Magellan Pipeline Company

FINAL 23-22693-5000387R

2021 Operational Reliability Assessment of the Longhorn Pipeline System

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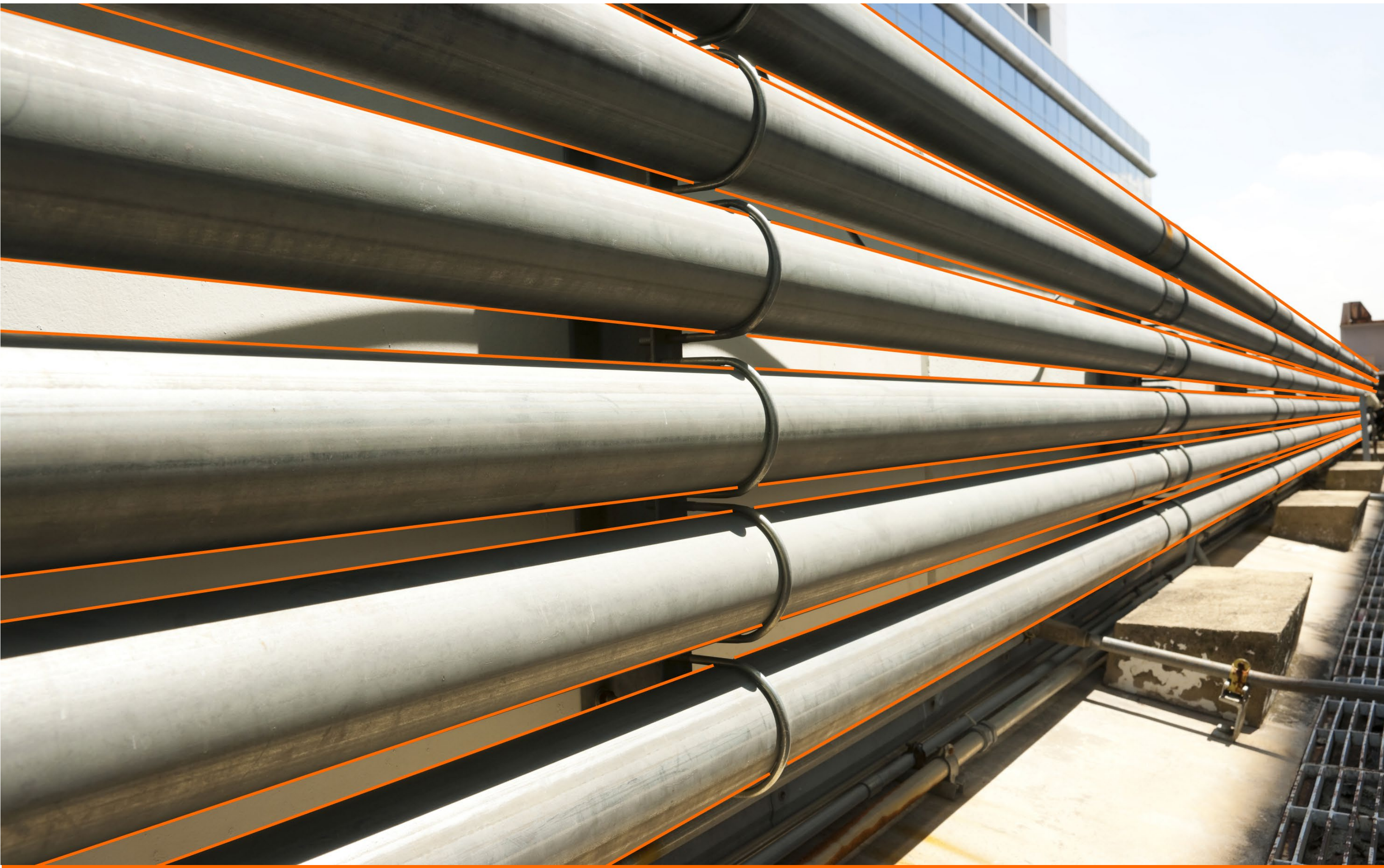
March 30, 2023



ENERGY & INDUSTRY DIVISION

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Final Report

2021 Operational Reliability Assessment of the Longhorn Pipeline System

to

Magellan Pipeline Company

on

March 30, 2023

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EXECUTIVE SUMMARY

This report presents the annual Operational Reliability Assessment (ORA) of the Longhorn Pipeline System for the 2021 operating year. Kiefner and Associates, Inc. (Kiefner) conducted the ORA, which provides Magellan Pipeline Company, L.P. (Magellan) with a technical assessment of the effectiveness of the System Integrity Plan (SIP), its Safety Management System. The technical assessment incorporates results from all SIP elements to evaluate the condition of the Longhorn assets. In addition, recommendations are provided to preserve the long-term integrity and mitigate areas of potential concern.

Kiefner conducted a pressure cycle fatigue analysis of the refined product and crude oil pipeline segments. Based on this analysis, only one pipeline segment has a suggested reassessment due date prior to 2027. The Crane to Texon crude oil segment has a suggested reassessment due date of December 2026.

The 2021 maintenance and non-destructive evaluation (NDE) reports were reviewed and correlated to in-line inspection (ILI) assessments from 2018, 2019, 2020, and 2021 to validate the ILI specified tool performance using the supplied background information and the API 1163 ILI validation methodology. Magellan performed 196 ILI anomaly investigations digs in 2021, which resulted in correlating features at all dig locations. Seventy-seven anomaly investigations targeted crack-like, crack colony, or crack-like inspection sheets, and three additional digs had crack-like features near an anomaly investigation target feature. In all, Magellan inspected 107 ILI-reported crack-like features. In-ditch evaluations confirmed 92 cracks, nine lack of fusion (LOF), four weld geometry features, and one inclusion. Upon in-ditch examination of one ILI identified crack colony, the target anomaly was not found; the targeted joint had two reported crack colonies and three crack-like anomalies, of which four of the features had in-ditch correlations. The in-ditch correlations on the targeted joint were all crack like and no crack colonies were found. Magellan continues conducting field investigations to remediate and validate metal loss.

The corrosion management data have been reviewed, including internal corrosion coupon data, rectifier inspection, test point survey, close interval surveys (CIS), and atmospheric inspections. Internal corrosion coupons show low corrosion rates (≤0.08 mpy). A CIS was performed in March 2021 and received by Magellan in May 2021 for the Tier III pipeline right-of-way (ROW) from Mile Post 11.5931 to 276.8333. Semi-annual surveys are conducted on Tier II and Tier III areas per Longhorn Mitigation Commitment (LMC) 32. Table 19 summarizes the details of the CIS data where the pipe segments are not meeting either a minimum of 100 mV of cathodic polarization or the polarized potential of -850 mV. AC pipe-to-soil voltages were collected during the CIS, showing the highest reading of 4.321 V at Mile Post 170.2953 (Brodie Lane WSD). A remote control unit (RMU) with AC current density monitoring device was installed at this location on May 5th, 2022, showing the AC current density was 2.6 A/m^2. This level of AC current density is not expected to cause AC induced corrosion on the pipe. Atmospheric inspection reports indicate no immediate action is required. Monitoring should continue to identify future potential changes.

Laminations were reviewed concurrently with reported inside diameter (ID) reductions to determine if there were any potential hydrogen blisters on the line segments inspected in 2021. Kiefner compared the 101 ID reductions identified from the 2021 electronic geometry pig (EGP) assessments to laminations reported by the 2009/2010 UT assessments. One dent and seven geometric anomalies (GMA) were present on the same joint as a lamination reported from the 2009/2010 UT assessments. Based on the 2021 maintenance reports, Magellan found 13 laminations during in-ditch inspections; two of the 13 laminations were targeted ILI anomaly features and 11 of the 13 were targeted as external metal loss and found to be laminations. All 11 laminations found in the field were located on joints that had reported laminations from the 2009/2010 UT assessments. Monitoring reported laminations for ID reductions might indicate the initiation of a hydrogen blister. Magellan should continue to monitor for lamination anomalies with ILI tools.

From the standpoint of earth movement and water forces, the primary integrity concerns are ground movement from aseismic faults and soil erosion caused by scouring at water crossings. Our analysis shows that the overall movement rates at six of the seven faults (Akron, Melde, Breen, McCarty, Negyev, and Oates) continue to be slow. The pipeline crossing those faults has more than 100 years[1] to reach the allowable displacement. However, the short-term rate of movements at these faults reveals that they have been more active lately, suggesting close monitoring. In particular, in the past few resurveys, the Akron, Hockley, and McCarty faults show high movement rates. Kiefner recommends continuing the semi-annual surveys of the faults to assess the need for any intervention, if necessary.

A depth-of-cover (DOC) survey was conducted for ten water crossings in 2021, including the crossings: Cypress Creek, Harris Creek, Rocky Branch, Muddy Creek, James River, Threadgill Creek, Onion Creek, Alum Creek, and Boons Creek. Magellan should continue to conduct surveys of these water crossings per the Longhorn Mitigation Plan (LMP) procedures and based on the conditions of the pipe reported on the past surveys. Except for three of the inspected crossings (i.e., Cypress, Harris, and Onion Creeks), the pipelines in all other crossings were partially exposed and, in two cases, suspended. However, the coating on the exposed pipelines was in good condition. Also, signs of erosion were observed on five crossings, including Cypress Creek, Harris Creek, Rocky Branch, Alum Creek, and Boons Creek. No inspection was conducted for the crossing of the Pin Oak Creek with East Houston to El Paso Line since March 2019, which reports partial exposure. Each crossing that has been surveyed and not mitigated is added to the potential re-inspection list. Re-inspections are scheduled every quarter and based on priority. Kiefner recommends Magellan continue to inspect the Pin Oak Creek crossing at an annual rate to monitor the conditions and perform further remediation if necessary.

The Longhorn third-party damage (TPD) prevention program exceeds the minimum requirements of federal and Texas state pipeline safety regulations. Aerial surveillance and ground patrol frequencies met the LMP goals, with one exception due to weather events in October 2021. However, Magellan began and completed patrols following event cessation within 72 hours.

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[1] This is the total time calculated from when the pipe is free of stress, i.e., since installation or the last time some form of stress relief was performed on it.

Magellan performs incident investigations on all events, including near misses. In 2021, there were six incident investigations on the Longhorn Pipeline, all classified as minor incidents. None of these incidents were reportable to PHMSA. These incidents were all formally documented and investigated. Corrective actions were implemented following Magellan's incident investigation report.

Magellan has recorded no stress-corrosion cracking (SCC) on the 449 miles of pipeline. Kiefner recommends Magellan continue to carry out inspections per procedure as part of the normal dig program by conducting an SCC examination program that uses magnetic particle testing or equivalent methodology at each dig site.

The 2021 facilities data indicates that the pump stations and terminal facilities have been properly maintained and operated and have had no adverse impact on public safety. Magellan performs Process Hazard Analyses (PHAs) on all new above-ground facilities and when any modifications to existing facilities occur. The latest PHA was completed in 2019 as a 5-year revalidation per Magellan's LMP requirement found under 3.5.11. No PHAs were completed in 2021.

A probabilistic risk model is used to effectively manage pipeline integrity and evaluate risk per 49 CFR 195.452. The results show that none of the pipeline segments exceeded Magellan's risk threshold; therefore, no additional mitigation measures were required or recommended.

The technical assessment of the SIP indicated that Magellan is achieving its goal of preventing incidents that threaten human health or safety or cause environmental harm. Regarding activity measures, Magellan exceeded the minimum required mileage for aerial surveillance and ground patrol in the total number of miles patrolled and exceeded the frequency requirement for patrol when weather permitted. In addition, Magellan held public-awareness meetings and implemented its damage prevention program to ensure the safety and reliability of the Longhorn Pipeline System.

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TERMS, DEFINITIONS, AND ACRONYMS

The terms and definitions are taken directly from Section 2.0 of the ORA Process Manual (ORAPM), titled Terms, Definitions, and Acronyms. Definitions in the ORAPM or Longhorn Mitigation Plan are italicized.

Accident	An undesired event that results in harm to people or damage to property.
AC	Alternating Current
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
Bbl	Barrels
bpd	Barrels per day
CFR	Code of Federal Regulations
CGR	Corrosion growth rate
CIS	Close interval survey
CMP	Corrosion Management Plan
CP	Cathodic Protection – A method of protection against galvanic corrosion of a buried or submerged pipeline through the application of protective electric currents.
Def	Deformation
Defect	An imperfection of a type or magnitude exceeding acceptable criteria. Definition based on API Publication 570 – Piping Inspection Code. (Also see anomaly).
Dent	An ID Reduction greater than or equal to 2% of the pipe diameter
DOC	Depth-of-cover
DOT	Department of Transportation
EA	Environmental Assessment – The National Environmental Policy Act (NEPA) process begins when a federal agency develops a proposal to take major federal action. These actions are defined in 40 CFR 1508.18. The environmental review under NEPA can involve three different levels of analysis: • Categorical Exclusion determination (CATEX) • Environmental Assessment/Finding of No Significant Impact • Environmental Impact Statement (EIS)

EFW	Electric-flash weld is a type of EW using electric-induction to generate weld heat.
EGP	Electronic geometry pig
Encroachments	Unannounced or unauthorized entries of the pipeline right-of-way by persons operating farming, trenching, drilling, or other excavating equipment. Also, debris and other obstructions along the right-of-way must periodically be removed to facilitate prompt access to the pipeline for routine or emergency repair activities. The System Integrity Plan (SIP) includes provisions for surveillance to prevent and minimize the effects of right-of-way encroachments.
EPA	Environmental Protection Agency
ERW	Electric-resistance weld is a type of EW using electric-resistance to generate weld heat.
EW	Electric welding is a process of forming a seam for electric resistance (ERW) or electric-induction (EFW) welding, wherein the edges to be welded are mechanically pressed together, and the resistance to the flow of the electric current generates the heat for welding. EW pipe has one longitudinal seam produced by the EW process.
Excavation Damage	Any excavation activity that results in the need to repair or replace a pipeline due to a weakening, or the partial or complete destruction, of the pipeline, including, but not limited to, the pipe, appurtenances to the pipe, protective coatings, support, cathodic protection or the housing for the line device or facility.
Existing Pipeline	Originally defined in the EA, it consists of the portion of the pipeline originally constructed by Exxon in 1949-1950 that runs from Valve J-1 to Crane pump station. Currently, the in-service portion of the Existing Pipeline runs from MP 9 to Crane because the 2-mile section from Valve J-1 to MP 9 is not in use.
External Corrosion	Deterioration of the pipe due to an electrochemical reaction between the pipe material and the environment outside the pipe
FAD	Failure Assessment Diagram
FEA	Finite element analysis
GMA	Geometric Anomaly – An ID Reduction of less than 2% of the pipe diameter
HCA	High Consequence Area – As defined in 49 CFR 195.450, a location where a pipeline release might have a significant adverse effect on one or more of the following: • Commercially navigable waterway • High population area • Other populated area • Unusually sensitive area (USA)

Hydrostatic Test	An integrity verification test that pressurizes the pipeline with water is called a hydro test or hydrostatic pressure test.
ID	Inside nominal diameter of line pipe
ID Reduction	A deformation of pipe diameter detected by the ILI tool
ILI	In-Line Inspection – The use of an electronically instrumented device that travels inside the pipeline to measure the characteristics of the pipe wall and detect anomalies such as metal loss due to corrosion, dents, gouges, and/or cracks, depending upon the type of tool used.
ILI Final Report	ILI vendor report that provides the operator with a comprehensive interpretation of the data from an ILI.
Incident	An event defined in the Incident Investigation Program of the LMP: Includes accidents, near-miss cases, repairs, and/or any combination thereof. Incidents are divided into three categories: major incidents, significant incidents, and minor incidents. A "PHMSA (or DOT) reportable incident" is a failure in a pipeline system in which there is a release of product resulting in explosion or fire, volume exceeding 5 gallons (5 barrels from a pipeline maintenance activity), death of any person, personal injury necessitating hospitalization, or estimated property damage exceeding $50,000.
Internal Corrosion	Deterioration of the pipe due to an electrochemical reaction between the pipe material and the environment outside the pipe
J-1 Valve	The Mainline pipeline valve in the Houston area is described in the LMP as the junction of the Existing Pipeline and a New Pipeline extension. Although this valve still exists, it is not a part of the currently active Longhorn Pipeline, and the actual junction is at MP 9 (2 miles from the J-1 Valve).
Jct	Junction
Kiefner	Kiefner and Associates, Inc.
Leak Detection System	Two technology-based leak detection systems are used for the Longhorn system: (1) A system-wide computer-based monitoring and alarm network using real-time flow information from various locations along the pipeline and (2) a buried sensing cable installed over the Edwards Aquifer recharge zone and the Slaughter Creek watershed in the Edwards Aquifer contributing zone.
LMC	Longhorn Mitigation Commitment – Commitments made by Longhorn are described in Chapter 1 of the LMP.
LMP	Longhorn Mitigation Plan – Commitments made by Longhorn to protect human health and the environment by conducting up-front (prior to pipeline start-up) and ongoing activities regarding pipeline system enhancements

and modifications, integrity management, operations and maintenance, and emergency response planning.

Magellan Magellan Pipeline Company, L.P.

Major Incident The Longhorn Mitigation Plan – Includes events that result in:

- Fatality
- Three or more people hospitalized
- Major news media coverage
- Property loss, casualty, or liability potentially greater than $500,000
- Major uncontrolled fire/explosion/spill/release that presents an imminent and serious or substantial danger to employees, public health, or the environment

MASP Maximum Allowable Surge Pressure

Minor Incident The Longhorn Mitigation Plan – Includes events that result in:

- Fire/explosion/spill/release or other events with casualty/property/liability loss potential under $25,000
- Employee or contractor OSHA recordable injury/illness without lost workday cases
- Citations under $25,000

MFL Magnetic flux leakage – The flow of magnetic flux from a magnetized material, such as the steel wall of a pipe, into a medium with lower magnetic permeability, such as gas or liquid. Often used in reference to an ILI tool that makes MFL measurements.

ML Metal loss

MOP Maximum Operating Pressure

MOCR Management of Change Request

MP Mile Post

mpy Mils per year – Often referenced in conjunction with corrosion growth rates

NACE NACE International – Formerly known as the National Association of Corrosion Engineers

NDE Non-destructive Evaluation

Near-Miss The number of unplanned/undesired third-party-related events that did not result in a significant loss but which, under slightly different circumstances, could have resulted in a minor, serious, or major incident. Near miss data are obtained from Hazard / Near Miss cards, incident investigations, aerial patrol reports, maintenance reports, and ROW inspection reports.

An event is defined in the Incident Investigation Program of the LMP as an undesired event that could have resulted in harm to people or damage to property under slightly different circumstances. In addition, the LMP states:

	that a specific scenario of a minor accident (minor actual loss) could also be a major near-miss (major potential loss). Thus, a near-miss may or may not result in an incident.
NEPA	National Environmental Policy Act
New Pipeline	In 1998 extensions were added to the Existing Pipeline to make the current Longhorn Pipeline. Extensions were added from Galena Park to MP 9 and Crane to El Paso Terminal. Laterals were added from Crane to Odessa and El Paso Terminal to Diamond Junction. In 2010 a 7-mile loop (3 ½ miles each way) was added, connecting Magellan's East Houston terminal to MP 6.
OD	Outside nominal diameter of line pipe.
One-Call	A notification system through which a person can notify pipeline operators of planned excavation to facilitate the locating and marking of any pipelines in the excavation area. Texas 811 is a computerized notification center that establishes a communications link between those who dig underground (excavators) and those who operate underground facilities. The Texas Underground Facility Damage Prevention Act requires that excavators in Texas notify a One-Call notification center 48 hours before digging, so the location of an underground facility can be marked. The Texas 811 System can be reached at toll-free number 811 or the website http://www.texas811.org/.
One-Call Violation	A violation of the requirements of the Texas Underground Facility Damage Prevention and Safety Act by an excavator. This ORA is concerned about violations within the Longhorn Pipeline ROW.
One-Call Violations	The number of excavations that occurred within the ROW boundaries where a one-call was not made and should have been. Texas One-Call (Utilities Code: Title 5, Chapter 251, Section 251.002, Sub-Section 5) defines excavate as "to use explosives or a motor, engine, hydraulic or pneumatically powered tool, or other mechanized equipment of any kind and includes auguring, backfilling, boring, compressing, digging, ditching, drilling, dragging, dredging, grading, mechanical probing, plowing-in, pulling-in, ripping, scraping, trenching, and tunneling to remove or otherwise disturb the soil to a depth of 16 or more inches." Additionally, one-call violations are identified when company personnel discover third-party activity on the ROW and inform the third party that a one-call is required. One-call violation data are obtained from Hazard / Near-Miss cards, One-Call tickets, incident investigations, aerial patrol reports, maintenance reports, and ROW inspection reports.
Operator	An entity or corporation responsible for the day-to-day operation and maintenance of pipeline facilities
OPS	Office of Pipeline Safety – Co-lead agency who performed the EA, now a part of PHMSA

ORA	Operational Reliability Assessment – Annual assessment activities to be performed on the Longhorn Pipeline System to determine its mechanical integrity and manage risk over time
ORAPM	The Operational Reliability Assessment Process Manual
PHA	Process Hazard Analysis
PHMSA	The Pipeline and Hazardous Materials Safety Administration – a federal agency within the DOT with safety jurisdiction over interstate pipelines.
PMI	Positive Material Identification
Positive Material Identification (PMI) Field Services	A process and procedure developed by T. D. Williamson to determine tensile strength, yield strength, and chemical composition on pipe in the field. The process includes mobile automated ball indention for mechanical properties and optical emission spectrometry for chemical composition.
POE	Probability of Exceedance – The likelihood that an event will be greater than a pre-determined level; used in the ORA to evaluate corrosion defect failure pressures versus intended operating pressures. The POE for depth (POE_D) is the probability that an anomaly is deeper than 80% of the wall thickness. The POE for pressure (POE_P) is the probability that the burst pressure of the remaining wall thickness will be less than the system operating pressure or surge pressure. The POE for each pipe joint is POE joint.
POF	Probability of Failure
Recommendation	Suggestions for activities or changes in procedures that are intended to enhance integrity management systems but are not specifically mandated in the LMP
Repair	The LMP describes a repair as a temporary or permanent alteration made to the pipeline or its affiliated components intended to restore the allowable operating pressure capability or correct a deficiency or possible breach in the mechanical integrity of the asset.
Requirement	Activities that must be performed to comply with the LMP commitments
Risk	A measure of loss is measured in terms of both incident likelihood of occurrence and magnitude of the consequences
Risk Assessment	A systematic, analytical process in which potential hazards from facility operation are identified, and the likelihood and consequences of potential adverse events are determined. Risk assessments can have varying scopes and be performed at varying levels of detail depending on the operator's objectives.
ROW	Right-of-way – A strip of land where, through a legal agreement, some property rights have been granted to Magellan and its affiliates. The ROW agreement enables Magellan to operate, inspect, repair, maintain or replace the pipeline.

SCC	Stress-Corrosion Cracking – A form of environmental attack on the pipe steel involving the interaction of a local corrosive environment and tensile stresses in the metal resulting in the formation and growth of cracks. (ASME 31.8S[2])
Significant Incident	The Longhorn Mitigation Plan – Includes events that result in: • Fire/explosion/spill/release/ less than three hospitalized or other events with casualty/property/liability loss potential of $25,000 - $500,000 • Employee or contractor OSHA recordable injury/illness lost workday cases • Citations with potential fines greater than $25,000
SIP	System Integrity Plan – A program designed to gather unique physical attributes of the Longhorn Pipeline System, identify and assess the public and environmental risks, and actively manage those risks by implementing the identified Process Elements. See LMP Chapter 3.
SMYS	Specified Minimum Yield Strength – A common measure of the minimum
Surge Pressure	Short-term pipeline pressure increases due to equipment operation changes such as valve closure or pump start-up. Surge pressures must be limited to no more than MOP in Tier II and Tier III areas and no more than 110% of MOP elsewhere.
TDW	T.D. Williamson
Tier I Areas	Areas of normal cross-country pipeline
Tier II Areas	Areas designated in the EA as environmentally sensitive due to population or environmental factors
Tier III Areas	Areas designated in the EA as environmentally hypersensitive due to the presence of high population or other environmentally sensitive areas
TFI	Transverse Field Inspection – An MFL Inspection tool with the magnetic field oriented in the circumferential direction. The tool differs from conventional MFL because these conventional tools have their field oriented in the axial direction or along the axis of the pipe.
TPD	Third-party damage – Accidental or intentional damage by a third party (that is, not the pipeline operator or contractor) that causes an immediate failure or introduces a weakness (such as a dent or gouge) into the pipe
TPD Annual Assessment	"Longhorn System Annual Third-Party Damage Prevention Program Assessment" Report. The annual report written by the operator summarizes the TPD prevention program. This report is found in Appendix D of the ORAPM as Item 71, Annual Third-Party Damage Assessment Report.
UT	Ultrasonic testing – A non-destructive testing technique using ultrasonic waves

[2] ASME 31.8S (2016), Managing System Integrity of Gas Pipelines, ASME Code for Pressure Piping, B31

WT	Wall thickness of line pipe
WTI	West Texas Intermediate (crude oil grade)
WTS	West Texas Sour (crude oil grade)

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2021 Operational Reliability Assessment of the Longhorn Pipeline System

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1 INTRODUCTION

1.1 Objective

Kiefner and Associates, Inc. (Kiefner) has conducted the annual Operational Reliability Assessment (ORA) report on the Longhorn Pipeline System for the 2021 operating year. The ORA report provides Magellan Pipeline Company, L.P. (Magellan), with a technical assessment of the System Integrity Plan (SIP) effectiveness on the Longhorn Pipeline. Results from all SIP elements are incorporated into the technical assessment to help evaluate the condition of the Longhorn assets. Kiefner provides recommendations to preserve long-term integrity and mitigate areas of potential concern.

1.2 Background

Magellan has operated the Longhorn pipeline system since 2005 and has held ownership since 2009. The previous owner, Longhorn Partners Pipeline, LP, participated in an Environmental Assessment (EA) prepared by the U.S. Environmental Protection Agency (EPA) and the Department of Transportation (DOT) in 1999 and 2000. The EA took place before the pipeline's refined product service started. The EA "Finding of No Significant Impact" was conditioned upon Longhorn's commitment to implement certain integrity-related activities and plans before pipeline start-up and periodically throughout the system's operation. The Longhorn Mitigation Plan (LMP) specifies Longhorn's commitment to minimizing the likelihood and consequences of product releases. These commitments included the Longhorn Continuing Integrity Commitment, where Longhorn agreed to implement System Integrity and Mitigation Commitments and conduct annual ORAs. A list of the Longhorn Mitigation Commitments (LMCs) addressed in the ORA report is provided in Appendix A – Mitigation Commitments.

The LMP committed Longhorn to implement a SIP, which Magellan maintains. Magellan's SIP has three elements:

- Tasks that address the integrity management program for the Longhorn pipeline system, including a commitment to perform an annual self-audit report.
- Direct operator interface with the daily operations and maintenance of the Longhorn pipeline system assets.
- An annual ORA performed by an independent third-party technical company, subject to the review and approval of the Pipeline and Hazardous Materials Safety Administration (PHMSA).
    - Longhorn selected and PHMSA approved Kiefner as the ORA contractor, and Magellan continues with this agreement.

The LMP stipulates specific and general requirements of the ORA. Those requirements were extracted from the LMP and used to develop the Operational Reliability Assessment Process Manual (ORAPM). The ORA is carried out according to the ORAPM. The "Mock ORA for Longhorn

Pipeline" that Kiefner performed before the pipeline commissioning provided additional information on the execution of the ORA. The ORAPM requires the ORA contractor to provide annual reports to Magellan and PHMSA.

The ORA contractor will assess the pipeline operating data and the results of integrity assessments, surveys, and inspections and make appropriate recommendations regarding the seven potential threats to pipeline integrity. The ORAPM identifies the data needed to conduct the ORA; Appendix B provides a list of the data used for the 2021 ORA Report. Managing these threats and preserving the integrity of the Longhorn system assets are among the goals of the SIP. The seven pipeline integrity threats are:

1. Pressure-Cycle-Induced Fatigue
2. Corrosion
3. Laminations and Hydrogen Blisters
4. Earth Movement and Water Forces
5. Third-Party Damage (TPD)
6. Stress-Corrosion Cracking (SCC)[3]
7. Threats to Facilities Other than Line Pipe

1.3 ORA Interaction with the SIP

The ORA report also reviews the inspection and pipeline system operation data collected and generated from Longhorn's SIP:

1. Corrosion Management Plan
2. In-Line Inspection (ILI) and Rehabilitation Program
3. Key Risk Area Identification and Assessment
4. Damage Prevention Program
5. Encroachment Procedures
6. Incident Investigation Program
7. Management of Change
8. Depth-of-Cover Program
9. Fatigue Analysis & Monitoring Program
10. Scenario-Based Risk Mitigation Analysis
11. Incorrect Operations Mitigation
12. System Integrity Plan Scorecarding and Performance Metrics Plan

1.4 Longhorn Pipeline System Description

The Longhorn pipeline system comprises a crude oil system (Eastern portion) and a refined products system (Western portion). Figure 1 through Figure 3 show the Longhorn System Map, Tier Levels, and a close-up of the Houston area.

[3]SCC has not been identified as a threat of concern to the Longhorn Pipeline and has not been recognized as a threat in the past but was added as SCC has been an unexpected problem for some pipelines.

The Eastern portion of the Longhorn system transports crude oil through an 18-inch pipeline over 424 miles from Crane Station to Satsuma Station. Intermediate pumping stations are located at Texon, Barnhart, Cartman, Kimble, James River, Eckert, Cedar Valley, Bastrop, Warda, and Buckhorn. The crude system continues with 32 miles of 20-inch pipe from Satsuma Station to East Houston Terminal and 9 miles of 20-inch pipe from East Houston Terminal to 9th Street Junction. The crude system contains some of the Existing Pipeline (as named in the original EA) built in 1949-1950 with some replacements and extensions in the Houston area.

The Western portion of the Longhorn system transports refined products from Odessa to El Paso, TX. The refined product system is 237 miles of 18-inch pipe from Crane Station to the El Paso Terminal and 29 miles of 8-inch pipe from Odessa to Crane Station. At the El Paso Terminal, there are four 9.4-mile laterals connecting the El Paso Terminal to El Paso Junction (also known as the El Paso Laterals). Most of the refined pipe system was built in 1998.

Table 1 shows the station locations for the Longhorn pipeline systems. The current flow rate for the crude system is 292,000 barrels per day (bpd) from Crane to East Houston. The flow rate for the refined product system is 92,180 bpd from Odessa to El Paso. Figure 4 shows a timeline of the history of the Longhorn Pipeline System.

Table 1. Longhorn Pipeline Station Locations

System	Station	Type	Milepost	Tier	MOP (psig)
Crude	Crane	Pump	457.5	II	1034
	Texon	Pump	416.6	II	898
	Barnhart	Pump	373.4	II	953
	Cartman	Pump	344.3	II	952
	Kimble	Pump	295.2	II	898
	James River	Pump	260.2	I	965
	Eckert	Pump	227.9	I	959
	Cedar Valley	Pump	181.6	II	965
	Bastrop	Pump	141.8	I	1012
	Warda	Pump	112.9	I	965
	Buckhorn	Pump	68.0	I	787
	Satsuma	Pump	34.1	III	786
	E. Houston	Terminal	2.35	II	1168
Refined Product	Odessa[4]	Meter	N/A	I	1440
	Crane	Pump	457.5	I	1440
	Cottonwood	Valve	576.3	I	1440
	El Paso	Terminal	694.4	I	1440
	8" Chevron	Meter	N/A	I	2160
	8" Kinder Morgan Flush Line	Meter	N/A	I	1440
	8" Strauss	Meter	N/A	I	1440
	12" Kinder Morgan	Meter	N/A	I	1440

[4] The Longhorn Mitigation Plan (LMP) covers the Odessa pig trap. The tanks and metering are not covered by the LMP.

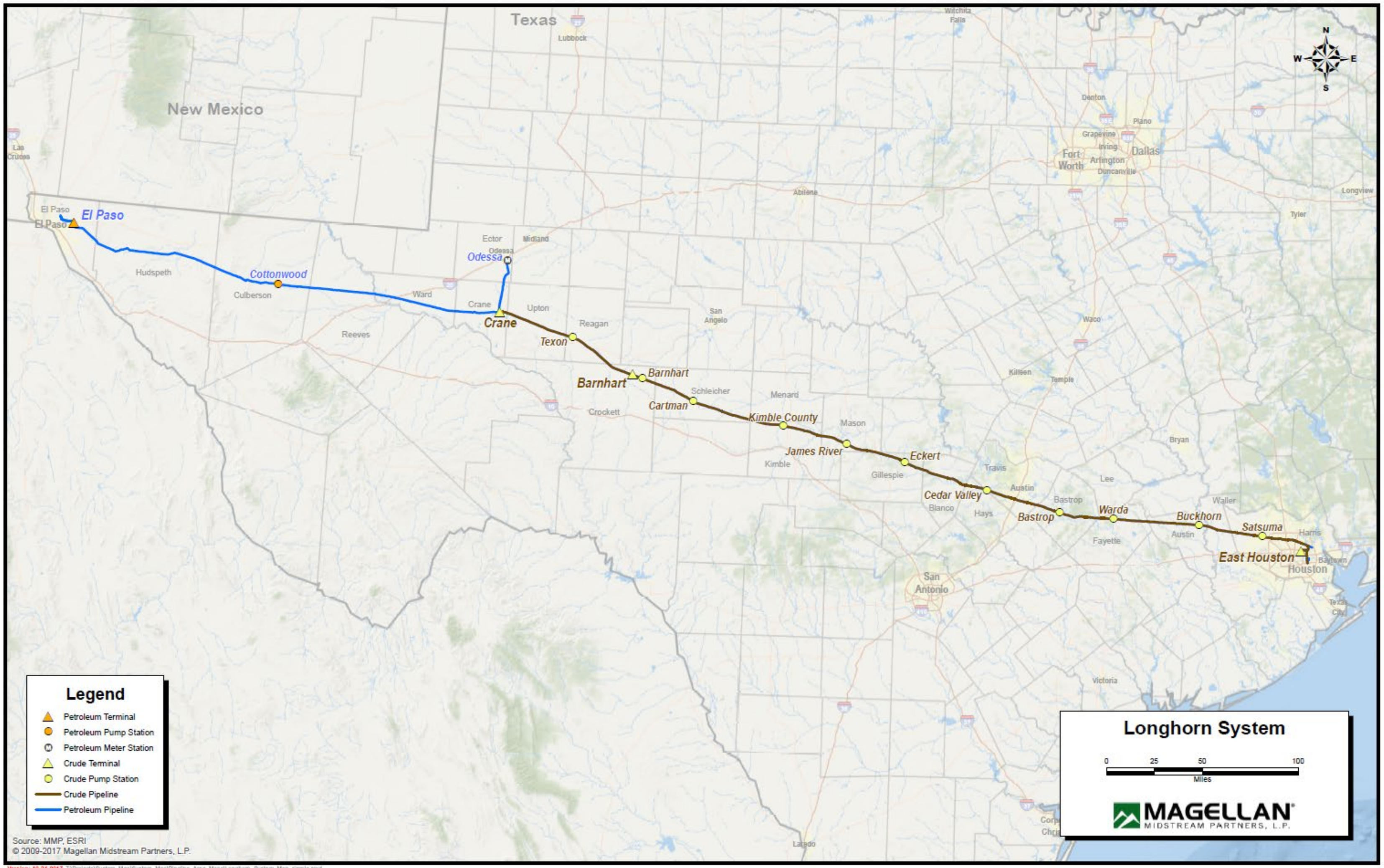

Figure 1. Longhorn System Map (2021)

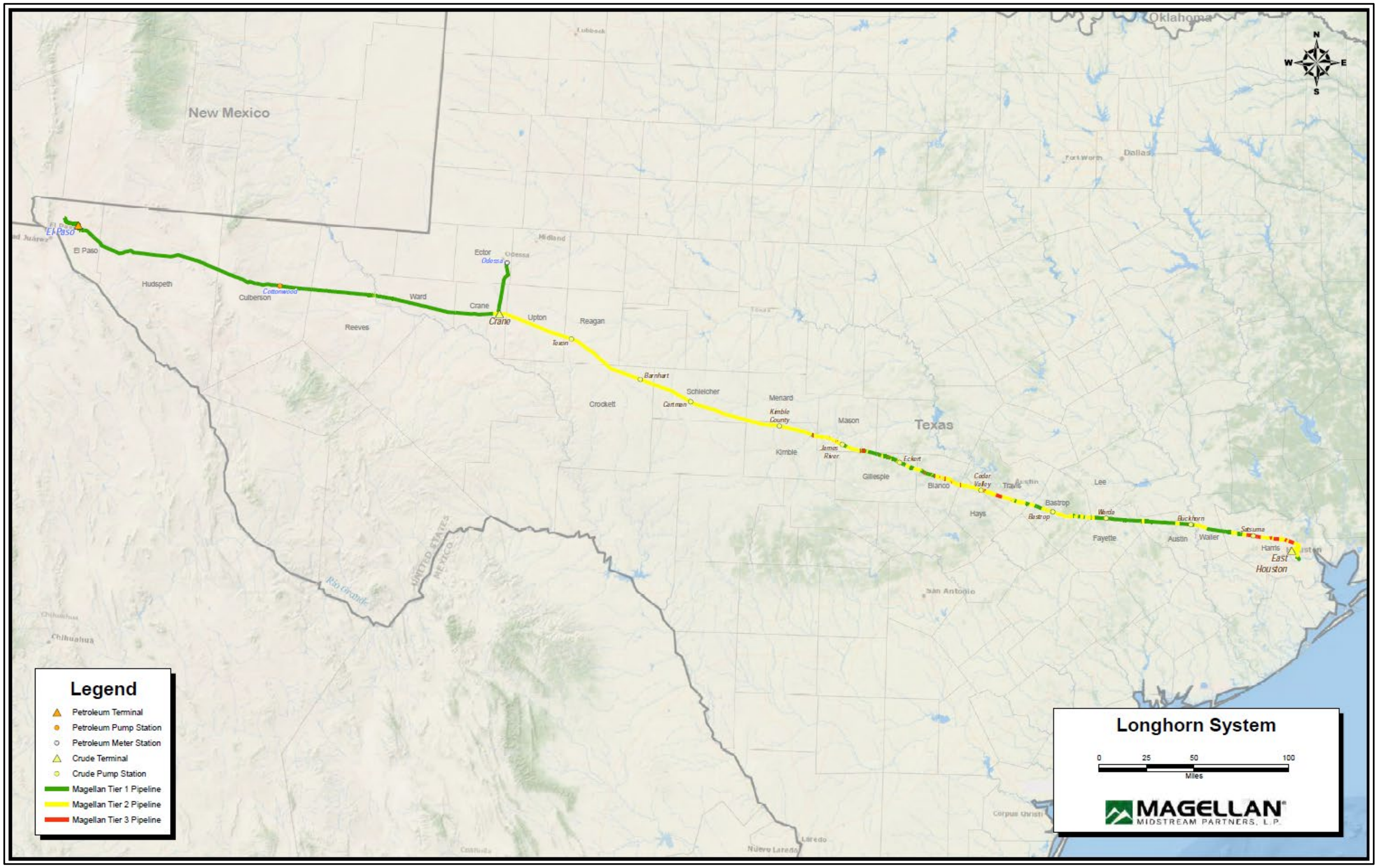

Figure 2. Longhorn System Map showing Tier Level (2021)

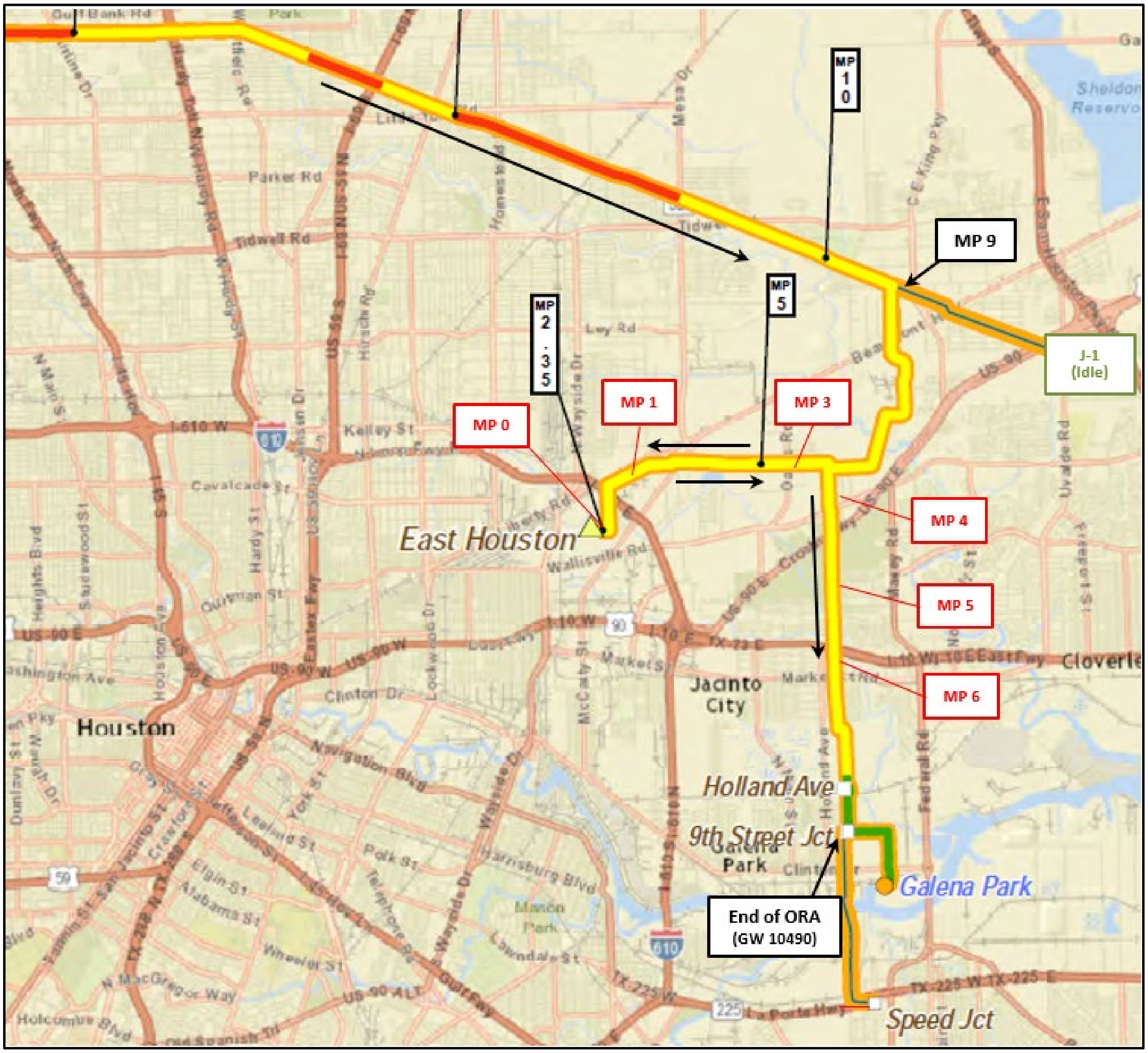

Figure 3. Map of Longhorn System within the Houston Area (2021)

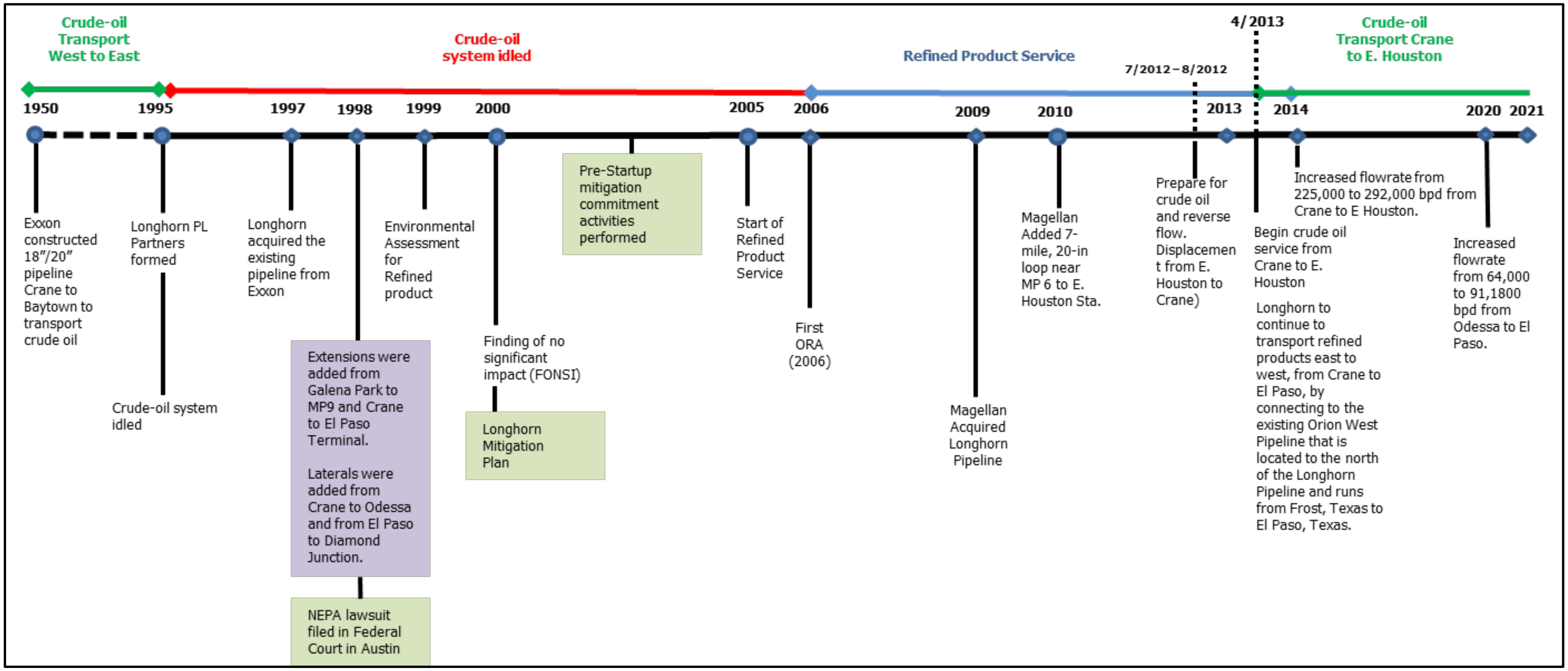

Figure 4. Timeline of the Longhorn Pipeline System

2 LMP AND SIP ANALYSES AND REVIEW

To maintain the integrity and reliability of the Longhorn pipeline, Magellan identifies, analyzes, and manages the risks associated with the operation of the pipeline and its associated assets. The LMP and SIP both help implement this policy.

