973	8	Crane	SEC 216,BLK F,CCSD	Pump Station	150	125	25	Equipment failure	Installed new equipment
20	3/22/1971	8	Crane	SEC 216,BLK F,CCSD, Crane Station	Pump Station	151	100	51	Drained line to install new piping	Installed new pipe
21	5/22/1979	1	Gillespie	NW/4 233,A738,WOODS, Eckert Station	Pump Station	153	65	88	Unknown event led to valve closure and subsequent build up of pressure on line	Installed pipe
22	7/6/1971	8	Crane	SEC 216,BLK F,CCSD, Crane Station	Pump Station	160	140	20	Oil lost when valve replaced	Installed new valve
23	9/26/1968	7C	Reagan	Sec.11 and 14, Univ. Lands, Kemper Station	Pump Station	168	Unknown	Unknown	Unknown	Unknown
24	12/14/1971	8	Crane	SEC 216,BLK F,CCSD, Crane Station	Pump Station	170	165	5	Oil lost when cut to make permanent repairs	Made repairs
25	4/8/1970	7C	Reagan	Sec.11 and 14, Univ. Lands, Kemper Station	Pump Station	200	150	50	Loss due to drainage for repairs	Unknown
26	6/19/1981	7C	Reagan	BLK 11, SEC.14,UL, Kemper Station	Pump Station	222	170	52	Other (tank drain hose developed hole)	Replaced hose
27	1/24/1982	1	Bastrop	Bastrop Station	Pump Station	225	120	105	Equipment failure (gasket failed on check valve)	Replaced check valve
28	3/16/1971	8	Crane	SEC 216,BLK F,CCSD, Crane Station	Pump Station	235	185	50	Drained line to install new piping	Installed new pipe
29	12/25/1979	7C	Reagan	14,11,UNIV.LD., Kemper Station	Pump Station	245	230	15	Metal fatigue	Replaced cooling line tubing
30	8/10/1986	3	Harris	Satsuma Station	Pump Station	280	278	2	Corrosion	Repaired existing equipment
31	9/4/1979	8	Crane	216,F,CCSD&RGNG RR, Crane Station	Pump Station	325	280	45	Equipment Failure (valve failure led copper tubing to fail)	Replaced tubing

Table 5-24. (Continued)

No.	Spill Date	District	County Name	Location	Facility	Barrels Lost	Barrels Recovered	Net Barrels Lost	Cause of Loss	Remedy
32	10/3/1980	3	Harris	Satsuma Station	Pump Station	340	320	20	Age of tank drain hose	Replaced hose
33	9/3/1984	3	Harris	Satsuma to Moore, 328+51	Pipe Line	350	325	25	Heavy equipment damage weakened pipeline	Replaced pipeline
34	8/5/1971	8	Crane	SEC 216,BLK F,CCSD, Crane Station	Pump Station	400	373	27	Oil lost when gate valve replaced	Installed new valve
35	4/21/1983	3	Harris	Satsuma Station	Pump Station	430	410	20	Corrosion	Repaired pipeline
36	8/30/1991	7C	Kimble	62,B.S.& F SVY, 5209+08	Pipe Line	465	415	50	Bulldozer punctured pipeline	Installed new pipe
37	9/18/1973	8	Crane	216, F, CCSD&RGNG	Pump Station	475	455	20	Unknown	Repaired existing equipment
38	11/13/1976	8	Crane	SE/4,216,F,CCSD&RGN	Pump Station	500	400	100	Equipment failure (check valve broke)	Installed new check valve
39	10/1/1991	7C	Kimble	SEC-232 DAVIS,W F H, 9488+40	Pipe Line	650	592	58	Bulldozer punctured pipeline	Installed new pipe
40	9/3/1979	1	Gillespie	NW/4 233,A738,WOODS, Eckert Station	Pump Station	760	685	75	Equipment failure (gasket failed on Check valve)	Repaired existing equipment
41	9/11/1982	7C	Reagan	BLK 11, SEC.14,UL, Kemper Station	Pump Station	900	90	810	Corrosion	Repaired tank
42	11/12/1969	3	Harris	20" Satsuma to Moore Pipeline	Pipe Line	1000	800	200	Unknown	Unknown
43	8/2/1975	7C	Reagan	11, 11, UNIV	Pump Station	1000	820	180	Corrosion	Repaired existing equipment
44	6/28/1978	7C	Reagan	S 1/2 11,11,UNIV.LD, Kemper Station	Pump Station	1085	1040	45	Incorrect operation led to excessive pressure on pipe fitting	Repaired existing equipment
45	10/27/1979	1	Travis	THEODOR BISSELL LGE, 12440+79	Pipe Line	1100	980	120	Backhoe punctured pipeline	Replaced damaged pipeline
46	8/5/1987	1	Travis	Eckert to Bastrop, 12305+41	Pipe Line	1150	1137	13	Ditching machine punctured line	Replaced pipeline
47	5/20/1981	7C	Reagan	14,11,UNIV.LD., Kemper Station	Pump Station	1160	1060	100	Corrosion	Repaired tank bottom