The LMP helps maintain the integrity of the Longhorn pipeline by identifying and monitoring threats such as pressure-cycle-induced fatigue cracking, corrosion, pipe laminations, hydrogen blisters, earth movement, TPD, SCC, and threats to facilities other than line pipe. Magellan had three pipeline segments assessed with final reports received in 2021; two additional segments were assessed in late 2020, with the final reports received in 2021. T.D. Williamson's (TDW) MFL and Deformation tools were used to assess the Odessa to Crane segment. The TDW Deformation tool was also used to assess the following segments: Satsuma to East Houston, Crane to Texon, and Crane to Cottonwood. The Crane to Cottonwood Deformation tool was ran as a Preventative and Mitigative Measures (PMM) measure to identify any possible intrusions that may be damaging the cleaning pigs and does not reset the re-inspection interval. Baker Hughes, a General Electric Company, Ultrascan™ CD (UCD) tool was used to assess the Kimble to James River segment. Refer to Table 2 for a list of assessments performed in 2021 by pipeline segment.

The SIP maintains the integrity of the Longhorn pipeline by identifying and managing incidents that would threaten human health and safety or cause environmental harm. The SIP contains 12 process elements. These elements are most closely related to the threats addressed by the ORAPM and are summarized in detail with recommendations to preserve the long-term integrity and mitigate areas of potential concern. These 12 process elements are listed in this report in Section 1.3 ORA Interaction with the SIP.

Table 2. Longhorn System ILI Assessments

Satsuma to East Houston	Kimble to James River	Crane to Texon	Crane to Cottonwood	Odessa to Crane
34.1 to 2.35	**295.2 to 260.2**	**457.5 to 416.6**	**457.5 to 576.3**	**29.26 to 0.00**
Corrosion				
				MFL
				9/8/2021
Pressure Cycle Induced Fatigue				
	UCD*			
	10/20/2020			
Third-Party Damage				
Deformation		Deformation	Deformation	Deformation
7/6/2021		9/9/2021	11/8/2020	9/8/2021

*Assessment performed in 2020, with the final report received in 2021.

2.1 Fatigue Analysis and Monitoring Program

It has been well documented that pre-existing long seam defects have caused pipeline failures due to pressure-cycle-induced fatigue.[5] These flaws are more prevalent in pipes manufactured prior to 1970 due to obsolete long-seam welding techniques such as low-frequency electrical resistance welding (LF-ERW) and flash welding (EFW). These vintage welds typically exhibit lower toughness and a higher prevalence of manufacturing flaws than the modern, post-1970 pipe. As a result, manufacturing flaws in or adjacent to the ERW or EFW long seams of the Existing Pipeline, manufactured in 1950, are considered to be susceptible to pressure-cycle-induced fatigue. A flaw that was too small to fail at the initial hydrostatic test after construction could grow due to pressure-cycle-induced fatigue and become large enough to cause a failure. Accordingly, Section 3 of the ORAPM requires monitoring of pressure cycles during the operation of the pipeline, calculating the worst-case crack growth in response to such cycles, and reassessing the integrity of the pipeline at appropriate intervals to find and eliminate potentially growing cracks before they reach a critical size.

The failure pressure of each potential flaw is controlled not only by its size but by the pipe's diameter, wall thickness, strength, and toughness. Toughness is the ability of the material containing a given-size crack to resist tearing at a particular value of applied tensile stress. Toughness in line pipe materials has been found to correspond reasonably well to the value of "upper-shelf" energy as determined utilizing standard Charpy V-notch impact tests. As noted in Reference [1], the full-size Charpy V-notch energy levels (CVN) for samples of the 1950 material ranged from 15 to 26 ft-lbs. To be conservative, Kiefner used the lower-bound CVN value of 15 ft-lbs for fatigue analysis.

Kiefner's Pipelife software performs fatigue assessment using the following methodology:

- Process the operating pressure data using rainflow-counting.
- Segment the pipeline according to location, elevation, diameter, grade, and wall thickness.
- Establish initial crack sizes based on the most recent hydrostatic test, ILI crack-tool run, or API 5L inspection standards.
- Determine the cracks' final (critical) sizes at failure when the predicted burst pressure reaches MOP.
- Simulate crack growth using Paris' law.
- Calculate the length of time (remaining life) for the known or potential cracks to grow to critical size.

2.1.1 Pressure Cycle Processing

Magellan supplied one year of operational pressure data for the crude oil pipeline system from Crane Station to 9th Street Jct. and the refined product system from Odessa to El Paso. The pressure data used in the analysis were recorded at stations' and facilities' discharge, suction, and receipt points. The pressure readings were recorded from January 1, 2021, to December 31, 2021, at 1-minute intervals. The pressure data supplied was added to all available pressure

[5] Kiefner, J. F., Kolovich, C. E., Wahjudi, T. F., and Zelenak, P. A., *"Estimating Fatigue Life For Pipeline Integrity Management"*, Paper Number IPC04-0167, Proceedings of IPC 2004, International Pipeline Conference, Calgary, Alberta, Canada (October 4 - 8, 2004).

data from previous years to create an operational pressure history for each segment. The amount of cumulative pressure data used depended on the number of consecutive years that Magellan provided data to Kiefner in the same time interval. For the crude oil pipeline system from Crane Station to 9th Street Jct., Kiefner used six years of collected pressure data. For the refined product system from Odessa to El Paso, Kiefner only used the 2021 pressure data as Magellan has begun operating the line differently starting in 2021 compared to previous years.

Kiefner used rainflow-counting to prepare the pressure data for analysis. Rainflow-counting converts a sequence of varying stresses into an equivalent set of constant amplitude stress reversals, transforming the complex pressure data into simple peaks and valleys to optimize computation time. According to Paris' law, rainflow-counted pressure cycles are used to simulate crack growth. Kiefner's rainflow-counting process complies with ASTM E1049-85 guidelines for rainflow-counting.[6]

Due to the density of liquid products, elevation changes impact the internal pressure loading of the pipe due to hydrostatic head losses and gains. Data for the intermediate locations between the pressure measurement locations were calculated based on elevation changes and the hydraulic pressure gradient.

2.1.2 Initial Flaw Size

Since 2018, all of the Existing Pipeline segments built around 1950 from Crane Station to the East Houston terminal have been inspected using ultrasound crack detection (UCD) ILI tools. The newer crude oil segment (1998 install year), East Houston to Speed Junction, was inspected by a spiral MFL (SMFL) tool capable of crack detection in 2014. The refined product system (1998 install year) has not been inspected by ILI tools capable of detecting cracks.

Using Detected ILI Defects

For the pipeline segments where ILI detected crack-like defects, the lengths and depths reported by the ILI tool were used as the initial flaw sizes with tool tolerance added. For features identified by the UCD tools, the tool tolerance was 0.3" for length and 0.036" for depth, so those values were added to the ILI-reported lengths and depths to use as initial flaw sizes. The SMFL ILI tools did not identify any crack-like defects, so tool tolerances were not applicable here.

Using ILI Thresholds

In addition to the known ILI features, hypothetical flaws based on the ILI detection thresholds were simulated at every change in the pipeline's physical properties, such as wall thickness, diameter, and grade, according to the procedure in Section 3.4 of the ORAPM. For segments inspected by the UCD tool, an 8" long defect with a depth of 0.036" was simulated at every change point. For the segment inspected by the SMFL tool, an 8" long defect with a depth of 25% wall thickness was simulated. The depth of 0.036" is from the tool manufacturer's

[6] ASTM, "Standard Practices for Cycle Counting in Fatigue Analysis", E 1049, Annual Book of Standards, 2002.

specifications. A length of 8" was used based on Kiefner's database of known pressure cycle fatigue failures, where 8" was the longest historical fatigue crack length.

Using API 5L Inspection Standards

For the refined product segments where no ILI crack tool has been run, Kiefner used the ultrasonic inspection standards for API 5L line pipe in 1998,[7] where a pipe was inspected ultrasonically using a standard calibration block with a 10% wall thickness (N10) notch. Therefore, Kiefner simulated initial flaws with a depth of 10% wall thickness and an upper-bound length of 8" derived from Kiefner's collection of known pipeline fatigue failures. A flaw was simulated at each change in pipe properties along the pipeline segment to guarantee that all possible pipe property scenarios were evaluated with respect to their location and elevation.

Locations near a pump discharge typically experience more aggressive pressure cycles than locations away from the pump discharge. For the current analysis, the pipe closest to the upstream pump station was used in the analysis where a pipe with similar attributes (grade, wall thickness, and other attributes) was present in a given segment. It is not necessary to calculate a fatigue life at all the points where the susceptible pipe exists because a pipe further downstream will have a longer fatigue life based on the hydraulic gradient and need not be evaluated as long as its difference in elevation, relative to upstream locations, is not significant.

Appendix C – Threshold Anomaly Fatigue Evaluation Results and Appendix D – Crack Detection ILI Anomaly Fatigue Evaluation Results contain all of the pressure-cycle-fatigue analysis results sorted by reassessment interval.

2.1.3 Fatigue Crack Growth Assessment

The pressure-cycle analysis for the Longhorn Pipeline was conducted using Paris' law[8], shown below: $\frac{da}{dN} = C(K)^n$

Kiefner's Pipelife software uses Paris law to simulate the incremental crack growth for a given flaw in response to the pressure cycles counted from the rainflow method (da/dN) is the increment of crack growth per load cycle, ΔK is the range of cyclic stress-intensity at the crack-tip, and C and n are material crack-growth parameters). The cyclic stress intensity factor was determined using the Raju-Newman equation.[9] These equations are available in the Mock ORA (Reference [2]). The pressure cycles were applied, and crack growth was calculated until failure was predicted at the MOP at the feature location. The cumulative number of pressure cycles at failure was then converted to a time to failure in years based on the interval of the pressure data collected. The fatigue life is the time in years for the defect to grow from the initial crack size to the final critical size. The recommended reassessment interval is calculated by taking 45% of the shortest fatigue life, corresponding to a safety factor of 2.22 (1/0.45) as specified in the ORAPM and per the LMP.

[7] API 5L, "Specification for Line Pipe," 41st Edition. April 1, 1995.
[8] Paris, P. C. and Erdogan, F., *"A Critical Analysis of Crack Propagation Laws"*, Transactions of the ASME, Journal of Basic Engineering, Series D, Vol. 85, No. 5, pp 405-09.
[9] Newman, J.C. and Raju, I.S., "An Empirical Stress-Intensity Factor Equation for the Surface Crack", Engineering Fracture Mechanics, Vol 15, No 1-2, pp. 185-192, 1981.

The material-parameter constants used in the Paris equation affect the crack growth calculated in response to a given pressure cycle. The constants are commonly referred to as the "crack-growth rate" parameters. These parameters are constants that depend on the nature of the material and the environment in which the crack exists. In the absence of empirical data for the particular crack-growth environment of the Longhorn Pipeline, values for the constants have been established through large numbers of laboratory tests published in the Fitness-For-Service API Standard 579-1/ASME FFS-1.[10]

Fatigue Assessment Results in Table 3 show flaws with a predicted reassessment date before 2030. The pressure cycle data since the most recent ILI tool run for each segment were used in the fatigue evaluation. A safety factor of 2.22 was applied to the calculated time to failure for each postulated flaw to determine a reassessment interval.

The earliest reassessment due date for the Odessa to Crane refined product segment was 4/08/2084, indicating that cyclic fatigue is an unlikely mode of failure for this segment. The API 5L manufacturing inspection thresholds were used since no UCD ILI has been run on the refined product segments.

The earliest reassessment due date for the Crane to El Paso refined product segment was 03/25/2233, indicating that cyclic fatigue is an unlikely mode of failure for this segment. The API 5L manufacturing inspection thresholds were used since no UCD ILI has been run on the refined product segments.

For the crude oil segments, Crane to Texon had the earliest reassessment due date of 12/21/2026. All crude oil analyses were conducted using UCD ILI data except for East Houston to 9th Street Jct, which used the API 5L manufacturing inspection thresholds since no UCD ILI has been run on East Houston to 9th Street Jct.

The results for the crude pipeline segment remained relatively consistent with the 2020 assessment performed by Kiefner, suggesting that pressure cycling for this pipeline has not changed significantly since the 2020 Kiefner assessment. Table 4 compares the current 2021 fatigue assessment results with previous assessments.

[10] API RP 579-1/ASME FFS-1, Fitness-For-Service, Third Edition, 6/1/2016

Table 3. Reassessment Due Date Before 2030

Pipeline Segment	OD (inch)	WT (inch)	Yield Stress (psi)	Defect Location (feet)	Elevation (feet)	Calc. Time to Failure (years)	Re-assessment Interval (years)	Re-assessment Due Date	ILI Date
Crane to Texon	18	0.246	52,000	24015+71	2,539	18.1	8.2	12/21/2026	10/19/2018
Crane to Texon	18	0.285	65,000	24080+38	2,540	18.2	8.2	12/26/2026	10/19/2018
Crane to Texon	18	0.246	52,000	23603+80	2,678	20.8	9.4	2/24/2028	10/19/2018
Crane to Texon	18	0.256	52,000	24040+22	2,531	22.6	10.2	12/21/2028	10/19/2018
Crane to Texon	18	0.256	52,000	22496+50	2,697	23.8	10.7	7/11/2029	10/19/2018
Crane to Texon	18	0.246	52,000	22041+83	2,663	23.8	10.7	7/15/2029	10/19/2018
Crane to Texon	18	0.256	52,000	23905+26	2,577	24.3	10.9	9/21/2029	10/19/2018
Crane to Texon	18	0.256	52,000	22274+39	2,674	24.7	11.1	12/04/2029	10/19/2018

*Year of construction.

Table 4. Comparison of Reassessment Dates from Past ORAs

Segment	2016 Report	2017 Report	2018 Report	2019 Report	2020 Report	2021 Report
East Houston to 9th Street	8/23/2202	7/11/2174	3/15/2195	3/23/2170	8/4/2173	2/10/2033
Satsuma to East Houston	11/14/2032	4/1/2035	9/7/2034	4/3/2084*	3/3/2045*	3/29/2046*
Buckhorn to Satsuma	1/31/2039	3/1/2034	10/17/2034	5/5/2034	11/27/2046*	8/9/2047*
Warda to Buckhorn	10/23/2027	11/23/2027	9/19/2030	3/6/2030	3/22/2039*	1/10/2041*
Bastrop to Warda	4/7/2025	4/5/2024	10/6/2024	8/9/2024	8/10/2035*	5/12/2054*
Cedar Valley to Bastrop	8/13/2046	2/9/2040	3/8/2044	8/8/2043	6/11/2053*	7/14/2054*
Eckert to Cedar Valley	9/30/2033	8/9/2034	10/7/2032	9/12/2031	4/4/2042*	9/17/2044*
James River to Eckert	11/5/2023	6/27/2025	3/28/2025	4/30/2025	2/20/2043*	8/16/2042*
Kimble to James River	9/11/2027	8/28/2030	9/6/2027	10/28/2027	1/16/2028	10/23/2047*
Cartman to Kimble	3/29/2022	10/20/2023	5/20/2024	7/4/2024	11/13/2040*	2/21/2041*
Barnhart to Cartman	1/17/2040	4/22/2045	12/1/2036	10/22/2037	1/31/2039*	9/27/2038*
Texon to Barnhart	7/23/2021	12/11/2022	12/25/2022	12/28/2022	6/24/2037*	6/27/2040*
Crane to Texon	4/13/2022	10/14/2027	1/28/2023	8/7/2025*	6/29/2024*	12/21/2026*
Crane to El Paso	11/29/2238	3/22/2109	1/4/2498	1/4/2498	3/25/2233	3/25/2233
Odessa to Crane	N/A	N/A	N/A	N/A	N/A	4/08/2084

*Based on as-called ILI indication sizes with tool tolerance added.

2.2 In-Line Inspection and Rehabilitation Program

Magellan is committed to performing ILI assessments on the Longhorn pipeline system. In 2021 one pipeline segment was assessed using MFL and EGP technology and two pipeline segments were addressed using EGP. Two segments were assessed in 2020 with final reports received in 2021: one segment assessed using UCD technology and one segment addressed using EGP. Refer to Table 2 for a list of assessments performed in 2021 by pipeline segment. Magellan performed 196 ILI anomaly investigations in 2021. Kiefner's review of the in-line inspection and rehabilitation program included the following: performing a run-to-run comparison corrosion growth assessment, reviewing reported crack-like features, reviewing maintenance reports and in-ditch evaluations, reviewing reported ID reductions, and comparing ID reductions to laminations for hydrogen blisters.

2.2.1 Run-to-Run Comparison Corrosion Growth Assessment

Kiefner reviewed the current ILI assessments with an understanding of the background and approach for API 1163 ILI verification. API 1163 Second Edition, April 2013, describes methods in Sections 7 and 8 that can be applied to verify that the ILI tool was performing as expected and reported inspection results are within the performance specification for the inspected pipeline. For further background and approach on API 1163 Section Edition, April 2013, refers to Appendix E – Approach to API 1163 Verification.

Process verification and quality control were reviewed for each assessment listed in Table 2. The general results for all of the reviewed 2021 MFL and EGP assessments were that the functionality of the inspection tools was determined to be within normal standard operating conditions, and the locating of reference points by the ILI tool was determined to be consistent over the entirety of the ILI assessments. The Kimble to James River UCD assessment noted damage to one sensor skid and one AUX data cable on the receiver. The UCD tool was determined to function within normal standard operating conditions and determined to be locating reference points consistently over the entirety of the assessment.

The threat of corrosion can be monitored using ILI assessments, which pipeline operators commonly use to identify and evaluate corrosion-caused metal loss and plan remediation. This typically involves running an ILI tool to identify and size corrosion features, followed by remediation of features that exceed a depth or a pressure failure threshold. This method is a valid approach for addressing line pipe corrosion. ILI assessments completed in 2021 are listed in Table 2. An overall ILI re-assessment schedule can be found in Section 4, Table 33 for the crude system, and Table 34 for the refined system. The next crude system assessment for corrosion is in 2023 for the Texon to Crane segment. The next refined system assessment for corrosion is in 2022 for the following segments: 8-inch El Paso to Chevron, 8-inch Kinder Morgan Flush Line, 12” El Paso to Kinder Morgan, and Cottonwood to El Paso.

A run-to-run comparison was performed on the Odessa to Crane segment utilizing the ILI assessment received in 2021 and the 2016 ILI assessment of Odessa to Crane. No pipe replacements were noted between the current and previous assessments. The 2021 ILI assessment reported five external metal loss features >10% WT (11-20% WT), while the 2016 ILI assessment reported ten external metal loss features >10% WT (11-18% WT).There were not enough data pairs to support corrosion growth rate (CGR) calculations. Data correlations were done using Kiefner’s CorroSure software.

2.2.2 Crack-Like Features

Crack features identified from the 2020 UCD assessment were correlated with crack features reported from TFI assessments performed in 2015. Table 5 provides a breakdown of reported crack-like features as called by the current UCD assessment and the previous TFI assessment. Six crack-like reported features from the Kimble to James River UCD assessment were found to either correlate or be present on the same joint with seam features reported from the 2015 TFI assessments. Table 6provides a breakdown of the correlations; feature quantities are based on the 2020 UCD assessment. Four matched crack-like features are noted as being under a sleeve.

Table 5. UCD Reported Feature Comparison

Segment	Reported Features				
	2020 UCD	2015 TFI			
	Crack-Like Seam Weld Inspection Sheet	SW Anomaly	SW Feature B	External Narrow Axial ML Feature	Internal SWML
Kimble to James River	15	307	3	8	3

Table 6. UCD Crack Feature Correlations[11]

Segment	Quantity			List of Joints with Correlated Features*
	Joint(s)	Matched Crack-like Features	Unmatched Crack-like Features	
Kimble to James River	3	5	1	16780, 17340, and 47430**~

The joint number highlighted in red has a matched crack feature located on the joint.
*The listed joint numbers are from the current UCD assessment.
**Matched feature is reported under a sleeve.
~Multiple crack-like features were reported on the joint from the 2020 UCD assessment.

2.2.3 Maintenance Reports and In-Ditch Evaluations

In 2021, Magellan performed 196 in-ditch ILI assessments corresponding to current ILI assessments (2018/2019/2020 MFL/UCD and 2021 EGP) and two pipeline investigations at a heavy equipment crossing. Anomaly investigations also included nondestructive evaluation (NDE) reports with detailed investigation results. Table 7 provides a breakdown, per pipeline segment, of where the in-ditch assessments occurred (HCA, segment, and tier). The total number of ILI anomalies addressed per pipeline segment in 2021 is listed in Table 8; the total number includes the targeted ILI anomalies and any anomaly found in the repair area for that associated dig.

The 2012 Environmental Assessment requires PMI[12] tests to be completed at 50% of the ILI anomaly investigation locations that do not have material documentation. In 2021, Magellan performed 196 ILI anomaly investigations, and 195 locations met the PMI requirement. Magellan performed PMI testing at 110 of the 195 anomaly investigation locations (57%), satisfying PMI requirements. Since the start of PMI testing in 2014, Magellan has performed PMI testing at 375 dig locations. Figure 5 shows the PMI dig locations are spread out along the length of the pipeline from East Houston to Crane, with some areas having a higher density of digs than other areas. Table 9 gives an overview of PMI testing since the PMI testing requirement was added.

[11] Features may not be directly correlating (i.e., overlapping area), but were identified in this table if reported on the same joint.
[12] 2012 Longhorn Pipeline Reversal EA (Reference [6]).

Table 7. ILI Anomaly Investigation Digs per Maintenance Reports Completed in 2021

	18" Cottonwood to El Paso	18" Crane to Cottonwood	18" Crane to Texon	18" Texon to Barnhart	18" Barnhart to Cartman	18" Cartman to Kimble	18" Kimble to James River	18" James River to Eckert	18" Eckert to Cedar Valley	18" Cedar Valley to Bastrop	18" Bastrop to Warda	18" Warda to Buckhorn	18" Buckhorn to Satsuma	20" Satsuma to E. Houston	20" E. Houston to Speed Jct	8" El Paso to Chevron	8" Kinder Morgan Flush Line	8" El Paso to Kinder Morgan	12" El Paso to Kinder Morgan	8" Crane to Odessa
ILI Date		11/8/20	9/9/21*	5/15/20	6/16/20	12/31/20	12/31/20	3/11/20	3/4/20	1/16/20	1/28/20			7/6/21*						9/8/21*
Maintenance Report	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No	No
Tier I	0	0	0	0	0	0	1	13	6	4	7	0	0	0	0	0	0	0	0	0
Tier II	0	0	7	35	24	42	14	18	7	7	6	0	0	2	0	0	0	0	0	0
Tier III	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Digs	0	0	7	35	24	42	18	31	13	11	13	0	0	2	0	0	0	0	0	0
HCA	0	0	0	0	0	0	4	1	3	5	3	0	0	2	0	0	0	0	0	0
Non-HCA	0	0	7	35	24	42	14	30	10	6	10	0	0	0	0	0	0	0	0	0

*Only performed an EGP assessment in 2021.

Table 8. Reported ILI Anomalies Excavated per 2021 ILI Anomaly Investigation Reports

ILI Anomaly Called	Number of Anomalies Addressed	18" Cottonwood to El Paso	18" Crane to Cottonwood	18" Crane to Texon	18" Texon to Barnhart	18" Barnhart to Cartman	18" Cartman to Kimble	18" Kimble to James River	18" James River to Eckert	18" Eckert to Cedar Valley	18" Cedar Valley to Bastrop	18" Bastrop to Warda	18" Warda to Buckhorn	18" Buckhorn to Satsuma	20" Satsuma to E. Houston	20" E. Houston to Speed Jct	8" El Paso to Chevron	12" El Paso to Kinder Morgan	8" Crane to Odessa
External ML	**730**	0	0	10	305	132	96	28	62	56	23	18	0	0	0	0	0	0	0
Internal ML	**12**	0	0	0	1	0	1	6	4	0	0	0	0	0	0	0	0	0	0
Mill Anomaly w/ML	**2**	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Crack-like feature at Seam Weld	**103**	0	0	2	13	3	27	1	17	6	23	10	0	0	1	0	0	0	0
Crack-like feature at Girth Weld	**1**	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Crack-like feature at Seam & Girth Weld	**5**	0	0	0	0	0	0	0	3	0	0	2	0	0	0	0	0	0	0
Crack Colony	**2**	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
ID Reduction	**2**	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
ID Reduction with associated ML	**4**	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0
ID Reduction on Weld	**1**	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
ID Reduction L<1.5D	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ID Reduction L>1.5D	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Geometric Anomaly	**20**	0	0	0	3	3	7	2	3	1	0	0	0	0	1	0	0	0	0
Geometric Anomaly Affecting Seam Weld	**3**	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0
Geometric Anomaly Affecting Girth Weld	**3**	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Geometric Anomaly associated w/Mill Anomaly	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Geometric Anomaly associated w/ML	**6**	0	0	0	0	2	0	4	0	0	0	0	0	0	0	0	0	0	0
Geometric Anomaly associated w/ML affecting Seam Weld	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Girth Weld Anomaly	**2**	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Lack of Fusion External	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lack of Fusion Mid-wall	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lack of Fusion Internal	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lamination	**2**	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Lamination – Variable Depth	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lamination Intermittent	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lamination Intermittent associated w/ML	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Seam Weld Anomaly	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**898**	**0**	**0**	**12**	**323**	**145**	**135**	**47**	**92**	**63**	**48**	**31**	**0**	**0**	**2**	**0**	**0**	**0**	**0**

Figure 5. Google Earth Screenshot Showing PMI Dig Locations (White Dots) along the Longhorn Pipeline Route (Red Line)

Table 9. Positive Material Identification Testing Activity

	Pipeline Segment	2014	2015	2016	2017	2018	2019	2020	2021
Refined System	8″ El Paso to Chevron	0	0	0	0	0	0	0	0
	8″ Crane to Odessa	0	0	0	0	0	0	0	0
	12″ El Paso to Kinder Morgan	0	0	0	0	0	0	0	0
	18″ Cottonwood to El Paso	0	0	0	0	0	0	0	0
	18″ Crane to Cottonwood	0	0	0	0	0	0	0	0
Crude System	18″ Crane to Texon	0	1	7	0	4	15	0	4
	18″ Texon to Barnhart	0	0	8	3	0	0	2	18
	18″ Barnhart to Cartman	0	0	11	0	0	0	0	14
	18″ Cartman to Kimble	0	0	12	0	0	0	0	21
	18″ Kimble to James River	0	0	5	0	0	0	0	9
	18″ James River to Eckert	0	1	3	0	0	0	0	24
	18″ Eckert to Cedar Valley	1	0	6	7	0	0	15	6
	18″ Cedar Valley to Bastrop	0	0	20	6	0	0	35	7
	18″ Bastrop to Warda	0	1	3	4	0	0	34	6
	18″ Warda to Buckhorn	0	2	0	14	0	0	18	0
	18″ Buckhorn to Satsuma	0	0	0	8	0	0	8	0
	20″ Satsuma to E. Houston	0	4	0	0	0	3	4	1
	20″ E. Houston to 9th Street Junction	0	0	0	0	0	0	0	0
	Total PMI Tests Performed	**1**	**9**	**75**	**42**	**4**	**18**	**116**	**110**
	Segments without available Material Documentation	**2**	**18**	**141**	**64**	**7**	**31**	**232**	**195**
	Percentage Addressed (Requirement of 50%)	**50%**	**50%**	**53%**	**65%**	**57%**	**58%**	**50%**	**56%**

The 2020 MFL and UCD assessments for the following segments were correlated with the 2021 dig results: Texon to Barnhart, Barnhart to Cartman, Cartman to Kimble, Kimble to James River, James River to Eckert, Eckert to Cedar Valley, Cedar Valley to Bastrop, and Bastrop to Warda. The Crane to Texon segment correlated to the 2018 MFL/UCD assessment, and the Satsuma to East Houston segment correlated to the 2019 MFL/UCD and 2021 EGP assessments. Dig results were provided in the form of in-ditch ILI anomaly investigation maintenance and NDE reports. The ILI anomaly investigation digs resulted in 147 individually correlated metal loss features and 30 individually correlated ID reduction features. Table 10 and Table 11 provide a breakdown of the ILI anomaly investigation dig data correlations for metal loss and ID reduction features, respectively. Thirteen laminations were identified during the ILI investigation digs; two digs targeted a reported lamination, one on James River to Eckert and one on Cedar Valley to Bastrop.

The pipeline segments were reviewed by individual segments (i.e., Barnhart to Cartman) and compared to the overall system results to see if any segment differed significantly from the whole. The Cedar Valley to Bastrop and Bastrop to Warda segments were not considered for individual tool performance as they had less than five metal loss data pairs, which is not a statistically significant number of ML validation measurements.

The 2021 field investigations resulted in one internal ML to internal ML data pair and 117 external ML to external ML data pairs. Seventy-eight of the 117 external ML correlations were within the ±10% WT tool performance specification. Figure 6 through Figure 8 show the in-ditch and ILI data pairs expressed as a unity plot; the unity plots indicate that the MFL tool tends to overcall external corrosion metal loss depths. The 2021 field investigations targeted 138 external metal loss features. External metal loss features were found in-ditch to be external metal loss 117 out of 138 times, for a probability of detection of 84.8%. The remaining 21 external metal features were found in-ditch as a gouge, internal metal loss, or lamination.

Kiefner performed statistical analysis to determine an average, standard deviation, and the presence of outliers or extreme values. Appendix F – Statistics Background provides additional information on the following terminology: average, standard deviation, outliers, and extreme values. Table 12 shows the results from the statistical analysis; a negative value represents that the ILI tool has under-called the correlated features compared to the in-ditch data. No correlated features were removed from the statistical analysis. A statistical analysis was not performed on three segments as they had five data pairs or less: Bastrop to Warda, Cedar Valley to Bastrop, and Crane to Texon. Overall, the MFL tool results for external metal loss corrosion depth are shown in Table 12 as being over-called on an average of 6.5% WT for correctly identified external metal loss features. The breakdown per pipeline segment evaluated shows that the MFL tool's average for external metal loss corrosion ranges from 3.4% to 8.9% WT.

Table 10. 2021 ILI Field Investigation Metal Loss Data Correlations

Pipeline Segment	EXT ML to EXT ML	EXT ML to INT ML	EXT ML to Gouge	EXT ML to Lamination	EXT ML to Mid Wall Lamination	EXT ML to Sloping Lamination	EXT ML (GW) to EXT ML	EXT ML (SW) to EXT ML	EXT ML (SW) to Gouge	EXT ML (SW & GW) to EXT ML	INT ML to INT ML	INT ML to No Anomaly Found	INT ML (GW) to Mid Wall Crack	INT ML (GW) to No ML – Possible High/Low from Pipe Fitting	INT Mill Anomaly to Mill Defect	Girth Weld Anomaly to Pin Holes	Girt Weld Anomaly to Porosity	Lamination to Lamination	Total Data Correlations
8-in El Paso to Chevron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
8-in Crane to Odessa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
12-in El Paso to Kinder Morgan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Cottonwood to El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Crane to Cottonwood	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Crane to Texon	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**
18-in Texon to Barnhart	32	2	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	**37**
18-in Barnhart to Cartman	12	5	1	0	0	3	1	0	0	0	0	0	0	0	0	0	1	0	**23**
18-in Cartman to Kimble	25	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	**31**
18-in Kimble to James River	9	0	1	0	0	0	0	0	1	0	0	3	1	0	1	0	0	0	**16**
18-in James River to Eckert	17	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	1	**21**
18-in Eckert to Cedar Valley	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**8**
18-in Cedar Valley to Bastrop	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	**4**
18-in Bastrop to Warda	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**4**
18-in Warda to Buckhorn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Buckhorn to Satsuma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Satsuma to E. Houston	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in E. Houston to Speed Jct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total	**112**	**7**	**2**	**4**	**1**	**6**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**2**	**2**	**1**	**1**	**2**	**149**

Table 11. 2021 ILI Field Investigation ID Reductions Data Correlations

Pipeline Segment	Dent to Dent	Dent w/ML to Dent w/ML	Dent w/ML to Dent	Dent Affecting Seam Weld to Dent	Geometric Anomaly to Geometric Anomaly	Geometric Anomaly to Geometric Anomaly w/ML	Geometric Anomaly to Gouge	Geometric Anomaly w/ML to Geometric Anomaly	Geometric Anomaly w/ML to Geometric Anomaly w/ML	Geometric Anomaly Affecting SW to Geometric Anomaly	Geometric Anomaly Affecting GW to Geometric Anomaly	Total Data Correlations
8-in El Paso to Chevron	0	0	0	0	0	0	0	0	0	0	0	**0**
8-in Crane to Odessa	0	0	0	0	0	0	0	0	0	0	0	**0**
12-in El Paso to Kinder Morgan	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Cottonwood to El Paso	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Crane to Cottonwood	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Crane to Texon	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Texon to Barnhart	0	0	0	0	3	0	0	0	0	0	0	**3**
18-in Barnhart to Cartman	0	2	0	1	3	0	0	1	1	0	1	**9**
18-in Cartman to Kimble	0	0	1	0	7	0	0	0	0	1	0	**9**
18-in Kimble to James River	2	0	1	0	2	0	0	4	0	1	1	**11**
18-in James River to Eckert	0	0	0	0	1	1	1	0	0	0	0	**3**
18-in Eckert to Cedar Valley	0	0	0	0	1	0	0	0	0	0	0	**1**
18-in Cedar Valley to Bastrop	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Bastrop to Warda	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Warda to Buckhorn	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Buckhorn to Satsuma	0	0	0	0	0	0	0	0	0	0	0	**0**
18-in Satsuma to E. Houston	0	0	0	0	1	0	0	0	0	0	0	**1**
18-in E. Houston to Speed Jct	0	0	0	0	0	0	0	0	0	0	0	**0**
Total	**2**	**2**	**2**	**1**	**18**	**1**	**1**	**5**	**1**	**2**	**2**	**37**

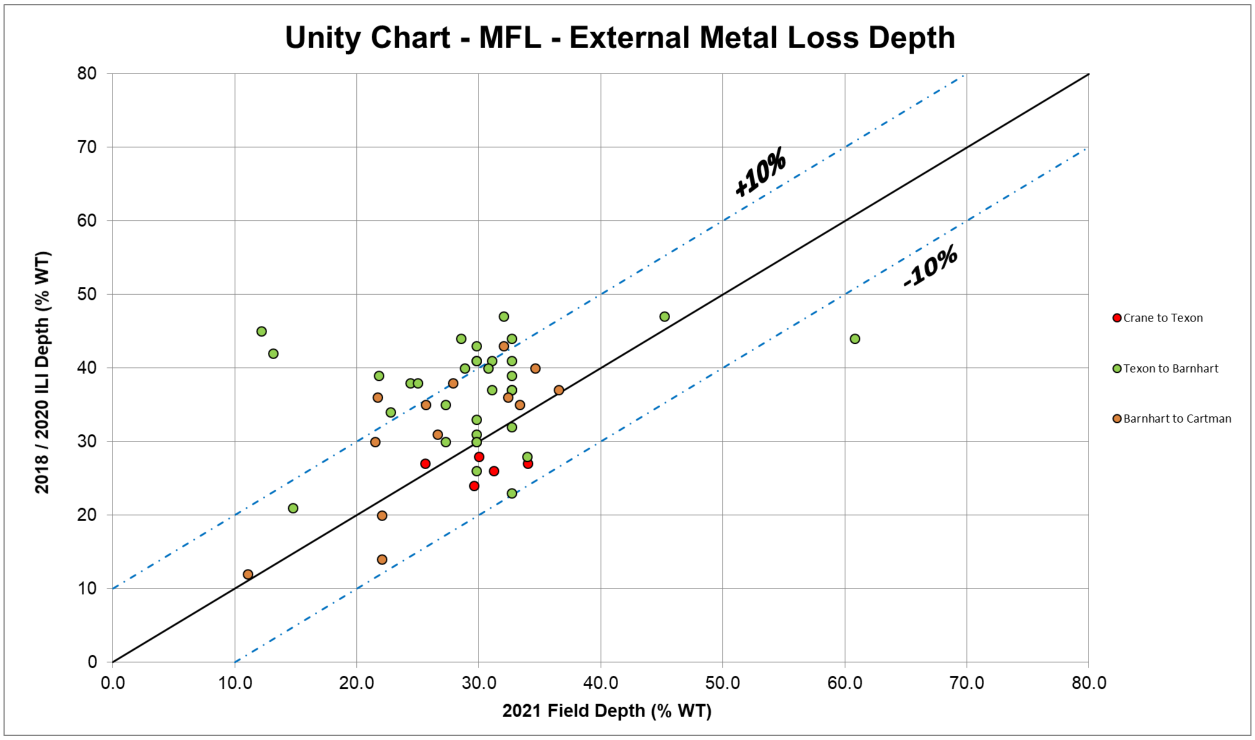

Figure 6. Unity Chart for Depth Verification for MFL External Metal Loss Crane to Cartman (Upper Bound ±10% WT)

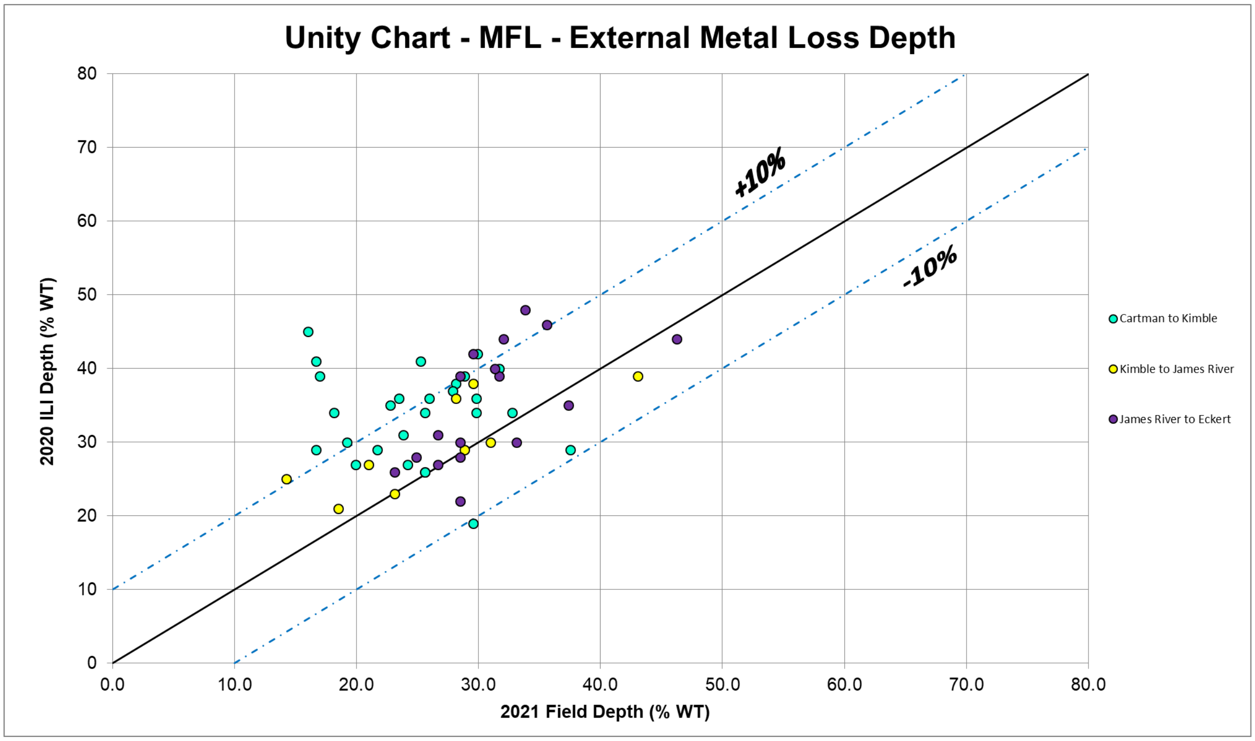

Figure 7. Unity Chart for Depth Verification for MFL External Metal Loss – Cartman to Eckert (Upper Bound ±10% WT)

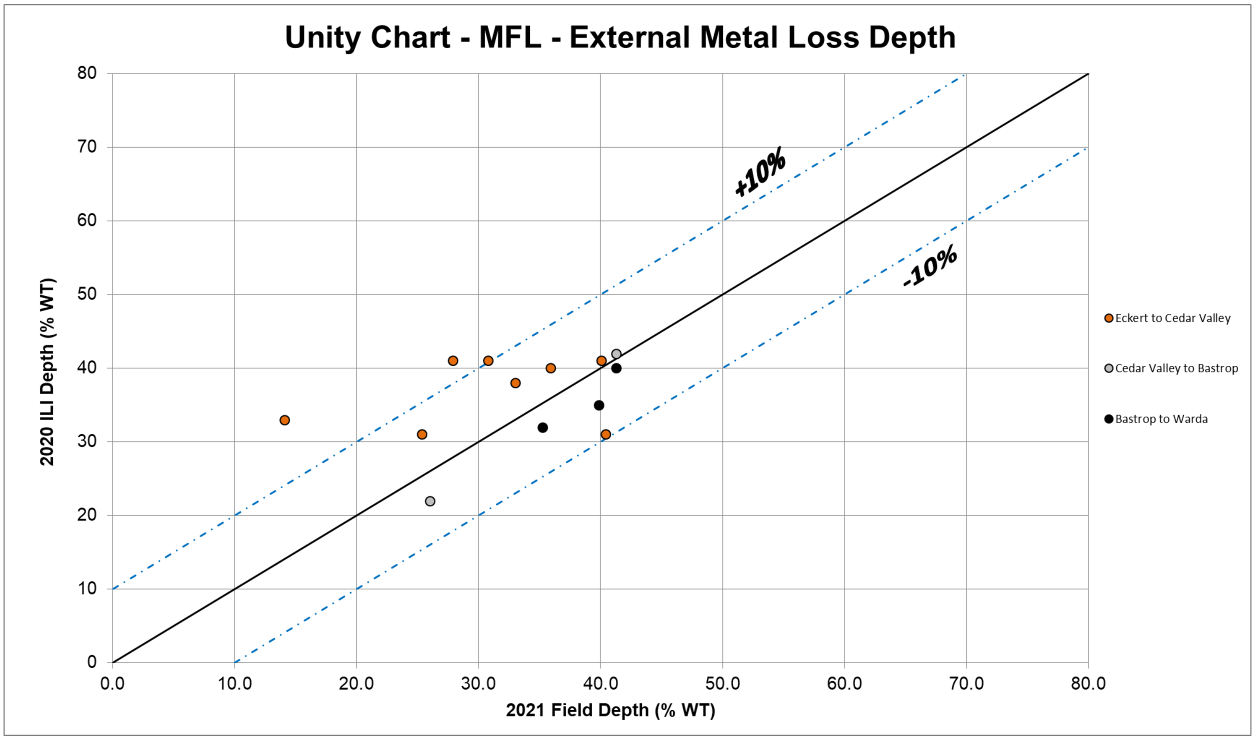

Figure 8. Unity Chart for Depth Verification for MFL External Metal Loss – Eckert to Warda (Upper Bound ±10% WT)

Table 12. Summary of Sizing and Population Density for MFL External Metal Loss Features

	2021 Overall MFL External ML Results	Texon to Barnhart	Barnhart to Cartman	Cartman to Kimble	Kimble to James River	James River to Eckert	Eckert to Cedar Valley
Depth Accuracy (%)	±10	±10	±10	±10	±10	±10	±10
Total Number of Matched Features	107	33	13	27	9	17	8
Number of Features used in Analysis	107	33	13	27	9	17	8
Total Number of Features within Tool Specification	68	19	10	14	8	12	5
Average Size Difference (% WT)	6.5	7.3	4.6	8.9	3.4	4.3	6.8
Standard Deviation (% WT)	8.2	9.7	6.1	8.6	5.1	6.3	8.5
80% Random Error (% WT)	10.5	12.4	7.8	11.0	6.5	8.1	10.9

In 2021, 78 ILI anomaly investigations targeted crack-like, crack colony, or crack-like inspection sheet features reported from the 2019/2020 UCD assessments on ten of the twelve pipeline segments between Crane to East Houston. Table 13 and Table 14 show the results for the UCD-reported crack-like features and the crack colony or crack-like inspection sheet features.

Magellan targeted 85 crack-like features in 2021 on nine pipeline segments, Table 13. Targeted crack-like features were found in-ditch as cracks 76 times. Six pipeline segments targeted five or more reported crack-like features. Reported crack-like features investigated in-ditch on these segments were found as cracks 78.9% of the time for the James River to Eckert segment, 80% of the time for the Eckert to Cedar Valley and the Bastrop to Warda segments; 90.9% of the time for the Cartman to Kimble segment; and 100% of the time for the Texon to Barnhart, and the Cedar Valley to Bastrop segments. The nine other crack-like features were found in-ditch as lack of fusion (LOF) indications five times and as weld geometry features four times.

Three crack colony features and 19 crack-like inspection sheet features were targeted in 2021, Table 14. Two crack colonies were located on the James River to Eckert segment, and one was on the Cartman to Kimble segment. The two crack colonies on the James River to Eckert segment were found as no anomaly found in-ditch and inclusion, while the ILI reported crack colony on the Cartman to Kimble segment was found in-ditch as cracking in the pipe body. The 19 crack-like inspection sheet features were reported over nine pipeline segments. Fifteen of the 19 crack-like inspection sheet features were confirmed as cracking, found in-ditch as cracking (78.9%). Three of the four other crack-like inspection sheet features were found in-ditch as LOF, and the remaining feature did not have an anomaly found in-ditch.

Table 13. In-Ditch Dig Results for ILI Reported Crack-Like Features

Pipeline Segment	ILI Reported Features	In-Ditch Field Results				Percentages (%)			
	Crack-Like	Crack	LOF	Weld Geometry	Weld Geometry with Mechanical Gash	Crack-like to Crack	Crack-like to LOF	Crack-like to Weld Geometry	Crack-like to Weld Geometry w/Mechanical Gash
Satsuma to East Houston	1	1	-	-	-	N/A	-	-	-
Bastrop to Warda	10	8	2	-	-	80	20	-	-
Cedar Valley to Bastrop	17	17	-	-	-	100	-	-	-
Eckert to Cedar Valley	5	4	1	-	-	80	20	-	-
James River to Eckert	19	15	-	3	1	78.9	-	15.8	5.3
Cartman to Kimble	22	20	2	-	-	90.9	9.1	-	-
Barnhart to Cartman	1	1	-	-	-	N/A	-	-	-
Texon to Barnhart	9	9	-	-	-	100	-	-	-
Crane to Texon	1	1	-	-	-	N/A	-	-	-
Total	**85**	**76**	**5**	**3**	**1**	**89.4**	**5.9**	**3.5**	**1.2**

Table 14. In-Ditch Dig Results for ILI Reported Crack Colony and Crack-Like Inspection Sheet Features

Pipeline Segment	ILI Reported Features		In-Ditch Field Results			
	Crack Colony	Crack-Like SW Inspection Sheet	Crack	LOF	No Anomaly Found	Inclusion
Bastrop to Warda	-	2	-	2	-	-
Cedar Valley to Bastrop	-	4	4	-	-	-
Eckert to Cedar Valley	-	1	-	1	-	-
James River to Eckert	2	1	-	1	1	1
Kimble to James River	-	1	1	-	-	-
Cartman to Kimble	1	3	4	-	-	-
Barnhart to Cartman	-	2	2	-	-	-
Texon to Barnhart	-	4	4	-	-	-
Crane to Texon	-	1	1	-	-	-
Total	**3**	**19**	**16**	**4**	**1**	**1**

2.2.4 ID Reductions

Magellan runs EGPs to assess TPD's threat and monitor for possible hydrogen blistering. The ORA classifies ID reductions as deformation of pipe diameter detected by the ILI tool; ID reductions ≥ 2.0% of the pipe diameter classify as dents, and ID reductions < 2.0% of the pipe diameter classify as GMAs.

The 2021 EGP assessments reported 101 ID reductions (ten dents and 91 GMAs) with depths ranging from 1.0% to 4.9% OD. Twelve ID reductions (two dents and ten GMAs) have been previously repaired, as noted in the ILI pipeline listings. Eight dents and 81 GMAs constitute the remaining 89 ID reductions. The ILI assessments reported no dents or GMAs associated with metal loss or seam welds. The Crane to Texon ILI assessment reported one GMA crossing a girth weld in a non-HCA.

Twenty-six ID reductions are reported in an HCA, with ten noted as previously repaired; Table 15 provides a breakdown of the ID reductions reported in an HCA. The largest reported unmitigated ID reduction depth per pipeline segment is noted in Table 15. Two segments did not have ID reductions reported in an HCA: Odessa to Crane and Crane to Texon. Magellan performed an ILI anomaly investigation on five ID reductions in HCA in 2021; one GMA associated with metal loss and affecting seam weld, one GWA affecting seam weld, and three GMAs. The remaining unmitigated ID reductions do not meet regulatory repair criteria (equal to or greater than 2% OD and interact with a long seam or girth weld).

Table 15. ID Reductions Reported within HCAs [13]

Segment	Quantity	Quantity Noted as Repaired	Peak Depth (% OD)*	Comment
Satsuma to East Houston	25	10	1.6	• 1 Dent (2.3% OD) – noted as repaired • 24 GMAs (1.0-1.8% OD) ○ Ten GMAs noted as repaired (1.0-1.8% OD)
Crane to Cottonwood	1	0	1.1	• 1 GMA (1.1% OD)
Total	**26**	**10**		

*Peak depth is the largest unmitigated ID Reduction located in an HCA for that pipeline segment.

2.2.5 Laminations and Hydrogen Blisters

Continued monitoring of the lamination anomalies for the possibility of blister growth with ILI tools was recommended per the Longhorn Pipeline Reversal EA, Section 6.2.1.2. Laminations can occur due to oxides or other impurities trapped in the material. As the material cools in the manufacturing process, a small pocket may form internally in the steel plate or billet. A lamination can eventually lead to failure when it is oriented such that it eventually grows to the inner or outer wall of the pipe or pipeline component through pressure cycles. Laminations parallel to the pipe wall surface generally do not pose an integrity concern unless a blister is formed. Crude oil may contain hydrogen sulfide, which can lead to the formation of hydrogen through anaerobic internal corrosion. Laminations in the pipe wall can trap hydrogen from the

[13] ID reductions are classified as either dents or geometric anomalies. A dent is an ID reduction greater than or equal to 2% OD and a geometric anomaly is an ID reduction less than 2% OD.

corrosion reaction and generate blisters. Elevated cathodic protection (CP) can also lead to hydrogen migration and blistering. Managing internal corrosion and monitoring CP levels could help mitigate these threats.

Kiefner correlated ID reductions identified from the 2021 EGP assessments with laminations reported from the 2009/2010 UT assessments. One dent and seven GMAs reported from the 2021 assessments were found to be present on the same joint that had a lamination(s) reported from the 2009/2010 UT assessments (see Table 16). The dent and GMAs did not correlate directly to laminations from the 2009/2010 UT assessments.

Table 16. ID Reductions Correlating with Laminations[14]

Segment	Quantity			Peak Depth (% OD)	List of Joints from 2021 Assessment	Comment
	Joint(s)	Dent(s)	GMA(s)			
Satsuma to East Houston	4	1	5	1.6~	14100*, 21400, 26300*, and 29360	• 2021 Joint 14100 has one reported dent; 2009 UT assessments reported two 'Intermittent Laminations' on the associated joint. • 2021 Joint 21400 has one reported GMA; 2009 UT assessments reported two laminations and two 'Intermittent Laminations' on the associated joint. • 2021 Joint 26300 has three reported GMAs all noted as repaired; 2009 UT assessments reported four laminations and four 'Intermittent Laminations' on the associated joint. • 2021 Joint 29360 has one reported GMA; 2009 UT assessments reported one 'Intermittent Lamination' on the associated joint.
Crane to Texon	1	0	2	1.3	43100	• 2021 Joint 43100 has two reported GMAs; 2010 UT assessments reported one 'Lamination Sloping' on the associated joint.
Total	**5**	**1**	**7**			

*Features are noted in the pipeline listing as repaired or addressed.
~Largest unmitigated GMA.

A review of the 2021 maintenance reports showed that two scheduled ILI anomaly investigations targeted a reported lamination. Thirteen laminations were found on eleven different joints during in-ditch assessments in 2021. Monitoring reported laminations for ID reductions might indicate the initiation of a hydrogen blister. Per the Longhorn EA Section 9.3.2.3, the monitoring frequency recommended should coincide with the EGP tool assessment schedule. EGP assessments are required for the Existing Pipe every three years, according to the LMP, except for the section between East Houston and Speed Junction. The next EGP assessment for the crude system is in 2022 for the Buckhorn to Warda segment; see Table 33.

[14] Features may not be directly correlating (i.e., overlapping area), but were identified in this table if reported on the same joint.

2.3 Corrosion Management Plan

The LMP entails an extensive Corrosion Management Plan (CMP) to control the extent of corrosion. The 2021 CMP considered the following items: Probability of Exceedance (POE), review of internal corrosion coupons, review of field digs reports (covered under Section 2.2.3 Maintenance Reports and In-Ditch Evaluations), review of CP system for buried pipelines, review of atmospheric inspection for above grade appurtenances, and review of tank inspections.

2.3.1 Probability of Exceedance Analysis

POE calculations were only performed on the Odessa to Crane segment assessed by MFL in 2021. The POE calculations incorporated the ILI tool specifications (TDW MFL) and utilized a CGR of 5 mpy for external ML and 1 mpy for internal ML over a 5-year range. No metal loss features had a calculated POE value exceeding $10E^{-7}$.

2.3.2 Internal Corrosion Coupons

Magellan monitors internal corrosion using internal corrosion coupons placed at six locations along the Longhorn Crude Lines and six locations along the Longhorn Refined Lines. The inserted and removed dates of coupons fell between 12/10/2020 to 12/15/2021. The coupon testing days were from 78 to 129 days for the Longhorn system. Due to the long days of exposure at some locations of the refined line, Magellan cannot achieve the three evaluation times in the calendar year 2021 for the refined line. The locations that did not have three evaluations in 2021 are highlighted in red in Table 17. One coupon from the 8-inch Odessa to Crane segment was lost in the line. According to the coupon testing results for the remaining coupons, corrosion rates observed ranged from no corrosion to the maximum of 0.08 mpy on the internal corrosion coupons for the Longhorn system. Monitoring should continue to identify future potential changes in the pipelines. Table 17 lists internal corrosion coupon results for the refined line and Table 18 for the crude line.

Table 17. Internal Corrosion Coupon Results for Refined Line

Pipe OD (inch)	Location	Line Designation (Line ID)	Coupon Number	Inserted	Removed	Exposure (days)	Rate (mpy)
12*	El Paso	KM 12" (6651)	AB2928	08/13/2021	12/15/2021	124	0.00
8*	El Paso	KM 8" flush (6652)	AB2929	08/13/2021	12/15/2021	124	0.00
8*	El Paso	Strauss 8" (6653)	AB3179	08/13/2021	12/15/2021	124	0.00
8*	Crane	8” Odessa to Crane (6648)	Lost in line 8/16/2021.				
18	El Paso	18" ML (6645)	AX0068	12/102020	04/15/2021	126	0.04
18	El Paso	18" ML (6645)	N0006	04/15/2021	08/13/2021	120	0.02
18	El Paso	18" ML (6645)	N0003	08/13/2021	12/15/2021	124	0.01
8	El Paso	Plains-8" (6650)	AX0064	12/10/2020	04/15/2021	126	0.07
8	El Paso	Plains-8" (6650)	N0007	04/15/2021	08/13/2021	120	0.02
8	El Paso	Plains-8" (6650)	N0004	08/13/2021	12/15/2021	124	0.02

*Stations highlighted in red had one internal corrosion coupon evaluation in 2021.

Table 18. Internal Corrosion Coupon Results for Crude Line

Pipe OD (inch)	Location	Line Designation (Line ID)	Coupon Number	Inserted	Removed	Exposure (days)	Rate (mpy)
20	Speed Jct	Speed Jct Manifold from E Houston (6643)	AA9274	12/15/2020	04/12/2021	118	0.03
20	Speed Jct	Speed Jct Manifold from E Houston (6643)	AB2846	04/12/2021	08/10/2021	120	0.00
20	Speed Jct	Speed Jct Manifold from E Houston (6643)	AB3224	08/10/2021	12/15/2021	124	0.00
20	E. Houston	East Houston ML (6645)	Y8723	12/14/2020	04/15/2021	122	0.06
20	E. Houston	East Houston ML (6645)	Y8685	4/15/2021	8/15/2021	122	0.05
20	E. Houston	East Houston ML (6645)	Y8715	8/15/2021	12/15/2021	122	0.02
18	Austin	18" Satsuma Station (6645)	AA9277	12/16/2020	04/14/2021	119	0.02
18	Austin	18" Satsuma Station (6645)	AB2848	04/14/2021	08/10/2021	118	0.03
18	Austin	18" Satsuma Station (6645)	AB3226	08/10/2021	12/10/2021	122	0.02
18	Austin	18" Cedar Valley Station (6645)	AA9276	01/08/2021	04/09/2021	91	0.04
18	Austin	18" Cedar Valley Station (6645)	AB2847	04/09/2021	08/16/2021	129	0.00
18	Austin	18" Cedar Valley Station (6645)	AB3225	08/16/2021	12/03/2021	109	0.01
18	Austin	18" Cartman Station (6645)	AA9275	01/12/2021	04/21/2021	99	0.03
18	Austin	18" Cartman Station (6645)	AB2845	04/21/2021	09/22/2021	154	0.04
18	Austin	18" Cartman Station (6645)	AA9252	09/22/2021	12/09/2021	78	0.00
24	Crane	24" Tank Manifold	Y8484	12/14/2020	04/14/2021	121	0.08
24	Crane	24" Tank Manifold	Y8682	04/14/2021	08/16/2021	124	0.02
24	Crane	24" Tank Manifold	Y8709	08/16/2021	12/09/2021	115	0.07

2.3.3 Cathodic Protection System

The rectifier inspections and maintenance, test point surveys, and CIS were reviewed to evaluate the effectiveness of the current CP systems for the Longhorn pipeline system. The rectifiers were inspected in 2021, including the effective date, as-found voltage and current, and as-left voltage and current, referring to the "Magellan CIS Report." Test point surveys were conducted throughout the Longhorn system (except Odessa to Crane) in May and November of 2021, referring to the "DOT summary report." A CIS was performed in March 2021 and received by Magellan in May 2021 for pipeline ROW 6645 tier 3 segment from Mile Post 11.5931 to 276.8333, referring to "Magellan CIS Report." This CIS survey covers a total of 136 test stations and 23 casings. The CIS data were analyzed and summarized in Table 19. Semi-annual surveys are being conducted on Tier II and Tier III areas per LMP 32.

Based on the Longhorn CMP, corrosion control activities are governed by company policies and procedures and DOT Part 195 regulations and are consistent with NACE International RP01-69, ASME, and API recommended practices where applicable.

NACE International has established criteria considered indicative of CP for metallic piping in NACE Standard Practice SP0169-2013 (formerly RP01-69) – "Control of External Corrosion on Underground or Submerged Metallic Piping Systems." The Standard lists the following criteria:

- A minimum of 100 mV of cathodic polarization. The formation or the polarization's decay must be measured to satisfy this criterion.
- A structure-to-electrolyte potential of -850 mV or more negative as measured with respect to a saturated copper/copper sulfate (CSE) reference electrode. This potential may be either a direct measurement of the polarized or current-applied potential. Interpreting a current-applied measurement requires considering the significance of voltage drops in the earth and metallic paths.

Table 19 summarizes the details of the CIS data where the pipe segments are not meeting either a minimum of 100 mV of cathodic polarization or the polarized potential of -850 mV. It was reported to Kiefner that the 2022 Tier III survey was completed as these locations showing zero locations not meeting a criteria. The survey results will be reviewed in the 2022 ORA report.

The 2021 CIS data also indicates that some pipe sections had the “instant off” readings slightly more electronegative than -1200 mV with respect to a CSE reference electrode, meaning the CP system may overprotect these pipe sections. Such areas are summarized in Table 20. Over-cathodic protection may deteriorate pipe coatings due to electrical osmosis and hydrogen reaction weakening the bonding between coating and pipe steel. The LMP states, “While no evidence exists that would indicate that excessive cathodic protection has caused damage to the external coating on the Longhorn Pipeline, the entire pipeline will be monitored for overprotection as well as under protection. Cathodic protection system adjustments will be made, as necessary, to remediate any area of concern. Overprotection will be monitored and minimized through the analysis of data from annual pipe-to-soil potential surveys, close-interval pipe-to-soil potential surveys, and pipeline visual inspections. A practical value of -1.2 V (polarized) in reference to copper/copper sulfate cell will be used as the value beyond which monitoring for overprotection shall be implemented.”

Table 19. CIS Areas not Meeting Any Criteria

Potentials Not Meeting any Criteria													
Exception #	Start ST	End ST	Total Feet	Start MP	End MP	Starting GPS		Ending GPS		P/S On	P/S Off	P/S Depol	Lowest Exception
						Latitude	Longitude	Latitude	Longitude				
1	9590+44	9591+71	127	181.6371	181.6612	30.24181175	-98.02285767	30.24190521	-98.02320862	-0.647	-0.556	-0.557	-0.001
2	9619+68	9619+86	18	182.1909	182.1943	30.24356651	-98.03157806	30.24356461	-98.03160095	-0.708	-0.457	-0.362	0.095
3	11258+90	11258+98	8	213.2367	213.2383	30.36450577	-98.52188873	30.36451149	-98.52189636	-1.635	-0.918	-0.825	0.093
4	11263+41	11263+41	0	213.3222	213.3222	30.36496735	-98.52329254	30.36496735	-98.52329254	-1.464	-0.683	-0.590	0.093
5	11270+13	11270+33	20	213.4494	213.4532	30.36544228	-98.52557373	30.36545181	-98.52561951	-1.144	-0.534	-0.473	0.061
6	11270+40	11271+40	100	213.4545	213.4735	30.36545372	-98.52564240	30.36552620	-98.52593231	-1.067	-0.437	-0.472	-0.035
7	11271+51	11277+36	585	213.4756	213.5864	30.36553001	-98.52596283	30.36624908	-98.52738953	-0.957	-0.333	-0.379	-0.046
8	11277+43	11278+71	128	213.5877	213.6119	30.36625862	-98.52741241	30.36639977	-98.52763367	-0.900	-0.386	-0.399	-0.013
9	11278+79	11278+82	3	213.6134	213.6140	30.36641121	-98.52764893	30.36641121	-98.52764893	-0.834	-0.437	-0.389	0.048
10	11279+09	11279+43	34	213.6191	213.6256	30.36643791	-98.52769470	30.36647797	-98.52774811	-0.849	-0.415	-0.349	0.066
11	11279+51	11279+79	28	213.6271	213.6324	30.36648560	-98.52776337	30.36652184	-98.52781677	-0.865	-0.410	-0.351	0.059
12	11279+86	11280+17	31	213.6337	213.6396	30.36652946	-98.52782440	30.36658096	-98.52787781	-0.848	-0.403	-0.349	0.054
13	14615+91	14615+91	0	276.8165	276.8165	30.62553787	-99.52713776	30.62553787	-99.52713776	-1.882	-0.612	-0.515	0.097
14	14615+98	14616+80	82	276.8178	276.8333	30.52716064	-99.52716064	30.62541389	-99.52701569	-1.913	-0.687	-0.777	-0.090
Note: 2022 Tier III survey was completed at these locations showing zero locations not meeting a criteria.													

Table 20. 2021 CIS Areas Where Off Potentials are More Negative Than -1.250 V

Off Above -1.250										
Exception #	Start ST	End ST	Total Feet	Start MP	End MP	Starting GPS		Ending GPS		Highest Exception
						Latitude	Longitude	Latitude	Longitude	
1	1046+41	1046+55	14	19.8184	19.8210	29.88571167	-95.38603973	29.88571930	-95.38610077	-1.254
2	1094+78	1094+90	12	20.7345	20.7367	29.88580322	-95.40180969	29.88580513	-95.40184784	-1.252
3	1095+21	1095+63	42	20.7426	20.7506	29.88577843	-95.40199280	29.88578033	-95.40210724	-1.255
4	1096+03	1097+21	118	20.7581	20.7805	29.88577652	-95.40225983	29.88578224	-95.40271759	-1.259
5	1097+50	1097+72	22	20.7860	20.7902	29.88578796	-95.40280914	29.88579178	-95.40287781	-1.251
6	1097+98	1098+21	23	20.7951	20.7994	29.88578987	-95.40295410	29.88579750	-95.40303802	-1.250
7	1108+72	1108+89	17	20.9985	21.0017	29.88574791	-95.40661621	29.88575172	-95.40666962	-1.258
8	1111+32	1112+08	76	21.0477	21.0621	29.88574600	-95.40742493	29.88573837	-95.40764618	-1.271
9	1112+36	1112+92	56	21.0674	21.0780	29.88574219	-95.40776062	29.88572502	-95.40792847	-1.257
10	1113+09	1115+64	255	21.0813	21.1295	29.88573456	-95.40802002	29.88574028	-95.40852356	-1.280
11	1120+67	1122+08	141	21.2248	21.2515	29.88579369	-95.40990448	29.88581085	-95.41034698	-1.268
12	1124+00	1124+20	20	21.2879	21.2917	29.88579941	-95.41087341	29.88579559	-95.41094208	-1.250
13	1125+41	1125+58	17	21.3146	21.3178	29.88586617	-95.41125488	29.88586998	-95.41133118	-1.277
14	1125+84	1125+87	3	21.3227	21.3233	29.88586998	-95.41139984	29.88586808	-95.41146088	-1.258
15	1227+29	1227+66	37	23.2441	23.2511	29.88996887	-95.44253540	29.88999367	-95.44264984	-1.255
16	1822+10	1822+30	20	34.5095	34.5133	29.91271782	-95.62513733	29.91276360	-95.62516022	-1.252
17	1992+55	1992+74	19	37.7377	37.7413	29.91933632	-95.67595673	29.91934395	-95.67601776	-1.251
18	1993+01	1994+21	120	37.7464	37.7691	29.91935349	-95.67610931	29.91938972	-95.67638397	-1.267
19	1994+43	1994+60	17	37.7733	37.7765	29.91939735	-95.67647552	29.91940308	-95.67652130	-1.253
20	1994+84	1996+03	119	37.7811	37.8036	29.91941261	-95.67661285	29.91943932	-95.67683411	-1.284
21	1996+37	1996+55	18	37.8100	37.8134	29.91946411	-95.67699432	29.91947365	-95.67704010	-1.260
22	1996+83	1997+47	64	37.8188	37.8309	29.91948700	-95.67713165	29.91952705	-95.67734528	-1.268
23	2002+89	2003+08	19	37.9335	37.9371	29.91975594	-95.67916107	29.91976547	-95.67922211	-1.252
24	2017+80	2023+72	592	38.2159	38.3280	29.92041969	-95.68425751	29.92066574	-95.68608093	-1.352
25	10811+86	10819+84	798	204.7701	204.9212	30.33363533	-98.38500977	30.33411789	-98.38716125	-1.975
26	10820+62	10830+66	1004	204.9360	205.1261	30.33419228	-98.38740540	30.33493423	-98.39004517	-1.392
27	12124+80	12129+80	500	229.6364	229.7311	30.45116997	-98.77286530	30.45157433	-98.77431488	-1.436
28	12131+94	12137+31	537	229.7716	229.8733	30.45174599	-98.77484894	30.45217896	-98.77616119	-1.632
29	14130+45	14130+64	19	267.6222	267.6258	30.60507774	-99.37578583	30.60509109	-99.37583160	-1.266

2.3.4 AC Potential Survey

The pipe-to-soil AC voltage survey was conducted when the 2021 CIS was performed for the pipeline ROW segment 6645. The AC voltage survey collected 135 test points during the CIS survey in March 2021, with a maximum reported AC voltage of 4.321 V at Mile Post 170.2953 (Brodie Lane WSD). Magellan has a remote control unit (RMU) with AC current density monitoring device installed at this location on May 5th, 2022, showing the AC current density was 2.6A/m^2. This level of AC current density is not expected to cause AC induced corrosion on the pipe. It is recommended to continue monitoring the AC readings during the future CIS survey.

2.3.5 Atmospheric Inspections

Magellan monitors the condition of above-grade appurtenances following annual atmospheric inspections, including station piping, tanks, valve settings, and exposed piping. Table 21 lists the locations of concern in the Longhorn Pipeline System where corresponding repairs were performed in 2021.

Table 21. Atmospheric Maintenance Summary

Atmospheric Facility Type	Location Description	Repair Found Date	Repair Corrected Date	Milepost	Inspection Remarks
Satsuma – East Houston station piping	Outbound trap	8/4/2021	6/4/2022	2.360	Inadequate coating on the piping North of valve 236 on the outbound risers. Update: coating has been repaired.
Buckhorn – Satsuma exposed pipe	Cypress creek	5/6/2021	5/17/2022	47.067	Mostly submerged by running water. What is visible is a 4. Re-inspect in Fall 2021
Buckhorn – Satsuma exposed pipe	East of oil field road	5/5/2021	5/17/2022	65.800	Submerged under muddy water. Re-inspect Fall 2021
Satsuma station piping	Receiver/Incoming and drain line	5/7/2021	6/1/2022	1.000	Spot repairs on MOV 16 and G1003 piping
Satsuma station piping	Launcher/Outgoing and drain line	5/7/2021	6/1/2022	3.000	Spot repairs on g1014/1" relief lines/stair supports/ grating
Satsuma station piping	West Piping/Valves	5/7/2021	6/1/2022	4.000	Spot repairs on g1014/1" relief lines/stair supports/ grating
Satsuma station piping	West Piping/Valves	5/7/2021	6/1/2022	5.000	Flange at MOV 1020b/ bottom of 16" BV/ horizontal surface of valve 1010A
Satsuma station piping	N. Pump suction/discharge	5/7/2021	6/1/2022	6.000	Recoat sump lines from pump containment
Satsuma station piping	S. Pump suction/discharge	5/7/2021	6/1/2022	7.000	Recoat sump lines from the pump
Texon – Barnhart exposed pipe	Exposure in Sand Flat - 1	1/27/2021	5/26/2021	412.280	Re-inspect by 6/1/2021
Texon – Barnhart exposed pipe	Exposure in Sand Flat - 3	1/27/2021	5/26/2021	412.312	Re-inspect by 6/1/2021
Kimble County station piping	Kimble station – central piping/valves	5/12/2021	8/12/2022	2.000	Completed touch-ups
Warda – Buckhorn exposed pipe	West of Schuster Rd. East of Pond	4/20/2021	10/11/2021	107.290	Silted in. Re-inspect Fall 2021
Warda – Buckhorn exposed pipe	Between Rauch Rd and FM 2145	4/20/2021	10/11/2021	108.130	Silted in. Re-inspect Fall 2021
Bastrop – Warda exposed pipe	E of CR 448	4/21/2021	3/23/2022	116.200	Needs <10 small spot repairs with an aerosol can
Bastrop – Warda exposed pipe	West of FM 448	4/21/2021	10/12/2021	117.920	Silted in. Re-inspect Fall 2021
James River – Eckert exposed pipe	Pasture Exposure	6/8/2021	10/20/2021	232.070	Submerged running creek. Re-inspect fall 2021
James River – Eckert exposed pipe	West of HWY 87, East of two track	6/8/2021	10/20/2021	244.830	Submerged running creek. Re-inspect fall 2021
Eckert station piping	Receiver/Incoming, bypass and drain line	6/9/2021	3/9/2022	1.000	Recoat top of MOVs 2 and 4/1" bypass/3in flange G206
Eckert station piping	Launcher/Outgoing and drain line	6/9/2021	3/9/2022	2.000	Recoat top of MOVs 7 and 8 and MOV 8 flange
Eckert station piping	Strainer Manifold	6/9/2021	3/9/2022	4.000	Recoat top of 4 MOVs and 20ft of 1in bypass
Eckert station piping	MOV 5/MOV 6 Manifold	6/9/2021	3/9/2022	5.000	MOV 5 and MOV 6 flange bolts of 1in bypass
Warda station piping	1010/1020/Strainer Manifold	6/21/2021	3/20/2022	4.000	Recoat the top of 4 MOVs and a small spot on the strainer riser
Bastrop station valve settings	Central Piping/Valves	6/22/2021	3/12/2022	3.000	Recoat tops of 4 MOVs
James River station valve settings	Central Piping/Valves	6/8/2021	3/5/2022	3.000	Top of 6 corroded MOVs
Cedar Valley station piping	Receiver/Incoming and drain line	1/1/2021	3/10/2022	1.000	Unallocated for 2022 as needed
Cedar Valley station piping	Launcher/Outgoing and drain line	7/1/2021	3/10/2022	3.000	Recoat 2 in line near ROV 9
Cedar Valley station piping	East and West Pumps	7/1/2021	3/10/2022	6.000	Recoat incoming and outgoing piping on both pumps
Cottonwood – El Paso exposed pipe	Exposed in wash	9/8/2021	6/20/2022	619.400	Recoat transition and add more matting. Repaired by AI

2.3.6 Tank Inspections

No API 653 tank inspections were conducted in 2021. Magellan conducted API 653 tank external inspections on individual tanks in 2017, 2018, 2019, and 2020 and has been reviewing the inspection interval to comply within 5 years.

2.4 Earth Movement and Water Forces

The LMP evaluates the integrity concerns resulting from the ground movement from aseismic faults and soil erosion caused by scouring. Fault crossings, allowable displacement at faults, and fault movements from the past 17.5 years were compared to evaluate any integrity threats on the Longhorn Pipeline System. In addition, waterway inspections and periodic depth of cover inspections were conducted at some of the river crossing locations.

2.4.1 Fault Crossings

The Longhorn Pipeline System crosses several aseismic faults between Harris County (Houston area) and El Paso, TX. No active fault crossing the pipeline is reported West of Harris County[15]. Within Harris County, the pipeline crosses seven aseismic faults that are considered to be active. Those active faults are Akron, Melde, Breen, and Hockley, which cross the original Longhorn pipeline, and McCarty, Negyev, and Oates faults, which cross the new East Houston line constructed in 2012. Table 22 includes approximate location information for each benchmark based on hand-held global positioning system (GPS) and pipeline alignment measurements. The stations have two benchmarks, one on each side of a fault trace. One benchmark is installed on the upthrown block (the side of the fault that appears to move up relative to the opposite side), and the other benchmark is installed on the downthrown block (the side of the fault that appears to move down relative to the opposite side). Table 23 summarizes the available geologic data for Akron, Melde, Breen, and Hockley faults.

Table 22. Approximate Location Information for each Faults Benchmark[16]

Fault	Benchmark	Latitude & Longitude		Drawing	Station
		North	West		
Akron	A-1	29.77605	-95.23153	GEA-160-009	202+90±60
	A-2	29.77530	-95.23175		
Melde	M-1	29.80163	-95.23200	-	298+60±50
	M-2	29.80193	-95.23200		
Breen	B-1	29.89350	-95.48500	-	1364+85±50
	B-2	29.89370	-95.48540		
Hockley	H-1	29.93790	-95.81740	GEA-161-050	2446+60±70
	H-2	29.93795	-95.81687		
McCarty	M-1	29.80271	-95.27849	3485-AL-02	34+00
	M-2	29.80245	-95.27854		
Negyev	N-1	29.80689	-95.24691	3485-AL-05	141+00
	N-2	29.80688	-95.24711		
Oates	O-1	29.80637	-95.24509	3485-AL-06	145+00
	O-2	29.80639	-95.24524		

[15] "Study of Aseismic Faults and Regional Subsidence along Longhorn Partners Pipeline", IT Corporation, June 14, 2000.
[16] From Geosyntec Semi-Annual Fault Displacement Monitoring Report for 2nd half of 2021

Table 23. Geologic Data for Akron, Melde, Breen, and Hockley Faults

Fault	Location	Fault				Soil	
	MP	Orientation	Dip	Displacement	Width (feet)	Classification	Formation
Akron	3.84	N85E	-	down N	-	CL*	-
Melde	5.66	N64E	-	down N	-	CL	Beaumont
Breen	25.85	N50E	-	down NW	13	CL	Lissie
Hockley	46.34	N56W	67SW	-	80	CL	Lissie

*CL refers to low-plasticity clay.
Note: Blank fields indicate that data was unavailable.

2.4.2 Allowable Displacement at Faults

Kiefner has conducted two series of stress analyses on the pipes to determine the allowable displacements at the faults, one in the 2005 ORA Report and one in the 2014 ORA Report. The original stress analysis in the 2005 ORA Report was conducted for Akron, Melde, Breen, and Hockley faults. Assumptions used in that analysis included: allowable stress levels based on the version of ASME B31.4[17] available at that time; stress resulting from regular operation (instead of fault movement) in the pipeline was determined by ASME B31.4 stress analysis; and soil properties were determined from the best estimate of obtainable properties.

The 2014 ORA Annual Report determined allowable displacements at the McCarty, Negyev, and Oates faults. Due to the high rate of movement and the relatively low allowable displacement at the Hockley fault, the stress analysis was repeated for the 2014 ORA Report. In the 2014 analysis, the stresses in the pipelines at various fault displacements were predicted through finite element analysis (FEA) with the same soil properties used in the previous 2005 analysis. The allowable fault displacement was then determined when the stress reached the allowable stress levels at the pipe based on the ASME B31.4-2012, which was the latest version at the time. In ASME B31.4-2012, the allowable longitudinal stress level increased compared to the previous versions from 54% SMYS to 90% SMYS. This new limit was considered for the stress analysis of McCarty, Negyev, and Oates faults. Given the pipeline vintage of the Hockley fault, Kiefner opted for a lower limit of 80% SMYS to determine the critical displacement. Please see the 2014 ORA Report for details of the analysis. Table 24 presents the resulting allowable displacement at each fault.

2.4.3 Fault Movements

Fault displacement is defined as the difference between two benchmark readings, one on each side of the fault trace: the upthrown block and the downthrown block. The spacing of the benchmarks allows the measurement of relative vertical displacement across the fault plane.

Monitoring stations across the Akron, Melde, Breen, and Hockley faults were installed in March 2004 in accordance with Section 6.2 of the ORAPM. Baseline readings were taken in late May

[17] ASME B31.4-2002, Pipeline Transportation Systems for Liquids and Slurries, ASME Code for Pressure Piping, B31. The standard allows longitudinal stress up to 54% of SMYS.

and early June 2004. Thirty-five subsequent displacement readings[18] have been taken at approximately 6-month intervals. Figure 9 shows a plot of the vertical displacements over time.

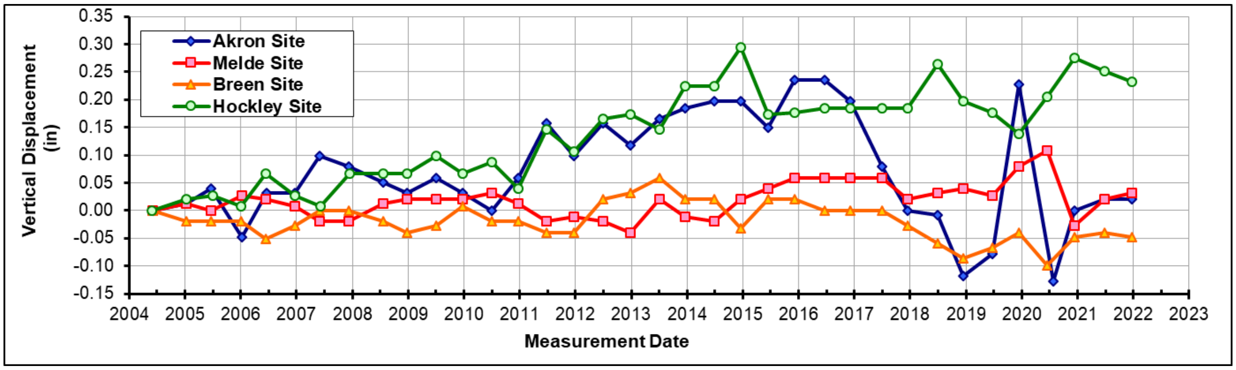

Figure 9. Fault Displacement over 17.5-Year Monitoring Period at Akron, Melde, Breen, and Hockley Faults

Since 2017, the benchmark recordings have shown Akron fault's multiple backward and rebound movements. Based on the 2021 readings, this fault experienced a relatively small amount of movement oscillating near its baseline displacement.

Data collected at Melde and Breen faults since the benchmarks were installed in 2004 shows slow progressive movement, as verified by the 34th and 35th resurveys[19] in 2021. For the Hockley fault, the recent resurveys indicate movement above the average historical rate suggesting continuous monitoring is required.

In 2012, three additional faults were instrumented for the lines constructed to connect the existing Longhorn line to East Houston. These are the McCarty fault near Station 35+80, Negyev Fault near Station 140+00, and Oates Fault near Station 147+00. Baseline readings were taken for the McCarty, Negyev, and Oates faults in September 2012. After the baseline readings, there have been 21 readings taken between December 2012 and December 2021, as shown in Figure 10.

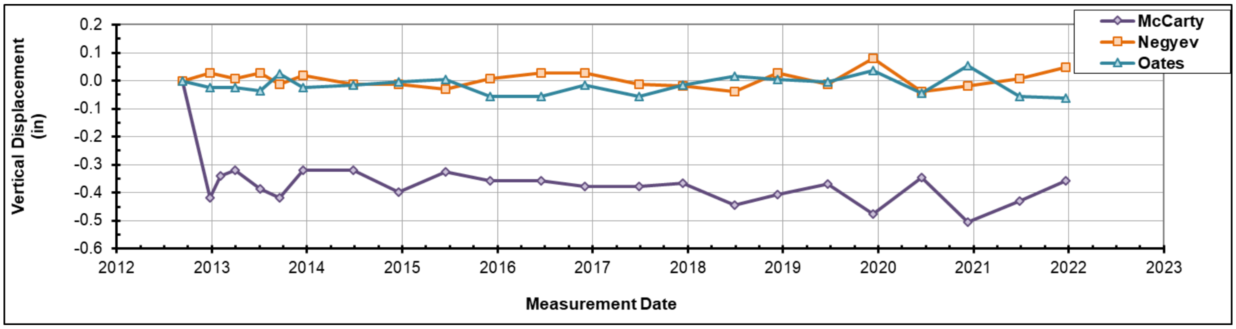

Figure 10. Fault Displacement over 9.5-Year Monitoring Period at McCarty, Negyev, and Oates Faults

[18] Geosyntec Semi-Annual Fault Displacement Monitoring Reports. The last report is for the 2nd half of 2019.
[19] Geosyntec – First-half and second-half Semi-Annual Fault Displacement Monitoring Reports.

The readings at the McCarty station from the baseline measurement in September 2012 to December 2012 indicated a jump of about one-half inch of displacement had occurred. No other large movement has been observed subsequent to the initial jump. This jump could be indicative of the benchmark equilibrating with its environment after installation or due to measurement error of the baseline reading. Accordingly, in calculating the McCarty fault's rate of movement, the baseline measurement in September 2012 was not considered. Instead, the December 2012 measurement was set as the basis for calculations. Since 2019, the resurveys have shown a relatively large rate of movement at McCarty fault. Negyev and Oates faults movements are slightly above the average historical rate.

Table 24 shows the allowable displacement at each fault, the rate of the movement, which is calculated in three different ways, and the time to reach the allowable displacement based on each of those three rates. The rate of movement for each fault is determined using the following methods:

- Historical rate: Linear regression of the recorded fault movements over the whole monitoring period.
- Short-term rate: Linear regression of the recorded fault movements over the last two years. This reflects the fault line's short-term trend and shows whether recent movement requires closer monitoring.
- Current rate: Dividing the last recorded fault movement (plus measurement error) by the total years monitored. This indicator combines the long-term effect and the latest fault motion.

The time to reach the allowable displacement for each fault (shown in the last column of Table 24) is obtained by dividing the allowable displacement by the rate of movement. This is the total time from when the pipe is free of stress to the final failure.

Table 24. Summary of Estimated Allowable Fault Displacement

Fault	Allowable Displacement (inch)	Average Rate of Movement (inch/year)			Time to Reach Allowable Displacement (years)		
		Long-term[ii]	Short-term[iii]	Current[iv]	Long-term	Short-term	Current
Akron	4.17	0.000	0.062	0.006	>1000	67	744
Melde	4.13	0.003	0.035	0.006	>1000	116	658
Breen	1.50	0.002	0.008	0.007	793	178	209
Hockley[i]	1.25	0.014	0.046	0.018	89	27	71
McCarty	0.95	0.008	0.031	0.015	126	31	62
Negyev	2.65	0.000	0.003	0.014	>1000	865	195
Oates	2.65	0.000	0.042	0.015	>1000	63	173

[i] Following the December 2018 fault monitoring, Magellan performed maintenance activities to relieve stress on the pipeline near the Hockley fault.
[ii] Average movement over the monitoring period.
[iii] Average based on the last two years.
[iv] Based solely on the last recorded fault movement.

Calculations based on the long-term historical rate of movement indicate that all the faults, except Hockley and McCarty, continue to move slowly. The pipeline crossing those faults has more than 100 years to reach the allowable displacement.

In some cases, the long-term historical rates appear to be less conservative estimates of time to potential failure. Hence, Kiefner also computed two additional assessments for each fault by considering the behavior of the fault during the last two years and its last recorded displacement. These assessments reveal that all the faults have been more active lately when compared to the historical records. In recent years, the relatively large displacement at the Akron fault grants closer monitoring. Since the pipeline crossing the Akron fault allows for a relatively large displacement at the fault location (4.17 inches), the semi-annual survey would be sufficient for now. At the Melde and Breen faults, higher recent rates of movements than the historical rate suggest continuous semi-annual monitoring is required at these faults. The shortest calculated time to reach allowable displacement at the Hockley fault is 27 years. Following the December 2018 fault monitoring, Magellan performed maintenance activities to relieve strain on the pipeline near the Hockley benchmark. With this mitigation, semi-annual monitoring would be sufficient.

Since December 2020, the resurveys have shown large activity in the McCarty fault. Based on the short-term trend of movement and the small allowable displacement at the pipeline crossing this fault, the time to reach allowable displacement is 31 years. Kiefner recommends close monitoring of this fault. The default semi-annual frequency for monitoring at McCarty fault is sufficient but needs re-evaluation each time. In Negyev and Oates, the shortest time to reach allowable displacement is more than 50 years. This indicates that the pipeline crossing is far from approaching the acceptance limits at these two faults; nevertheless, Kiefner recommends continuing the semi-annual resurveys. According to the U.S. Geological Survey of September 2005[20], there are documented cases of fault movement reinitiating.

It should be noted that Section 6.4 on Aseismic Faulting/Subsidence Hazards in Appendix 9E of the EA (Reference [5]) estimated the rates of movement on the order of 0.20 inch/year based on field observations at the top four faults listed in Table 24. Actual measurements over the past 17.5 years show rates less than an order of magnitude of the estimates from the EA. Thus, one of the original reasons for monitoring these four faults was overly conservative in estimating fault movement rates.

2.4.4 Waterway Inspections and Depth-of-Cover Program

Since 2015, Magellan has conducted annual waterway inspections by directly measuring the depth-of-cover (DOC) of the pipeline at the water crossings. Using these surveys, Magellan can plan for any remediation needed once the erosion threshold is reached. Table 25 summarizes the finding of the recent inspections.

[20] Verbeek, E.R., Ratzlaff, K.W., Clanton, U.S., Faults in Parts of North-Central and Western Houston Metropolitan Area, Texas, U.S. Geological Survey, September 2005.

Table 25. Summary of Water Crossing Inspections in 2021

River Name	Route Name	River Crossing ID	Re-inspection	Priority Level	Survey Comments
Cypress Creek (Harris County)	Satsuma-Buckhorn	925	1 year	2	16 feet of suspension with good coating condition is reported. Signs of erosion are noted.
Cypress Creek (Waller County)	Satsuma-Buckhorn	3049	3 years	3	No exposure. Minimum DOC of 2'3"
Harris Creek	Satsuma-Buckhorn	1370	3 years	3	No exposure. Minimum DOC of 0'6". Signs of notable erosion are reported
Rocky Branch	Buckhorn–Warda	2184	1 year	2	13 feet of suspension and 24 feet of exposure with good coating conditions are reported. Signs of erosion are noted.
Muddy Creek	Buckhorn–Warda	3048	1 year	2	1 foot of exposure with good coating condition is reported.
James River	James River-Kimble	1441	1 year	2	6 feet of suspension and 25 feet of exposure with good coating conditions are reported.
Threadgill Creek	Eckert–James River	3129	1 year	2	119 feet of exposure, including four exposed river weights. The coating on the exposed pipeline is in good condition.
Onion Creek	Bastrop – Cedar Valley	1878	1 year	2	No exposure. Minimum DOC of 1'6".
Alum Creek	Warda - Bastrop	3127	1 year	2	12 feet of exposure with good coating conditions is reported. Erosion is significant.
Boons Creek	Warda - Bastrop	606	1 year	2	6 feet of exposure with good coating conditions are reported on the east bank. Signs of erosion are noted.

ONYX Services performed a DOC survey of the Satsuma-Buckhorn pipeline that crosses Cypress Creek in Harris County and Waller County, Texas, on February 2021. Onyx reported that the pipeline is suspended across the entire channel width (i.e., 16 feet of suspension) for the crossing in Harris County. However, the coating on the exposed pipeline is in good condition. Also, the East and West Banks show signs of erosion downstream of the centerline. Onyx recommends a re-inspection within one year, and a priority level 2 is assigned. For the water crossing of the same pipeline in Waller County with Cypress Creek, the survey found a minimum DOC of 2 feet and 3 inches at the center of the channel and a maximum depth of cover of 3 feet and 5 inches at West Bank water's edge. The East and West Banks show few signs of erosion upstream and downstream of the centerline.

Another crossing of the Satsuma-Buckhorn pipeline is with Harris Creek in Waller County, Texas. The survey on February 2021 reports a minimum DOC of 6 inches at the center of the channel and a maximum depth of cover of 11 inches at the West and East Bank water's edge. The East and West Banks show signs of erosion. A re-inspection within three years is recommended, and a priority level 3 is assigned.

Buckhorn–Warda pipeline crosses Rocky Branch in Austin County, Texas. The Onyx DOC survey in May 2021 identified 13 feet of suspension and 24 feet of exposure. The coating is reported to be in good condition. Onyx recommended a re-inspection within one year and assigned a priority level 2. Buckhorn–Warda pipeline also crosses Muddy Creek in Austin County, Texas. The Onyx DOC report on February 2021 indicates that 1 foot of the pipeline crossing is exposed while the coating was found to be in good condition. The East and West Banks show signs of erosion upstream and downstream of the centerline.