Table 5-24. (Continued)

No.	Spill Date	District	County Name	Location	Facility	Barrels Lost	Barrels Recovered	Net Barrels Lost	Cause of Loss	Remedy
48	3/15/1977	1	Gillespie	NW/4 233,A738,WOODS, Eckert Station	Pump Station	1400	1185	215	Corrosion	Replaced fitting
49	1/26/1993	3	Harris	A-655 S C RICE, Satsuma Station	Pump Station	1825	1800	25	Corrosion	Repaired tank
50	5/21/1980	7C	Upton	182 E CCSD&RGNG, 2484+31	Pipe Line	2309	1320	989	Dozer punctured pipeline	Replaced pipeline
51	10/11/1976	1	Travis	M GREEN A314,13218+75	Pipe Line	2761	2100	661	Dozer punctured pipeline	Repaired line
52	5/4/1979	7C	Reagan	S 1/2 11,11,UNIV.LD, Kemper Station	Pump Station	2971	0	2971	Corrosion	Repaired tank bottom
53	11/25/1973	3	Harris	Satsuma Station	Pump Station	4125	4100	25	Corrosion	Installed new equipment
54	12/29/1967	1	Bastrop	Bastrop Station	Pump Station	4750	0	4750	Unknown	Unknown
55	8/21/1968	3	Harris	Satsuma Station	Pump Station	5550	Unknown	Unknown	Unknown	Unknown
56	9/6/1969	7C	Reagan	Sec.11 and 14, Univ. Lands, Kemper Station	Pump Station	8550	Unknown	Unknown	Equipment failure (meter controlling flows to two tanks failed resulting in overflow)	Installed new meters
57	4/22/1977	7C	Reagan	SE/4 11,11,UNIV.LDS, Kemper Station	Pump Station	10500	10300	200	Other (defective pipe)	Repaired split pipeline
58	5/4/1979	7C	Kimble	163,J.D.NAPP SUR., 6614+00	Pipe Line	25224	8730	16494	Incorrect operation led to an operational upset which led to a 65" long longitudinal seam weld failure	Repaired/replaced pipeline

Table 5-25. Number Profile of Spills at EPC Pump Stations

Cause	Spill Volume				
	> 5000[a] bbl	5000 – 500 bbl	500 –50 bbl	< 50 bbl	Total
Outside Forces	0	0	0	0	0
Corrosion	0	7	4	15	26
Equipment Failure(metal fatigue, seal, gasket, age, weld)	1	2	10	16	29
Incorrect Operation	0	1	1	1	3
Unknown	0	0	1	0	1
Repair/Install	0	0	9	2	11
Other	0	0	2	2	5
Not Listed	1	1	6	61	69
Seam Split	1	0	0	0	0
Power Failure	0	0	0	3	3
Total Number	3	11	34	99	147
% of Total	2	7.5	23.1	67.4	100

[a] Individual Spill Summary

- 10,500-barrel spill on 4/22/77. Cause listed as defective pipe
- 8,550-barrel spill on 9/6/69. Cause listed as failure of meter controlling flow to tank, causing tank overflow
- 5,550-barrel leak on 8/28/68. Cause not listed

Table 5-26. Size Profile of Spills at EPC Pump Stations

Cause	Volume of Spills (bbl)				
	> 5000[a]	5000 - 500	<500 –50	< 50	Total
Outside Forces	0	0	0	0	0
Corrosion	0	13,380	800	206	14,386
Equipment Failure(Metal fatigue, seal, gasket, age, weld)	8,550	1,260	1,785	228	11823
Incorrect Operation	0	1,085	115	4	1,204
Unknown	0	0	353	0	353
Repair/Install	0	0	1,683	32	1,715
Other	0	0	697	8	705
Not Listed	5,550	4,750	34	725	11,059
Seam Split	10,500	0	0	0	10,500
Power Failure	0	0	0	58	58
Total Volume	24,600	20,475	5,467	1,261	51,793
% of Total Volume	47.5	39.5	10.6	2.4	100

[a] Individual Spill Summary
- 10,500-barrel spill on 4/22/77. Cause listed as defective pipe.
- 8,550-barrel spill on 9/6/69. Cause listed as failure of meter controlling flow to tank, causing tank overflow.
- 5,550-barrel leak on 8/28/68. Cause not listed.