A DOC survey was performed for the James River-Kimble pipeline that crosses the James River in Mason County, Texas, on May 2021. This crossing is found exposed for 25 feet and suspended for 6 feet. The coating is reported to be in good condition. At the East Bank water's edge, the pipeline has a maximum DOC of 2 feet and 3 inches. The observation of bed material transport indicates the occurrence of, at minimum, one flood event capable of transporting gravel-sized material between 2018 and 2021.

For the Eckert–James River pipeline that crosses Threadgill Creek in Mason County, Texas, a DOC survey was carried out on May 2021. A total length of 119 feet is exposed with good coating conditions. Four instances of river weight are reported on the exposed pipeline crossing. Onyx recommends a re-inspection within one year, and a priority level 2 is assigned.

At the Bastrop–Cedar Valley pipeline that crosses Onion Creek in Travis County, Texas, the DOC survey was performed on May 2021. A minimum DOC of 1 foot and 6 inches near the center of the channel and a maximum DOC of 4 feet at the West Bank water's edge were reported. No signs of erosion were reported. However, the erosion signs may have been submerged as the stream appeared to be above average flow on the survey day.

A DOC survey of the Warda–Bastrop pipeline that crosses Alum Creek in Bastrop County, Texas, was conducted on May 2021. 12 feet of exposure with good coating conditions were reported. The pipeline had a maximum DOC of 2 feet at the West Bank water's edge. The East and West Banks show signs of erosion, including upstream and downstream of the centerline. On the East Bank, a washout is located downstream of the centerline, and the soil is heavily disturbed by grazing cattle.

DOC survey of the crossing between the Warda–Bastrop pipeline that crosses Boons Creek in Fayette County, Texas, was performed on March 2021. 6 feet of exposure with good coating conditions on the East bank is reported. The pipeline had a minimum DOC of 1 foot and 1 inch at the East Bank water's edge and a maximum DOC of 8 feet and 10 inches at the West Bank water's edge. The East bank shows signs of recent erosion. Bank instability is observed for both the east and west banks.

The crossing of the Pin Oak Creek in Bastrop County in Texas with East Houston to El Paso Line was last surveyed by Onyx in March 2019. Comparing DOC surveys by Onyx from 2017 to 2019, the DOC decreased over time, and a part of the pipeline was exposed. A Survey from March 2019 found 5 feet of exposed pipeline off the West Bank. No further inspection was performed after that. Kiefner recommends that Magellan resume inspections at the Pin Oak Creek crossing at an annual rate to monitor the conditions and apply further remediation if necessary. Remediation includes installing deeper pipelines through horizontal direction drilling (HDD) or placing sandbags or concrete mats at the river bottom to prevent scouring.

No inspections on the Brazos River and Colorado River crossings were reported in 2021. Segments of the pipeline crossings with these rivers have been buried below via HDD.

Flood monitoring should be conducted periodically to identify existing and potential problem areas, especially for lack of coating in flooded regions. For Magellan, a "Natural Event Response Procedure" is in place that provides a method for upfront planning, communication, monitoring, and establishment of safeguards for natural events such as flooding. In September 2021, a post flood inspection was conducted for the Greens Bayou crossing. Based on the inspection, the pipeline was not accessible to determine its condition and to check whether it was exposed or not. However, the inspection indicated that the nearest above-ground valves were not submerged and not in danger of being struck by a vessel or debris, and the pipeline markers were still in place. It was also noted that the sheet piling and rip rap were not affected by flooding and is still protecting the bank near the asset.

2.5 Damage Prevention Program

The Longhorn Damage Prevention Program far exceeds the minimum requirements of federal or Texas State Pipeline Safety Regulations and represents a model program for the industry. Damage prevention and inspection activities that continued to be successful in 2021 include ROW surveillance, One-Call System, and public-awareness activities. The aerial surveillance and ground patrol frequencies for ROW surveillance exceeded the frequencies outlined in the LMP with no exception.

Two one-call violations occurred on the East Houston to Satsuma section in 2021; the violations occurred in April 2021 at Milepost 15 and November 2021 at Milepost 12.28. There was a third one-call violation to the East Houston to Satsuma section in January of 2022 at Milepost 12.12. The ORAPM requires that an ILI tool using EGP and high-resolution MFL or UT tools be run if three or more one-call violations occur on any 25-mile pipeline segment within 12 months. Magellan inspected the East Houston to Satsuma section in July 2021 with a deformation tool. The Crane to Texon and Crane to Odessa segments were also inspected in 2021 with a deformation tool. LMC 12A requires that ILI assessments for TPD detection between Valve J-1[21] and Crane Station be performed within three years of the previous inspection. Based on this, no additional ILI inspections are required. For specific inspection dates to fulfill the requirement for each of the 12 intervals spanning the Existing Pipeline from Crane to East Houston, see Table 33 in Section 4, Integration of Intervention Requirements and Recommendations.

2.5.1 Third-Party Damage

TPD refers to accidental or intentional damage by a third party, not the pipeline operator or subcontractor, which causes an immediate failure or introduces a weakness (such as a dent or gouge) in the pipe. A pipeline's susceptibility to third-party excavation damage is dependent on characteristics such as the extent and type of excavation or agricultural activity along the pipeline ROW, the effectiveness of the One-Call System in the area, the amount of patrolling of the pipeline by the operator, the placement and quality of ROW markers, and the DOC over the pipeline. In all cases, different threats could exist at different locations along the pipeline.

The annual Third-Party Damage Prevention Program Assessment contains information and data specific to the Longhorn pipeline. Including the number of detected unauthorized ROW encroachments, changes in activity levels and one-call frequency, physical hits, near-misses, DOC, and repairs along the pipeline. Potential TPD, such as dents, scrapes, and gouges detected by both ILI tools and maintenance activities, are also part of this assessment.

[21] Valve J-1 is no longer in service. ILI assessments for TPD are currently performed from E. Houston to Crane.

Kiefner received a complete log of aerial patrol and ground patrol reports for 2021. Each patrol report includes the date of inspections, the date of the previous inspection, the number of inspections year-to-date (YTD), ROW miles covered, and deadhead miles, in addition to the observations of the patroller. These observations range in significance from no impact on the ROW to those that could damage the pipeline without intervention from the pipeline operator. Each patrol report is identified by location (MP), by inspection date, and whether or not there has been an emergency observation. In addition to the observations, these planned actions are recorded as well.

Based on a review of the TPD data and a review of the 2021 Third-Party Damage Annual Assessment, Kiefner concluded:

- There were no physical hits to the pipeline in 2021.
- There was one ROW near-miss that resulted in property damage.
- There were two one-call violations in 2021.
- There was an increase of approximately 23% in aerial patrol observations.
- There were six unauthorized encroachments recorded.
- One-call frequency decreased by 34%, and the number of tickets sent to Field Operations for clearing/locating decreased by 54% from 2020 to 2021.

2.5.2 ROW Surveillance

Total possible surveillance mileage includes the 694-mile mainline plus the 29-mile lateral from Crane to Odessa and the four 9.4-mile laterals from El Paso Terminal to Diamond Junction. The 3.5-mile double lateral from East Houston to MP 6 was added to the patrol mileage in 2011. Tier-II and Tier-III areas from Galena Park to Pecos River (Segment 301) must be inspected every 2½ days, not exceeding 72 hours. The Tier-I area from the Pecos River to El Paso (Segment 303) needs to be inspected once per week, not exceeding 12 days, and at least 52 times per year. Daily patrols are also required over the Edwards Aquifer Recharge Zone (MP 170.5 to 173.3), with one patrol per week to be a ground-level patrol. To meet the minimum ROW surveillance mileage, Magellan would need to perform 64,560 miles of aerial patrol for the Galena Park to MP 528 segment and 8,153 miles of aerial patrol from MP 528 to 694. For ground patrol, Magellan needs to perform a minimum of 583 miles in the Edwards Aquifer area.

The pipeline ROW was flown over daily from Galena Park to the Pecos River (MP 528) segment (weather permitting) as well as weekly from the Pecos River (MP 528) to the El Paso Terminal (MP 694) segment (weather permitting). In addition, regular ground patrols were made in the Edwards Aquifer Recharge Zone (MP 170.5 to 173.3), weather permitting. Table 26 shows the 2021 cumulative miles of patrols for these three areas listed by month.

Table 26. Cumulative Miles of Patrols

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Tiers II & III: Aerial Patrol (every 2.5 days, not to exceed 72 hours)													
301: Galena Park to MP 528	15,328	9,420	10,327	13,419	11,647	13,707	13,812	12,868	14,944	14,668	12,833	14,827	**157,800**
Tier I: Aerial Patrol (once/week, not to exceed 12 days)													
303: MP 528 to 694	1,052	909	1,052	1,315	789	1,052	1,315	1,435	1,052	789	1,578	1,052	**13,390**
Ground Patrol (once/week)													
Edwards Aquifer: MP 170.5 to 173.3	66	55	55	55	55	55	55	55	55	55	55	55	**671**

Magellan met the Longhorn commitment to inspect Tier I areas from the Pecos River (MP 528) to the El Paso Terminal (MP 694), including the El Paso Laterals, at least once a week. The Annual Third-Party Damage Prevention Program reported six unauthorized ROW encroachments.

2.5.3 One-Call Ticket Analysis

In 2021 there were 7730 one-call tickets, of which 36% of the required "field locates" were potential ROW encroachments. There were two one-call violations during the 2021 year. The violations were due to third parties not following One-Call directives.

Magellan is effectively screening the one-calls and separating them based on the location, information associated with each "ticket," and the likely encroachments from the "no locates" (one-call locations that are sufficiently remote from the ROW to assure that no effort is needed to mark the location of the pipeline).

Most one-call tickets continue to occur in Harris and Travis counties. Harris County (Houston) accounted for 2805 (36.3%) of the one-call tickets, while Travis County (Austin) accounted for 1942 (25.1%) of the one-call tickets. Thus, 38.4% of the one-call notifications on the pipeline occurred in these large metropolitan areas. Based on those data, these two areas present the greatest potential for third-party damage. The Crane area has the next highest number of one-calls, with 1558 tickets (21.3%).

2.5.4 Public Awareness

The Longhorn Public Awareness Plan incorporates various activities to reach stakeholder audiences and provide them with damage prevention information in 12 languages; English, Spanish, French, German, Hmong, Hungarian, Italian, Japanese, Korean, Norwegian, Polish, and Vietnamese. The damage prevention information includes annual mailings, emergency response/excavator meetings, door-to-door visits, meetings with emergency response agencies, conversations with public officials, local school presentations, public service announcements, sponsorships and banners, Ads and PSAs in the press and media, and safety information on the Magellan website.

The Magellan website is a communication tool used to inform the public about pipeline safety, damage prevention, emergency preparedness, and mitigation measures. Information about

Magellan's operations is posted on the website, such as the annual self-audit report and the results of the annual ORA.

Through the current Longhorn Public Awareness Plan, Magellan targets schools in the Austin area, and the Safe at Home School Program targets schools in the Houston area, located within a 1-mile radius of the Longhorn pipeline system. Schools in Austin are given presentations to provide to their students. Schools in Houston are given presentations by a Safe at Home representative. In 2021 Magellan proposed replacing these two programs with a program run by the Smalley Foundation. This program offers a custom School Pipeline Safety Webpage, an annual mailer to school officials, documentation of all outreaches to measure effectiveness (metrics), and an in-person visit to school officials on a 4-year rotating calendar. This new program would help expand Magellan's current outreach and target more schools in Houston and Austin. These changes will take effect in 2023.

2.5.5 Encroachment Procedures

Encroachments are entries to the pipeline ROW by persons operating farming, trenching, drilling, or other excavating equipment. Removing debris and other obstructions along the ROW to facilitate prompt access to the pipeline for routine or emergency repair activities is also considered an encroachment.

The SIP includes provisions for surveillance to prevent and minimize the effects of unannounced or unauthorized ROW encroachments. Magellan conducted four incident investigations as part of the SIP, none associated with Third-Party Unauthorized Encroachment.

There were six unauthorized encroachments during 2021, and corrective actions were implemented to help prevent a recurrence in all instances. There was no damage to the pipeline. When properly followed by the encroaching party, the encroachment procedures have effectively prevented TPD to the pipeline.

2.6 Stress-Corrosion Cracking (SCC)

SCC is a form of environmental attack on pipe steel involving the interaction of a local corrosive environment and tensile stresses in the metal resulting in the formation and growth of cracks. The Longhorn Pipeline has not identified SCC as a threat but added SCC as a threat since SCC has been an unexpected problem for some pipelines. In the 72 years the existing pipeline has been in operation, there have been no SCC failures, no SCC has been discovered in-ditch at any location on the pipeline, and no SCC reported by ILI assessments.

Per the LMC 19(a) and the 2003 Office of Pipeline Safety (OPS) Advisory Bulletin ADM-05-03 "Stress-Corrosion Cracking (SCC) Threat to Gas and Hazardous Liquid Pipelines," Longhorn was required to inspect for SCC for the first three years (2005-2007) by selecting specific sites most susceptible to SCC. Subsequent inspection for SCC has been continued by Magellan as a supplemental examination when the pipe is exposed and examined for other reasons, such as ILI anomaly excavations.

In 2021 Magellan continued checking the exposed pipe surface for SCC using magnetic particle testing during ILI investigation digs. Magnetic particle inspection is conducted on the entire pipe circumference between coating cuts. The coating is typically removed a couple of feet to either side of the ILI target anomaly. If multiple ILI target anomalies within a single joint, the coating is typically removed for the entire distance between anomaly targets (unless the two target anomalies are at opposite ends of the joint). Since no evidence of SCC has been detected, it is not necessary to recommend an intervention measure. Magellan will continue to monitor this threat through their current method, which consists of looking for evidence of SCC when maintenance excavations are performed.

2.7 Threats to Facilities

Threats to facilities address the operational reliability of facilities other than line pipes, including pump stations, terminals, and associated mechanical components. Magellan monitors the integrity of these facilities through scheduled maintenance and inspection activities prescribed by the SIP. The SIP Mechanical Integrity Program focuses on maintaining the integrity of all equipment within the Longhorn system (e.g., station pumps, tanks, valves, and control systems). The program includes the following activities:

- Identification and categorization of equipment and instrumentation
- Inspection and testing methods and procedures
- Testing acceptance criteria and documentation of test results
- Maintenance procedures and training of maintenance personnel
- Documentation of specific manufacturer recommendations

Magellan implements their preventive maintenance program through its Enviance/Compliance Management System. This software system establishes an inspection and maintenance schedule for equipment items in the Longhorn System and can be adjusted based on the risk level. An Action Item Tracking and Resolution Initiative (database) provides a method of tracking mechanical integrity recommendations.

A Facility Risk Management Program is in place to manage the risks at above-ground facilities. The LMP requires that all changes on the Longhorn system be evaluated using an appropriate PHA methodology and that the change be assessed to ensure that the appropriate risk mitigation levels on the system are maintained. PHAs are also conducted on a 5-year interval to evaluate and control the hazards associated with the Longhorn facilities. The latest PHA was completed in 2019 as a 5-year revalidation per Magellan's LMP requirement found under 3.5.11. No PHAs were completed in 2021.

Facility inspections addressing items related to safety, security, and environmental compliance are conducted regularly. Staffed facilities are inspected yearly; unstaffed facilities are inspected every two years. Pump stations located in sensitive and hypersensitive areas are inspected every two and one-half days. Technicians are onsite on a regular basis to perform routine maintenance and operation activities. Technicians are also on-call to respond to emergencies or other operational events. Additionally, remote cameras are in place for monitoring purposes. Atmospheric Inspection surveys are conducted annually at pre-assigned above-ground piping and facilities. Kiefner received safety review reports for ten facilities, as shown in Table 27.

Table 27. Facility Inspections received in 2021

Facility	Inspection Date
Kimble	9/23/2021
Cartman	9/23/2021
Eckert	9/24/2021
James River	9/24/2021
Cedar Valley	9/29/2021
Bastrop	9/30/2021
Buckhorn	9/30/2021
Warda	9/30/2021
Satsuma	10/01/2021
El Paso East	10/25/2021

From the standpoint of facility data acquired for 2021, one can conclude that the facilities were well maintained. Additional emphasis is needed to reduce operational errors. Kiefner recommends that Magellan continue its detailed documentation of incidents, its facility integrity processes, and its reporting of the facility maintenance program.

A limited scope facility risk assessment (FRA) was conducted at LMP12 (Mesa Road) in 2021. LMP12 is a Magellan-owned valve site on the Satsuma to East Houston segment; it is an unmanned facility but is visited by Magellan personnel weekly. The FRA executive summary recommends evaluating the installation of an H2S detector at LMP12 and conducting a limited scope facility risk re-assessment within 7 years.

2.8 Incident Investigation Program and Incorrect Operations Mitigation Program

Magellan performs incident investigations on all incidents and near-misses whether or not they are Department of Transportation (DOT)-reportable[22]. For each incident, corrective actions were implemented following Magellan's incident investigation report and provided to PHMSA. Magellan should continue to record all relevant data on incident reports, including a detailed description of the incident, root cause, and contributing factors to help improve the overall effectiveness of the incident investigation program.

In addition to their incident investigation program, Magellan also implements an Incorrect Operations Mitigation Program to identify and reduce the likelihood of human errors that could impact the mechanical integrity of the Longhorn Pipeline System. "Incorrect Operations" is described as incorrect operation or maintenance procedures or a failure of pipeline operator personnel to follow procedures correctly.

[22] DOT-Reportable Requirement. A "PHMSA (or DOT) reportable incident" is a failure in a pipeline system in which there is a release of product resulting in explosion or fire, volume exceeding 5 gallons (5 barrels from a pipeline maintenance activity), death of any person, personal injury necessitating hospitalization, or estimated property damage exceeding $50,000.

There were six Longhorn system incidents in 2021; all of them were One-Calls/Encroachments and classified as minor events. Three of these minor incidents involved Magellan Operations employees encountering a fence built over the ROW of the Longhorn Pipeline. The employees implemented corrective actions for all One-Call/Encroachment incidents, including determining the DOC for the pipeline and the concrete fence posts and notifying the Magellan Real Estate Representative of the situation.

On March 18, 2021, the fourth incident occurred in Willis, Texas, when a contractor from Superior Telecom Services bored across the Longhorn pipeline at a depth of 10 inches without approval from Magellan personnel. The pipeline DOC is 43 inches, contractors are permitted to bore within 50 feet of the edge of the easement. The contractor and crew immediately ceased work, and the Supervision and the Real Estate Representative were notified.

On October 21, 2021, the fifth incident occurred in El Paso, Texas, and was categorized as a One-Call/Encroachment. The incident involved a Magellan Operations employee encountering a landowner pouring a concrete slab to install a metal framed building over the ROW. The landowner immediately ceased work, and the proper Magellan personnel were notified.

The last incident occurred on December 28, 2021, near Satsuma, Texas. During an aerial patrol of the Longhorn pipeline ROW, technicians reported that a building was being constructed near the ROW. Although there was no digging directly above the ROW, it was within a distance to warrant a ROW encroachment. The landowner was contracted to address the situation; however, there was no response.

Although no exact cost was specified for any of the incidents, the estimated cost for minor incidents is less than $25,000. Most of the incident reports gave an estimated cost of $0 for the One-Call/Encroachment incidents. None of these incidents were DOT reportable. These incidents were all formally documented and investigated. Corrective actions were implemented following Magellan's incident investigation report.

2.9 Risk Analysis Program

In the SIP, two functions address Risk on the Longhorn Pipeline system:

1.) Key Risk Areas Identification and Assessment,
2.) Scenario-Based Risk Mitigation Analysis.

Magellan's Key Risk Areas Identification and Assessment program aims to ensure that resources are focused on those areas of the Longhorn Pipeline System with the highest identified or perceived risks. While the objective of Magellan's Scenario-Based Risk Mitigation Analysis program is to identify preventive measures and/or modifications that can be recommended that would reduce the risks to the environment and the population in the event of a product release. The Key Risk Area Identification and Assessment Program results are incorporated into the Scenario-Based Risk Mitigation Analysis Program.

2.9.1 Key Risk Areas Identification and Assessment

The Longhorn Pipeline System traverses various unique areas of land use, topography, and population density; it presents a variety of risk concerns to these lands and to the people who either inhabit or are present in these areas. To help prioritize risk management efforts, Magellan has categorized the Longhorn Pipeline System with the following designations:

- Tier I – normal cross-country pipeline
- Tier II – sensitive areas
- Tier III – hypersensitive areas

Further, the area across the Edwards Aquifer in South Austin is a Tier III designated area of additional heightened environmental sensitivity that has resulted in even more scrutiny and the commitment to incremental risk mitigation measures.

Magellan's probabilistic risk model utilizes integrated data and incorporates a dynamic segmentation process to maintain adequate resolution and avoid mischaracterization or loss of detail. The risk measurement methodology includes a POF threshold management to manage pipeline integrity and evaluate risk in accordance with 49 CFR 195.452. The POF measurement integrates all available information about the integrity of the pipeline. This integration aids in the identification of preventive and mitigation measures to protect areas along the pipeline.

The LMP risk management plan commitment is to maintain pipeline-related failure rates at or below a probability level of 1 in 10,000 (0.0001) per mile-year. The scenario-based risk mitigation analysis (SBRMA) for the 2021 operating year was performed in 2022. The results show that none of the pipeline segments exceeded the risk threshold; therefore, no additional mitigation measures were required or recommended.

Magellan enhanced its Facility Integrity Management Program (FIMP) in late 2018 and early 2019 and began conducting more rigorous integrity evaluations for its surface facilities and equipment in 2019. In 2020, Magellan implemented a new FIMP element of its Integrity Management Plan. The FIMP requires a detailed FRA, which provides risk analysis and re-inspection interval recommendations based on an assessment of data from the various FIMP elements in place to protect the integrity of the facility. FRAs focus on leak detection, mechanical integrity, prime equipment, corrosion control, operating pressure programs, fire safety, and re-inspection intervals and are prioritized on a risk-based schedule. Magellan completed one FRA for LPS facilities in 2021.

2.9.2 Scenario-Based Risk Mitigation Analysis

The primary focus of Magellan's scenario-based risk mitigation analysis is mechanical integrity, operating controls, and prevention of TPD. The pipeline risk model was updated and executed in 2022 with information from operations in 2021. Results show no areas along the pipeline with POF greater than $1E^{-4}$ failures and, as such, support the effectiveness of Magellan's existing Integrity Management Program.

2.10 Management of Change Program

Magellan has established an effective program to manage changes to process chemicals, technology, equipment, procedures, and facilities across the Longhorn Pipeline System. The Longhorn Mitigation Plan requires that all changes to the Longhorn system be evaluated using an appropriate PHA. The Magellan Management of Change Request (MOCR) process helps identify changes that impact the LMP. In 2021 Magellan had 69 MOCRs on the Longhorn

Pipeline System; 16 of the 69 were determined to have some impact on the LMP. Per the Self-Audit Report, all 16 MOCRs had detailed reports and were reviewed by the appropriately impacted Magellan personnel or departments.

2.11 System Integrity Plan Scorecarding and Performance Metrics Plan

Magellan has implemented an effective method for evaluating the effectiveness of the SIP on an annual basis using performance measures (or scorecarding) from three categories:

- Activity measures – proactive activities aimed at preserving pipeline integrity;
- Deterioration measures – evidence of deterioration of pipeline integrity; and
- Failure measures – occurrences of failures or near-failures.

The technical assessment of the SIP indicated that Magellan is achieving the goal of the SIP, namely, preventing incidents that would threaten human health or safety or cause environmental harm. Magellan exceeded the minimum required mileage for both aerial surveillance and ground patrol. In addition, ROW markers and signs were repaired or replaced where necessary, and public-awareness meetings were held (Table 28). In the Houston area, six schools participated in the "Safe at Home School Program" that Magellan offers. Due to COVID-19 concerns, Austin schools participated in an online survey tied in with the "Pipelines All Around You" presentation. A total of 31 teachers at 21 elementary schools were targeted; three schools participated.

Regarding metal loss deterioration measures, no metal loss features met POE dig requirements from the 2021 ILI runs. Regarding failure measures, there were no DOT-reportable incidents and no physical hit to the pipeline.

Table 28. Educational and Outreach Meetings

EVENT	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Emergency Responder / Excavator Meetings	14	12	11	11	11	11	11	11	11	25	30	30	16	16	24	25	25
School Program - Houston	2	2	3	4		6	5	6	1	3	4	4	5	5	5	4	6
School Program - Austin	3	2	7	3	4	3	4	5	5	2	2	2	3	2	3		3
Texas Statewide School Pipeline Safety Outreach													16	3	30		
Neighborhood Meetings	2	2															
Misc. Meetings:													*	*	*	*	*
Creekside Nursery	1																
Cy Fair ISD	1																
Region 6 LEPC Conference (Houston)	1																
Public Events	4		4	3	2	2							*	12	12	17	9
TOTAL	28	18	25	21	17	22	20	22	17	30	36	36	24	38	75	46	43

NOTE: Public meetings were tallied for the years 2005-2020 as follows:

- Emergency Responder / Excavator Meetings: Count only the number of meetings (not the total number of counties).
- School Program: Houston Program - count the schools that request the Safe at Home Program; Austin Program - count only schools where Longhorn/Magellan gave presentations.
- Texas Statewide: Texas School Safety Conference
- Neighborhood Meetings: Phased out in 2007 and replaced by school programs and public events enhancements.
- Misc. Meetings: Count all other meetings that are not public events (i.e., daycares, church meetings, public speaking engagements, etc.).
- Public Events: Count events such as rodeos, county fairs, fundraisers, home shows, Safety Day Camps, etc.

*Refer to the 2020 TPD Annual Assessment for details.

3 OVERALL SIP PERFORMANCE MEASURES

The LMP describes the philosophy of the SIP. By this philosophy, Magellan commits to "constructing, operating and maintaining the Longhorn Pipeline assets in a manner that ensures the long-term safety of the public, and to its employees, and that minimizes the potential for negative environmental impacts." The ORAPM provides a method for evaluating the effectiveness of the SIP on an annual basis using performance measures (or scorecarding) from three categories (listed below). The 2021 status of each of these measures is evaluated in Sections 3.1 through 3.3.

- Activity measures – proactive activities aimed at preserving pipeline integrity
- Deterioration measures – evidence of deterioration of pipeline integrity
- Failure measures – occurrences of failures or near-failures

3.1 Activity Measures

The activity measures monitor the surveillance and preventive activities that Magellan has implemented since the preceding ORA. These measures indicate how well Magellan implements the various SIP elements; Table 29 summarizes the SIP Activity Measures from 2005 through 2021. The activity measures are:

- The number of miles inspected in 12 months by aerial and ground survey (per pipeline segment). The minimum patrol mileage needed for ROW aerial surveillance to meet this requirement is 64,560 miles for Galena Park to MP 528 and 8,153 miles for MP 528 to 694. For ground patrol, 583 miles are needed for the Edwards Aquifer area. This metric is compared to the previous 12-month period. Magellan met this commitment in 2021.

- The number of warning or ROW identification signs installed, replaced, or repaired is 12 months. The metric is compared to previous Magellan performance. This metric is used to measure consistent effort by Magellan to protect the ROW and prevent TPD. There is no "passing grade" because proper placement and maintenance of signs may lead to fewer signs being replaced or repaired in future years, and this decline will not indicate any failure on the part of Magellan. Tracking the replacement or repair of signs by pipeline segment may indicate potential third-party vandalism or carelessness in certain segments of the system, which could be used as a leading indicator that additional public education might be needed in that region of the pipeline route.

- The number of outreach or training meetings (listed with locations and dates) to educate and train the public and third parties about pipeline safety. This metric is used to gauge consistent effort by Magellan to educate the public regarding pipeline safety and to prevent TPD to the pipeline. There is no "passing grade," although comparing the results from this metric with sign placement, repair, and replacement can be used to see if public education is being emphasized in the same geographic region where sign maintenance indicates problems.

- The number of calls into the one-call system to mark or flag the Longhorn Pipeline (sorted by Tier-I, Tier-II, or Tier-III). This is completed to measure the effectiveness of the one-call system in preventing TPD. The measure is compared to previous years of Magellan records. Since this is a metric that is not subject to control by Magellan, there is no "passing grade." This metric can be compared to encroachments allowing an overall measurement of how efficiently the one-call process is being used.

Table 29. System Integrity Plan Activity Measures

Year	Measure		
	Miles of pipelines inspected by aerial and ground survey (73,296 mi required)	*No. of warning or ROW identification signs installed, replaced, or repaired*	*No. of outreach or training meetings to educate and train the public and third parties about pipeline safety*
2005	203,081	979	28
2006	197,234	732	18
2007	188,884	237	25
2008	187,931	536	21
2009	181,308	460	17
2010	180,045	291	22
2011	188,564	76	20
2012	188,722	66	22
2013	179,107	539	17
2014	176,884	266	30
2015	175,920	130	36
2016	173,996	315	36
2017	162,030	194	24
2018	152,322	105	24
2019	160,553	93	33
2020	154,252	195	29
2021	171,861	2372*	31

*The increase in marker repairs was due to replacement of stickers along the line; not due to damaged signs.

3.2 Deterioration Measures

Deterioration measures evaluate maintenance trends to indicate when the system's integrity could be seen as declining despite preventive actions. Table 30 provides a summary of the deterioration measures from 2006 through 2021. In 2021 there were:

- No immediate conditions as defined by the SIP and 49 CFR 195.452.
- No ILI-reported metal loss features met POE evaluation dig requirements in 2021.
- Hydrostatic test leaks per mile have not been an indicator of performance because no hydrostatic reassessment tests have been performed for pipeline integrity purposes.

The monitoring and excavation program should continue to address significant ILI-reported anomalies, and POE calculations should continue to be performed.

Table 30. System Integrity Plan Deterioration Measures

Year	Measure					
	Number of immediate ILI anomalies per mile pigged	Number of immediate ILI anomalies per mile pigged, sorted by tier classification			Total number of anomalies per hydrostatic test*	Number of POE Evaluations per mile pigged
		Tier 1	Tier 2	Tier 3		
2005	0.029	N/A	N/A	0.192	N/A	1.48
2006	0.0203	0.212	0.0208	N/A	N/A	0.54
2007	0.038	0.035	N/A	0.003	N/A	0.69
2008	0.004	0.006	N/A	N/A	N/A	0
2009	0	0	0	0	N/A	0.017
2010	0	0	0	0	N/A	0.14
2011	0	0	0	0	N/A	0.035
2012	0	0	0	0	N/A	0.025
2013	0	0	0	0	N/A	0.033
2014	0	0	0	0	N/A	0.017
2015	0.004	0	0.004	0	N/A	0.013~
2016	0	0	0	0	N/A	0
2017	0	0	0	0	N/A	0
2018	0	0	0	0	N/A	0.067
2019	0	0	0	0	N/A	0.15
2020	0.036	0.012	0.024	0	N/A	0.28^
2021	0	0	0	0	N/A	0

*Hydrostatic tests were performed for pipeline commissioning purposes.

~POE calculations were only performed on the MFL assessments; the number of POE evaluations per mile pigged did not include the TFI mileage.

^The number of POE evaluations per mile did not include the UCD mileage.

3.3 Failure Measures

Failure Measures are generated from leak history, incident reports, incident responses, and product loss accounting. These metrics can be used to gauge progress towards fewer spills and improved response or to measure the deterioration of overall system integrity. These measures are listed below in Table 31. Response times, volumes, and costs are for DOT-reportable leaks. Service interruptions, both scheduled and unscheduled, that were reported during 2021 are shown in Table 32.

Table 31. System Integrity Plan Failure Measures

Measure		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Number of leaks (DOT-reportable)		2	0	1	3	0	1	2	0	2	2	0	0	3	1	0	1	0
Average response time in hours for a product release.	Tier I	Immed.	NA	Immed.	Immed.	N/A	Immed.	Immed.	N/A	Immed.	Immed.	N/A	N/A	Immed.	Immed.	N/A	Immed.	N/A
	Tier II	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Immed.	Immed.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Tier III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Immed.	Immed.	N/A	N/A	Immed.	N/A	N/A	N/A	N/A
Average product volume released per incident (bbl)	Tier I	5.7	0	5.7	0.4	N/A	0.4	1.2	N/A	0.47	2.74	N/A	N/A	1048	282	0	0.24	N/A
	Tier II	0	0	0	0	N/A	0	0	N/A	0	0	N/A	N/A	N/A	N/A	0	0	N/A
	Tier III	0	0	0	0	N/A	0	0	N/A	4	0	N/A	N/A	28	N/A	0	0	N/A
Total product vol. released in 12-month period (bbl)	Tier I	17	0	5.7	1.3	N/A	0.4	2.5	N/A	0.47	5.48	N/A	N/A	2096	94	0	0.24	N/A
	Tier II	0	0	0	0	N/A	0	0	N/A	0	0	N/A	N/A	N/A	N/A	0	0	N/A
	Tier III	0	0	0	0	N/A	0	0	N/A	4 bbls	0	N/A	N/A	28	N/A	0	0	N/A
Cleanup cost totals per year		< $100k	$0	< $200k	< $150k	N/A	< $50	< $50	N/A	> $100k	< $25	N/A	N/A	>$528k	$7.2M	<$500K	$500	N/A
Cleanup cost per incident		< $35k	N/A	< $200k	< $50k	N/A	< $50	< $25	N/A	< $25k < $50k > $100k	< $25	N/A	N/A	$28k $500k No info	$7.2M	<$500K	$500	N/A
Reports from aerial surveys or ground surveys of encroachments into the pipeline ROW without proper one-call		1	0	1	3	3	1	1	2	2	0	3	2	4	5	4	1	6
Number of known physical hits (contacts with pipeline) by third-party activities		0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0
Number of near-misses to the pipeline by third parties		7	1	7	5	6	2	4	3	2	0	4	0	8	2	1	1	1
Number of service interruptions		115	165	155	74	16*	17	9	8	15	15	11	8	13	114	141	43	132

Table 32. Service Interruptions per Month for 2021[23]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
No./Month	15	9	12	11	10	14	7	17	7	10	10	10	**132**

[23] Service interruptions include both scheduled and unscheduled interruptions.

4 INTEGRATION OF INTERVENTION REQUIREMENTS AND RECOMMENDATIONS

4.1 Integration of Primary Line Pipe Inspection Requirements

Section 11 of the ORAPM specifies the integration of primary line pipe inspection requirements addressing corrosion, fatigue-cracking, lamination and hydrogen blisters, TPD, and earth movement. Magellan has four remediation commitments for using ILI for the pipeline: LMC 10, LMC 11, LMC 12, and LMC 12A. These commitments required Magellan to: use an MFL tool for corrosion inspection in the first three months of operation, use a TFI tool for seam inspection (which includes hook cracks and preferential seam corrosion) within the first three years of operation, use a UT wall measurement tool within the first five years of operation for inspection of laminations and detection of blisters, and use an EGP tool at least every three years for inspection of TPD to the pipe. Future inspection requirements are based on reassessment interval procedures set by the ORAPM, with the additional requirement that EGP tools must be run at least every three years.

There is an overlap in anomaly detection capabilities of the various commercially available ILI tools and considerable variability in vendor availability. As each cycle of the ORA is performed, additional data will become available not only from ILI tools but also from routine maintenance reports and ILI anomaly investigation reports. The ORA process will continue to integrate these data to minimize the level of risk to the pipeline system integrity from each identified failure mode. To maintain and further reduce risk where possible, the ORA will identify and recommend the most appropriate ILI technology to obtain the necessary additional information. The use of one ILI tool technology may satisfy multiple inspection requirements for a pipe segment. The tools Magellan has committed to using have multiple capabilities.

Table 33 and Table 34 present the most recently completed ILI assessment and note requirement dates for future planned assessments for the crude and refined pipelines. The required reassessments are specified per the ORAPM. Reassessment requirements for pressure-cycle-fatigue crack growth reassessment intervals were based on the analysis performed in Section 2.1

Fatigue Analysis and Monitoring Program. Reassessment requirements for corrosion and TPD are based on the most recent inspection date; corrosion inspections are required every five years, while TPD is required every three years for the crude line and every five years for the refined line. Earth movement, the fifth component for threat integration, is not included in Table 33 and Table 34 because it is currently addressed using surface surveys rather than ILI technology. For a complete listing of all ILI assessments on the crude and refined pipeline systems, refer to the 2017 Longhorn ORA Final Report.

Table 33. Completed ILI Runs and Planned Future ILIs for Longhorn Crude System

	E. Houston to Speed Jct	E. Houston to Satsuma	Satsuma to Buckhorn	Buckhorn to Warda	Warda to Bastrop	Bastrop to Cedar Valley	Cedar Valley to Eckert	Eckert to James River	James River to Kimble	Kimble to Cartman	Cartman to Barnhart	Barnhart to Texon	Texon to Crane
Mileage	**0 to 10.8**	**2.35 to 34.1**	**34.1 to 68.0**	**68.0 to 112.9**	**112.9 to 141.8**	**141.8 to 181.6**	**181.6 to 227.9**	**227.9 to 260.2**	**260.2 to 295.2**	**295.2 to 344.3**	**344.3 to 373.4**	**373.4 to 416.6**	**416.6 to 457.5**
Assessments													
Corrosion													
Tool	Multi-Data	Multi-Data	TFI	TFI	TFI	TFI	TFI	TFI	TFI	TFI	TFI	TFI	TFI
Date of Tool Run	2-Oct-14	1-Oct-14	18-Dec-15	16-Dec15	11-Dec-15	8-Dec-15	4-Dec-15	19-Aug-15	1-Sep-15	29-Aug-15	24-Aug-15	11-Aug-15	17-Jul-15
Tool	GMFL	MFL		MFL									MFL
Date of Tool Run	28-Aug-19	13-Aug-19		5-Nov-19									16-Oct-18
Tool			MFL		MFL	MFL	MFL	MFL	MFL	MFL	MFL	MFL	
Date of Tool Run			14-Jan-20		9-Jan-20	6-Jan-20	4-Feb-20	4-Mar-20	11-Aug-20	8-Jul-20	12-Jun-20	5-May-20	
Pressure Cycle Induced Fatigue													
Tool		TFI ‡	TFI	TFI	TFI	TFI	TFI	TFI	TFI	TFI	TFI	TFI	TFI
Date of Tool Run		6-Jul-07	18-Dec-15	16-Dec-15	11-Dec-15	8-Dec-15	4-Dec-15	19-Aug-15	1-Sep-15	29-Aug-15	24-Aug-15	11-Aug-15	17-Jul-15
Tool		UCD	UCD	UCD									UCD
Date of Tool Run		16-Aug-19	6-Dec-19	8-Nov-19									19-Oct-18
Tool					UCD	UCD	UCD	UCD	UCD	UCD	UCD	UCD	
Date of Tool Run					28-Jan-20	16-Jan-20	4-Mar-20	11-Mar-20	20-Oct-20	25-Aug-20	16-Jun-20	15-May-20	
Laminations & Hydrogen Blisters													
Tool		UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT
Date of Tool Run		22-Sep-09	24-Nov-09	24-Nov-09	24-Jan-10	24-Jan-10	20-Feb-10	25-Jun-10	25-Jun-10	25-Jun-10	8-Jul-10	8-Jul-10	8-Jul-10
Third-Party Damage													
Tool	Def.			Def.									
Date of Tool Run	28-Aug-19			5-Nov-19									
Tool			Def.		Def.	Def.	Def.	Def.	Def.	Def.	Def.	Def.	
Date of Tool Run			14-Jan-20		9-Jan-20	6-Jan-20	4-Feb-20	4-Mar-20	11-Aug-20	8-Jul-20	12-Jun-20	5-May-20	
Tool		Def.											Def.
Date of Tool Run		6-Jul-21											9-9-21
Next Required Assessment													
Corrosion	28-Aug-24	13-Aug-24	14-Jan-25	5-Nov-24	9-Jan-25	6-Jan-25	4-Feb-25	4-Mar-25	11-Aug-25	8-Jul-25	12-Jun-25	5-May-25	16-Oct-23
Pressure-Cycle Induced Fatigue	2033	2046	2047	2041	2054	2054	2044	2042	2058	2041	2046	2040	21-Dec-26
Third-Party Damage*	28-Aug-24	6-Jul-24	14-Jan-23	5-Nov-22	9-Jan-23	6-Jan-23	4-Feb-23	4-Mar-23	11-Aug-23	8-Jul-23	12-Jun-23	5-May-23	9-Sep-24

‡The TFI was used to remediate Phase I and Phase II corrosion anomalies and, in some cases, was used to remediate POE anomalies but was not used to set the next corrosion reassessment using the POE process.
*Per Longhorn EA section 9.3.2.3, EGP assessments are required every 3 years per the LMP. ID reductions identified from these assessments will be correlated to the existing laminations found from the UT assessments.

Table 34. Completed ILI Runs and Planned Future Inspections for Longhorn Refined System

		Crane to Cottonwood	Cottonwood to El Paso	Crane to Odessa	8" El Paso to Chevron	8" Kinder Morgan Flush Line	8" El Paso to Strauss	12" El Paso to Kinder Morgan
	Mileage	**457.5 to 576.3**	**576.3 to 694.4**	**0 to 29.26**	**0 to 9.4**	**0 to 9.4**	**0 to 9.4**	**0 to 9.4**
Assessments	**Corrosion**							
	Tool		MFL		SMFL	SMFL		SMFL
	Date of Tool Run		1-Nov-17		13-Jul-17	13-Jul-17		14-Jul-17
	Tool	MFL					MFL	
	Date of Tool Run	18-Apr-18					25-Oct-18	
	Tool			MFL				
	Date of Tool Run			8-Sep-21				
	Third-Party Damage							
	Tool		Deformation		Deformation	Deformation		Deformation
	Date of Tool Run		14-Aug-17		13-Jul-17	13-Jul-17		14-Jul-17
	Tool						Deformation	
	Date of Tool Run						25-Oct-18	
	Tool	Deformation						
	Date of Tool Run	8-Nov-20						
	Tool			Deformation				
	Date of Tool Run			8-Sep-21				
	Next Required Assessment							
	Corrosion	18-Apr-23	1-Nov-22	8-Sep-26	13-Jul-22	13-Jul-22	25-Oct-23	14-Jul-22
	Pressure-Cycle Induced Fatigue	Not susceptible*	Not susceptible*	Not susceptible*	Not susceptible~	Not susceptible~	Not susceptible~	Not susceptible~
	Third-Party Damage	8-Nov-25	14-Aug-22	8-Sep-26	13-Jul-22	13-Jul-22	25-Oct-23	14-Jul-22

*These line segments were constructed in 1998 with high frequency ERW pipe and therefore have a lower risk of cyclic fatigue.
~These line segments were constructed in 2002 with high frequency ERW pipe and therefore have a lower risk of cyclic fatigue.

4.2 Integration of DOT HCA Inspection Requirements

Magellan must comply with the DOT Integrity Management Rule, 49 CFR 195.452, for HCAs and meet the LMP requirements. The pipeline from 9th Street Junction to El Paso is under DOT jurisdiction, including the four laterals connecting El Paso to Diamond Junction and the lateral from Odessa to Crane.

The HCA rule states that an operator must establish 5-year intervals, not to exceed 68 months, for continually assessing the pipeline's integrity. An operator must base the assessment intervals on the risk the line pipe poses to the HCA to determine the priority for assessing the pipe. At this time, corrosion has proven to be the higher priority risk of the five threats to pipeline integrity. Because of the LMP requirements and the multiple capabilities of each tool, the HCA line pipe between the 9th Street Junction and Crane has been inspected in less than five years intervals. The HCA requirement will continue to be integrated into the ILI requirements as additional tool runs are completed to ensure the required 5-year interval is not exceeded.

LMC 12A requires an EGP tool to be run every three years on the existing pipeline (between Valve J-1 and Crane). This interval is due to a greater risk of mechanical damage to the existing pipeline. The existing pipeline is often buried shallower than 30 inches in depth below the surface because of burial requirements when the pipeline was built. The HCA requirement (49 CFR 195.452) for the new pipeline extensions requires an EGP tool to be run every five years. The risk of mechanical damage on the New Pipeline is less because the pipeline is buried at least 30 inches deep.

4.3 Pipe Replacement Schedule

There were no pipe replacements in 2021.

5 NEW INTEGRITY MANAGEMENT TECHNOLOGIES

The LMP requires the incorporation and consideration of new and emerging technologies and processes that will assess or prove the integrity of the pipeline system. There is no requirement to incorporate these processes, but as the analyses improve and evolve in the industry, they may be used where appropriate.

5.1 Geohazard Program Development

Recent PHMSA advisory bulletins emphasize the importance of the safety-related issues resulting from earth movement and other geological hazards. The advisory issued on May 2, 2019,[24] recommends several monitoring techniques to ensure pipeline safety. Some of these are already in place within Magellan's IMP, but it is useful to review the methods mentioned to ensure a thorough geohazard program as earth movement, and other geological hazards continue to threaten the integrity of the pipeline across its lifetime.

Identifying geodetic monitoring points, i.e., survey benchmarks or seismometers, can track potential ground movement or the effects of nearby blasting. Installing seismometers can monitor the effects of nearby blasting. Installation of slope inclinometers may track ground movement that is not detectable via right-of-way patrols. Installing standpipe piezometers can track changes in groundwater conditions that may affect slope stability. Installing strain gauges on the pipeline can evaluate the accumulation of strain on the pipeline caused by ground movement. The inertia mapping unit (IMU from an ILI tool can be used to perform stress/strain analysis within dents or pipe bending from movement. Aerial mapping light detection and ranging (LIDAR) or other technology can also track changes in ground movement.

5.2 Pressure Cycling Monitoring

Evaluating cyclic fatigue in pipelines is crucial in capturing the potential for the reduced lifespan of the asset and is required by federal regulation[25]. For pipeline systems experiencing aggressive cycling, pressure data monitoring or in tandem with regular review programs may need to be implemented. If cycles are aggressive, remaining defects within mill tolerances and/or undetected by ILI tools or left after a hydro test would experience a high potential for crack growth and lead to failure sooner than anticipated. For those pipelines which experience high-pressure cycling, monitoring capabilities may assist in managing the integrity of the asset. An

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[24] PHMSA Advisory Bulletin ADB-2019-02. *Pipeline Safety: Potential for Damage to Pipeline Facilities Caused by Earth Movement and Other Geological Hazards.* Docket No. PHMSA-2019-0087. Pipeline and Hazardous Materials Safety Administration (PHMSA), DOT. May 2, 2019.
[25] 49 CFR Part 195.452(g)(1)(xvi)

annual analysis of the pressure cycle data could be integrated to evaluate the aggressiveness to determine any operational changes that may need to be made to preserve the integrity of the asset.

5.3 Phased Array In-Line Inspection Advancements

In-line inspections are the most common way to identify defects to characterize and address the state of a pipeline and make informed integrity decisions. However, some defects, such as cracking and longitudinal weld imperfections, have been difficult for standard UT or MFL ILI tools to detect and size accurately. Recent developments in ILI technologies continue to move toward solving common industry problems. Detection and sizing crack flaws and characterization of the longitudinal welds for identifying imperfections can be improved over the use of traditional ultrasonic crack detection ILI tools by integrating phased array technology.

Phased array technology used in an ILI environment can apply both shear wave and compression waves to identify and size cracks and metal loss. NDT Global[26,27], TRAPIL[28], and Baker Hughes[29] have published information regarding this technology and how it can influence the industry in better understanding the condition of pipelines.

6 REFERENCES

1. Kiefner, J. F. and Mitchell, J. L., "Charpy V-Notch Impact Data for Six Samples of Seam-Weld Material from the Longhorn Pipeline," Kiefner and Associates, Inc., Final Report 06-6 to Longhorn Partners Pipeline Company, (January 19, 2006).
2. Kiefner, J. F., Johnston, D. C., and Kolovich, C. E., "Mock ORA for Longhorn Pipeline," Kiefner and Associates, Inc., Final Report 00-49 to Longhorn Pipeline Partners, LP (October 16, 2000).
3. Kiefner, J. F., Kolovich, C. E., Zelenak, P. A., and Wahjudi, T. F., "Estimating Fatigue Life for Pipeline Integrity Management," Paper No. IPC04-0167, Proceedings of IPC 2004 International Pipeline Conference, Calgary, Alberta, Canada (October 4-8, 2004).
4. Verbeek, E.R., Ratzlaff, K.W., Clanton, U.S., Faults in Parts of North-Central and Western Houston Metropolitan Area, Texas, U.S. Geological Survey, September 2005.
5. Environmental Assessment, Appendix 9E, Longhorn Mitigation Plan Mandated Studies Summaries.
6. Final Environmental Assessment of the Longhorn Pipeline Reversal, PHMSA-2012-0175, December 2012.
7. The Longhorn Mitigation Plan, September 2000.

[26] Haro et al. "Long Seam Characterization by Means of a Phased Array Based Inline Inspection". ASME. IPC2022-87416. September 30, 2022. Calgary, AB, Canada.
[27] Hass et al. "Phased Array Shot Scenario and Shot Sequence Optimization for Crack Detection Inline Inspection Tools". ASME. IPC2022-87765. September 30, 2022. Calgary, AB, Canada.
[28] Benichou et al. "Combined defect assessments using Phased Array Inline Inspection technology". Pipeline Technology Journal 1/2022. Pages 44-58. January 2022. ISSN 2196-4300.
[29] Spies et al. "A New Phased Array Sensor for Pipeline Inspection – Optimization and Quantitative Performance Evaluation". Pipeline Technology Journal 1/2022. Pages 24-32. January 2022. ISSN 2196-4300.

APPENDIX A – MITIGATION COMMITMENTS

Table A-1. Longhorn Mitigation Commitments (pg. 1 of 7)

No.	Description	Timing of Implementation	Risk(s) Addressed
1	Longhorn shall hydrostatically test the hypersensitive (Tier III) and sensitive (Tier II) areas of the pipeline and those portions of the pipeline identified by the Surge Pressure Analysis as being potentially subject to surge pressures in excess of the current MASP. See Mitigation Appendix, Items 1 and 9.	Prior to startup / Completed	Outside Force Damage, Corrosion, Material Defects, and Previous Defects; Establish Safety Factor
2	Longhorn shall "proof test" all portions of the pipeline from the J-1 Valve to Crane Station that have not been hydrostatically tested pursuant to Mitigation Commitment No. 1. See Mitigation Appendix, Item 2	Prior to startup / Completed	Outside Force Damage, Corrosion, Material Defects, and Previous Defects
3	Longhorn shall replace approximately 19 miles of the existing pipeline over the Edwards Aquifer recharge and contributing zones with thick-walled pipe; the pipe will be protected by a concrete barrier. See Mitigation Appendix, Item 3	Prior to startup / Completed	Outside Force Damage, Corrosion, Material Defects, and Operator Error
4	Longhorn shall perform the following additional cathodic protection mitigation work: (a) Install 13 additional CP ground beds at locations described in Mitigation Appendix, Item 4. (b) Perform interference testing at 20 locations, if necessary, as described in Mitigation Appendix, Item 4. (c) Replace at least 600 feet of coating identified by the CP survey analysis as described in Mitigation Appendix, Item 4. (d) Repair or replace, as necessary, 12 shorted casings identified by the CP survey analysis at the locations described in Mitigation Appendix, Item 4.	Prior to startup / Completed	Corrosion
5	Longhorn shall lower, replace, or recondition, if necessary, the pipe at 12 locations per the Environmental Assessment (including Marble Creek). See Mitigation Appendix, Item 5.	Prior to startup / Completed	Outside Force Damage, Corrosion, and Material Defects
6	Longhorn shall remove stopple fittings at the following locations: Station Nos. 9071+36, 8936+35, and 8796+99 (MP 171.86, 169.25, and 166.61). See Mitigation Appendix, Item 6.	Prior to startup / Completed	Material Defects
7	Longhorn shall excavate the pipeline at two locations, near Satsuma Station and in Waller County, indicated by the 1995 in-line inspection, and determine condition and repair, if necessary. See Mitigation Appendix, Item 7.	Prior to startup / Completed	Material Defects and Corrosion
8	Longhorn shall replace the pipeline at the crossing of Rabb's Creek and investigate at least 5 dent locations identified by Kiefner, based upon the 1995 in-line inspection and repair, if necessary. See Mitigation Appendix, Items 8 and 19.	Prior to startup / Completed	Material Defects, Corrosion, and Outside Force Damage

Table A-2 (continued). Longhorn Mitigation Commitments (pg. 2 of 7)

No.	Description	Timing of Implementation	Risk(s) Addressed
9	Longhorn shall remediate any maximum allowable surge pressure (MASP) problems identified by Longhorn's most recent Surge Pressure Analysis by hydrostatically testing those portions of the pipeline which the Surge Pressure Analysis indicates could exceed MASPs. The hydrostatic test will requalify the portions of the pipeline, which will be tested to a MASP which is within permissible limits as established by the most recent Surge Pressure Analysis. Further, Longhorn will implement appropriate measures in all Tier II and Tier III areas of the pipeline to eliminate the possibility of conditions causing a surge pressure exceeding maximum operating pressure (MOP). See Mitigation Appendix, Item 9 and Longhorn Mitigation Commitment 34.	Prior to startup / Completed	Material Defects and Corrosion
10	Longhorn shall, following the use of sizing and (where appropriate) geometry tools, perform an in-line inspection of the Existing Pipeline (Valve J-1 to Crane) with a transverse field magnetic flux inspection (TFI) tool and remediate any problems identified. See the Longhorn Pipeline System Integrity Plan in Sec. 3.5.2 and the associated Operational Reliability Assessment in Sec. 4.0.	At such intervals as are established by the ORA, provided that an inspection shall be performed no more than 3 years after system startup in Tier II and III areas	Material Defects, Corrosion, Outside Force Damage and Previous Defects
11	Longhorn shall, following the use of sizing and (where appropriate) geometry tools, perform an in-line inspection of the Existing Pipeline (Valve J-1 to Crane) with a high-resolution magnetic flux leakage (HRMFL) tool and remediate any problems identified. Until Mitigation Item 11 has been completed, an interim MOP (MOPi) shall be established for the Existing Pipeline at a pressure equal to 0.88 times the MOP. (NOTE: 1.25 times the MOPi is equal to the Proof Test Pressure discussed in Mitigation Item 2 above). See the SIP in Sec. 3.5.2 and the associated ORA in Sec. 4.0.	Within 3 months of startup and thereafter at such intervals as are established by the ORA	Corrosion, Outside Force Damage, and Previous Defects
12	Longhorn shall, following the use of sizing and (where appropriate) geometry tools, perform an in-line inspection of the Existing Pipeline (Valve J-1 to Crane) with an ultrasonic wall measurement tool and remediate any problems identified. See the SIP at sec: 3.5.2 and the associated ORA at Sec. 4.0.	At such intervals, as are established by the ORA, provided that an inspection shall be performed no more than 5 years after system startup	Corrosion, Material Defects, Outside Force Damage, and Previous Defects
12A	Longhorn shall perform an in-line inspection of the Existing Pipeline (Valve J-1 to Crane) with a "smart" geometry inspection tool and remediate any problems identified. See the SIP in Sec. 3.5.2 and the associated ORA in Sec. 4.0.	At such intervals, as are established by the ORA, provided that no more than 3 years shall pass without an in-line inspection being performed using an inspection tool capable of detecting third-party damage (e.g., TFI, MFL, or geometry)	Outside Force Damage

Table A-3 (continued). Longhorn Mitigation Commitments (pg. 3 of 7)

No.	Description	Timing of Implementation	Risk(s) Addressed
13	Longhorn shall install an enhanced leak detection and control system, which will include a transient model-based leak detection system utilizing 9-meter stations (6 clamp-on meters and 3 turbine meters). Additionally, a leak detection system will be installed over the Edwards Aquifer Recharge Zone and the Slaughter Creek watershed in the Edwards Aquifer Contributing Zone that will detect a leak of extremely minute volume in 12 to 120 minutes from contact, depending upon the product sensed by the system. That leak detection system will be a buried hydrocarbon sensing cable system designed to meet the leak detection performance specifications described in the preceding sentence. The pipeline system is designed to achieve an emergency shutdown within 5 minutes of a probable leak indication. See Mitigation Appendix, Item 13.	System installation prior to startup and system operational within 6 months of startup / Completed	Leak Detection and Control
14	Longhorn shall perform close interval pipe to soil potential surveys to survey (a) hypersensitive areas and (b) pipeline segments which were not surveyed by the 1998 close interval survey (Station Nos. 10753+40 – 10811+06 [MP 203.66 – 204.75], 8897+60 – 8945+40 [MP 168.52 – 169.42], and 1729+24 – 1734+81 [MP 32.75 – 32.86]) and remediate corrosion-related conditions identified by the surveys as necessary. See Mitigation Appendix, Item 4 (Areas 12, 13, and 15) and the Longhorn Pipeline System Integrity Plan, section 3.5.1.	Prior to startup / Completed	Corrosion
15	Longhorn shall perform an engineering analysis to verify that all pipeline spans are adequately supported and protected from external loading. Longhorn shall implement the recommendations of such analysis to ensure the stability of such spans. Longhorn shall provide documentary or analytical confirmation of the pipe grade or the pipeline across the Colorado River. See Mitigation Appendix, Item 15.	Prior to startup / Completed	Material Defects, Outside Force Damage and Corrosion, Establish Safety Factors
16	Longhorn shall remove all encroachments along the pipeline right-of-way that could reasonably be expected to obstruct prompt access to the pipeline for routine or emergency repair activities, or that could reasonably be expected to hinder Longhorn's ability to promptly detect leaks or other problems. Potential encroachments will be evaluated using the guidelines in section 3.5.5, Encroachment Procedures of the Longhorn Pipeline System Integrity Plan.	Within one year of startup / Completed	Outside Force Damage, Leak Detection and Control
17	Longhorn shall clear the right-of-way to excellent condition (right-of-way encroachments shall be resolved by Longhorn pursuant to Mitigation Commitment 16). See Mitigation Appendix, Item 17.	Prior to startup and continuously thereafter	Outside Force Damage, Leak Detection and Control

Table A-4 (continued). Longhorn Mitigation Commitments (pg. 4 of 7)

No.	Description	Timing of Implementation	Risk(s) Addressed
18	As necessary, Longhorn shall inspect, repair, or replace 26 locations identified by Williams in its risk assessment model as areas requiring further investigation. See Mitigation Appendix, Item 18.	Prior to startup / Completed	Outside Force Damage, Material Defects, Corrosion, and Previous Defects
19	Longhorn has performed studies evaluating each of the following matters along the pipeline and shall implement the recommendations of such studies:	Prior to startup / Completed	
	(a) Stress-corrosion cracking potential.		Outside Force Damage, Corrosion, and Material Defects
	(b) Scour, erosion, and flood potential.		Outside Force Damage and Corrosion
	(c) Seismic activity.		Outside Force Damage
	(d) Ground movement, subsidence, and aseismic faulting.		Outside Force Damage
	(e) Landslide potential.		Outside Force Damage
	(f) Soil stress.		Outside Force Damage
			Outside Force Damage
	(g) Root cause analysis on all historical leaks and repairs.		Outside Force Damage, Corrosion, Material Defects, and Operator Error
20	Longhorn shall increase the frequency of patrols in hypersensitive and sensitive areas every two and one-half days, daily in the Edwards Aquifer area and weekly in all other areas. See the SIP, Section 3.5.4.	Continuously after startup	Outside Force Damage, Corrosion, Material Defects, Leak Detection and Control
21	Longhorn shall increase the frequency of inspections at pump stations to every two and one-half days in sensitive and hypersensitive areas. Additionally, remote cameras for monitoring pump stations will be installed within 6 months of startup for existing stations and at future stations prior to startup. See Mitigation Appendix, Item 21.	Continuously after startup	Outside Force Damage, Corrosion, Material Defects, Leak Detection and Control
22	Longhorn shall commission a study that quantifies the costs and benefits of additional valves at the following river and stream crossings: Marble Creek, Onion Creek, Long Branch, Barton Creek, Fitzhugh Creek, Flat Creek, Cottonwood Creek, Hickory Creek, White Oak Creek, Crabapple Creek, Squaw Creek, Threadgill Creek, and James River. Longhorn shall install additional valves if it determines, on the basis of the study, with DOT/OPS concurrence, that additional valves will be beneficial. See Mitigation Appendix, Item 22.	Prior to startup / Completed	Outside Force Damage, Corrosion, Material Defects, and Leak Detection and Control
23	Longhorn shall develop a response center in the middle area of the pipeline, which will include available response equipment and personnel such that under normal conditions, a maximum 2-hour full response can be assured. See Mitigation Appendix, Items 23, 24, and 26. (Items 23, 24, and 26 are grouped under the heading "Enhanced Facility Response Plan" in the Mitigation Appendix.)	Prior to startup / Completed	Leak Detection and Control

Table A-5 (continued). Longhorn Mitigation Commitments (pg. 5 of 7)

No.	Description	Timing of Implementation	Risk(s) Addressed
24	Longhorn shall revise its facilities response plan to better address firefighting outside of metropolitan areas (Houston, Austin, and El Paso) where HAZMAT units do not exist. See Mitigation Appendix, Items 23, 24, and 26. (Items 23, 24, and 26 are grouped under the heading "Enhanced Facility Response Plan" in the Mitigation Appendix.)	Prior to startup / Completed	Leak Detection and Control
25	Longhorn shall develop enhanced public education/damage prevention programs to, inter alia, (a) ensure awareness among contractors and potentially affected public, (b) promote cooperation in protecting the pipeline, and (c) provide information to potentially affected communities with regard to detection of and responses to well water contamination. See the SIP, Section 3.5.4. See Mitigation Appendix, Item 25. (This item has been superseded in large part by API RP 1162.)	Continuously after startup	Outside Force Damage, Leak Detection and Control
Appendix Item 3	Longhorn will replace approximately six miles of Existing Pipeline in the Pedernales River watershed that is characterized as having a time of travel for a spill from Lake Travis of eight hours or less.	Segment 5 crossing the Pedernales River will be completed prior to the date of pipeline startup. Segments 1 through 4 will be replaced as determined by the System Integrity Plan and ORA, but in any case, no later than seven years from the startup date.	Outside force damage
26	Longhorn shall revise its facility response plan to provide more detailed response planning for areas where high populations of potentially sensitive receptors are on or adjacent to the pipeline right-of-way. See Mitigation Appendix, Items 23, 24, and 26. (Items 23, 24, and 26 are grouped under the heading "Enhanced Facility Response Plan" in the Mitigation Appendix.)	Prior to startup / Completed	Leak Detection and Control
27	Longhorn shall provide evidence (as-built engineering drawings and similar such documentation) that secondary containment was installed, during construction, under and around all storage and relief tanks, in accordance NFPA 30. Longhorn shall install secondary containment at the Cedar Valley pump station in Hays County.	Prior to startup / Completed	Leak Detection and Control
28	Longhorn shall revise its facility response plan, if or as necessary, to make it consistent, to the extent practicable; the referenced plans are Control with the City of Austin's Barton Springs oil spill developed contingency plan and the United States Fish and Wildlife Service's Barton Springs Salamander Recovery Plan. See Mitigation Appendix, Item 28.	Prior to startup / Completed	Leak Detection and Control

Table A-6 (continued). Longhorn Mitigation Commitments (pg. 6 of 7)

No.	Description	Timing of Implementation	Risk(s) Addressed
29	Longhorn shall provide funding for a contractor (employing personnel with the necessary education, training, and experience) to conduct water quality monitoring at each of the 12 locations in proximity to stream crossings of the pipeline to determine the presence of gasoline constituents. See Mitigation Appendix, Item 29.	For a period of two years after startup to evaluate the effectiveness of the program and thereafter as dictated by the Longhorn ORA (See Section 4.0).	Leak Detection and Control
30	Longhorn shall provide alternate water supplies to certain water municipalities and private well users as detailed in Longhorn's contingency plans. See Mitigation Appendix, Item 30.	Prior to startup / Completed	Leak Detection and Control
31	Longhorn shall perform a surge pressure analysis prior to any increase in the pumping capacity above those rates for which analyses have been performed or any other change which has the capability to change the surge pressures in the system. Longhorn will be required to submit mitigation measures acceptable to DOT/OPS prior to any such change in the system, which mitigation measures will adequately address any MASP problems on the system identified by the surge pressure analysis.	Prior to any change in the system that has the capability to cause surge pressures to occur on the system.	Material Defects
32	Longhorn shall perform pipe-to-soil potential surveys semi-annually over sensitive and hypersensitive areas (which is twice the frequency required by DOT regulation – 49 CFR 195.573), and corrective measures will be implemented, as necessary, where indicated by the surveys. See Longhorn Pipeline System Integrity Plan, Section 3.5.1.	No more than six months after startup and semi-annually thereafter.	Corrosion
33	(a) Longhorn shall provide the necessary funding to establish an adequate refugium and captive breeding program for the Barton Springs Salamander to offset any losses that might occur in the highly unlikely event of a release that caused the loss of individual salamanders. This program will be conducted in coordination with the Austin Ecological Services Field Office of the U.S. Fish and Wildlife Service; and	Within 30 days of startup / Completed	Potential adverse effects to the Barton Springs Salamander
	(b) Longhorn shall perform conservation measures developed in consultation with the U.S. Fish and Wildlife Service to mitigate potential impacts to threatened and endangered species in the highly unlikely event that future pipeline construction activities and operation may adversely affect such species or their habitat. See Mitigation Appendix, Item 33.	At any time, such activity could have an adverse effect on listed species or habitat.	Potential adverse effects to listed species or habitat

Table A-7 (continued). Longhorn Mitigation Commitments (pg. 7 of 7)

No.	Description	Timing of Implementation	Risk(s) Addressed
34	Longhorn shall implement system changes through system and equipment modification and/or observance of operating practices to limit surge pressure to no more than MOP in sensitive and hypersensitive areas. Such system changes shall include (a) replacement of the pipe at the following locations: 6752+06 – 6758+40 (MP 127.88 – 128.00) and 10489+47 – 10490+00 (MP 198.66 – 198.67) and (b) installation of pressure active by-pass systems at the Brazos, Colorado, Pedernales, and Llano rivers. In addition, Longhorn shall replace one 671-foot section of pipe previously characterized as Grade B. See Mitigation Appendix, Item 34 and Longhorn Mitigation Commitment 9.	Prior to startup and thereafter	Outside Force Damage, Corrosion, Operator Error, and Material Defects
35	Longhorn shall not transport products through the pipeline system which contains the additive methyl tertiary butyl ether (MTBE) or similar aliphatic ether additives (e.g., TAME, ETBE, and DIPE) in greater than trace amounts. This limitation with be incorporated into the Longhorn product specifications.	During the operational life of the pipeline system	Potential adverse impacts to water resources
36	Longhorn shall prepare site-specific environmental studies for each new pump station planned for construction. These studies shall be responsive to National Environmental Policy Act (NEPA) requirements as supplements to the EA of the Proposed Longhorn Pipeline System. For each such pump station, Longhorn shall submit the site-specific environmental study to the U.S. DOT no less than 180 days prior to the commencement of construction.	Prior to construction of any new pump station	Consistency with NEPA
37	Longhorn shall maintain pollution legal liability insurance of no less than $15 million to cover on-site and off-site third-party claims for bodily injury, property damage, and costs of response and clean-up in the event of a release of product from the Longhorn Pipeline System.	Prior to startup and during the operational life of the pipeline system	Financial Assurance
38	Longhorn shall submit periodic reports to DOT/OPS that will include information about the status of mitigation commitment implementation, the character of interim developments as related to mitigation commitments, and the results of mitigation-related studies and analyses. The reports shall also summarize developments related to its ORA. The reports shall be made available to the public.	Quarterly during the first 2 years of system operation and annually thereafter for the operational life of the pipeline system.	Assurance of mitigation commitment implementation and public access to related information
39	The Longhorn Mitigation Plan and associated Pipeline System Integrity Plan and ORA shall not be unilaterally changed. The LMP may be modified only after Longhorn has reviewed the proposed changes with DOT/OPS and received written concurrence from DOT/OPS with the proposed modifications.	During the operational life of the pipeline system	Assurance of full implementation of the Longhorn Mitigation Commitments

APPENDIX B – NEW DATA USED IN THIS ANALYSIS

Table B-1. 2021 ORA Data List (pg. 1 of 2)

Topics	Data / Notes
1. Pipeline and Facilities	• Alignment Sheets – 6643 – E. Houston to 9th Street – 6645 – E. Houston to El Paso • Linefill Sheets • Maps and Flow Schematics (strip maps, KMZ files) • Tier Classifications • List of HCAs • Facility Inspection Reports – El Paso East (10/21) – Cartman (9/21) – Kimble (9/21) – James River (9/21) – Eckert (9/21) – Cedar Valley (9/21) – Bastrop (9/21) – Warda (9/21) – Buckhorn (9/21) – Satsuma (10/21)
2. Flow and Pressure Data	• Monthly spreadsheet of flow and pressures • Service Interruptions
3. ILI & Anomaly Investigation Reports	• Deformation Reports: – Satsuma to East Houston – Crane to Texon – Crane to Cottonwood • MFL and Deformation Reports: – Odessa to Crane • UCD Reports: – Kimble to James River • Tool specifications
4. Hydrostatic Testing Reports	• No hydrostatic tests were performed in 2021.
5. Corrosion Management Surveys & Reports	• Cathodic Protection Data – Rectifier Inspection Reports – Rectifier Maintenance Reports – Test Point Exception Reports – CIS Reports • Coupon Data • Atmospheric Inspection Reports • No tank inspections were performed in 2021.

Table B-1 (continued). 2021 ORA Data List (pg. 2 of 2)

Topics	Data / Notes
6. Earth Movement & Water Forces	• Fault monitoring (semi-annual reports) • Depth of cover surveys – James River (Kimble to James River segment) – Threadgill Creek (James River to Eckert segment) – Onion Creek (Cedar Valley to Bastrop segment) – Boons Creek (Bastrop to Warda segment) – Alum Creek (Bastrop to Warda segment) – Rocky Branch (Warda to Buckhorn segment) – Muddy Creek (Warda to Buckhorn segment) – Cypress Creek (Buckhorn to Satsuma segment) – Harris Creek (Buckhorn to Satsuma segment) • Master River Inspections Spreadsheet • Flood monitoring (daily)
7. Maintenance and Inspection Reports	• Maintenance Reports • Nondestructive Evaluation (NDE) • Positive Material Identification (PMI) • Mainline Valve Inspection Reports • Longhorn Year-end Preventive Maintenance Tasks Summary
8. Project Work Progress and Quality Control Reports	• CMS Year-End Task Report • Preventive Maintenance Summary • Scorecards • Annual Asset Integrity Summary for 2021 • 2021 Annual Commitment Implementation Status Report • 2021 Annual Self-Audit
9. One-Call Violations and Third-Party Damage Prevention Data	• Third-Party Damage Report • One-call list • Encroachments • Patrol Data • Website Visits • Damage Prevention Training
10. Incident, Root Cause, and Metallurgical Failure Analysis Reports	• Incident Data and Incident Investigation Reports
11. Other SIP / Risk Assessment Studies, Evaluations, and other Program Data	• Process Hazard Analyses – None performed in 2021.
12. Leak Detection	• Pipeline Leak Monitoring (PLM) Records • Description of System(s)
13. Integrity Management Plan (IMP) & Related Procedures	• IMP Plan and related procedures

B.2. Major Pipeline Incidents, Industry, or Agency Advisories Affecting Pipeline Integrity

B.2.1 PHMSA Advisories

None were applicable to the Longhorn Pipeline during 2021.

B.2.2 PHMSA Notices

Pipeline Safety: Periodic Updates of Regulatory References to Technical Standards and Miscellaneous Amendments, 1/15/2021.
PHMSA published this document as a notice of proposed rulemaking to incorporate 20 consensus standards into the Federal pipeline safety regulations. The notice would also make corrections to clarify regulator language in certain provisions.

A. American Petroleum Institute (API):
    1. API Recommended Practice 651, Cathodic Protection of Aboveground Petroleum Storage Tanks.
    2. API Recommended Practice 2026, "Safe Access/Egress Involving Floating Roofs of Storage Tanks in Petroleum Service"
    3. API Specification 5L, Specification for Line Pipe
    4. API Specification 6D, Specification for Pipeline and Piping Valves
    5. API Standard 620, Design and Construction of Large, Welded, Low-Pressure Storage Tanks
    6. API Standard 650, Welded Tanks for Oil Storage
    7. API Standard 1104, Welding of Pipelines and Related Facilities
    8. ANSI/API Standard 2000, Venting Atmospheric and Low-Pressure Storage Tanks
    9. API Standard 2350, Overfill Prevention for Storage Tanks in Petroleum Facilities
B. The American Society of Mechanical Engineers (ASME):
    1. ASME B31.8, Gas Transmission and Distribution Piping Systems
    2. ASME B31.8S, Supplement to B31.8 on Managing System Integrity of Gas Pipelines
    3. ASME B36.10M, Welded and Seamless Wrought Steel Pipe
C. ASTM International (Formerly American Society for Testing and Materials)
    1. ASTM A53/A53M, Standard Specification for Pipe, Steel, Black, Hot-Dipped, Zinc-Coated, Welded, and Seamless
    2. ASTM A106/106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
    3. ASTM A333/A333M, Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness
    4. ASTM A381, Standard Specification for Metal-Arc-Welded Carbon or High-Strength Low-Alloy Steel Pipe for Use with High-Pressure Transmission Systems
    5. ASTM A671/671M, Standard Specification for Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures
    6. ASTM A691/691M, Standard Specification for Carbon and Alloy Steel Pipe, Electric-Fusion-Welded for High-Pressure Service at High Temperatures

D. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry:
   1. ANSI/MSS SP-44, Steel Pipeline Flanges
   2. MSS SP-75, High-Test, Wrought, Butt-Welding Fittings
E. NACE International (Formerly National Association of Corrosion Engineers):
   1. NACE SP0204, Standard Practice: Stress Corrosion Cracking Direct Assessment Methodology
F. National Fire Protection Association (NFPA):
   1. NFPA 58, Liquefied Petroleum Gas Code
   2. NFPA 59, Utility LP-Gas Plant Code
   3. NFPA 70, National Electrical Code (NEC)

B.2.3 DOT Regulations

No new regulations affecting the Longhorn ORA occurred in 2021.

B.2.4 Literature Reviewed

See references.

B.2.5 Texas Railroad Commission

Chapter 8 - §8.1 – General Applicability and Standards: Effective September 13, 2021, the minimum safety standards for intrastate pipelines must meet either 49 CFR Part 192, Transportation of Natural and Other Gas by Pipeline, or 49 CFR Part 195, Transportation of Hazardous Liquids by Pipeline. All operators of pipelines or pipeline facilities regulated by this chapter, other than master metered systems and distribution systems, shall comply with §3.70 of this title (relating to Pipeline Permits Required).

- Chapter 8 - §8.1 – General Applicability and Standards affect the Odessa to Crane pipeline segment.

APPENDIX C – THRESHOLD ANOMALY FATIGUE EVALUATION RESULTS

Table C-1 and Table C-2 show the fatigue lives predicted for pipeline segments with hypothetical anomalies that may have escaped detection. These hypothetical anomalies have been simulated for all variations in pipe properties, including wall thickness, grade, pipe OD, elevation, and nearness to the pump station discharge. Fatigue reassessment results are sorted by the earliest reassessment interval.

Note that a simulation cap of 500 years was imposed to reduce the calculation time. Also, note that the reassessment intervals were calculated using a safety factor of 2.22, consistent with the specification for safety factor in the Magellan ORA Manual, which requires that the reassessment interval be taken as 45% of the shortest fatigue life.

Table C-1. Reassessment Intervals for Threshold Defects on Refined Product Segments

Pipeline Segment	Assessment Location	OD (inch)	Wall Thickness (inch)	Grade	Elevation (feet)	Year of Installation	Threshold Flaw Depth (inch)	Threshold Anomaly Depth at API 5L Detection Threshold (% WT)	Re-assessment Interval (years)	Re-assessment Due Date
Odessa to Crane	1516+94	8.625	0.188	X60	2,847	1998	0.019	10	86.3	4/08/2084
Odessa to Crane	1526+10	8.625	0.250	X60	2,857	1998	0.025	10	223.9	12/13/2221
Odessa to Crane	1483+32	8.625	0.250	X46	2,863	1998	0.025	10	192.5	7/16/2190
Odessa to Crane	1413+58	8.625	0.250	X42	2,853	1998	0.025	10	178.1	2/25/2176
Odessa to Crane	1521+51	8.625	0.277	B	2,855	1998	0.028	10	225.2	3/26/2223
Odessa to Crane	1517+42	8.625	0.277	X60	2,848	1998	0.028	10	225.2	3/26/2223
Odessa to Crane	1544+74	8.625	0.322	B	2,863	1998	0.032	10	225.2	3/26/2223
Odessa to Crane	1544+20	8.625	0.322	X42	2,862	1998	0.032	10	225.2	3/26/2223
Odessa to Crane	1544+68	8.625	0.322	X52	2,864	1998	0.032	10	225.2	3/26/2223
Crane to Cottonwood	27879+57	18	0.500	X52	2,621	2008	0.050	10	225.2	3/25/2233
Crane to Cottonwood	30429+00	18	0.281	X65	3,843	1998	0.028	10	225.2	3/26/2223
Cottonwood to El Paso	36664+58	18	0.281	X65	4,022	1998	0.028	10	225.2	3/26/2223
Crane to Cottonwood	30430+16	18	0.375	X52	3,841	2008	0.038	10	225.2	3/25/2233
Crane to Cottonwood	30429+60	18	0.375	X65	3,840	2008	0.038	10	225.2	3/25/2233
Cottonwood to El Paso	36642+98	18	0.375	X65	4,017	1998	0.038	10	225.2	3/26/2223
Cottonwood to El Paso	36665+05	18	0.375	X52	4,022	1998	0.038	10	225.2	3/26/2223

Table C-2. Reassessment Intervals for Threshold Defects on Crude Segments (Page 1 of 4)

Pipeline Segment	Assessment Location	OD (inch)	Wall Thickness (inch)	Grade	Elevation (feet)	Year of Installation	Threshold Flaw Depth (inch)	Threshold Anomaly Depth at ILI Detection Threshold (% WT)	Re-assessment Interval (years)	Re-assessment Due Date
E Houston to Speed Jct	0+02	20	0.375	B	37	1998	0.094	25	18.4	2/10/2033
E Houston to Speed Jct	0+14	20	0.375	X52	37	1998	0.094	25	22.4	3/6/2037
E Houston to Speed Jct	188+83	20	0.312	X52	17	1998	0.078	25	23.8	7/19/2038
Crane to Texon	24062+95	18	0.250	X52	2,525	1950	0.040	16	39.3	2/6/2058
Texon to Barnhart	21999+54	18	0.250	X52	2,675	1950	0.040	16	39.4	9/25/2059
E Houston to Speed Jct	235+10	20	0.344	X52	18	1998	0.086	25	41.5	3/19/2056
E Houston to Speed Jct	187+12	20	0.375	X60	19	1998	0.094	25	45.8	7/29/2060
Bastrop to Warda	7483+48	18	0.281	X45	395	1950	0.040	14	49.5	8/9/2069
Cartman to Kimble	18168+81	18	0.281	X45	2,445	1950	0.040	14	53.4	1/16/2074
James River to Eckert	13733+47	18	0.281	X45	1,705	1950	0.040	14	56.3	7/9/2076
Cartman to Kimble	18173+61	18	0.281	X65	2,445	1950	0.040	14	56.4	1/29/2077
Kimble to James River	14758+39	18	0.219	X52	1,669	1950	0.040	18	62.8	8/22/2083
Crane to Texon	24157+75	18	0.281	X65	2,524	1950	0.040	14	63.8	8/8/2082
Cartman to Kimble	17883+21	18	0.281	X52	2,399	1950	0.040	14	73.4	1/1/2094
Bastrop to Warda	7157+10	18	0.281	X65	348	1950	0.040	14	81.6	8/26/2101
Cartman to Kimble	18174+51	18	0.312	X45	2,445	1950	0.040	13	84.0	8/26/2104
Warda to Buckhorn	5702+41	18	0.281	X45	380	1950	0.040	14	87.6	6/15/2107
Barnhart to Cartman	19716+78	18	0.281	X65	2,605	1950	0.040	14	88.5	12/08/2108
James River to Eckert	13371+07	18	0.281	X65	1,649	1950	0.040	14	90.1	3/30/2110
Kimble to James River	15584+59	18	0.281	X45	2,223	1950	0.040	14	90.6	5/22/2111
Eckert to Cedar Valley	12033+42	18	0.281	X45	1,736	1950	0.040	14	94.9	2/5/2115
Buckhorn to Satsuma	3587+47	18	0.281	X45	171	1950	0.040	14	102.2	2/7/2122
Warda to Buckhorn	5961+54	18	0.312	X45	359	1950	0.040	13	102.3	3/9/2122
James River to Eckert	13585+57	18	0.312	X60	1,777	1950	0.040	13	110.3	6/14/2130
Satsuma to E Houston	1800+22	20	0.312	B	126	1950	0.040	13	121.1	9/15/2140
Barnhart to Cartman	19726+03	18	0.312	X45	2,603	1950	0.040	13	131.4	11/10/2151
Texon to Barnhart	21388+14	18	0.281	X65	2,664	1950	0.040	14	133.0	5/18/2153
Barnhart to Cartman	19717+38	18	0.312	X52	2,605	1950	0.040	13	134.9	5/17/2155
Kimble to James River	15260+29	18	0.281	X65	2,123	1950	0.040	14	136.0	10/10/2156
Barnhart to Cartman	19262+28	18	0.281	X45	2,533	1950	0.040	14	137.1	7/29/2157
Eckert to Cedar Valley	12029+82	18	0.312	X45	1,744	1950	0.040	13	150.1	4/14/2170
Cedar Valley to Bastrop	8965+58	18	0.281	X45	790	1950	0.040	14	157.8	11/7/2177
Crane to Texon	22422+53	18	0.281	X46	2,664	1950	0.040	14	168.9	9/19/2187
Eckert to Cedar Valley	11499+12	18	0.281	X45	1,648	1950	0.040	14	171.4	8/14/2191
Cartman to Kimble	18178+76	18	0.375	B	2,446	1950	0.040	11	172.9	7/21/2193
James River to Eckert	13735+06	18	0.375	B	1,712	1950	0.040	11	184.1	4/13/2204
Bastrop to Warda	6789+27	18	0.312	X45	470	1950	0.040	13	192.8	11/3/2212
Bastrop to Warda	7360+80	18	0.375	B	394	1950	0.040	11	193.7	10/22/2213
Crane to Texon	24158+24	18	0.375	B	2,524	1950	0.040	11	195.5	5/4/2214

Table C-2. Reassessment Intervals for Threshold Defects on Crude Segments (Page 2 of 4)

Pipeline Segment	Assessment Location	OD (inch)	Wall Thickness (inch)	Grade	Elevation (feet)	Year of Installation	Threshold Flaw Depth (inch)	Threshold Anomaly Depth at ILI Detection Threshold (% WT)	Re-assessment Interval (years)	Re-assessment Due Date
Texon to Barnhart	21351+54	18	0.312	X45	2,666	1950	0.040	13	207.5	11/26/2227
Texon to Barnhart	22000+11	18	0.375	B	2,675	1950	0.040	11	212.2	7/24/2232
Texon to Barnhart	21998+94	18	0.375	X42	2,674	1950	0.040	11	217.0	5/22/2237
Buckhorn to Satsuma	3064+08	18	0.281	X45	179	1950	0.040	14	217.4	5/13/2237
Crane to Texon	24112+45	18	0.375	X65	2,540	1950	0.040	11	222.5	4/23/2241
James River to Eckert	13435+87	18	0.385	X65	1,783	1950	0.040	10	225.2	6/3/2245
Kimble to James River	14878+99	18	0.375	X42	1,827	1950	0.040	11	225.2	1/12/2246
Satsuma to E Houston	312+01	20	0.250	X52	35	1950	0.040	16	225.2	11/7/2244
Kimble to James River	14604+19	18	0.375	X45	1,511	1950	0.040	11	225.2	1/12/2246
Buckhorn to Satsuma	3372+81	18	0.375	X45	141	1950	0.040	11	225.2	2/26/2245
Crane to Texon	23916+23	18	0.375	X52	2,575	1950	0.040	11	225.2	1/11/2244
Cartman to Kimble	17884+41	18	0.375	X65	2,400	1950	0.040	11	225.2	11/17/2245
Warda to Buckhorn	5518+21	18	0.375	B	512	1950	0.040	11	225.2	1/29/2245
Cartman to Kimble	17307+51	18	0.375	X52	2,271	1950	0.040	11	225.2	11/17/2245
Texon to Barnhart	19727+34	18	0.375	X52	2,602	1950	0.040	11	225.2	8/7/2245
Satsuma to E Houston	1122+56	20	0.375	X52	83	1950	0.040	11	225.2	11/7/2244
Kimble to James River	15144+49	18	0.375	X65	2,106	1950	0.040	11	225.2	1/12/2246
Bastrop to Warda	6887+67	18	0.375	X52	356	1950	0.040	11	225.2	4/20/2245
Satsuma to E Houston	1171+67	20	0.375	X42	86	1950	0.040	11	225.2	11/7/2244
Cedar Valley to Bastrop	8430+98	18	0.281	X65	553	1950	0.040	14	225.2	04/9/2245
James River to Eckert	12186+09	18	0.375	X70	1,606	1950	0.040	11	225.2	6/3/2245
James River to Eckert	12921+69	18	0.375	X65	1,698	1950	0.040	11	225.2	6/3/2245
Buckhorn to Satsuma	3073+11	18	0.375	X65	177	1950	0.040	11	225.2	2/26/2245
Buckhorn to Satsuma	3071+61	18	0.385	X65	177	1950	0.040	10	225.2	2/26/2245
Satsuma to E Houston	832+03	20	0.312	X60	57	1950	0.040	13	225.2	11/7/2244
Barnhart to Cartman	18853+98	18	0.312	X65	2,501	1950	0.040	13	225.2	9/8/2245
Bastrop to Warda	5965+07	18	0.312	X65	355	1950	0.040	13	225.2	4/20/2245
Satsuma to E Houston	482+41	20	0.312	X52	39	1950	0.040	13	225.2	11/7/2244
James River to Eckert	13586+77	18	0.375	X65	1,778	1950	0.040	11	225.2	6/3/2245
Satsuma to E Houston	1688+49	20	0.375	X60	117	1950	0.040	11	225.2	11/7/2244
Satsuma to E Houston	1572+09	20	0.375	B	121	1950	0.040	11	225.2	11/7/2244
Satsuma to E Houston	381+01	20	0.344	X52	30	1950	0.040	12	225.2	11/7/2244
Crane to Texon	24020+03	18	0.385	X65	2,537	1950	0.040	10	225.2	1/11/2244
Warda to Buckhorn	5945+30	18	0.375	X65	315	1950	0.040	11	225.2	1/29/2245
Cartman to Kimble	17586+21	18	0.385	X65	2,414	1950	0.040	10	225.2	11/17/2245
Kimble to James River	14607+19	18	0.385	X65	1,528	1950	0.040	10	225.2	1/12/2246
Buckhorn to Satsuma	3387+21	18	0.500	X42	150	1950	0.040	8	225.2	2/26/2245
Cedar Valley to Bastrop	8896+16	18	0.312	X45	708	1950	0.040	13	225.2	4/9/2245
Bastrop to Warda	7113+00	18	0.375	X45	337	1950	0.040	11	225.2	4/20/2245

Table C-2. Reassessment Intervals for Threshold Defects on Crude Segments (Page 3 of 4)

Pipeline Segment	Assessment Location	OD (inch)	Wall Thickness (inch)	Grade	Elevation (feet)	Year of Installation	Threshold Flaw Depth (inch)	Threshold Anomaly Depth at ILI Detection Threshold (% WT)	Re-assessment Interval (years)	Re-assessment Due Date
Buckhorn to Satsuma	1947+38	18	0.375	X52	136	1950	0.040	11	225.2	2/26/2245
Cedar Valley to Bastrop	7828+82	18	0.500	X65	503	1950	0.040	8	225.2	4/9/2245
Barnhart to Cartman	18561+24	18	0.375	X52	2,477	1950	0.040	11	225.2	9/8/2245
Cedar Valley to Bastrop	9099+68	18	0.375	X52	865	1950	0.040	11	225.2	4/9/2245
Barnhart to Cartman	19265+88	18	0.385	X65	2,532	1950	0.040	10	225.2	9/8/2245
Bastrop to Warda	7115+40	18	0.385	X65	337	1950	0.040	10	225.2	4/20/2245
James River to Eckert	12039+26	18	0.312	X45	1,717	1950	0.040	13	225.2	6/3/2245
Satsuma to E Houston	490+46	20	0.375	X60	39	1950	0.040	11	225.2	11/7/2244
Bastrop to Warda	7115+70	18	0.375	X65	337	1950	0.040	11	225.2	4/20/2245
Bastrop to Warda	6797+67	18	0.375	X42	430	1950	0.040	11	225.2	4/20/2245
Barnhart to Cartman	18180+24	18	0.375	X45	2,446	1950	0.040	11	225.2	9/8/2245
Barnhart to Cartman	18303+24	18	0.500	X52	2,452	1950	0.040	8	225.2	9/8/2245
Buckhorn to Satsuma	3386+91	18	0.500	X42	150	1950	0.040	8	225.2	2/26/2245
Cedar Valley to Bastrop	9561+68	18	0.385	X65	973	1950	0.040	10	225.2	4/9/2245
Buckhorn to Satsuma	3373+11	18	0.375	X45	141	1950	0.040	11	225.2	2/26/2245
Eckert to Cedar Valley	10508+23	18	0.375	B	996	1950	0.040	11	225.2	5/25/2245
Barnhart to Cartman	18852+18	18	0.375	X65	2,501	1950	0.040	11	225.2	9/8/2245
Kimble to James River	15585+23	18	0.375	X52	2,221	1950	0.040	11	225.2	1/12/2246
Barnhart to Cartman	18860+28	18	0.375	X60	2,501	1950	0.040	11	225.2	9/8/2245
James River to Eckert	13200+97	18	0.375	X52	1,511	1950	0.040	11	225.2	6/3/2245
Warda to Buckhorn	4080+61	18	0.385	X65	229	1950	0.040	10	225.2	1/29/2245
Barnhart to Cartman	18862+38	18	0.312	X60	2,501	1950	0.040	13	225.2	9/8/2245
Eckert to Cedar Valley	12035+40	18	0.375	X52	1,728	1950	0.040	11	225.2	5/25/2245
Cedar Valley to Bastrop	9590+73	18	0.375	X65	1,032	1950	0.040	11	225.2	4/9/2245
Eckert to Cedar Valley	11389+62	18	0.385	X65	1,585	1950	0.040	10	225.2	5/25/2245
Buckhorn to Satsuma	3386+31	18	0.375	X42	150	1950	0.040	11	225.2	2/26/2245
Texon to Barnhart	21353+94	18	0.375	X65	2,665	1950	0.040	11	225.2	8/7/2245
Kimble to James River	14596+69	18	0.375	X45	1,533	1950	0.040	11	225.2	1/12/2246
James River to Eckert	13448+47	18	0.375	X42	1,842	1950	0.040	11	225.2	6/3/2245
Buckhorn to Satsuma	3371+01	18	0.375	X65	142	1950	0.040	11	225.2	2/26/2245
Cartman to Kimble	18037+41	18	0.500	X52	2,426	1950	0.040	8	225.2	11/17/2245
Buckhorn to Satsuma	2025+86	18	0.375	X52	143	1950	0.040	11	225.2	2/26/2245
Eckert to Cedar Valley	11998+62	18	0.375	X65	1,822	1950	0.040	11	225.2	5/25/2245
Buckhorn to Satsuma	2496+20	18	0.281	X65	176	1950	0.040	14	225.2	2/26/2245
Warda to Buckhorn	4539+01	18	0.385	X65	319	1950	0.040	10	225.2	1/29/2245
Warda to Buckhorn	5041+21	18	0.375	X52	391	1950	0.040	11	225.2	1/29/2245
Cartman to Kimble	17141+01	18	0.375	X45	2,229	1950	0.040	11	225.2	11/17/2245
Texon to Barnhart	21599+94	18	0.385	X65	2,723	1950	0.040	10	225.2	8/7/2245
Buckhorn to Satsuma	1803+16	18	0.375	B	126	1950	0.040	11	225.2	2/26/2245

Table C-2. Reassessment Intervals for Threshold Defects on Crude Segments (Page 4 of 4)

Pipeline Segment	Assessment Location	OD (inch)	Wall Thickness (inch)	Grade	Elevation (feet)	Year of Installation	Threshold Flaw Depth (inch)	Threshold Anomaly Depth at ILI Detection Threshold (% WT)	Re-assessment Interval (years)	Re-assessment Due Date
Buckhorn to Satsuma	1955+44	18	0.281	X52	137	1950	0.040	14	225.2	2/26/2245
Eckert to Cedar Valley	11439+42	18	0.500	B	1,705	1950	0.040	8	225.2	5/25/2245
Warda to Buckhorn	4506+01	18	0.281	X45	338	1950	0.040	14	225.2	1/29/2245
Buckhorn to Satsuma	1983+64	18	0.375	B	142	1950	0.040	11	225.2	2/26/2245
Warda to Buckhorn	4027+51	18	0.375	X52	340	1950	0.040	11	225.2	1/29/2245
E Houston to Speed Jct	363+98	20	0.500	X52	5	1998	0.125	25	225.2	12/25/2239
E Houston to Speed Jct	403+64	20	0.500	X42	0	1998	0.125	25	225.2	12/25/2239

APPENDIX D – CRACK DETECTION ILI ANOMALY FATIGUE EVALUATION RESULTS

Table D-1 through Table D-12 show the reassessment intervals for anomalies detected by crack detection ILI tools. The results are sorted by earliest reassessment interval. Kiefner has added the ILI vendor's length and depth tolerances to the listed ILI lengths and depths.