Table 5-27. EPC Spills ≥ 50 Bbl by County (Pipe and Pump Stations)

Counties	No. Incidents	Mileage in County	Spill Rate (Spills/mile-year)
Harris	9	41.13	0.0076
Waller	0	13.72	0.0000
Austin	0	28.80	0.0000
Fayette	0	27.00	0.0000
Bastrop	3	33.74	0.0031
Travis	3	27.84	0.0037
Hays	0	10.09	0.0000
Blanco	0	26.11	0.0000
Gillespie	3	23.56	0.0044
Mason	0	33.25	0.0000
Kimble	3	34.75	0.0030
Menard	0	3.74	0.0000
Schleicher	1	53.53	0.0006
Crockett	0	25.92	0.0000
Reagan	17	28.02	0.0209
Upton	1	33.46	0.0010
Crane	18	5.00	0. 0.1241

Total Spill Rate (spills/mile-year) = 0.0044

Table 5-28. Comparison of Average National Hazardous Liquid Spill Volumes and Frequencies for All Corporate Pipeline and Terminal Operations for Selected Companies[a] (1990-1997)

	Exxon	Williams	Company A[b]	National Average
Pipe Spill Frequency (spills/year/1,000 miles)	0.55	0.71	0.63	0.86
Pipe Spill Volume (bbl/year/mile)	0.44	0.43	0.45	0.70
Pipe and Station Spill Frequency (spills/year/mile)	0.87	1.01	1.10	1.3
Pipe and Stations Spill Volume (bbl/year/mile)	0.62	1.05	0.63	0.94

[a] National data are from DOT for all hazardous liquid pipeline operators

- Pipeline miles for companies is taken from FERC Form 6
- Pipeline miles for National Average is taken from OPS

Source: (Allegro, 1999.)

[b] Company A operates a crude oil pipeline that parallels the Longhorn pipeline.

Table 5-29. Comparison of Common Causes for EPC System and National Averages

Cause	EPC System[a] ≥ 50 Bbl	EPC % of Total	Kiefner[b]	% of Kiefner Total	National Reportable Average (1993-1998)[b]	National % of Total
Outside Forces	7	12.1	7	30.4	49.5	25
Corrosion	12	20.7	2	8.7	49.5	25
Equipment Failure(metal fatigue, seal, gasket, age)	13	22.3	1	4.3	11.88	6
Weld Failure (all welds except longitudinal seam welds)	0	0.0	2	8.7	9.9	5
Incorrect Operation	3	5.2	0	0.0	13.86	7
Unknown	10	17.3	3	13.0	27.72	14
Repair/Install	10	17.3	0	0.0	13.86	7
Other	2	3.4	0	0.0	13.86	7
Seam Split	1	1.7	8	34.8	9.9	5
Total	58	100	23	100	198	100

[a] EPC incidents ≥ 50 barrels includes pipeline and station incidents in this table
[b] As cited by (Johnston, 1999)

Table 5-30. Comparison of EPC Crude Oil Spill Data to National Hazardous Liquids Spill Data (1975 - 1999)

Event Category	EPC Rate ≥50 Bbl	National Crude Oil Reportable Rate	National Refined Products Reportable Rate	National Crude Oil + Refined Products Reportable Rate	Units
Spill Frequency	2.8×10^{-3}	1.1×10^{-3}	6.8×10^{-4}	8.9×10^{-4}	Spills/year/mile
Deaths	0	2.4×10^{-3}	8.6×10^{-3}	4.9×10^{-3}	Deaths/Incidents
Injuries	0	2.0×10^{-2}	6.1×10^{-2}	3.6×10^{-2}	Injuries/Incidents

Table 5-31. Comparison of EPC Crude Oil Spill Data to National Hazardous Liquids Spill Data (1984-1997)

Event Category	EPC Rate ≥ 50 Bbl	National Reportable Rate	Units
Spill Frequency	1.3×10^{-3}	1.3×10^{-3}	Spills/year/mile
Unrecovered Spill Volume	0.30	0.754	Barrels/year/mile
Deaths	0	1.50×10^{-5}	Deaths/year/mile
Injuries	0	1.06×10^{-4}	Injuries/year/mile