Note that a simulation cap of 500 years was imposed to reduce the calculation time. Also, note that the reassessment intervals were calculated using a safety factor of 2.22, consistent with the specification for safety factor in the Magellan ORA Manual, which requires that the reassessment interval be taken as 45% of the shortest fatigue life.

Table D-1. Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Crane to Texon – ILI Date October 19, 2018 (pg. 1 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
24015+71	2,539	18	0.246	52,000	3.83	0.088	8.2	12/21/2026
24080+38	2,540	18	0.285	65,000	4.07	0.122	8.2	12/26/2026
23603+80	2,678	18	0.246	52,000	5.13	0.088	9.4	2/24/2028
24040+22	2,531	18	0.256	52,000	7.83	0.074	10.2	12/21/2028
22496+50	2,697	18	0.256	52,000	8.07	0.090	10.7	7/11/2029
22041+83	2,663	18	0.246	52,000	3.24	0.107	10.7	7/15/2029
23905+26	2,577	18	0.256	52,000	4.07	0.090	10.9	9/21/2029
22274+39	2,674	18	0.256	52,000	4.30	0.108	11.1	12/4/2029
24047+56	2,530	18	0.246	52,000	6.30	0.068	11.6	5/8/2030
24015+66	2,539	18	0.246	52,000	4.42	0.075	11.6	6/5/2030
22330+21	2,664	18	0.250	52,000	3.60	0.109	11.7	6/22/2030
23009+60	2,702	18	0.256	52,000	3.24	0.120	12.0	11/04/2030
22169+17	2,655	18	0.256	52,000	5.36	0.095	13.0	10/13/2031
23983+38	2,549	18	0.256	52,000	4.07	0.082	13.1	11/19/2031
23574+82	2,712	18	0.256	52,000	4.07	0.095	13.1	12/5/2031
23538+93	2,763	18	0.256	52,000	3.24	0.103	13.9	9/2/2032
22528+36	2,697	18	0.246	52,000	2.18	0.127	14.6	6/5/2033
23087+02	2,662	18	0.256	52,000	8.54	0.082	14.7	7/9/2033
23973+77	2,561	18	0.256	52,000	2.77	0.090	14.7	7/17/2033
23060+85	2,696	18	0.246	52,000	3.83	0.095	15.2	12/26/2033
23395+80	2,792	18	0.246	52,000	3.95	0.088	15.4	3/4/2034
23464+41	2,785	18	0.246	52,000	2.89	0.095	16.3	1/29/2035
23983+37	2,549	18	0.256	52,000	4.30	0.074	16.6	5/15/2035
24012+05	2,541	18	0.246	52,000	3.83	0.068	16.7	7/10/2035
23717+74	2,630	18	0.246	52,000	2.65	0.088	16.8	7/20/2035
23710+02	2,634	18	0.256	52,000	3.13	0.090	17.5	4/6/2036
23053+11	2,681	18	0.256	52,000	1.60	0.154	17.6	6/6/2036
23901+65	2,578	18	0.246	52,000	2.89	0.075	18.5	4/14/2037
22614+78	2,707	18	0.256	52,000	4.54	0.095	18.6	5/9/2037
22151+61	2,646	18	0.256	52,000	6.42	0.082	18.6	6/6/2037
23960+12	2,561	18	0.246	52,000	2.07	0.083	18.7	7/14/2037
23591+08	2,691	18	0.256	52,000	1.95	0.115	18.8	7/22/2037
22403+42	2,662	18	0.256	52,000	5.01	0.090	19.2	12/23/2037
24006+01	2,543	18	0.256	52,000	3.24	0.074	19.6	5/28/2038
23824+96	2,592	18	0.246	52,000	1.71	0.095	20.2	12/15/2038
22944+94	2,629	18	0.246	52,000	3.83	0.088	20.3	1/25/2039
24040+95	2,531	18	0.246	52,000	1.36	0.095	20.4	2/26/2039
22261+55	2,670	18	0.246	52,000	3.60	0.088	20.4	2/27/2039
24000+46	2,543	18	0.256	52,000	6.19	0.062	20.9	9/25/2039
23816+52	2,597	18	0.246	52,000	2.77	0.075	21.0	11/2/2039
22237+61	2,661	18	0.256	52,000	3.48	0.095	21.9	9/21/2040
23957+54	2,563	18	0.246	52,000	1.24	0.102	22.0	10/30/2040
23736+57	2,624	18	0.246	52,000	1.71	0.095	22.2	1/15/2041
23637+28	2,666	18	0.246	52,000	1.36	0.115	22.3	1/24/2041
22082+18	2,658	18	0.246	52,000	1.71	0.115	22.4	3/17/2041
23983+43	2,549	18	0.256	52,000	5.36	0.062	22.8	8/8/2041
23445+69	2,774	18	0.246	52,000	2.54	0.088	23.2	1/7/2042

Table D-1 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Crane to Texon – ILI Date October 19, 2018 (pg. 2 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
23999+74	2,543	18	0.246	52,000	2.42	0.068	23.3	2/4/2042
22316+25	2,666	18	0.246	52,000	2.30	0.102	23.3	2/7/2042
23983+43	2,549	18	0.256	52,000	2.65	0.074	23.4	3/5/2042
22316+35	2,666	18	0.246	52,000	1.83	0.115	23.4	3/17/2042
22656+09	2,713	18	0.256	52,000	2.18	0.120	23.5	5/2/2042
23538+79	2,764	18	0.256	52,000	1.71	0.115	23.6	5/18/2042
23532+45	2,776	18	0.246	52,000	1.60	0.107	23.7	6/24/2042
23293+68	2,769	18	0.246	52,000	1.48	0.122	23.9	9/27/2042
22528+44	2,697	18	0.246	52,000	1.60	0.127	24.0	10/14/2042
22758+47	2,698	18	0.246	52,000	4.07	0.083	24.0	10/25/2042
24012+12	2,541	18	0.246	52,000	1.36	0.088	24.0	10/28/2042
24015+78	2,539	18	0.246	52,000	2.77	0.063	24.2	1/4/2043
24001+84	2,543	18	0.246	52,000	1.36	0.088	24.3	1/31/2043
22024+89	2,666	18	0.256	52,000	6.30	0.074	24.5	4/4/2043
22205+98	2,659	18	0.246	52,000	2.42	0.095	24.8	7/31/2043
23727+74	2,629	18	0.246	52,000	3.36	0.068	25.1	11/28/2043
23529+07	2,774	18	0.256	52,000	1.83	0.108	25.2	12/23/2043
23076+67	2,661	18	0.246	52,000	4.89	0.075	25.3	2/15/2044
22537+13	2,698	18	0.256	52,000	2.18	0.115	25.9	09/13/2044
23983+38	2,549	18	0.256	52,000	2.77	0.069	26.1	11/27/2044
22322+80	2,666	18	0.246	52,000	4.77	0.075	26.2	1/16/2045
24028+80	2,534	18	0.256	52,000	2.54	0.069	26.3	2/15/2045
23428+08	2,762	18	0.256	52,000	2.07	0.103	26.3	2/16/2045
23521+84	2,767	18	0.256	52,000	2.54	0.090	26.3	2/20/2045
22807+78	2,654	18	0.246	52,000	2.54	0.095	26.7	7/17/2045
22519+65	2,698	18	0.246	52,000	1.71	0.115	27.4	3/22/2046
22830+50	2,662	18	0.246	52,000	1.95	0.107	27.5	4/12/2046
24048+17	2,530	18	0.256	52,000	1.24	0.095	27.9	9/5/2046
23994+37	2,545	18	0.256	52,000	3.48	0.062	27.9	9/10/2046
23948+94	2,567	18	0.246	52,000	1.12	0.095	28.2	12/14/2046
24023+50	2,536	18	0.256	52,000	1.95	0.074	28.4	3/24/2047
23771+58	2,602	18	0.256	52,000	1.60	0.095	29.1	11/11/2047
24019+76	2,537	18	0.246	52,000	1.12	0.088	29.1	11/28/2047
23308+00	2,785	18	0.256	52,000	2.07	0.103	29.1	12/01/2047
23612+46	2,673	18	0.246	52,000	1.12	0.115	29.3	1/31/2048
22279+25	2,672	18	0.246	52,000	2.89	0.083	29.9	9/19/2048
22632+38	2,710	18	0.256	52,000	1.95	0.115	30.5	4/21/2049
22840+70	2,646	18	0.256	52,000	1.60	0.128	30.6	6/1/2049
23845+50	2,591	18	0.256	52,000	1.24	0.103	30.8	8/9/2049
23996+83	2,544	18	0.256	52,000	1.48	0.082	31.4	3/12/2050
23960+82	2,562	18	0.256	52,000	2.18	0.069	31.7	7/16/2050
22769+90	2,687	18	0.256	52,000	8.77	0.069	31.7	7/17/2050
23925+54	2,574	18	0.256	52,000	2.30	0.069	31.8	8/16/2050
24035+87	2,533	18	0.256	52,000	2.54	0.062	31.9	8/27/2050
23439+51	2,770	18	0.256	52,000	1.60	0.108	32.0	10/27/2050
24017+51	2,538	18	0.256	52,000	1.95	0.069	32.3	2/13/2051
22945+89	2,626	18	0.246	52,000	1.48	0.115	32.5	4/2/2051

Table D-1 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Crane to Texon – ILI Date October 19, 2018 (pg. 3 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
24000+46	2,543	18	0.256	52,000	1.71	0.074	32.5	4/5/2051
23442+16	2,769	18	0.246	52,000	1.60	0.095	32.5	4/9/2051
24043+13	2,530	18	0.256	52,000	1.60	0.074	32.7	7/2/2051
22100+06	2,662	18	0.256	52,000	3.13	0.082	33.0	10/19/2051
23665+38	2,651	18	0.256	52,000	2.65	0.074	33.1	12/1/2051
23956+01	2,564	18	0.256	52,000	2.07	0.069	33.3	1/19/2052
22721+23	2,700	18	0.246	52,000	2.07	0.095	34.2	1/4/2053
23158+08	2,752	18	0.246	52,000	1.60	0.102	34.6	5/26/2053
22718+16	2,699	18	0.246	52,000	7.60	0.063	34.9	9/20/2053
22461+31	2,673	18	0.256	52,000	2.07	0.103	35.4	3/16/2054
22486+89	2,693	18	0.246	52,000	1.71	0.102	35.6	5/13/2054
22372+74	2,662	18	0.256	52,000	2.65	0.090	35.6	5/30/2054
22009+84	2,675	18	0.246	52,000	3.36	0.068	35.7	7/19/2054
23651+85	2,658	18	0.256	52,000	1.48	0.095	35.8	8/7/2054
22818+99	2,654	18	0.256	52,000	2.77	0.090	35.8	8/7/2054
23933+21	2,572	18	0.256	52,000	1.36	0.082	36.5	5/7/2055
22517+70	2,698	18	0.246	52,000	3.36	0.075	36.8	7/27/2055
23864+26	2,585	18	0.256	52,000	1.24	0.090	37.4	3/5/2056
24012+23	2,541	18	0.246	52,000	1.48	0.063	37.6	6/3/2056
23984+97	2,548	18	0.246	52,000	1.12	0.075	38.2	1/1/2057
22354+97	2,665	18	0.256	52,000	2.18	0.095	38.3	2/18/2057
23434+38	2,771	18	0.256	52,000	1.36	0.108	38.9	9/9/2057
22661+48	2,713	18	0.256	52,000	1.95	0.103	39.2	12/14/2057
23282+94	2,764	18	0.246	52,000	2.42	0.075	39.3	2/14/2058
23651+31	2,659	18	0.256	52,000	1.12	0.108	39.4	3/26/2058
22160+42	2,650	18	0.246	52,000	2.54	0.075	39.6	6/6/2058
22694+43	2,705	18	0.256	52,000	2.54	0.090	39.7	7/10/2058
22494+28	2,696	18	0.246	52,000	3.01	0.075	39.9	9/19/2058
22406+99	2,661	18	0.256	52,000	1.83	0.103	40.0	10/5/2058
23925+58	2,574	18	0.256	52,000	1.24	0.082	40.2	12/13/2058
23996+39	2,544	18	0.256	52,000	1.12	0.082	40.8	8/16/2059
22045+68	2,662	18	0.246	52,000	1.60	0.088	40.9	9/25/2059
23994+88	2,544	18	0.256	52,000	1.48	0.069	41.0	10/24/2059
23566+84	2,720	18	0.256	52,000	2.77	0.069	41.1	11/26/2059
23751+36	2,612	18	0.246	52,000	1.95	0.063	41.3	1/27/2060
23561+10	2,730	18	0.256	52,000	1.83	0.082	41.5	4/6/2060
23463+42	2,785	18	0.246	52,000	2.42	0.068	41.7	7/13/2060
23816+48	2,597	18	0.246	52,000	1.24	0.075	42.0	10/16/2060
23845+46	2,591	18	0.256	52,000	1.12	0.090	42.5	4/2/2061
23535+12	2,773	18	0.256	52,000	2.30	0.074	42.7	7/18/2061
23853+47	2,590	18	0.256	52,000	1.71	0.069	42.9	9/25/2061
23241+44	2,752	18	0.246	52,000	3.83	0.063	43.0	10/16/2061
23263+07	2,730	18	0.246	52,000	2.18	0.075	43.2	1/3/2062
23845+23	2,591	18	0.256	52,000	1.71	0.069	43.3	1/31/2062
23458+97	2,781	18	0.256	52,000	3.01	0.069	43.4	3/14/2062
22614+77	2,707	18	0.256	52,000	2.07	0.095	43.4	3/26/2062
22733+22	2,705	18	0.246	52,000	1.36	0.107	43.7	6/26/2062

Table D-1 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Crane to Texon – ILI Date October 19, 2018 (pg. 4 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
23406+31	2,782	18	0.246	52,000	2.42	0.068	43.8	8/5/2062
23385+38	2,796	18	0.256	52,000	1.71	0.090	44.2	12/18/2062
23974+41	2,561	18	0.246	52,000	1.12	0.068	44.2	12/22/2062
22049+12	2,661	18	0.246	52,000	1.48	0.088	44.4	3/24/2063
22403+20	2,661	18	0.256	52,000	2.65	0.082	44.5	4/5/2063
23764+41	2,606	18	0.256	52,000	1.60	0.074	44.7	7/4/2063
22128+79	2,653	18	0.246	52,000	1.36	0.095	44.9	9/23/2063
22567+86	2,703	18	0.246	52,000	2.07	0.083	45.2	1/9/2064
23533+89	2,775	18	0.246	52,000	2.42	0.063	45.3	1/19/2064
23534+09	2,774	18	0.256	52,000	1.71	0.082	45.6	5/17/2064
22959+30	2,632	18	0.246	52,000	1.95	0.083	45.8	8/2/2064
23500+62	2,752	18	0.256	52,000	1.48	0.090	45.9	9/6/2064
23148+27	2,746	18	0.256	52,000	3.01	0.074	46.6	5/11/2065
22109+70	2,663	18	0.256	52,000	1.60	0.095	46.6	5/30/2065
23328+41	2,814	18	0.246	52,000	2.42	0.068	47.1	11/14/2065
22823+25	2,660	18	0.246	52,000	1.36	0.102	47.2	12/24/2065
22899+53	2,626	18	0.246	52,000	1.24	0.107	47.3	1/26/2066
22423+10	2,664	18	0.256	52,000	1.83	0.095	47.3	1/30/2066
22820+97	2,658	18	0.256	52,000	1.36	0.115	47.6	5/15/2066
22727+73	2,703	18	0.256	52,000	3.48	0.074	47.7	7/13/2066
23322+88	2,805	18	0.256	52,000	2.54	0.074	47.8	8/11/2066
23539+02	2,763	18	0.256	52,000	1.12	0.103	48.0	10/27/2066
22558+77	2,701	18	0.246	52,000	1.12	0.115	48.2	1/8/2067
23688+18	2,642	18	0.246	52,000	1.24	0.075	48.2	1/17/2067
23816+43	2,597	18	0.246	52,000	1.24	0.068	48.4	2/24/2067
22774+47	2,686	18	0.256	52,000	2.07	0.090	48.5	4/9/2067
23972+81	2,561	18	0.256	52,000	1.24	0.069	48.5	4/20/2067
23024+26	2,672	18	0.256	52,000	1.48	0.103	49.9	8/28/2068
23021+92	2,671	18	0.256	52,000	3.71	0.069	50.0	10/20/2068
23399+68	2,789	18	0.246	52,000	1.24	0.088	50.5	4/10/2069
22042+51	2,663	18	0.256	52,000	1.83	0.082	50.6	5/17/2069
23207+54	2,752	18	0.246	52,000	1.12	0.102	50.8	8/2/2069
23527+95	2,773	18	0.246	52,000	1.71	0.068	51.0	10/27/2069
23671+54	2,649	18	0.256	52,000	1.12	0.090	51.1	11/13/2069
23241+44	2,752	18	0.246	52,000	1.83	0.075	51.2	12/21/2069
22899+42	2,625	18	0.246	52,000	1.24	0.102	51.5	4/3/2070
22230+54	2,656	18	0.256	52,000	2.07	0.082	51.5	4/13/2070
23471+39	2,778	18	0.246	52,000	1.48	0.075	51.8	7/21/2070
22018+99	2,669	18	0.246	52,000	1.36	0.083	51.9	9/28/2070
22669+53	2,712	18	0.236	52,000	2.07	0.069	52.1	12/11/2070
23432+96	2,771	18	0.256	52,000	3.24	0.062	52.6	6/2/2071
23426+99	2,761	18	0.256	52,000	3.24	0.062	52.7	7/17/2071
22746+56	2,703	18	0.246	52,000	3.71	0.063	52.8	8/13/2071
22928+97	2,678	18	0.246	52,000	3.48	0.063	52.8	8/23/2071
23733+39	2,625	18	0.246	52,000	1.24	0.068	52.9	9/6/2071
23083+10	2,658	18	0.256	52,000	1.71	0.090	53.0	10/5/2071
22879+76	2,617	18	0.246	52,000	1.71	0.083	53.0	10/19/2071

Table D-1 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Crane to Texon – ILI Date October 19, 2018 (pg. 5 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
23757+67	2,609	18	0.246	52,000	1.36	0.063	53.3	1/27/2072
23205+85	2,751	18	0.246	52,000	1.48	0.083	53.3	2/12/2072
23205+84	2,751	18	0.246	52,000	1.48	0.083	53.3	2/13/2072
22114+87	2,663	18	0.256	52,000	2.30	0.074	53.3	2/16/2072
22928+96	2,678	18	0.246	52,000	2.07	0.075	53.6	6/7/2072
23892+60	2,579	18	0.256	52,000	1.48	0.062	53.8	7/28/2072
23691+23	2,641	18	0.256	52,000	1.60	0.069	54.0	10/9/2072
22958+97	2,632	18	0.246	52,000	1.48	0.088	54.0	10/23/2072
22288+85	2,665	18	0.246	52,000	1.12	0.102	54.3	2/16/2073
23527+39	2,773	18	0.256	52,000	2.65	0.062	54.4	3/7/2073
23120+63	2,706	18	0.256	52,000	1.12	0.115	54.5	4/26/2073
22733+18	2,705	18	0.246	52,000	1.71	0.083	54.6	5/13/2073
23525+11	2,770	18	0.246	52,000	1.12	0.083	54.6	6/6/2073
23574+64	2,712	18	0.256	52,000	1.60	0.074	54.6	6/7/2073
24052+17	2,529	18	0.256	52,000	1.12	0.062	55.0	10/11/2073
22704+04	2,699	18	0.256	52,000	2.18	0.082	55.7	7/9/2074
23374+93	2,801	18	0.256	52,000	1.12	0.103	55.9	9/11/2074
22354+33	2,665	18	0.246	52,000	1.24	0.095	56.0	10/28/2074
23751+35	2,612	18	0.246	52,000	1.12	0.068	56.5	4/11/2075
22141+15	2,638	18	0.256	52,000	1.48	0.090	56.6	5/12/2075
23827+03	2,591	18	0.256	52,000	1.12	0.074	56.7	6/24/2075
22665+96	2,712	18	0.246	52,000	1.48	0.088	57.0	10/4/2075
23207+49	2,752	18	0.246	52,000	1.12	0.095	57.0	10/13/2075
23951+85	2,566	18	0.256	52,000	1.24	0.062	57.2	12/29/2075
22632+54	2,710	18	0.256	52,000	3.36	0.069	57.2	1/14/2076
23147+75	2,745	18	0.256	52,000	1.24	0.103	57.5	4/4/2076
23607+01	2,673	18	0.246	52,000	1.12	0.075	57.5	4/26/2076
23817+00	2,596	18	0.256	52,000	1.24	0.069	57.6	6/11/2076
22534+85	2,697	18	0.256	52,000	1.36	0.103	58.1	11/13/2076
22995+61	2,688	18	0.246	52,000	1.36	0.088	58.3	2/21/2077
22289+91	2,664	18	0.256	52,000	2.77	0.069	59.0	11/1/2077
23009+91	2,702	18	0.256	52,000	4.30	0.062	59.2	1/4/2078
23752+28	2,611	18	0.256	52,000	1.60	0.062	59.3	1/29/2078
23276+79	2,750	18	0.256	52,000	1.36	0.090	59.8	7/31/2078
23360+53	2,809	18	0.256	52,000	1.83	0.074	60.2	12/24/2078
23085+40	2,660	18	0.256	52,000	1.36	0.095	61.0	10/17/2079
22274+27	2,674	18	0.256	52,000	1.48	0.090	61.2	1/10/2080
22865+78	2,601	18	0.256	52,000	1.60	0.090	61.3	2/5/2080
23521+95	2,767	18	0.256	52,000	1.24	0.082	62.0	10/4/2080
22551+84	2,700	18	0.256	52,000	1.60	0.090	62.2	1/5/2081
23300+37	2,775	18	0.256	52,000	1.83	0.074	62.3	2/10/2081
23214+03	2,754	18	0.246	52,000	1.48	0.075	62.8	7/27/2081
22362+55	2,664	18	0.246	52,000	1.36	0.083	63.8	8/17/2082
22718+18	2,699	18	0.246	52,000	2.18	0.068	64.2	12/18/2082
23150+84	2,748	18	0.256	52,000	1.12	0.103	64.5	4/4/2083
23149+72	2,747	18	0.256	52,000	1.95	0.074	65.1	12/11/2083
22359+00	2,665	18	0.246	52,000	1.95	0.068	65.3	2/12/2084

Table D-1 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Crane to Texon – ILI Date October 19, 2018 (pg. 6 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
22008+86	2,676	18	0.246	52,000	1.24	0.075	65.5	5/3/2084
22831+45	2,659	18	0.246	52,000	2.54	0.063	65.7	7/1/2084
23264+00	2,730	18	0.256	52,000	1.24	0.090	66.0	10/16/2084
23121+33	2,706	18	0.256	52,000	1.24	0.095	66.2	1/1/2085
22516+52	2,698	18	0.246	52,000	1.24	0.088	66.8	8/8/2085
22661+60	2,713	18	0.256	52,000	1.48	0.090	68.0	10/24/2086
23646+44	2,661	18	0.256	52,000	1.24	0.069	69.1	11/20/2087
23009+93	2,701	18	0.256	52,000	2.30	0.069	69.5	4/14/2088
22820+12	2,656	18	0.256	52,000	2.42	0.069	70.6	5/23/2089
22122+41	2,661	18	0.256	52,000	2.42	0.062	71.7	6/26/2090
22247+53	2,668	18	0.256	52,000	1.24	0.090	72.0	10/25/2090
22248+72	2,668	18	0.256	52,000	1.24	0.090	72.0	11/4/2090
22480+25	2,688	18	0.256	52,000	1.24	0.095	72.5	4/26/2091
22560+99	2,701	18	0.246	52,000	1.83	0.068	72.6	5/24/2091
23133+69	2,728	18	0.246	52,000	1.12	0.083	72.9	9/15/2091
22504+99	2,698	18	0.246	52,000	1.24	0.083	73.1	11/26/2091
22708+93	2,691	18	0.256	52,000	3.24	0.062	73.2	12/20/2091
22331+50	2,664	18	0.256	52,000	1.48	0.082	73.2	12/30/2091
23671+40	2,649	18	0.256	52,000	1.12	0.069	73.3	1/31/2092
22939+60	2,645	18	0.246	52,000	1.71	0.068	73.8	8/16/2092
22776+27	2,685	18	0.256	52,000	1.24	0.095	74.2	12/28/2092
23485+80	2,751	18	0.246	52,000	1.12	0.068	74.4	3/6/2093
22209+96	2,656	18	0.256	52,000	1.36	0.082	74.4	3/29/2093
22624+51	2,709	18	0.246	52,000	1.24	0.083	74.5	4/17/2093
23157+46	2,752	18	0.246	52,000	1.24	0.075	75.9	9/30/2094
22232+43	2,658	18	0.246	52,000	1.48	0.068	76.4	3/5/2095
23461+94	2,784	18	0.256	52,000	1.71	0.062	76.6	5/18/2095
23551+00	2,748	18	0.256	52,000	1.24	0.069	76.6	5/27/2095
22708+87	2,691	18	0.256	52,000	2.18	0.069	77.0	10/6/2095
22181+97	2,661	18	0.256	52,000	1.12	0.090	77.0	10/16/2095
22007+62	2,676	18	0.256	52,000	1.48	0.069	77.9	9/11/2096
22965+56	2,629	18	0.256	52,000	1.71	0.074	78.0	10/30/2096
22659+80	2,713	18	0.256	52,000	1.83	0.074	78.1	11/22/2096
22928+95	2,678	18	0.246	52,000	1.60	0.068	78.6	5/15/2097
23192+17	2,728	18	0.246	52,000	1.36	0.068	79.1	11/22/2097
23344+92	2,815	18	0.256	52,000	1.12	0.082	80.4	3/20/2099
22390+27	2,657	18	0.256	52,000	1.36	0.082	80.8	08/23/2099
22719+49	2,700	18	0.246	52,000	1.60	0.068	81.6	5/29/2100
22076+71	2,659	18	0.256	52,000	1.12	0.082	81.9	9/16/2100
23558+58	2,737	18	0.256	52,000	1.12	0.069	82.6	5/23/2101
22460+43	2,674	18	0.256	52,000	1.36	0.082	82.8	7/28/2101
22905+54	2,645	18	0.256	52,000	1.36	0.082	82.9	8/27/2101
23228+97	2,755	18	0.256	52,000	1.36	0.074	83.5	4/16/2102
23259+98	2,729	18	0.256	52,000	1.48	0.069	84.3	2/1/2103
22537+80	2,698	18	0.256	52,000	1.36	0.082	84.5	4/7/2103
22041+78	2,663	18	0.246	52,000	1.12	0.068	84.5	4/14/2103
22459+30	2,673	18	0.256	52,000	1.83	0.069	84.8	8/7/2103

Table D-1 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Crane to Texon – ILI Date October 19, 2018 (pg. 7 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
22050+86	2,661	18	0.246	52,000	1.12	0.068	85.1	11/15/2103
23448+55	2,776	18	0.256	52,000	1.48	0.062	85.6	6/8/2104
22694+40	2,705	18	0.256	52,000	1.36	0.082	85.7	7/3/2104
23647+45	2,661	18	0.256	52,000	1.12	0.062	85.9	9/29/2104
22559+31	2,701	18	0.246	52,000	1.24	0.075	86.0	10/31/2104
22571+05	2,703	18	0.256	52,000	2.42	0.062	86.3	2/4/2105
22807+07	2,659	18	0.246	52,000	1.71	0.063	86.3	2/14/2105
23014+75	2,691	18	0.256	52,000	1.24	0.082	87.2	1/9/2106
22638+28	2,711	18	0.256	52,000	1.60	0.074	87.3	1/30/2106
22716+78	2,697	18	0.246	52,000	1.71	0.063	87.4	2/28/2106
22999+90	2,692	18	0.256	52,000	1.24	0.082	87.7	7/14/2106
22443+11	2,673	18	0.246	52,000	1.60	0.063	88.4	3/30/2107
22338+31	2,661	18	0.256	52,000	2.07	0.062	89.1	11/14/2107
23179+91	2,737	18	0.246	52,000	1.36	0.063	89.1	11/30/2107
22410+69	2,661	18	0.246	52,000	1.12	0.075	90.7	7/7/2109
23137+69	2,733	18	0.256	52,000	1.12	0.082	90.7	7/7/2109
22117+92	2,662	18	0.256	52,000	1.36	0.069	90.7	7/11/2109
22303+97	2,661	18	0.256	52,000	1.36	0.074	91.1	11/25/2109
23222+48	2,755	18	0.246	52,000	1.12	0.068	91.3	2/19/2110
22822+16	2,659	18	0.246	52,000	1.36	0.068	91.5	04/24/2110
23347+11	2,814	18	0.256	52,000	1.12	0.074	92.2	12/16/2110
22517+79	2,698	18	0.246	52,000	1.12	0.075	93.6	6/3/2112
22807+79	2,654	18	0.246	52,000	1.12	0.075	94.1	12/10/2112
22074+67	2,659	18	0.256	52,000	1.24	0.069	94.6	6/12/2113
23031+39	2,644	18	0.246	52,000	1.36	0.063	95.6	5/27/2114
22537+10	2,698	18	0.256	52,000	1.60	0.069	96.0	11/2/2114
22572+81	2,703	18	0.246	52,000	1.48	0.063	96.5	4/25/2115
23283+57	2,765	18	0.246	52,000	1.12	0.063	97.0	10/9/2115
22402+16	2,661	18	0.256	52,000	1.12	0.082	97.5	4/28/2116
22012+27	2,674	18	0.256	52,000	1.12	0.069	97.9	9/2/2116
22135+39	2,646	18	0.256	52,000	1.12	0.074	98.0	10/15/2116
22614+77	2,707	18	0.256	52,000	1.95	0.062	99.6	5/12/2118
22648+82	2,711	18	0.256	52,000	1.36	0.074	99.9	9/8/2118
23347+09	2,814	18	0.256	52,000	1.12	0.069	100.9	9/29/2119
22600+57	2,705	18	0.256	52,000	1.12	0.082	102.3	2/3/2121
22954+89	2,631	18	0.256	52,000	1.71	0.062	103.5	5/8/2122
22928+41	2,680	18	0.256	52,000	1.24	0.074	104.1	11/16/2122
23374+45	2,802	18	0.256	52,000	1.24	0.062	104.2	1/3/2123
22389+15	2,657	18	0.256	52,000	1.36	0.069	104.3	1/27/2123
22899+31	2,625	18	0.246	52,000	1.12	0.068	105.2	1/16/2124
23112+12	2,697	18	0.256	52,000	1.12	0.074	105.3	2/18/2124
22944+89	2,629	18	0.246	52,000	1.24	0.063	105.9	9/28/2124
23095+91	2,683	18	0.256	52,000	1.24	0.069	106.8	08/10/2125
22571+03	2,703	18	0.256	52,000	1.24	0.074	107.1	11/19/2125
22571+01	2,703	18	0.256	52,000	1.24	0.074	107.1	11/19/2125
22578+24	2,704	18	0.256	52,000	1.24	0.074	107.2	12/28/2125
22553+38	2,700	18	0.246	52,000	1.12	0.068	107.7	7/5/2126

Table D-1 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Crane to Texon – ILI Date October 19, 2018 (pg. 8 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
22777+42	2,684	18	0.246	52,000	1.24	0.063	110.4	3/29/2129
22847+46	2,624	18	0.256	52,000	1.60	0.062	111.9	9/12/2130
22405+91	2,661	18	0.256	52,000	1.12	0.074	112.2	1/1/2131
22858+68	2,607	18	0.256	52,000	1.12	0.074	115.3	1/25/2134
22537+48	2,698	18	0.256	52,000	1.24	0.069	117.2	12/31/2135
23293+75	2,769	18	0.256	52,000	1.12	0.062	118.6	5/19/2137
22750+92	2,702	18	0.246	52,000	1.12	0.063	120.1	11/11/2138
22656+82	2,713	18	0.256	52,000	1.48	0.062	120.7	7/4/2139
22131+45	2,650	18	0.256	52,000	1.12	0.062	122.5	4/25/2141
22825+21	2,663	18	0.256	52,000	1.12	0.069	127.6	6/7/2146
22389+15	2,657	18	0.256	52,000	1.24	0.062	129.3	2/21/2148
22667+16	2,712	18	0.256	52,000	1.24	0.062	137.1	11/11/2155
22911+56	2,662	18	0.256	52,000	1.12	0.062	143.1	11/23/2161
22673+63	2,712	18	0.256	52,000	1.12	0.062	148.1	12/8/2166

Table D-2. Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Texon to Barnhart – ILI Date May 15, 2020 (pg. 1 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
21982+31	2,575	18	0.246	52,000	2.43	0.075	20.1	6/27/2040
21666+58	2,612	18	0.246	52,000	2.66	0.083	21.3	8/30/2041
21804+33	2,577	18	0.246	52,000	2.90	0.075	21.3	9/16/2041
21827+85	2,575	18	0.246	52,000	1.72	0.088	24.0	5/29/2044
21981+44	2,574	18	0.246	52,000	3.13	0.063	24.1	6/12/2044
21946+18	2,553	18	0.256	52,000	1.95	0.082	26.5	10/27/2046
21983+33	2,575	18	0.246	52,000	2.07	0.068	27.4	9/27/2047
21876+02	2,571	18	0.246	52,000	1.36	0.088	28.8	2/28/2049
21915+00	2,576	18	0.246	52,000	2.43	0.063	30.4	10/11/2050
21826+56	2,575	18	0.246	52,000	1.36	0.088	30.4	10/24/2050
21890+20	2,577	18	0.256	52,000	1.36	0.095	31.0	5/18/2051
21412+58	2,590	18	0.256	52,000	3.13	0.082	31.0	5/29/2051
21960+10	2,550	18	0.246	52,000	1.25	0.083	31.2	7/16/2051
21647+30	2,626	18	0.246	52,000	3.61	0.063	32.3	08/19/2052
21938+04	2,559	18	0.246	52,000	1.13	0.088	32.5	11/8/2052
21854+80	2,570	18	0.246	52,000	2.43	0.063	32.5	11/14/2052
21634+35	2,634	18	0.256	52,000	2.90	0.074	33.2	7/22/2053
21826+43	2,575	18	0.246	52,000	1.25	0.088	33.2	7/24/2053
21647+68	2,625	18	0.256	52,000	2.78	0.074	33.7	2/3/2054
21808+61	2,577	18	0.256	52,000	1.48	0.090	34.0	5/29/2054
21817+14	2,575	18	0.246	52,000	1.60	0.075	34.3	9/14/2054
21694+78	2,600	18	0.256	52,000	4.55	0.062	35.1	6/19/2055
21984+76	2,577	18	0.246	52,000	1.48	0.068	35.3	9/5/2055
21674+08	2,606	18	0.256	52,000	2.43	0.074	36.2	8/1/2056
21647+03	2,626	18	0.246	52,000	1.84	0.075	36.8	2/20/2057
21446+55	2,635	18	0.256	52,000	2.43	0.082	37.4	9/25/2057
21819+19	2,574	18	0.246	52,000	1.36	0.075	39.4	10/26/2059

Table D-2 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Texon to Barnhart – ILI Date May 15, 2020 (pg. 2 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
21878+58	2,572	18	0.246	52,000	1.25	0.075	39.8	3/5/2060
21432+84	2,612	18	0.246	52,000	1.36	0.095	40.5	11/4/2060
21550+21	2,675	18	0.246	52,000	1.48	0.083	41.8	2/18/2062
21609+40	2,631	18	0.246	52,000	1.36	0.083	42.4	10/13/2062
21811+98	2,576	18	0.246	52,000	1.25	0.075	42.9	4/2/2063
21761+11	2,566	18	0.246	52,000	1.13	0.083	43.1	6/20/2063
21587+09	2,658	18	0.246	52,000	1.25	0.088	43.2	7/19/2063
21834+04	2,573	18	0.256	52,000	1.48	0.074	45.0	5/19/2065
21890+22	2,577	18	0.256	52,000	1.36	0.074	45.4	10/19/2065
21911+69	2,578	18	0.256	52,000	1.84	0.062	46.0	5/7/2066
21927+98	2,568	18	0.256	52,000	1.25	0.074	46.8	3/7/2067
21728+63	2,582	18	0.246	52,000	1.48	0.068	47.0	5/13/2067
21800+13	2,576	18	0.246	52,000	1.48	0.063	48.7	1/20/2069
21739+68	2,575	18	0.246	52,000	1.36	0.068	49.7	1/13/2070
20955+37	2,588	18	0.295	45,000	5.02	0.095	50.0	5/3/2070
21499+37	2,648	18	0.256	52,000	1.95	0.074	51.6	12/15/2071
21403+89	2,587	18	0.246	52,000	1.36	0.083	51.9	4/1/2072
21834+03	2,573	18	0.256	52,000	1.25	0.074	52.0	5/16/2072
21675+54	2,606	18	0.256	52,000	2.19	0.062	53.3	9/9/2073
21441+31	2,626	18	0.246	52,000	1.84	0.068	53.7	1/7/2074
20401+90	2,618	18	0.315	45,000	4.55	0.121	54.4	10/13/2074
21620+84	2,636	18	0.256	52,000	1.72	0.069	56.3	8/18/2076
21673+85	2,605	18	0.256	52,000	1.84	0.062	59.7	1/30/2080
21446+63	2,635	18	0.256	52,000	2.66	0.062	59.9	4/24/2080
21553+51	2,675	18	0.246	52,000	1.13	0.075	62.4	10/14/2082
21671+62	2,609	18	0.246	52,000	1.13	0.068	62.5	11/29/2082
21390+04	2,581	18	0.246	52,000	1.13	0.083	63.1	6/8/2083
21668+23	2,611	18	0.246	52,000	1.25	0.063	63.9	4/25/2084
21499+38	2,648	18	0.256	52,000	1.25	0.082	64.3	9/12/2084
21420+28	2,599	18	0.246	52,000	1.25	0.075	64.5	11/1/2084
21487+01	2,649	18	0.246	52,000	1.36	0.068	65.0	5/18/2085
21891+07	2,577	18	0.256	52,000	1.13	0.062	66.7	2/7/2087
21608+91	2,630	18	0.246	52,000	1.13	0.068	66.9	4/15/2087
21696+60	2,599	18	0.256	52,000	1.48	0.062	67.6	12/21/2087
21537+58	2,672	18	0.256	52,000	1.13	0.082	68.4	10/1/2088
21413+97	2,589	18	0.256	52,000	1.25	0.082	69.6	12/17/2089
21572+81	2,675	18	0.246	52,000	1.25	0.063	71.2	7/9/2091
20940+52	2,604	18	0.305	45,000	5.50	0.088	71.4	9/21/2091
21408+92	2,588	18	0.246	52,000	1.13	0.075	71.4	10/19/2091
21422+84	2,600	18	0.246	52,000	1.25	0.068	73.9	4/2/2094
21765+68	2,563	18	0.256	52,000	1.13	0.062	76.5	11/13/2096
21446+58	2,635	18	0.256	52,000	1.25	0.074	78.2	8/8/2098
20261+92	2,631	18	0.315	45,000	3.25	0.121	78.7	1/30/2099
21273+18	2,553	18	0.305	45,000	4.43	0.076	85.6	12/29/2105
20742+69	2,664	18	0.305	52,000	5.14	0.088	86.1	6/11/2106
21495+30	2,653	18	0.256	52,000	1.13	0.069	89.4	10/4/2109
21448+26	2,637	18	0.256	52,000	1.13	0.069	93.5	11/12/2113

Table D-2 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Texon to Barnhart – ILI Date May 15, 2020 (pg. 3 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
21328+17	2,567	18	0.305	45,000	3.25	0.076	97.0	5/1/2117
19944+89	2,546	18	0.305	45,000	3.61	0.094	98.7	1/17/2119
20264+44	2,631	18	0.305	45,000	4.79	0.088	101.2	7/31/2121
19762+06	2,526	18	0.315	45,000	3.72	0.090	113.0	5/16/2133
20871+29	2,655	18	0.305	45,000	4.67	0.076	115.5	11/13/2135
21268+48	2,553	18	0.315	45,000	2.07	0.090	123.5	11/12/2143
19786+15	2,528	18	0.315	45,000	7.86	0.074	124.1	6/13/2144
21204+14	2,582	18	0.315	45,000	2.19	0.090	125.3	9/11/2145
20504+01	2,616	18	0.305	45,000	5.50	0.076	127.7	1/15/2148
20937+88	2,606	18	0.305	45,000	10.10	0.063	128.3	08/27/2148
20179+80	2,597	18	0.305	45,000	9.04	0.070	134.0	5/25/2154
21115+52	2,587	18	0.305	45,000	3.25	0.070	136.0	5/19/2156
20494+75	2,609	18	0.315	45,000	3.96	0.083	149.1	6/16/2169
21261+87	2,549	18	0.315	45,000	3.02	0.068	152.6	12/23/2172
21111+46	2,574	18	0.305	45,000	1.72	0.082	161.0	5/9/2181
20326+14	2,640	18	0.315	45,000	5.73	0.074	163.5	11/27/2183
20325+08	2,640	18	0.315	45,000	4.91	0.074	174.6	1/8/2195
20689+66	2,623	18	0.315	52,000	2.78	0.083	176.4	9/26/2196
21110+22	2,572	18	0.305	45,000	1.25	0.094	176.6	12/28/2196
21273+17	2,553	18	0.305	45,000	1.60	0.070	182.9	4/26/2203
20326+13	2,640	18	0.315	45,000	3.02	0.083	183.4	10/18/2203
20780+74	2,652	18	0.305	45,000	1.25	0.109	183.5	11/24/2203
19898+67	2,534	18	0.315	45,000	2.54	0.083	188.6	12/29/2208
20368+09	2,622	18	0.305	45,000	2.66	0.076	197.0	5/20/2217
20416+95	2,600	18	0.305	45,000	2.07	0.082	204.9	4/11/2225
21057+86	2,570	18	0.305	45,000	1.48	0.076	209.4	10/11/2229
20661+16	2,596	18	0.305	45,000	2.43	0.070	217.0	5/29/2237
20439+50	2,604	18	0.305	45,000	3.96	0.063	218.2	7/24/2238
19895+69	2,532	18	0.315	45,000	1.72	0.090	223.1	6/17/2243
20641+54	2,615	18	0.315	45,000	1.60	0.068	225.2	8/7/2245
20392+06	2,629	18	0.315	45,000	1.36	0.068	225.2	8/7/2245
21138+22	2,613	18	0.305	45,000	1.36	0.070	225.2	8/7/2245
21204+14	2,582	18	0.315	45,000	1.48	0.068	225.2	8/7/2245
20847+62	2,663	18	0.305	45,000	1.13	0.070	225.2	8/7/2245
21348+18	2,582	18	0.344	45,000	1.25	0.081	225.2	8/7/2245
21226+11	2,545	18	0.315	45,000	1.36	0.061	225.2	8/7/2245
20573+75	2,610	18	0.305	45,000	1.36	0.063	225.2	8/7/2245
20156+22	2,596	18	0.305	45,000	3.02	0.063	225.2	8/7/2245
19765+45	2,526	18	0.315	45,000	1.95	0.068	225.2	8/7/2245
21122+88	2,612	18	0.305	45,000	1.13	0.063	225.2	8/7/2245
20113+46	2,572	18	0.315	45,000	1.48	0.083	225.2	8/7/2245
20871+85	2,654	18	0.315	45,000	2.66	0.061	225.2	8/7/2245
20262+01	2,631	18	0.315	45,000	1.13	0.068	225.2	8/7/2245
20611+97	2,621	18	0.315	45,000	1.13	0.061	225.2	8/7/2245
20307+69	2,637	18	0.315	45,000	3.84	0.068	225.2	8/7/2245
20338+59	2,631	18	0.315	45,000	1.48	0.068	225.2	8/7/2245
19868+96	2,515	18	0.305	45,000	1.84	0.070	225.2	8/7/2245

Table D-2 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Texon to Barnhart – ILI Date May 15, 2020 (pg. 4 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
19895+66	2,532	18	0.315	45,000	1.25	0.083	225.2	8/7/2245
19923+86	2,551	18	0.315	45,000	1.13	0.096	225.2	8/7/2245
20414+93	2,606	18	0.315	45,000	1.13	0.061	225.2	8/7/2245
21231+82	2,547	18	0.315	45,000	1.36	0.074	225.2	8/7/2245
20188+04	2,599	18	0.315	45,000	2.19	0.083	225.2	8/7/2245
20550+79	2,617	18	0.315	45,000	1.13	0.061	225.2	8/7/2245
20261+93	2,631	18	0.315	45,000	1.13	0.074	225.2	8/7/2245
20798+21	2,653	18	0.315	45,000	1.48	0.068	225.2	8/7/2245
20635+89	2,624	18	0.315	45,000	1.60	0.083	225.2	8/7/2245

Table D-3. Pressure Cycle Fatigue Analysis — ILI-Indicated Anomalies Barnhart to Cartman – ILI Date June 16, 2020 (pg. 1 of 2)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
19287+94	2,529	18	0.295	45,000	4.32	0.107	26.3	10/12/2046
18958+56	2,509	18	0.276	45,000	4.08	0.083	45.3	9/27/2065
18469+86	2,463	18	0.266	45,000	3.61	0.076	55.3	10/21/2075
18805+39	2,503	18	0.276	45,000	4.55	0.075	58.8	4/6/2079
19595+59	2,581	18	0.315	45,000	5.85	0.074	59.7	3/5/2080
18236+71	2,445	18	0.266	45,000	4.20	0.068	60.8	4/16/2081
19406+59	2,498	18	0.315	45,000	4.67	0.083	61.2	8/14/2081
18202+48	2,438	18	0.285	45,000	4.91	0.076	62.3	9/25/2082
19521+58	2,539	18	0.315	45,000	2.90	0.083	73.9	5/25/2094
19423+72	2,483	18	0.315	45,000	2.55	0.090	78.2	8/19/2098
18242+03	2,446	18	0.276	45,000	1.72	0.088	85.0	6/22/2105
18674+38	2,484	18	0.276	45,000	2.07	0.083	85.5	12/26/2105
18930+70	2,523	18	0.276	45,000	2.31	0.069	98.4	11/6/2118
18284+26	2,440	18	0.266	45,000	1.95	0.068	99.7	3/13/2120
19590+62	2,579	18	0.315	45,000	1.72	0.083	100.9	5/29/2121
18564+20	2,471	18	0.276	45,000	2.07	0.075	103.6	2/5/2124
19354+46	2,516	18	0.315	45,000	3.02	0.074	104.4	11/14/2124
19501+18	2,500	18	0.315	45,000	4.44	0.061	104.5	1/1/2125
19129+04	2,526	18	0.276	45,000	1.48	0.075	105.9	5/23/2126
18200+03	2,435	18	0.276	45,000	2.07	0.069	107.2	8/18/2127
18960+78	2,508	18	0.276	45,000	2.31	0.064	110.8	4/3/2131
18201+61	2,437	18	0.276	45,000	1.36	0.083	113.0	6/13/2133
18493+91	2,473	18	0.276	45,000	2.55	0.064	118.4	10/27/2138
18930+75	2,523	18	0.276	45,000	2.07	0.064	120.5	12/19/2140
19051+68	2,506	18	0.276	45,000	1.48	0.064	139.1	8/5/2159
19590+85	2,579	18	0.315	45,000	1.60	0.068	140.1	7/20/2160
19590+85	2,579	18	0.315	45,000	1.13	0.083	143.7	3/3/2164
19537+14	2,560	18	0.315	45,000	1.60	0.068	147.8	4/10/2168
19331+09	2,510	18	0.305	45,000	1.36	0.070	167.3	10/1/2187
19521+62	2,539	18	0.315	45,000	1.36	0.068	167.5	12/3/2187
19510+15	2,511	18	0.315	45,000	1.13	0.074	177.3	9/22/2197
19280+09	2,532	18	0.315	45,000	1.48	0.074	177.7	2/21/2198

Table D-3 (continued). Pressure Cycle Fatigue Analysis — ILI-Indicated Anomalies Barnhart to Cartman – ILI Date June 16, 2020 (pg. 2 of 2)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
19697+08	2,589	18	0.315	45,000	1.13	0.061	177.8	4/8/2198
19334+90	2,509	18	0.315	45,000	1.36	0.074	180.0	6/2/2200
19334+87	2,509	18	0.315	45,000	1.36	0.068	199.8	3/27/2220
19315+42	2,514	18	0.315	45,000	1.13	0.074	213.2	9/15/2233
19436+06	2,521	18	0.315	45,000	1.13	0.061	225.2	9/8/2245

Table D-4. Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Cartman to Kimble – ILI Date August 25, 2020 (pg. 1 of 5)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
18091+77	2,434	18	0.276	45,000	13.38	0.094	3.3	12/14/2023
18058+13	2,424	18	0.276	45,000	8.78	0.094	6.0	8/15/2026
18010+58	2,398	18	0.276	45,000	6.07	0.088	10.9	8/2/2031
18054+93	2,423	18	0.266	45,000	7.37	0.076	11.3	12/27/2031
17690+62	2,337	18	0.266	45,000	5.49	0.089	11.8	6/25/2032
18116+16	2,438	18	0.276	45,000	3.01	0.102	12.1	9/12/2032
18114+30	2,438	18	0.276	45,000	9.96	0.075	12.2	11/14/2032
17698+67	2,357	18	0.276	45,000	6.90	0.088	13.4	1/28/2034
17688+47	2,333	18	0.266	45,000	9.37	0.076	13.6	4/11/2034
17863+21	2,370	18	0.276	45,000	2.89	0.108	13.9	7/13/2034
18058+07	2,424	18	0.276	45,000	4.78	0.083	14.6	4/19/2035
18110+06	2,439	18	0.276	45,000	5.96	0.075	16.1	9/27/2036
18091+88	2,434	18	0.276	45,000	3.95	0.083	16.2	11/3/2036
18094+59	2,436	18	0.276	45,000	5.72	0.075	16.7	5/3/2037
17121+65	2,190	18	0.276	45,000	13.03	0.083	17.2	11/13/2037
18054+81	2,423	18	0.266	45,000	3.60	0.076	17.7	5/17/2038
17041+95	2,235	18	0.276	45,000	8.90	0.088	20.1	10/1/2040
17570+86	2,372	18	0.266	45,000	4.54	0.081	20.5	2/21/2041
18162+65	2,441	18	0.276	45,000	2.42	0.083	22.1	10/3/2042
18140+79	2,439	18	0.276	45,000	3.84	0.069	23.9	8/5/2044
18167+30	2,440	18	0.276	45,000	3.48	0.069	24.6	4/14/2045
18020+93	2,407	18	0.276	45,000	4.42	0.069	25.0	8/9/2045
17995+86	2,397	18	0.276	45,000	6.55	0.064	25.6	4/15/2046
16836+64	2,331	18	0.305	45,000	5.37	0.121	25.8	5/26/2046
18086+30	2,433	18	0.266	45,000	2.78	0.068	25.8	6/17/2046
17092+04	2,238	18	0.266	45,000	14.91	0.068	26.4	1/9/2047
17986+95	2,397	18	0.276	45,000	1.95	0.088	28.3	12/5/2048
18012+39	2,398	18	0.276	45,000	4.42	0.064	29.6	3/24/2050
17676+63	2,331	18	0.276	45,000	6.07	0.069	29.8	6/24/2050
18117+32	2,437	18	0.276	45,000	2.66	0.069	30.5	2/9/2051
18162+60	2,441	18	0.276	45,000	2.42	0.069	31.0	8/17/2051
17570+34	2,371	18	0.266	45,000	2.07	0.089	31.9	7/16/2052
17071+65	2,284	18	0.276	45,000	5.84	0.083	32.4	2/2/2053
18168+66	2,440	18	0.276	45,000	1.24	0.094	33.0	8/26/2053
17457+58	2,376	18	0.266	45,000	3.25	0.076	33.8	7/1/2054
17331+27	2,298	18	0.276	45,000	3.72	0.083	34.7	5/16/2055

Table D-4 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Cartman to Kimble – ILI Date August 25, 2020 (pg. 2 of 5)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
17439+71	2,373	18	0.266	45,000	4.42	0.068	36.7	5/10/2057
18053+73	2,424	18	0.285	45,000	4.07	0.062	37.2	11/11/2057
17448+93	2,376	18	0.276	45,000	4.07	0.075	37.5	2/11/2058
17101+57	2,194	18	0.266	45,000	2.66	0.089	38.3	12/27/2058
17235+84	2,329	18	0.266	45,000	5.84	0.068	38.5	3/7/2059
17308+30	2,271	18	0.276	45,000	10.43	0.064	41.2	11/15/2061
17732+39	2,314	18	0.285	45,000	6.66	0.062	41.8	6/27/2062
17561+65	2,355	18	0.276	45,000	3.72	0.069	42.4	1/30/2063
17186+22	2,261	18	0.266	45,000	7.61	0.063	43.4	1/3/2064
17326+61	2,300	18	0.276	45,000	5.37	0.069	43.9	7/6/2064
17727+59	2,313	18	0.266	45,000	2.07	0.068	44.1	9/18/2064
17007+76	2,300	18	0.266	45,000	10.32	0.063	44.9	8/4/2065
17965+34	2,405	18	0.276	45,000	1.83	0.069	45.3	12/27/2065
17089+28	2,235	18	0.276	45,000	7.84	0.069	46.0	8/7/2066
17107+84	2,193	18	0.276	45,000	3.25	0.083	46.7	5/16/2067
17491+53	2,327	18	0.266	45,000	3.25	0.063	48.1	9/13/2068
17494+70	2,318	18	0.276	45,000	4.42	0.064	48.4	1/28/2069
17549+62	2,367	18	0.276	45,000	3.01	0.069	48.6	4/17/2069
17538+97	2,365	18	0.276	45,000	2.42	0.075	48.7	4/20/2069
17436+94	2,377	18	0.276	45,000	5.01	0.064	48.8	6/6/2069
16670+45	2,224	18	0.315	45,000	9.49	0.096	52.3	12/3/2072
17095+56	2,226	18	0.276	45,000	1.83	0.102	52.7	5/1/2073
18114+21	2,438	18	0.276	45,000	1.13	0.069	56.9	7/25/2077
17216+30	2,294	18	0.276	45,000	2.78	0.075	59.2	11/24/2079
17927+07	2,418	18	0.266	45,000	1.24	0.063	59.4	1/25/2080
17471+74	2,347	18	0.276	45,000	3.01	0.064	60.1	10/14/2080
18046+56	2,426	18	0.276	45,000	1.13	0.069	60.8	5/31/2081
17302+87	2,267	18	0.266	45,000	2.30	0.068	61.2	11/7/2081
17717+58	2,323	18	0.276	45,000	1.95	0.064	61.4	1/9/2082
15747+66	2,210	18	0.276	45,000	8.08	0.075	69.8	6/29/2090
16860+88	2,278	18	0.305	45,000	11.02	0.076	69.9	7/10/2090
17033+60	2,243	18	0.266	45,000	2.66	0.068	71.1	9/14/2091
17713+21	2,313	18	0.266	45,000	1.24	0.063	72.3	12/5/2092
17688+57	2,334	18	0.266	45,000	1.13	0.068	72.7	5/19/2093
17519+76	2,365	18	0.276	45,000	1.95	0.064	74.6	3/28/2095
17384+39	2,331	18	0.276	45,000	2.30	0.064	76.2	11/17/2096
17099+93	2,193	18	0.276	45,000	2.78	0.069	76.3	12/22/2096
16332+31	2,385	18	0.315	45,000	7.25	0.096	76.9	7/21/2097
16873+99	2,302	18	0.315	45,000	7.13	0.083	78.1	9/24/2098
17337+62	2,290	18	0.276	45,000	2.19	0.064	81.7	5/20/2102
16850+80	2,290	18	0.315	45,000	6.31	0.083	84.1	9/21/2104
17007+81	2,300	18	0.266	45,000	2.66	0.063	84.1	10/14/2104
17034+58	2,240	18	0.266	45,000	2.42	0.063	86.3	12/19/2106
15743+26	2,220	18	0.266	45,000	2.89	0.081	87.5	2/11/2108
16935+45	2,311	18	0.305	45,000	8.08	0.070	90.0	9/4/2110
16533+14	2,313	18	0.315	45,000	9.37	0.083	91.2	11/13/2111
17004+84	2,301	18	0.276	45,000	1.95	0.075	93.1	10/12/2113

Table D-4 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Cartman to Kimble – ILI Date August 25, 2020 (pg. 3 of 5)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
17403+11	2,357	18	0.276	45,000	1.60	0.064	94.9	7/9/2115
16640+91	2,286	18	0.315	45,000	4.78	0.090	95.1	10/6/2115
17217+23	2,297	18	0.266	45,000	1.60	0.063	96.1	9/25/2116
17325+30	2,298	18	0.276	45,000	1.60	0.064	101.4	2/1/2122
17020+69	2,267	18	0.276	45,000	1.13	0.094	106.4	1/30/2127
16935+19	2,310	18	0.305	45,000	4.78	0.070	109.5	2/8/2130
16149+32	2,378	18	0.315	45,000	5.60	0.090	115.0	8/11/2135
16638+92	2,292	18	0.305	45,000	2.78	0.088	122.5	3/3/2143
17247+79	2,324	18	0.276	45,000	1.36	0.064	122.6	4/1/2143
17181+03	2,279	18	0.276	45,000	1.13	0.075	123.5	3/7/2144
16201+58	2,337	18	0.315	45,000	2.42	0.115	127.8	6/22/2148
16731+77	2,284	18	0.315	45,000	2.42	0.096	128.5	3/7/2149
16550+31	2,281	18	0.305	45,000	5.84	0.070	137.1	10/3/2157
16976+70	2,317	18	0.315	45,000	4.31	0.068	137.5	3/5/2158
17108+10	2,193	18	0.276	45,000	1.36	0.064	137.6	3/18/2158
16862+16	2,276	18	0.315	45,000	2.66	0.083	138.7	4/24/2159
16781+46	2,276	18	0.315	45,000	6.31	0.068	140.0	9/1/2160
16677+51	2,217	18	0.315	45,000	4.66	0.074	143.5	3/10/2164
16705+01	2,282	18	0.305	45,000	7.02	0.063	143.8	6/9/2164
16079+52	2,261	18	0.315	45,000	3.95	0.090	144.6	4/6/2165
16984+27	2,310	18	0.305	45,000	2.54	0.070	145.8	6/27/2166
16837+58	2,328	18	0.315	45,000	10.43	0.061	147.8	6/11/2168
16795+01	2,328	18	0.305	45,000	1.83	0.088	151.0	8/17/2171
16938+63	2,324	18	0.305	45,000	2.07	0.076	152.4	1/27/2173
16605+67	2,284	18	0.315	45,000	2.54	0.090	152.9	7/26/2173
15776+20	2,205	18	0.276	45,000	3.48	0.064	154.9	7/5/2175
16112+32	2,299	18	0.315	45,000	4.31	0.083	162.3	12/15/2182
16407+12	2,301	18	0.305	45,000	3.48	0.076	163.4	2/5/2184
16438+89	2,310	18	0.305	45,000	8.55	0.063	165.3	11/30/2185
16449+58	2,290	18	0.305	45,000	2.19	0.088	168.4	1/20/2189
16989+67	2,325	18	0.315	45,000	1.71	0.083	172.1	10/2/2192
16550+44	2,281	18	0.305	45,000	1.95	0.088	172.7	4/28/2193
16980+30	2,320	18	0.305	45,000	2.42	0.063	177.1	9/28/2197
16756+30	2,243	18	0.305	45,000	1.71	0.082	181.8	6/7/2202
16508+90	2,307	18	0.315	45,000	1.60	0.108	182.0	8/17/2202
16545+66	2,289	18	0.315	45,000	11.26	0.061	182.3	12/1/2202
16503+06	2,326	18	0.315	45,000	13.14	0.061	182.7	4/23/2203
16705+82	2,283	18	0.305	45,000	3.36	0.063	188.8	6/29/2209
16948+83	2,351	18	0.305	45,000	2.19	0.063	192.8	7/1/2213
16292+67	2,394	18	0.315	45,000	4.31	0.074	193.7	5/23/2214
16595+09	2,302	18	0.315	45,000	2.89	0.074	198.4	1/21/2219
16733+39	2,284	18	0.315	45,000	1.60	0.090	200.9	7/23/2221
16651+34	2,260	18	0.315	45,000	1.13	0.121	202.3	12/2/2222
16850+48	2,292	18	0.305	45,000	1.36	0.082	203.4	1/28/2224
16874+91	2,303	18	0.315	45,000	2.30	0.068	207.0	9/5/2227
16455+82	2,268	18	0.315	45,000	2.19	0.083	216.7	5/8/2237
16903+95	2,324	18	0.315	45,000	1.71	0.074	217.1	10/5/2237

Table D-4 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Cartman to Kimble – ILI Date August 25, 2020 (pg. 4 of 5)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
16104+61	2,285	18	0.315	45,000	2.78	0.074	225.2	11/17/2245
16457+05	2,265	18	0.315	45,000	1.83	0.061	225.2	11/17/2245
16457+26	2,265	18	0.315	45,000	2.42	0.061	225.2	11/17/2245
16274+44	2,369	18	0.315	45,000	1.36	0.096	225.2	11/17/2245
16274+46	2,369	18	0.315	45,000	1.36	0.068	225.2	11/17/2245
16216+21	2,340	18	0.315	45,000	2.30	0.068	225.2	11/17/2245
16125+54	2,306	18	0.325	45,000	3.48	0.069	225.2	11/17/2245
16050+13	2,288	18	0.315	45,000	1.71	0.068	225.2	11/17/2245
16304+00	2,406	18	0.315	45,000	1.95	0.074	225.2	11/17/2245
16318+60	2,408	18	0.305	45,000	3.48	0.063	225.2	11/17/2245
16288+27	2,385	18	0.305	45,000	2.89	0.070	225.2	11/17/2245
15748+11	2,209	18	0.276	45,000	1.24	0.075	225.2	11/17/2245
16201+62	2,337	18	0.315	45,000	1.13	0.090	225.2	11/17/2245
16201+79	2,338	18	0.315	45,000	1.60	0.068	225.2	11/17/2245
16847+42	2,309	18	0.305	45,000	1.24	0.076	225.2	11/17/2245
16555+60	2,292	18	0.305	45,000	1.60	0.070	225.2	11/17/2245
16414+69	2,298	18	0.315	45,000	1.24	0.083	225.2	11/17/2245
16456+94	2,265	18	0.315	45,000	1.24	0.090	225.2	11/17/2245
16985+12	2,310	18	0.315	45,000	1.60	0.068	225.2	11/17/2245
16826+55	2,340	18	0.315	45,000	1.24	0.061	225.2	11/17/2245
16676+20	2,217	18	0.315	45,000	1.60	0.083	225.2	11/17/2245
16371+37	2,371	18	0.315	45,000	1.48	0.074	225.2	11/17/2245
16123+74	2,299	18	0.305	45,000	3.36	0.063	225.2	11/17/2245
16129+49	2,317	18	0.315	45,000	3.84	0.061	225.2	11/17/2245
16428+68	2,316	18	0.305	45,000	1.36	0.063	225.2	11/17/2245
16434+09	2,314	18	0.305	45,000	2.07	0.063	225.2	11/17/2245
16479+33	2,302	18	0.315	45,000	1.60	0.083	225.2	11/17/2245
16717+33	2,263	18	0.315	45,000	1.48	0.083	225.2	11/17/2245
16748+06	2,250	18	0.315	45,000	1.48	0.061	225.2	11/17/2245
15934+05	2,207	18	0.276	45,000	1.13	0.064	225.2	11/17/2245
16237+53	2,381	18	0.305	45,000	1.60	0.076	225.2	11/17/2245
16201+52	2,337	18	0.315	45,000	1.83	0.083	225.2	11/17/2245
16522+62	2,289	18	0.305	45,000	1.36	0.070	225.2	11/17/2245
16670+52	2,223	18	0.315	45,000	1.71	0.061	225.2	11/17/2245
16697+75	2,272	18	0.305	45,000	2.07	0.063	225.2	11/17/2245
16219+36	2,339	18	0.315	45,000	1.24	0.061	225.2	11/17/2245
16521+07	2,286	18	0.315	45,000	1.83	0.083	225.2	11/17/2245
16457+16	2,265	18	0.315	45,000	1.24	0.068	225.2	11/17/2245
16457+17	2,265	18	0.315	45,000	1.60	0.068	225.2	11/17/2245
16457+18	2,265	18	0.315	45,000	1.24	0.074	225.2	11/17/2245
16756+26	2,243	18	0.305	45,000	1.60	0.063	225.2	11/17/2245
16260+10	2,378	18	0.315	45,000	6.31	0.061	225.2	11/17/2245
16450+48	2,287	18	0.325	45,000	1.13	0.082	225.2	11/17/2245
16755+73	2,243	18	0.315	45,000	1.24	0.090	225.2	11/17/2245
16390+34	2,323	18	0.315	45,000	1.36	0.090	225.2	11/17/2245
16329+59	2,384	18	0.315	45,000	1.83	0.074	225.2	11/17/2245
16638+92	2,292	18	0.305	45,000	1.24	0.070	225.2	11/17/2245

Table D-4 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Cartman to Kimble – ILI Date August 25, 2020 (pg. 5 of 5)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
16692+25	2,265	18	0.305	45,000	1.60	0.063	225.2	11/17/2245
16708+46	2,281	18	0.315	45,000	3.13	0.061	225.2	11/17/2245

Table D-5. Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Kimble to James River – ILI Date October 20, 2020

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
14932+66	2,028	18	0.276	45,000	5.97	0.088	37.8	8/22/2058
15478+03	2,203	18	0.266	45,000	2.31	0.076	50.4	3/16/2071
15348+30	2,273	18	0.276	45,000	2.07	0.088	59.3	2/18/2080
15340+44	2,223	18	0.285	45,000	3.73	0.067	78.5	4/10/2099
15181+91	2,161	18	0.276	45,000	2.43	0.069	96.5	4/8/2117
14069+19	1,719	18	0.276	45,000	3.02	0.075	108.1	11/18/2128
14067+40	1,707	18	0.276	45,000	1.72	0.075	162.0	10/23/2182
14913+30	2,010	18	0.276	45,000	1.48	0.069	172.9	9/18/2193
14349+48	1,748	18	0.276	45,000	1.13	0.094	181.6	6/9/2202

Table D-6. Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies James River to Eckert – ILI Date March 11, 2020 (pg. 1 of 3)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
13381+10	1,630	18	0.266	45,000	3.84	0.076	22.4	8/16/2042
12885+69	1,562	18	0.266	45,000	4.20	0.089	23.3	6/14/2043
13021+94	1,672	18	0.266	45,000	5.02	0.081	23.4	8/17/2043
12975+73	1,725	18	0.266	45,000	6.56	0.076	25.0	3/24/2045
13383+06	1,636	18	0.266	45,000	4.67	0.068	26.0	3/16/2046
13291+08	1,661	18	0.266	45,000	5.50	0.068	26.7	11/4/2046
13493+35	1,697	18	0.266	45,000	3.61	0.068	26.7	11/6/2046
13353+07	1,589	18	0.266	45,000	3.02	0.076	27.2	6/9/2047
13381+07	1,630	18	0.266	45,000	1.95	0.089	28.0	2/27/2048
12994+88	1,766	18	0.266	45,000	14.47	0.063	28.6	10/20/2048
13695+53	1,644	18	0.266	45,000	2.19	0.068	29.0	3/6/2049
12861+12	1,582	18	0.266	45,000	6.09	0.076	29.0	3/11/2049
13508+59	1,672	18	0.266	45,000	3.84	0.063	29.7	11/23/2049
13700+68	1,656	18	0.266	45,000	2.07	0.068	30.0	3/6/2050
13282+73	1,641	18	0.266	45,000	5.97	0.063	31.2	5/26/2051
13370+81	1,562	18	0.266	45,000	4.43	0.063	31.9	2/1/2052
13195+13	1,456	18	0.285	45,000	4.91	0.076	34.9	1/17/2055
13195+11	1,456	18	0.285	45,000	3.02	0.087	35.5	9/4/2055
13342+56	1,619	18	0.266	45,000	3.84	0.063	35.5	9/18/2055
12672+49	1,664	18	0.266	45,000	5.85	0.076	35.8	12/29/2055
13175+65	1,493	18	0.266	45,000	3.49	0.068	37.7	11/19/2057
12955+75	1,702	18	0.266	45,000	5.38	0.068	38.7	11/14/2058
13346+51	1,610	18	0.266	45,000	2.54	0.068	38.7	11/14/2058

Table D-6 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies James River to Eckert – ILI Date March 11, 2020 (pg. 2 of 3)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
13431+83	1,693	18	0.256	45,000	1.60	0.069	39.7	11/14/2059
12134+99	1,571	18	0.266	45,000	3.96	0.089	41.3	6/30/2061
13605+79	1,688	18	0.266	45,000	1.48	0.068	42.8	1/14/2063
13175+13	1,496	18	0.266	45,000	2.66	0.068	44.7	11/17/2064
12141+65	1,589	18	0.266	45,000	6.68	0.076	45.0	3/12/2065
12324+44	1,599	18	0.266	45,000	5.73	0.076	46.3	7/13/2066
12893+00	1,564	18	0.266	45,000	2.78	0.076	47.2	5/6/2067
13575+73	1,702	18	0.266	45,000	1.36	0.068	47.4	8/3/2067
13047+44	1,607	18	0.285	45,000	3.02	0.082	47.8	12/10/2067
12579+56	1,678	18	0.266	45,000	7.03	0.068	48.0	3/24/2068
12867+31	1,578	18	0.266	45,000	4.08	0.068	48.1	4/3/2068
12151+72	1,561	18	0.256	45,000	3.13	0.082	49.0	2/23/2069
12316+07	1,593	18	0.266	45,000	9.16	0.068	49.4	8/21/2069
13463+37	1,733	18	0.266	45,000	1.25	0.076	49.8	12/9/2069
13510+91	1,680	18	0.266	45,000	1.60	0.063	50.2	5/8/2070
13206+51	1,448	18	0.266	45,000	2.54	0.063	50.7	11/20/2070
13603+39	1,690	18	0.266	45,000	1.13	0.068	53.4	7/22/2073
12672+53	1,664	18	0.266	45,000	4.79	0.068	53.6	10/23/2073
13057+98	1,556	18	0.285	45,000	4.91	0.067	54.4	8/8/2074
13044+90	1,620	18	0.285	45,000	5.14	0.067	54.4	8/17/2074
12430+28	1,611	18	0.266	45,000	3.25	0.081	54.5	8/31/2074
13021+55	1,676	18	0.266	45,000	1.95	0.076	55.1	4/8/2075
12923+46	1,629	18	0.266	45,000	2.19	0.076	55.3	6/28/2075
12955+80	1,702	18	0.266	45,000	3.61	0.063	56.0	2/25/2076
12722+31	1,579	18	0.266	45,000	3.96	0.068	56.2	5/8/2076
12880+77	1,576	18	0.266	45,000	3.96	0.063	56.9	1/26/2077
12656+53	1,708	18	0.285	45,000	5.50	0.076	57.6	9/30/2077
12427+94	1,595	18	0.266	45,000	9.16	0.063	58.1	4/13/2078
12805+23	1,581	18	0.266	45,000	3.25	0.068	58.3	6/10/2078
12893+03	1,564	18	0.266	45,000	3.61	0.063	58.8	12/10/2078
13109+57	1,472	18	0.266	45,000	2.31	0.063	59.9	2/1/2080
12868+24	1,575	18	0.266	45,000	2.78	0.068	60.3	7/2/2080
12863+87	1,584	18	0.266	45,000	2.78	0.068	60.6	10/30/2080
12885+72	1,562	18	0.266	45,000	2.54	0.068	62.8	12/14/2082
12793+99	1,587	18	0.266	45,000	2.90	0.068	63.2	5/25/2083
12515+50	1,623	18	0.266	45,000	4.32	0.068	64.1	4/12/2084
12929+84	1,620	18	0.266	45,000	2.90	0.063	64.1	5/1/2084
12529+16	1,688	18	0.285	45,000	3.84	0.082	65.6	11/1/2085
13089+92	1,513	18	0.266	45,000	1.95	0.063	68.4	8/18/2088
12372+52	1,582	18	0.266	45,000	4.43	0.068	69.3	7/5/2089
12715+87	1,587	18	0.266	45,000	3.49	0.063	71.1	4/12/2091
12046+84	1,617	18	0.266	45,000	5.14	0.068	71.3	7/13/2091
12137+70	1,572	18	0.266	45,000	5.02	0.068	71.4	8/20/2091
12440+59	1,631	18	0.266	45,000	3.73	0.068	73.3	6/24/2093
12212+51	1,592	18	0.266	45,000	6.80	0.063	73.9	1/20/2094
12956+68	1,696	18	0.266	45,000	2.19	0.063	74.5	8/22/2094
12678+15	1,645	18	0.266	45,000	3.37	0.063	75.4	7/30/2095

Table D-6 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies James River to Eckert – ILI Date March 11, 2020 (pg. 3 of 3)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
12842+62	1,582	18	0.266	45,000	2.07	0.068	75.4	8/21/2095
12321+24	1,600	18	0.266	45,000	3.96	0.068	75.9	2/1/2096
12888+92	1,570	18	0.266	45,000	2.31	0.063	76.1	4/18/2096
13071+56	1,578	18	0.266	45,000	1.48	0.068	76.2	6/2/2096
12976+52	1,727	18	0.285	45,000	3.02	0.067	76.7	11/12/2096
12462+18	1,656	18	0.266	45,000	4.55	0.063	77.4	7/20/2097
13253+93	1,533	18	0.266	45,000	1.13	0.068	77.4	7/22/2097
12997+42	1,768	18	0.295	45,000	1.60	0.095	80.4	8/4/2100
13103+16	1,484	18	0.285	45,000	2.66	0.062	80.6	10/2/2100
12896+62	1,578	18	0.266	45,000	2.07	0.063	81.0	3/15/2101
13003+31	1,765	18	0.266	45,000	1.48	0.068	83.6	10/23/2103
13006+50	1,754	18	0.285	45,000	3.02	0.062	85.6	10/16/2105
12208+93	1,614	18	0.266	45,000	2.43	0.076	87.4	8/17/2107
12666+46	1,684	18	0.285	45,000	2.66	0.076	88.5	8/25/2108
12202+65	1,666	18	0.266	45,000	1.25	0.108	89.3	7/16/2109
12452+71	1,626	18	0.266	45,000	3.37	0.063	90.0	3/8/2110
12707+42	1,598	18	0.266	45,000	2.31	0.063	90.8	1/14/2111
12595+88	1,642	18	0.266	45,000	1.72	0.076	91.0	3/24/2111
12168+17	1,546	18	0.266	45,000	3.84	0.063	96.0	3/16/2116
12449+55	1,612	18	0.266	45,000	1.60	0.081	97.3	6/30/2117
12647+93	1,684	18	0.266	45,000	1.84	0.068	99.2	5/29/2119
12315+80	1,592	18	0.266	45,000	2.54	0.068	99.6	10/30/2119
12142+62	1,587	18	0.266	45,000	3.49	0.063	101.7	11/20/2121
12413+75	1,597	18	0.285	45,000	4.43	0.067	101.8	12/12/2121
12227+19	1,617	18	0.266	45,000	2.54	0.068	103.8	1/2/2124
12899+32	1,577	18	0.266	45,000	1.25	0.068	103.9	1/23/2124
12429+84	1,608	18	0.266	45,000	2.07	0.068	107.3	6/14/2127
12817+56	1,590	18	0.266	45,000	1.25	0.068	112.7	11/28/2132
13028+04	1,659	18	0.285	45,000	1.48	0.062	126.2	5/10/2146
12341+24	1,599	18	0.266	45,000	2.07	0.063	128.0	3/29/2148
12340+05	1,599	18	0.266	45,000	2.07	0.063	128.1	4/22/2148
12224+27	1,617	18	0.266	45,000	1.84	0.068	129.7	11/10/2149
12251+14	1,503	18	0.266	45,000	2.07	0.063	132.6	10/8/2152
12241+38	1,565	18	0.285	45,000	3.49	0.062	144.4	7/26/2164
12656+20	1,708	18	0.285	45,000	2.07	0.062	146.9	1/20/2167
12443+76	1,621	18	0.266	45,000	1.48	0.063	150.9	2/18/2171
12413+77	1,597	18	0.285	45,000	2.43	0.062	159.7	11/22/2179
12515+52	1,623	18	0.266	45,000	1.25	0.063	162.3	7/7/2182
12428+32	1,597	18	0.266	45,000	1.25	0.063	172.2	5/8/2192
12515+47	1,623	18	0.266	45,000	1.13	0.063	175.5	9/2/2195
12847+03	1,580	18	0.285	45,000	1.13	0.062	182.3	7/14/2202
12372+64	1,581	18	0.266	45,000	1.13	0.063	192.3	7/14/2212
12241+37	1,566	18	0.285	45,000	1.25	0.062	225.2	6/2/2245

Table D-7. Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Eckert to Cedar Valley – ILI Date March 2, 2020 (pg. 1 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
11653+65	1,532	18	0.295	45,000	8.81	0.095	24.5	9/17/2044
11835+05	1,664	18	0.295	45,000	6.56	0.095	25.0	3/13/2045
11874+86	1,710	18	0.285	45,000	6.56	0.087	25.2	5/13/2045
11866+04	1,647	18	0.285	45,000	8.92	0.082	25.3	6/19/2045
11690+42	1,467	18	0.285	45,000	5.26	0.096	26.1	3/24/2046
11863+65	1,633	18	0.285	45,000	6.09	0.087	26.6	9/22/2046
11929+59	1,771	18	0.305	45,000	7.51	0.094	27.8	1/7/2048
11825+97	1,664	18	0.295	45,000	24.16	0.074	31.6	10/15/2051
11465+59	1,570	18	0.295	45,000	4.55	0.107	34.3	6/28/2054
12026+26	1,679	18	0.295	45,000	9.99	0.074	34.3	7/1/2054
11885+64	1,697	18	0.305	45,000	10.93	0.082	35.7	11/4/2055
11882+04	1,708	18	0.305	45,000	5.14	0.094	36.0	2/26/2056
11859+51	1,636	18	0.285	45,000	6.56	0.076	37.5	9/5/2057
11888+02	1,674	18	0.305	45,000	9.40	0.082	37.8	12/7/2057
11855+64	1,658	18	0.295	45,000	11.76	0.074	39.2	5/9/2059
10798+69	1,114	18	0.305	45,000	11.64	0.103	39.8	12/22/2059
11755+18	1,639	18	0.285	45,000	7.27	0.076	40.1	3/25/2060
11811+06	1,621	18	0.295	45,000	29.48	0.068	40.8	12/19/2060
11885+22	1,698	18	0.285	45,000	3.73	0.082	42.0	3/7/2062
11490+19	1,556	18	0.295	45,000	10.22	0.083	42.7	11/20/2062
11859+85	1,634	18	0.305	45,000	13.06	0.076	42.9	1/30/2063
11811+03	1,621	18	0.295	45,000	5.14	0.083	43.8	12/28/2063
10095+95	1,044	18	0.295	45,000	12.47	0.095	45.2	5/6/2065
10705+70	1,051	18	0.295	45,000	7.86	0.101	47.4	7/14/2067
11150+24	1,253	18	0.295	45,000	6.68	0.095	48.2	5/9/2068
11785+68	1,756	18	0.295	45,000	2.66	0.101	49.7	10/28/2069
11850+88	1,688	18	0.305	45,000	8.45	0.076	50.8	12/24/2070
11509+88	1,587	18	0.295	45,000	5.03	0.089	50.9	2/6/2071
11895+66	1,714	18	0.295	45,000	5.50	0.074	51.4	7/22/2071
11660+53	1,521	18	0.295	45,000	9.75	0.074	51.6	10/9/2071
11204+17	1,319	18	0.295	45,000	11.76	0.083	51.7	11/29/2071
11928+80	1,773	18	0.305	45,000	3.61	0.088	53.4	7/22/2073
11850+23	1,689	18	0.295	45,000	5.50	0.074	53.8	1/1/2074
12006+41	1,740	18	0.295	45,000	5.73	0.068	54.2	5/4/2074
11914+87	1,760	18	0.305	45,000	6.44	0.076	54.3	6/5/2074
11972+91	1,709	18	0.295	45,000	4.08	0.074	54.6	9/27/2074
11792+73	1,690	18	0.295	45,000	6.09	0.074	54.8	12/19/2074
11924+83	1,782	18	0.295	45,000	7.51	0.068	56.5	9/7/2076
11911+74	1,746	18	0.295	45,000	12.94	0.063	56.5	9/16/2076
11142+47	1,229	18	0.295	45,000	6.80	0.089	58.7	11/19/2078
11931+18	1,768	18	0.285	45,000	2.78	0.076	59.4	7/16/2079
11077+32	1,212	18	0.295	45,000	7.27	0.089	59.6	10/25/2079
11839+97	1,670	18	0.305	45,000	5.73	0.076	60.1	3/22/2080
11755+31	1,641	18	0.285	45,000	2.66	0.082	61.7	11/15/2081
11889+40	1,671	18	0.295	45,000	9.52	0.063	61.7	11/27/2081
11493+36	1,560	18	0.295	45,000	9.63	0.074	62.0	2/16/2082
12011+18	1,719	18	0.295	45,000	5.97	0.063	62.2	5/19/2082

Table D-7 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Eckert to Cedar Valley – ILI Date March 2, 2020 (pg. 2 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
11535+89	1,639	18	0.305	45,000	3.96	0.094	62.7	11/20/2082
11578+43	1,526	18	0.285	45,000	2.78	0.087	63.5	09/18/2083
11054+10	1,219	18	0.305	45,000	7.27	0.094	64.0	3/5/2084
11792+71	1,690	18	0.295	45,000	4.32	0.074	64.6	10/1/2084
11542+51	1,618	18	0.305	45,000	10.22	0.076	65.6	10/17/2085
11803+06	1,637	18	0.285	45,000	1.95	0.087	67.6	10/26/2087
11850+96	1,688	18	0.305	45,000	6.56	0.070	68.0	3/9/2088
11884+06	1,702	18	0.285	45,000	2.31	0.076	68.8	12/8/2088
11778+25	1,701	18	0.295	45,000	5.73	0.068	69.6	9/22/2089
11854+85	1,662	18	0.295	45,000	2.43	0.083	69.6	10/20/2089
11267+42	1,329	18	0.295	45,000	12.11	0.074	69.8	12/7/2089
11772+55	1,714	18	0.305	45,000	7.98	0.070	69.8	12/21/2089
11543+45	1,613	18	0.305	45,000	8.57	0.076	69.9	1/27/2090
11051+71	1,200	18	0.305	45,000	14.71	0.082	70.4	8/4/2090
11493+24	1,560	18	0.295	45,000	6.92	0.074	70.6	10/24/2090
11067+68	1,284	18	0.295	45,000	7.98	0.083	71.1	3/30/2091
10769+11	1,128	18	0.285	45,000	5.97	0.087	72.2	5/8/2092
11485+82	1,557	18	0.295	45,000	6.56	0.074	72.8	12/22/2092
11616+82	1,491	18	0.295	45,000	7.74	0.068	73.0	2/27/2093
11535+88	1,639	18	0.305	45,000	7.74	0.076	73.5	8/18/2093
11688+93	1,474	18	0.295	45,000	1.48	0.116	73.6	10/12/2093
11852+76	1,675	18	0.295	65,000	6.68	0.063	74.0	3/16/2094
11520+07	1,622	18	0.295	45,000	5.85	0.074	74.2	4/28/2094
11510+29	1,589	18	0.305	45,000	3.96	0.088	74.6	10/24/2094
11130+16	1,219	18	0.295	45,000	6.44	0.083	74.8	12/8/2094
11756+34	1,665	18	0.305	45,000	5.73	0.070	79.2	5/4/2099
11493+26	1,560	18	0.295	45,000	2.43	0.095	79.2	5/5/2099
11654+27	1,533	18	0.295	45,000	9.16	0.063	79.9	2/9/2100
11622+83	1,487	18	0.295	45,000	3.96	0.074	80.0	3/5/2100
11493+37	1,560	18	0.295	45,000	8.45	0.068	81.0	2/28/2101
11283+59	1,343	18	0.295	45,000	4.44	0.083	81.0	3/5/2101
11610+94	1,474	18	0.305	45,000	4.91	0.076	81.6	10/22/2101
12012+77	1,704	18	0.295	45,000	2.43	0.068	81.9	1/25/2102
11770+27	1,718	18	0.305	45,000	2.43	0.088	82.7	11/26/2102
11850+24	1,689	18	0.295	45,000	4.44	0.063	83.0	2/15/2103
11815+01	1,630	18	0.305	45,000	1.95	0.094	83.2	5/11/2103
11599+13	1,475	18	0.285	45,000	2.66	0.076	83.2	06/1/2103
11607+35	1,470	18	0.305	45,000	7.39	0.070	83.7	11/5/2103
11332+28	1,486	18	0.305	45,000	8.92	0.076	84.5	9/5/2104
11658+68	1,518	18	0.295	45,000	3.37	0.074	84.7	11/7/2104
10760+77	1,136	18	0.305	45,000	9.28	0.088	84.9	1/27/2105
10767+51	1,133	18	0.305	45,000	15.19	0.082	85.4	7/31/2105
11683+57	1,451	18	0.305	45,000	5.50	0.070	85.8	12/6/2105
11324+33	1,427	18	0.305	45,000	8.45	0.076	86.5	9/7/2106
11153+80	1,261	18	0.295	45,000	4.79	0.083	86.6	10/26/2106
11125+42	1,245	18	0.295	45,000	3.84	0.089	87.1	3/24/2107
11535+91	1,639	18	0.305	45,000	8.33	0.070	87.7	11/26/2107

Table D-7 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Eckert to Cedar Valley – ILI Date March 2, 2020 (pg. 3 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
11483+44	1,558	18	0.295	45,000	6.44	0.068	89.8	12/27/2109
10550+67	983	18	0.285	45,000	9.75	0.076	91.1	4/24/2111
11308+97	1,348	18	0.295	45,000	9.75	0.068	91.5	8/19/2111
11806+68	1,643	18	0.305	45,000	2.31	0.082	92.1	4/27/2112
11612+17	1,479	18	0.305	45,000	2.55	0.088	92.3	6/15/2112
10724+38	1,039	18	0.295	45,000	7.51	0.083	92.3	7/3/2112
11283+58	1,343	18	0.295	45,000	3.61	0.083	92.7	11/11/2112
11051+76	1,200	18	0.305	45,000	13.18	0.076	93.2	5/16/2113
10445+83	907	18	0.295	45,000	3.84	0.101	93.5	9/19/2113
10162+13	1,050	18	0.295	45,000	6.09	0.089	94.1	4/17/2114
10868+32	1,222	18	0.295	45,000	4.55	0.089	94.7	11/21/2114
11542+58	1,618	18	0.305	45,000	15.54	0.063	95.4	8/3/2115
11542+41	1,619	18	0.305	45,000	15.07	0.063	96.1	3/25/2116
11789+89	1,718	18	0.295	45,000	3.73	0.063	96.2	5/29/2116
10970+17	1,260	18	0.295	45,000	10.11	0.074	96.6	10/5/2116
11339+92	1,464	18	0.295	45,000	7.74	0.068	96.7	11/5/2116
11851+68	1,684	18	0.305	65,000	4.67	0.063	98.4	8/6/2118
11066+86	1,281	18	0.295	45,000	7.86	0.074	98.6	10/12/2118
11653+55	1,532	18	0.295	45,000	2.66	0.074	98.8	12/9/2118
11082+56	1,167	18	0.295	45,000	7.39	0.074	98.9	1/12/2119
11528+45	1,662	18	0.305	45,000	5.97	0.070	99.6	10/5/2119
11333+07	1,482	18	0.295	45,000	4.55	0.074	99.9	1/9/2120
11895+77	1,714	18	0.295	45,000	2.19	0.068	100.1	4/4/2120
11479+47	1,561	18	0.295	45,000	7.51	0.063	101.8	12/28/2121
11150+95	1,255	18	0.295	45,000	3.73	0.083	101.8	1/4/2122
11850+95	1,688	18	0.305	45,000	2.66	0.070	104.4	7/10/2124
11763+80	1,738	18	0.295	45,000	3.37	0.063	105.4	8/13/2125
11522+85	1,635	18	0.305	45,000	3.61	0.076	106.7	11/22/2126
11305+79	1,356	18	0.305	45,000	8.57	0.070	107.3	7/5/2127
11124+26	1,243	18	0.305	45,000	5.03	0.082	107.5	9/15/2127
10873+47	1,213	18	0.305	45,000	5.26	0.088	107.7	10/29/2127
12012+37	1,709	18	0.295	45,000	1.84	0.063	108.6	10/05/2128
10247+06	974	18	0.295	45,000	6.80	0.083	108.7	11/25/2128
10715+66	1,056	18	0.295	45,000	4.20	0.089	109.1	4/19/2129
10770+30	1,128	18	0.285	45,000	5.38	0.076	110.5	9/19/2130
10724+59	1,038	18	0.295	45,000	10.58	0.074	110.6	9/30/2130
10748+65	1,091	18	0.295	45,000	10.22	0.074	111.0	3/2/2131
11540+27	1,630	18	0.305	45,000	3.25	0.076	111.5	8/23/2131
11911+70	1,745	18	0.295	45,000	2.19	0.063	111.6	10/15/2131
10681+49	1,024	18	0.295	45,000	2.55	0.107	112.7	10/29/2132
11690+41	1,467	18	0.285	45,000	2.43	0.062	113.1	4/9/2133
11230+81	1,270	18	0.305	45,000	8.81	0.070	113.5	9/4/2133
11243+87	1,318	18	0.295	45,000	4.08	0.074	113.8	1/6/2134
11490+20	1,556	18	0.295	45,000	3.61	0.068	114.6	10/2/2134
10742+10	1,050	18	0.295	45,000	4.91	0.083	115.2	5/12/2135
11339+85	1,464	18	0.295	45,000	7.51	0.063	116.3	7/1/2136
11201+51	1,314	18	0.295	45,000	4.20	0.074	116.6	10/5/2136

Table D-7 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Eckert to Cedar Valley – ILI Date March 2, 2020 (pg. 4 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
10078+22	1,096	18	0.285	45,000	3.49	0.087	116.8	1/3/2137
11301+17	1,370	18	0.295	45,000	5.03	0.068	117.1	4/5/2137
11599+00	1,474	18	0.305	45,000	2.66	0.076	117.6	10/18/2137
11210+07	1,301	18	0.295	45,000	2.07	0.095	118.4	8/4/2138
11406+29	1,544	18	0.295	45,000	3.96	0.068	119.1	3/30/2139
11493+14	1,560	18	0.295	45,000	1.72	0.089	119.8	12/20/2139
10763+97	1,142	18	0.305	45,000	6.92	0.082	119.8	12/25/2139
11553+44	1,564	18	0.305	45,000	5.97	0.063	119.9	2/13/2140
11119+91	1,227	18	0.285	45,000	7.74	0.062	120.0	3/11/2140
11625+67	1,504	18	0.295	45,000	2.07	0.074	120.1	4/5/2140
11615+06	1,495	18	0.305	45,000	2.07	0.082	121.7	10/31/2141
11665+07	1,521	18	0.295	45,000	2.31	0.068	122.6	9/21/2142
10970+06	1,260	18	0.295	45,000	9.28	0.068	124.8	12/9/2144
10925+34	1,303	18	0.295	45,000	5.85	0.074	125.3	6/9/2145
11221+97	1,324	18	0.305	45,000	4.44	0.076	125.3	7/2/2145
11204+14	1,319	18	0.295	45,000	5.26	0.068	125.5	8/15/2145
11083+79	1,158	18	0.295	45,000	6.68	0.068	126.0	2/22/2146
11654+02	1,533	18	0.295	45,000	1.84	0.074	126.8	1/2/2147
10877+61	1,212	18	0.305	45,000	7.98	0.076	128.1	3/31/2148
11222+96	1,321	18	0.285	45,000	3.49	0.067	128.8	1/1/2149
11003+72	1,262	18	0.305	45,000	11.05	0.070	129.2	5/19/2149
11867+70	1,659	18	0.305	45,000	2.31	0.063	130.2	5/31/2150
11163+62	1,257	18	0.295	45,000	8.45	0.063	130.7	1/17/2150
11114+00	1,222	18	0.295	45,000	9.75	0.063	130.9	1/20/2151
11598+99	1,474	18	0.305	45,000	3.96	0.063	132.3	6/24/2152
11120+99	1,231	18	0.305	45,000	7.39	0.070	132.4	8/11/2152
11432+94	1,624	18	0.295	45,000	2.43	0.074	132.8	12/4/2152
11048+89	1,188	18	0.295	45,000	2.43	0.089	132.8	1/2/2153
11201+66	1,314	18	0.295	45,000	2.07	0.089	133.8	1/8/2154
11920+84	1,781	18	0.305	45,000	2.19	0.063	133.9	2/5/2154
11156+90	1,268	18	0.295	45,000	3.49	0.074	134.2	5/11/2154
11474+77	1,566	18	0.285	45,000	2.19	0.067	134.4	7/25/2154
11402+33	1,522	18	0.295	45,000	3.14	0.068	134.6	10/2/2154
11653+64	1,532	18	0.295	45,000	1.25	0.089	134.9	1/30/2155
11228+43	1,289	18	0.285	45,000	4.20	0.062	136.0	3/12/2156
11758+85	1,720	18	0.295	45,000	1.72	0.068	136.8	12/18/2156
10970+05	1,260	18	0.295	45,000	3.02	0.083	137.6	10/11/2157
11500+50	1,571	18	0.295	45,000	2.55	0.068	137.7	10/29/2157
11233+60	1,281	18	0.305	45,000	10.46	0.063	138.4	8/9/2158
11156+53	1,267	18	0.295	45,000	7.03	0.063	139.1	3/24/2159
11644+56	1,501	18	0.305	45,000	1.48	0.088	139.3	6/5/2159
11542+35	1,619	18	0.305	45,000	4.08	0.063	139.9	1/23/2160
11525+34	1,647	18	0.305	45,000	4.20	0.063	141.2	5/2/2161
11102+36	1,240	18	0.305	45,000	4.20	0.076	142.9	2/10/2163
10836+64	1,160	18	0.295	45,000	4.91	0.074	143.4	7/30/2163
11868+49	1,670	18	0.285	45,000	1.25	0.062	143.8	12/14/2163
11339+45	1,463	18	0.295	45,000	4.08	0.063	144.4	7/30/2164

Table D-7 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Eckert to Cedar Valley – ILI Date March 2, 2020 (pg. 5 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
11097+97	1,202	18	0.285	45,000	2.31	0.076	146.8	12/29/2166
10102+74	1,009	18	0.295	45,000	3.84	0.083	147.8	1/1/2168
10792+17	1,109	18	0.285	45,000	5.26	0.067	148.0	2/26/2168
11589+52	1,509	18	0.285	45,000	1.84	0.062	148.8	12/4/2168
10440+68	920	18	0.295	45,000	6.44	0.074	149.0	3/8/2169
10188+57	862	18	0.295	45,000	3.84	0.083	149.3	6/16/2169
11220+48	1,327	18	0.295	45,000	3.49	0.068	149.6	10/24/2169
10603+53	1,069	18	0.295	45,000	9.75	0.068	152.3	7/6/2172
11084+47	1,158	18	0.295	45,000	6.09	0.063	153.8	12/23/2173
10871+09	1,215	18	0.285	45,000	6.44	0.062	155.6	10/26/2175
11883+26	1,704	18	0.305	45,000	1.36	0.070	156.9	1/8/2177
10223+76	969	18	0.295	45,000	9.75	0.068	159.6	10/9/2179
11533+47	1,652	18	0.285	45,000	1.13	0.082	159.7	11/27/2179
11124+72	1,244	18	0.315	45,000	2.66	0.090	161.1	4/9/2181
11301+09	1,370	18	0.295	45,000	2.66	0.068	161.7	11/7/2181
11099+14	1,209	18	0.305	45,000	8.92	0.063	161.9	2/3/2182
11934+76	1,760	18	0.305	45,000	1.25	0.070	162.0	3/20/2182
10695+53	1,023	18	0.295	45,000	6.92	0.068	163.0	2/15/2183
11408+67	1,568	18	0.295	45,000	2.78	0.063	163.2	5/4/2183
11779+76	1,712	18	0.295	45,000	1.13	0.074	164.4	7/18/2184
11168+91	1,223	18	0.295	45,000	3.14	0.068	164.6	10/23/2184
11606+91	1,471	18	0.305	45,000	2.43	0.063	166.1	4/10/2186
10445+82	907	18	0.295	45,000	7.62	0.068	171.2	5/22/2191
10882+36	1,212	18	0.295	45,000	4.67	0.068	171.3	6/10/2191
11165+98	1,238	18	0.295	45,000	3.84	0.063	171.7	11/28/2191
11676+91	1,469	18	0.305	45,000	1.60	0.070	171.8	12/18/2191
10879+98	1,213	18	0.295	45,000	6.92	0.063	174.6	10/4/2194
11431+77	1,621	18	0.295	45,000	1.95	0.068	175.0	3/20/2195
10896+22	1,227	18	0.295	45,000	6.44	0.063	176.6	10/7/2196
11492+97	1,560	18	0.295	45,000	1.72	0.068	177.7	11/8/2197
10894+84	1,223	18	0.295	45,000	4.20	0.068	178.2	5/3/2198
10401+51	981	18	0.305	45,000	5.73	0.076	178.7	11/30/2198
11151+42	1,256	18	0.295	45,000	2.78	0.068	179.5	9/17/2199
10068+18	1,093	18	0.305	45,000	3.14	0.088	179.6	9/29/2199
11267+40	1,329	18	0.295	45,000	2.90	0.063	180.2	5/9/2200
11510+03	1,588	18	0.305	45,000	2.55	0.063	180.3	6/18/2200
11414+23	1,569	18	0.295	45,000	1.60	0.074	180.3	7/7/2200
10868+44	1,221	18	0.295	45,000	3.14	0.074	180.4	7/20/2200
11663+79	1,523	18	0.295	45,000	1.48	0.063	181.2	5/10/2201
11284+38	1,346	18	0.295	45,000	2.78	0.063	181.5	8/18/2201
10603+54	1,069	18	0.295	45,000	3.96	0.074	181.5	9/6/2201
11789+50	1,724	18	0.295	45,000	1.25	0.063	181.9	1/9/2202
10769+12	1,128	18	0.285	45,000	3.49	0.067	182.4	8/6/2202
10748+67	1,091	18	0.295	45,000	7.74	0.063	182.5	8/30/2202
10724+38	1,039	18	0.295	45,000	4.91	0.068	183.2	6/2/2203
11210+05	1,301	18	0.295	45,000	1.60	0.083	183.4	8/11/2203
11150+93	1,255	18	0.295	45,000	3.37	0.063	185.2	5/23/2205

Table D-7 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Eckert to Cedar Valley – ILI Date March 2, 2020 (pg. 6 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
11653+87	1,532	18	0.295	45,000	1.13	0.074	185.3	7/2/2205
11648+92	1,517	18	0.295	45,000	1.13	0.074	186.1	4/25/2206
11511+44	1,593	18	0.295	45,000	1.13	0.083	188.5	9/1/2208
10438+56	929	18	0.295	45,000	3.96	0.074	188.6	10/16/2208
11059+74	1,272	18	0.305	45,000	3.61	0.070	189.2	4/30/2209
10924+98	1,303	18	0.295	45,000	4.91	0.063	191.0	3/1/2211
11490+58	1,557	18	0.295	45,000	1.13	0.083	192.1	4/18/2212
10445+81	907	18	0.295	45,000	5.50	0.068	192.9	1/18/2213
10895+84	1,226	18	0.295	45,000	4.91	0.063	194.1	4/8/2214
10532+80	922	18	0.305	45,000	6.80	0.070	195.2	5/15/2215
11510+12	1,588	18	0.305	45,000	1.48	0.076	196.0	3/7/2216
11125+44	1,245	18	0.295	45,000	2.43	0.068	198.8	12/19/2218
10863+56	1,214	18	0.305	45,000	3.25	0.076	199.8	12/6/2219
11150+66	1,254	18	0.295	45,000	1.25	0.095	199.8	12/29/2219
10969+24	1,259	18	0.295	45,000	1.84	0.083	200.8	1/4/2221
11614+23	1,494	18	0.305	45,000	1.72	0.063	201.2	5/6/2221
10873+07	1,214	18	0.285	45,000	3.37	0.062	201.3	6/20/2221
11419+94	1,591	18	0.295	45,000	1.84	0.063	204.0	2/22/2224
10246+75	974	18	0.295	45,000	3.49	0.074	204.9	2/3/2225
11679+97	1,447	18	0.305	45,000	1.48	0.063	205.7	12/2/2225
10245+57	975	18	0.295	45,000	4.79	0.068	207.2	5/5/2227
10070+99	1,104	18	0.295	45,000	3.25	0.074	207.3	6/28/2227
10707+04	1,054	18	0.295	45,000	3.84	0.068	207.5	9/20/2227
11553+46	1,564	18	0.305	45,000	1.48	0.070	208.0	2/20/2228
11510+27	1,589	18	0.305	45,000	1.36	0.076	209.4	8/16/2229
11089+00	1,178	18	0.295	45,000	2.31	0.068	210.5	9/3/2230
10226+55	985	18	0.295	45,000	7.03	0.063	211.8	12/25/2231
11222+52	1,323	18	0.295	45,000	1.60	0.074	213.6	10/5/2233
11636+88	1,477	18	0.305	45,000	1.25	0.070	215.0	3/16/2235
10070+98	1,104	18	0.295	45,000	3.02	0.074	216.8	1/6/2237
10558+65	1,020	18	0.285	45,000	3.02	0.067	217.1	4/23/2237
11539+74	1,632	18	0.305	45,000	1.25	0.076	218.3	6/7/2238
11665+82	1,520	18	0.295	45,000	1.13	0.063	219.0	3/5/2239
10525+02	904	18	0.305	45,000	9.99	0.063	221.5	9/4/2241
11679+99	1,447	18	0.305	45,000	1.13	0.070	222.0	3/1/2242
10071+18	1,104	18	0.295	45,000	3.84	0.068	222.6	10/5/2242
9793+23	1,058	18	0.374	45,000	1.25	0.077	225.2	5/26/2245
10883+56	1,212	18	0.295	45,000	1.25	0.068	225.2	5/26/2245
10749+29	1,095	18	0.295	45,000	1.13	0.074	225.2	5/26/2245
10875+04	1,213	18	0.305	45,000	1.36	0.082	225.2	5/26/2245
10110+85	1,050	18	0.285	45,000	2.43	0.067	225.2	5/26/2245
10119+05	1,077	18	0.305	45,000	1.60	0.076	225.2	5/26/2245
11406+29	1,544	18	0.295	45,000	1.36	0.068	225.2	5/26/2245
10096+75	1,041	18	0.295	45,000	3.37	0.068	225.2	5/26/2245
11067+81	1,285	18	0.295	45,000	1.36	0.068	225.2	5/26/2245
10658+76	993	18	0.285	45,000	1.48	0.076	225.2	5/26/2245
10644+51	1,055	18	0.295	45,000	1.72	0.068	225.2	5/26/2245

Table D-7 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Eckert to Cedar Valley – ILI Date March 2, 2020 (pg. 7 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
10644+54	1,055	18	0.295	45,000	1.72	0.068	225.2	5/26/2245
10748+67	1,091	18	0.295	45,000	1.36	0.068	225.2	5/26/2245
10714+75	1,058	18	0.295	45,000	2.55	0.068	225.2	5/26/2245
11095+12	1,192	18	0.305	45,000	1.36	0.076	225.2	5/26/2245
10088+32	1,045	18	0.295	45,000	1.25	0.089	225.2	5/26/2245
10556+66	1,009	18	0.305	45,000	3.14	0.063	225.2	5/26/2245
10585+57	1,051	18	0.305	45,000	1.25	0.076	225.2	5/26/2245
10436+13	940	18	0.295	45,000	1.36	0.074	225.2	5/26/2245
10074+83	1,101	18	0.305	45,000	1.25	0.063	225.2	5/26/2245
10401+50	981	18	0.305	45,000	2.43	0.063	225.2	5/26/2245
11346+80	1,473	18	0.295	45,000	1.25	0.074	225.2	5/26/2245
10751+69	1,101	18	0.295	45,000	1.13	0.074	225.2	5/26/2245
10765+29	1,141	18	0.305	45,000	2.07	0.063	225.2	5/26/2245
11012+28	1,280	18	0.305	45,000	1.36	0.063	225.2	5/26/2245
11012+42	1,280	18	0.305	45,000	1.48	0.063	225.2	5/26/2245
10158+68	1,049	18	0.295	45,000	1.72	0.074	225.2	5/26/2245
10724+36	1,039	18	0.295	45,000	1.36	0.068	225.2	5/26/2245
10742+09	1,050	18	0.295	45,000	1.13	0.074	225.2	5/26/2245
10075+36	1,100	18	0.285	45,000	1.13	0.062	225.2	5/26/2245
10115+50	1,052	18	0.285	45,000	1.72	0.076	225.2	5/26/2245
10251+57	966	18	0.295	45,000	2.31	0.063	225.2	5/26/2245
10527+66	900	18	0.305	45,000	1.13	0.063	225.2	5/26/2245
11337+13	1,466	18	0.295	45,000	1.13	0.074	225.2	5/26/2245
11337+99	1,464	18	0.295	45,000	1.25	0.063	225.2	5/26/2245
10519+29	924	18	0.295	45,000	1.25	0.083	225.2	5/26/2245
11247+72	1,262	18	0.295	45,000	1.36	0.063	225.2	5/26/2245
10749+17	1,094	18	0.295	45,000	2.07	0.063	225.2	5/26/2245
11120+96	1,231	18	0.305	45,000	1.84	0.070	225.2	5/26/2245
11120+99	1,231	18	0.305	45,000	2.31	0.070	225.2	5/26/2245
10445+98	906	18	0.295	45,000	1.25	0.063	225.2	5/26/2245
10859+14	1,202	18	0.305	45,000	1.13	0.063	225.2	5/26/2245
10309+62	1,080	18	0.354	45,000	2.19	0.107	225.2	5/26/2245
11018+39	1,284	18	0.305	45,000	1.36	0.070	225.2	5/26/2245
10511+40	927	18	0.305	45,000	3.61	0.063	225.2	5/26/2245
11067+96	1,285	18	0.295	45,000	1.84	0.063	225.2	5/26/2245
10445+83	907	18	0.295	45,000	2.43	0.063	225.2	5/26/2245
10808+68	1,126	18	0.305	45,000	5.14	0.063	225.2	5/26/2245
10786+78	1,132	18	0.285	45,000	1.13	0.062	225.2	5/26/2245
11156+47	1,267	18	0.295	45,000	1.48	0.074	225.2	5/26/2245
10873+50	1,213	18	0.305	45,000	1.25	0.063	225.2	5/26/2245
10704+32	1,046	18	0.295	45,000	1.48	0.095	225.2	5/26/2245
10998+00	1,254	18	0.285	45,000	1.25	0.062	225.2	5/26/2245
10823+56	1,127	18	0.295	45,000	1.13	0.074	225.2	5/26/2245
10823+57	1,127	18	0.295	45,000	1.13	0.089	225.2	5/26/2245
10420+32	947	18	0.295	45,000	1.72	0.074	225.2	5/26/2245
10441+75	916	18	0.295	45,000	2.31	0.068	225.2	5/26/2245
11051+75	1,200	18	0.305	45,000	1.95	0.063	225.2	5/26/2245

Table D-7 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Eckert to Cedar Valley – ILI Date March 2, 2020 (pg. 8 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
10649+77	1,057	18	0.295	45,000	1.95	0.063	225.2	5/26/2245
11012+36	1,280	18	0.305	45,000	1.36	0.063	225.2	5/26/2245
11225+97	1,305	18	0.295	45,000	1.60	0.068	225.2	5/26/2245
11314+16	1,371	18	0.305	45,000	1.25	0.076	225.2	5/26/2245
10724+35	1,039	18	0.295	45,000	1.25	0.063	225.2	5/26/2245
10873+86	1,213	18	0.305	45,000	1.36	0.082	225.2	5/26/2245
11510+12	1,588	18	0.305	45,000	1.25	0.070	225.2	5/26/2245
10830+35	1,143	18	0.295	45,000	2.66	0.063	225.2	5/26/2245
10521+48	917	18	0.305	45,000	2.43	0.063	225.2	5/26/2245
11271+18	1,328	18	0.305	45,000	1.36	0.070	225.2	5/26/2245
10556+65	1,009	18	0.305	45,000	3.02	0.070	225.2	5/26/2245
10074+76	1,101	18	0.305	45,000	2.19	0.076	225.2	5/26/2245
10224+97	982	18	0.295	45,000	2.90	0.074	225.2	5/26/2245
10225+78	985	18	0.295	45,000	3.84	0.068	225.2	5/26/2245
10364+79	992	18	0.354	45,000	2.55	0.121	225.2	5/26/2245
11222+52	1,323	18	0.295	45,000	1.13	0.083	225.2	5/26/2245
10975+44	1,241	18	0.295	45,000	1.25	0.063	225.2	5/26/2245
10553+05	992	18	0.305	45,000	2.43	0.063	225.2	5/26/2245
10117+48	1,062	18	0.285	45,000	2.78	0.062	225.2	5/26/2245
10257+21	994	18	0.295	45,000	2.78	0.074	225.2	5/26/2245
10257+23	994	18	0.295	45,000	1.72	0.089	225.2	5/26/2245

Table D-8. Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Cedar Valley to Bastrop – ILI Date January 16, 2020 (pg. 1 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
7833+09	411	18	0.256	45,000	7.40	0.074	34.5	7/14/2054
8607+90	543	18	0.295	45,000	7.99	0.095	37.6	8/9/2057
7513+36	295	18	0.266	45,000	5.74	0.076	38.4	5/29/2058
8272+15	401	18	0.256	45,000	4.44	0.082	40.0	1/26/2060
7499+19	293	18	0.266	45,000	5.03	0.076	41.0	1/5/2061
8271+76	403	18	0.256	45,000	8.82	0.069	41.7	9/13/2061
7798+07	403	18	0.256	45,000	5.50	0.074	41.9	12/20/2061
8066+14	431	18	0.256	45,000	3.97	0.082	44.0	2/1/2064
7739+65	357	18	0.256	45,000	6.57	0.069	44.3	4/18/2064
7968+24	415	18	0.256	45,000	6.92	0.069	48.3	4/28/2068
7786+37	402	18	0.256	45,000	4.09	0.074	50.7	9/21/2070
8761+75	574	18	0.295	45,000	4.20	0.095	52.7	10/11/2072
8487+29	450	18	0.285	45,000	7.04	0.082	55.5	7/10/2075
8698+84	464	18	0.295	45,000	3.02	0.107	55.8	10/31/2075
7524+00	301	18	0.246	45,000	2.43	0.068	56.6	8/24/2076
8473+91	477	18	0.295	45,000	9.88	0.083	56.6	9/8/2076
7853+38	402	18	0.256	45,000	7.99	0.062	58.0	1/18/2078
8031+80	405	18	0.256	45,000	3.85	0.074	58.6	8/9/2078
7646+55	338	18	0.256	45,000	3.61	0.069	58.7	9/13/2078
8066+02	431	18	0.256	45,000	3.85	0.074	59.1	2/23/2079

Table D-8 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Cedar Valley to Bastrop – ILI Date January 16, 2020 (pg. 2 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
7523+78	301	18	0.246	45,000	2.55	0.063	63.6	8/8/2083
7897+02	435	18	0.266	45,000	6.21	0.068	66.9	11/22/2086
8053+41	424	18	0.256	45,000	4.09	0.069	67.4	5/30/2087
8937+33	680	18	0.295	45,000	5.62	0.074	69.3	4/24/2089
8223+31	507	18	0.246	45,000	3.49	0.063	73.8	11/9/2093
7853+37	402	18	0.256	45,000	2.43	0.074	77.0	1/5/2097
7990+77	395	18	0.256	45,000	4.68	0.062	79.3	5/8/2099
8194+18	456	18	0.266	45,000	2.67	0.081	80.2	3/11/2100
8843+36	574	18	0.295	45,000	2.07	0.101	80.2	4/9/2100
8828+83	577	18	0.295	45,000	14.97	0.063	82.6	8/15/2102
8669+22	449	18	0.295	45,000	6.33	0.074	83.6	8/16/2103
8239+18	497	18	0.256	45,000	4.32	0.062	85.1	2/13/2105
8787+38	566	18	0.295	45,000	4.91	0.074	85.2	4/5/2105
8843+56	575	18	0.295	45,000	2.31	0.089	91.6	8/23/2111
8753+37	570	18	0.295	45,000	4.32	0.074	93.9	12/27/2113
8200+37	483	18	0.266	45,000	3.61	0.068	94.5	7/11/2114
8761+23	573	18	0.295	45,000	2.90	0.083	94.8	10/27/2114
8813+53	542	18	0.285	45,000	5.74	0.062	95.3	4/29/2115
8843+70	576	18	0.295	45,000	2.55	0.083	96.2	3/31/2116
8807+11	544	18	0.285	45,000	5.62	0.062	96.7	9/24/2116
8798+28	547	18	0.295	45,000	5.27	0.068	98.3	5/8/2118
8258+50	430	18	0.256	45,000	1.96	0.074	98.6	8/6/2118
8803+37	545	18	0.295	45,000	3.38	0.074	102.6	8/23/2122
8434+39	471	18	0.295	45,000	9.88	0.068	102.6	9/2/2122
7647+33	339	18	0.256	45,000	2.07	0.062	103.3	4/18/2123
8685+49	446	18	0.295	45,000	2.78	0.083	103.5	8/02/2123
8886+54	609	18	0.295	45,000	1.25	0.116	103.8	10/28/2123
8456+55	453	18	0.295	45,000	8.46	0.068	106.6	8/31/2126
7540+25	306	18	0.246	45,000	1.25	0.063	107.8	11/3/2127
9199+29	812	18	0.354	65,000	3.38	0.096	109.4	6/5/2129
8258+49	430	18	0.256	45,000	1.96	0.069	111.4	6/1/2131
8487+18	449	18	0.285	45,000	1.60	0.102	111.6	8/15/2131
8151+95	480	18	0.266	45,000	2.67	0.068	113.8	11/1/2133
8687+17	447	18	0.295	45,000	4.56	0.068	114.7	10/3/2134
9171+04	812	18	0.374	65,000	5.03	0.096	116.3	5/6/2136
8027+52	397	18	0.266	45,000	3.14	0.063	116.4	6/20/2136
8099+49	467	18	0.256	45,000	1.60	0.074	117.2	3/23/2137
7816+52	401	18	0.256	45,000	1.60	0.069	117.9	12/16/2137
8484+09	455	18	0.295	45,000	6.10	0.068	118.0	1/1/2138
8487+19	449	18	0.285	45,000	4.20	0.067	118.6	9/4/2138
8473+51	478	18	0.305	45,000	7.99	0.070	120.9	12/19/2140
8194+37	454	18	0.266	45,000	1.84	0.076	122.2	3/21/2142
8293+91	386	18	0.256	45,000	2.19	0.062	122.3	5/11/2142
8285+44	391	18	0.256	45,000	2.19	0.062	122.6	8/31/2142
8726+20	519	18	0.295	45,000	5.15	0.063	124.1	2/22/2144
8242+51	463	18	0.256	45,000	1.25	0.082	124.7	9/29/2144
8194+47	453	18	0.266	45,000	2.31	0.068	124.9	12/16/2144

Table D-8 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Cedar Valley to Bastrop – ILI Date January 16, 2020 (pg. 3 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
8502+42	474	18	0.305	45,000	3.38	0.082	126.5	7/10/2146
8681+32	446	18	0.295	45,000	5.27	0.063	127.1	3/3/2147
7918+48	432	18	0.256	45,000	1.96	0.062	127.3	5/12/2147
8194+17	457	18	0.266	45,000	1.72	0.076	129.1	2/22/2149
8581+47	484	18	0.295	45,000	3.14	0.074	129.1	2/26/2149
8880+88	613	18	0.295	45,000	1.48	0.089	129.6	8/20/2149
8214+87	500	18	0.266	45,000	2.67	0.063	130.9	12/21/2150
8699+48	466	18	0.295	45,000	4.56	0.063	132.4	6/22/2152
8246+27	456	18	0.256	45,000	1.37	0.074	133.2	4/13/2153
8737+50	554	18	0.295	45,000	3.14	0.068	133.5	6/30/2153
8246+24	456	18	0.256	45,000	1.96	0.062	133.6	8/27/2153
8272+95	401	18	0.256	45,000	1.13	0.082	136.2	3/22/2156
8761+75	574	18	0.295	45,000	2.31	0.074	136.4	6/7/2156
8839+52	570	18	0.295	45,000	3.14	0.063	138.4	6/2/2158
8251+28	452	18	0.256	45,000	1.48	0.069	138.5	8/1/2158
8246+06	456	18	0.256	45,000	1.48	0.069	138.7	9/18/2158
8843+45	574	18	0.295	45,000	1.60	0.083	138.9	11/23/2158
7905+38	435	18	0.256	45,000	1.37	0.069	139.8	10/31/2159
7791+91	403	18	0.256	45,000	1.25	0.069	141.7	9/25/2161
8292+11	387	18	0.256	45,000	1.25	0.074	142.3	4/27/2162
9171+05	812	18	0.374	65,000	3.61	0.096	142.4	6/13/2162
8704+02	469	18	0.295	45,000	2.90	0.068	142.7	10/4/2162
8880+90	613	18	0.295	45,000	2.19	0.068	143.9	12/20/2163
8503+22	475	18	0.305	45,000	4.68	0.070	145.5	7/26/2165
8487+18	449	18	0.285	45,000	3.61	0.062	148.1	3/09/2168
8843+39	574	18	0.295	45,000	2.67	0.063	149.9	12/12/2169
8496+64	468	18	0.295	45,000	3.49	0.068	150.3	5/10/2170
8713+33	499	18	0.295	45,000	3.26	0.063	152.3	4/22/2172
8678+18	447	18	0.295	45,000	3.38	0.063	153.5	8/2/2173
8296+78	386	18	0.256	45,000	1.25	0.069	156.6	8/5/2176
8843+67	575	18	0.295	45,000	2.43	0.063	157.7	10/1/2177
7843+26	402	18	0.256	45,000	1.13	0.069	158.9	12/3/2178
8441+24	464	18	0.295	45,000	3.26	0.068	160.5	7/13/2180
8607+96	543	18	0.295	45,000	1.37	0.095	161.8	10/24/2181
8678+02	447	18	0.295	45,000	1.96	0.074	162.8	11/8/2182
8843+69	576	18	0.295	45,000	1.60	0.074	163.3	5/2/2183
8443+43	461	18	0.295	45,000	4.09	0.063	165.4	6/19/2185
8441+24	464	18	0.295	45,000	4.09	0.063	165.7	9/16/2185
8947+09	690	18	0.295	45,000	1.60	0.068	165.8	11/2/2185
7977+34	391	18	0.256	45,000	1.13	0.069	168.0	1/31/2188
8575+84	477	18	0.295	45,000	2.55	0.068	170.3	5/13/2190
8681+91	446	18	0.295	45,000	2.67	0.063	172.5	7/20/2192
8475+50	476	18	0.295	45,000	1.48	0.089	179.1	2/23/2199
8113+81	476	18	0.266	45,000	1.60	0.063	181.0	1/23/2201
8491+09	455	18	0.305	45,000	4.56	0.063	181.7	9/30/2201
8588+93	489	18	0.295	45,000	1.84	0.074	183.3	5/4/2203
8194+19	456	18	0.266	45,000	1.13	0.076	185.1	2/17/2205

Table D-8 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Cedar Valley to Bastrop – ILI Date January 16, 2020 (pg. 4 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
8658+24	445	18	0.295	45,000	1.37	0.083	186.0	1/17/2206
8744+68	569	18	0.295	45,000	1.48	0.074	190.5	7/22/2210
8027+55	397	18	0.266	45,000	1.25	0.068	191.8	11/5/2211
7980+87	391	18	0.256	45,000	1.13	0.062	192.5	7/17/2212
8608+93	535	18	0.295	45,000	2.43	0.063	194.0	1/7/2214
8468+02	473	18	0.295	45,000	2.19	0.068	199.8	10/24/2219
8765+40	564	18	0.295	45,000	1.84	0.063	199.9	12/2/2219
8194+26	455	18	0.266	45,000	1.37	0.063	202.1	2/9/2222
8537+87	552	18	0.295	45,000	1.25	0.089	202.8	11/15/2222
8606+44	550	18	0.305	45,000	2.19	0.070	206.2	4/15/2226
7806+88	404	18	0.266	45,000	1.13	0.063	208.9	12/11/2228
8788+99	565	18	0.295	45,000	1.25	0.074	209.0	1/12/2229
8027+59	397	18	0.266	45,000	1.25	0.063	211.5	7/17/2231
8194+20	456	18	0.266	45,000	1.13	0.068	213.1	2/14/2233
8581+47	484	18	0.295	45,000	1.25	0.083	214.6	8/12/2234
8940+10	693	18	0.295	45,000	1.13	0.068	216.5	7/27/2236
8843+63	575	18	0.295	45,000	1.25	0.068	219.3	4/20/2239
8843+37	574	18	0.295	45,000	1.25	0.068	219.4	5/29/2239
8752+28	571	18	0.295	45,000	1.25	0.063	225.2	4/9/2245
8650+22	444	18	0.295	45,000	1.25	0.063	225.2	4/9/2245
8660+16	424	18	0.354	65,000	1.96	0.068	225.2	4/9/2245
8660+16	424	18	0.354	65,000	1.13	0.061	225.2	4/9/2245
9067+64	724	18	0.354	65,000	1.13	0.075	225.2	4/9/2245
9167+84	815	18	0.374	65,000	3.02	0.062	225.2	4/9/2245
8678+01	447	18	0.295	45,000	1.13	0.074	225.2	4/9/2245
8683+76	446	18	0.295	45,000	1.60	0.063	225.2	4/9/2245
8606+44	550	18	0.305	45,000	1.96	0.063	225.2	4/9/2245
8619+12	495	18	0.295	45,000	1.25	0.068	225.2	4/9/2245
8363+31	432	18	0.295	45,000	1.25	0.074	225.2	4/9/2245
8770+11	555	18	0.305	45,000	1.13	0.063	225.2	4/9/2245
8585+10	486	18	0.295	45,000	1.37	0.068	225.2	4/9/2245
8659+49	422	18	0.354	65,000	1.13	0.075	225.2	4/9/2245
8659+54	422	18	0.354	65,000	1.25	0.089	225.2	4/9/2245
8671+60	449	18	0.295	45,000	1.60	0.063	225.2	4/9/2245
8588+93	489	18	0.295	45,000	1.60	0.063	225.2	4/9/2245

Table D-9. Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Bastrop to Warda – ILI Date January 27, 2020 (pg. 1 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
6835+22	244	18	0.256	45,000	4.44	0.082	15.4	5/12/2054
7471+93	294	18	0.266	45,000	2.79	0.076	17.6	3/20/2059
7125+72	250	18	0.256	65,000	2.90	0.082	18.9	2/2/2062
7365+39	307	18	0.256	45,000	2.31	0.074	19.5	6/20/2063
7145+34	259	18	0.256	65,000	4.68	0.069	20.0	6/18/2064
7194+49	258	18	0.256	45,000	3.14	0.069	21.6	12/1/2067

Table D-9 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Bastrop to Warda – ILI Date January 27, 2020 (pg. 2 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
6812+08	243	18	0.256	45,000	4.21	0.074	22.1	3/7/2069
6445+54	268	18	0.246	45,000	4.21	0.075	22.4	10/5/2069
6973+04	251	18	0.256	45,000	4.21	0.069	22.5	1/19/2070
7418+82	322	18	0.246	45,000	1.60	0.068	23.1	6/5/2071
7331+25	284	18	0.256	45,000	3.14	0.062	23.3	10/10/2071
7354+10	292	18	0.285	45,000	2.67	0.087	23.4	2/13/2072
7351+19	303	18	0.256	45,000	1.84	0.074	23.9	2/13/2073
7366+36	307	18	0.256	45,000	2.79	0.062	24.1	7/31/2073
7365+37	307	18	0.256	45,000	2.08	0.069	24.2	9/7/2073
6246+87	302	18	0.256	45,000	6.69	0.074	24.2	9/15/2073
7468+31	323	18	0.266	45,000	1.60	0.081	25.0	9/5/2075
6653+39	224	18	0.256	45,000	4.32	0.074	25.1	10/31/2075
6578+83	373	18	0.256	45,000	9.89	0.062	25.5	10/9/2076
6413+88	251	18	0.256	45,000	7.28	0.069	25.6	12/5/2076
7479+43	306	18	0.266	45,000	2.19	0.068	25.8	5/8/2077
7353+49	296	18	0.256	45,000	2.55	0.062	25.8	5/9/2077
7078+67	272	18	0.256	45,000	2.90	0.069	25.8	6/15/2077
7417+96	323	18	0.266	45,000	1.84	0.076	26.1	1/30/2078
6078+41	305	18	0.256	45,000	4.21	0.082	27.8	11/1/2081
6720+52	327	18	0.256	45,000	3.50	0.074	27.9	1/9/2082
7478+84	308	18	0.266	45,000	1.96	0.068	27.9	1/14/2082
7471+94	293	18	0.266	45,000	1.96	0.068	28.1	5/28/2082
6449+16	260	18	0.246	45,000	2.43	0.083	28.2	9/18/2082
6418+40	260	18	0.256	45,000	4.80	0.074	28.3	12/27/2082
6438+09	267	18	0.256	45,000	2.55	0.090	29.0	5/28/2084
7331+08	283	18	0.256	45,000	2.19	0.062	29.1	8/10/2084
6488+48	234	18	0.256	45,000	2.43	0.090	29.2	10/21/2084
6147+08	311	18	0.256	45,000	5.63	0.074	29.4	4/11/2085
6414+66	254	18	0.256	45,000	6.10	0.069	29.4	4/29/2085
6321+82	226	18	0.256	45,000	4.80	0.074	30.1	11/7/2086
6578+85	373	18	0.256	45,000	4.92	0.069	30.3	4/6/2087
6059+29	300	18	0.256	45,000	2.55	0.095	30.8	7/19/2088
6306+14	237	18	0.256	45,000	2.55	0.090	31.5	1/17/2090
6435+88	265	18	0.256	45,000	2.31	0.090	32.1	4/27/2091
6246+48	301	18	0.256	45,000	4.68	0.074	32.2	8/19/2091
6411+45	257	18	0.266	45,000	2.19	0.103	32.5	4/19/2092
6329+19	223	18	0.256	45,000	2.43	0.090	32.6	5/16/2092
6812+10	243	18	0.256	45,000	1.48	0.095	33.3	12/1/2093
6403+08	273	18	0.256	45,000	5.15	0.069	33.3	1/7/2094
6535+13	313	18	0.256	45,000	2.08	0.090	33.3	2/8/2094
7145+26	259	18	0.256	65,000	2.08	0.069	33.6	10/5/2094
6953+86	247	18	0.256	45,000	1.96	0.074	34.5	8/23/2096
7476+53	312	18	0.266	45,000	1.72	0.063	34.6	10/14/2096
6713+44	273	18	0.256	45,000	2.55	0.074	35.5	10/24/2098
6584+17	352	18	0.266	45,000	2.43	0.089	35.5	12/8/2098
5983+69	231	18	0.256	45,000	3.14	0.082	36.3	10/8/2100
6093+93	277	18	0.256	45,000	2.43	0.090	36.6	5/21/2101

Table D-9 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Bastrop to Warda – ILI Date January 27, 2020 (pg. 3 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
6418+05	259	18	0.256	45,000	4.32	0.069	36.8	9/5/2101
6713+49	274	18	0.256	45,000	2.43	0.074	36.9	12/6/2101
7211+28	250	18	0.256	45,000	1.84	0.062	37.1	5/10/2102
6458+08	255	18	0.266	45,000	2.55	0.089	37.2	7/26/2102
7228+92	257	18	0.256	45,000	1.37	0.069	38.6	11/13/2105
6450+54	258	18	0.266	45,000	3.73	0.076	39.4	6/13/2107
6310+59	241	18	0.256	45,000	4.21	0.069	39.9	9/11/2108
7192+06	260	18	0.256	45,000	1.37	0.069	40.3	6/10/2109
6577+75	372	18	0.256	45,000	2.55	0.074	40.5	1/21/2110
6331+03	228	18	0.256	45,000	1.96	0.090	40.6	4/22/2110
6281+64	226	18	0.256	45,000	1.96	0.090	41.9	1/30/2113
6410+23	259	18	0.256	45,000	2.79	0.074	42.4	4/11/2114
6147+03	311	18	0.256	45,000	4.32	0.069	43.0	6/10/2115
5971+32	259	18	0.256	45,000	4.56	0.069	43.0	7/10/2115
6285+23	237	18	0.256	45,000	2.31	0.082	43.2	12/2/2115
6432+81	266	18	0.256	45,000	3.26	0.069	43.6	10/19/2116
6363+67	270	18	0.256	45,000	3.50	0.069	43.7	1/11/2117
6261+90	253	18	0.256	45,000	1.72	0.095	43.7	3/12/2117
6577+75	372	18	0.256	45,000	2.31	0.074	43.8	5/19/2117
6259+74	258	18	0.256	45,000	3.02	0.074	43.8	6/1/2117
6567+25	349	18	0.256	45,000	1.84	0.082	44.1	1/14/2118
6593+85	348	18	0.256	45,000	2.19	0.074	45.0	12/15/2119
6578+85	373	18	0.256	45,000	2.67	0.069	45.1	3/18/2120
7149+29	256	18	0.256	65,000	1.72	0.062	45.2	7/1/2120
6193+80	322	18	0.256	45,000	2.31	0.082	45.6	5/25/2121
6236+79	308	18	0.256	45,000	2.90	0.074	46.0	3/6/2122
6608+94	394	18	0.256	45,000	2.08	0.074	46.6	8/11/2123
6535+12	313	18	0.256	45,000	2.19	0.074	47.1	7/18/2124
6720+71	328	18	0.256	45,000	1.48	0.082	47.1	9/12/2124
6288+74	242	18	0.256	45,000	2.67	0.074	47.3	3/3/2125
6277+88	226	18	0.256	45,000	1.72	0.090	48.0	7/14/2126
6835+23	244	18	0.256	45,000	1.72	0.069	48.6	11/18/2127
6425+10	269	18	0.256	45,000	4.09	0.062	48.7	2/6/2128
6578+86	373	18	0.256	45,000	3.26	0.062	49.4	9/28/2129
6307+21	239	18	0.256	45,000	4.56	0.062	49.5	1/9/2130
6563+30	349	18	0.256	45,000	3.26	0.062	49.9	10/29/2130
6966+18	246	18	0.256	45,000	1.37	0.069	51.0	5/16/2133
7405+31	323	18	0.266	45,000	1.13	0.063	51.1	7/3/2133
7126+68	253	18	0.256	65,000	1.48	0.062	51.4	2/11/2134
6833+96	242	18	0.256	45,000	1.37	0.074	52.6	11/19/2136
6424+32	270	18	0.256	45,000	2.08	0.074	53.2	1/26/2138
6617+13	310	18	0.256	45,000	1.72	0.074	53.5	10/22/2138
6263+01	258	18	0.256	45,000	2.31	0.074	53.9	10/12/2139
6586+78	340	18	0.256	45,000	1.25	0.090	54.2	5/8/2140
6835+23	244	18	0.256	45,000	1.13	0.082	54.3	8/22/2140
6186+35	331	18	0.266	45,000	4.44	0.068	54.3	9/3/2140
6481+22	233	18	0.256	45,000	3.02	0.062	54.9	1/22/2142

Table D-9 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Bastrop to Warda – ILI Date January 27, 2020 (pg. 4 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
6886+45	286	18	0.256	45,000	1.37	0.069	55.6	7/2/2143
6031+11	279	18	0.256	45,000	1.96	0.082	55.7	9/28/2143
6231+26	293	18	0.256	45,000	2.19	0.074	57.5	9/26/2147
6463+80	253	18	0.256	45,000	1.48	0.082	58.0	11/26/2148
6439+91	269	18	0.256	45,000	1.84	0.074	58.1	12/15/2148
6299+99	243	18	0.256	45,000	2.43	0.069	58.1	2/10/2149
6409+63	260	18	0.266	45,000	2.08	0.076	62.9	10/8/2159
6412+34	255	18	0.256	45,000	1.96	0.069	63.5	12/21/2160
6748+88	303	18	0.256	45,000	1.60	0.062	66.3	3/25/2167
6268+05	227	18	0.256	45,000	2.08	0.069	66.3	4/3/2167
6125+24	310	18	0.256	45,000	2.19	0.069	68.6	5/31/2172
6571+15	342	18	0.256	45,000	1.48	0.069	70.6	9/13/2176
6690+39	233	18	0.266	45,000	1.96	0.063	71.3	5/6/2178
6267+97	228	18	0.256	45,000	1.60	0.074	72.5	12/29/2180
6268+68	215	18	0.256	45,000	1.84	0.069	72.5	2/18/2181
6821+47	243	18	0.256	45,000	1.25	0.062	73.5	4/16/2183
5970+89	258	18	0.256	45,000	1.72	0.074	75.4	7/6/2187
6301+30	240	18	0.256	45,000	2.08	0.062	78.3	12/6/2193
6102+74	269	18	0.256	45,000	1.84	0.069	78.5	5/10/2194
6094+83	277	18	0.256	45,000	1.60	0.074	78.5	5/11/2194
6678+76	228	18	0.256	45,000	1.13	0.069	79.4	5/11/2196
6809+32	243	18	0.256	45,000	1.13	0.062	80.6	12/24/2198
6199+59	312	18	0.256	45,000	1.25	0.082	80.7	3/12/2199
6125+59	310	18	0.256	45,000	1.48	0.074	83.3	12/17/2204
6298+32	244	18	0.256	45,000	1.13	0.082	84.1	11/17/2206
6414+90	255	18	0.256	45,000	1.60	0.062	87.2	8/22/2213
6069+92	309	18	0.256	45,000	2.08	0.062	87.3	10/29/2213
6006+53	251	18	0.256	45,000	2.08	0.062	87.8	12/19/2214
6694+95	237	18	0.266	45,000	1.25	0.068	88.4	6/2/2216
6580+61	369	18	0.256	45,000	1.25	0.062	93.0	7/30/2226
6233+02	301	18	0.256	45,000	1.37	0.069	94.2	2/9/2229
5973+04	255	18	0.256	45,000	1.13	0.082	94.3	6/28/2229
6135+25	278	18	0.256	45,000	1.25	0.074	95.9	1/7/2233
6305+25	239	18	0.256	45,000	1.25	0.069	97.0	7/11/2235
6414+67	254	18	0.256	45,000	1.37	0.062	97.6	9/29/2236
6186+38	331	18	0.266	45,000	1.25	0.081	100.8	11/1/2243
5988+07	213	18	0.266	45,000	1.72	0.068	104.6	3/25/2252
6404+95	271	18	0.256	45,000	1.13	0.062	114.1	6/23/2273
6002+92	237	18	0.256	45,000	1.13	0.069	118.6	6/16/2283
5982+61	225	18	0.256	45,000	1.13	0.069	118.8	10/14/2283
6132+90	284	18	0.266	45,000	1.13	0.063	155.2	7/25/2364
7108+88	244	18	0.364	45,000	1.48	0.083	174.7	1/3/2408

Table D-10. Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Warda to Buckhorn – ILI Date November 7, 2019 (pg. 1 of 3)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
5844+01	331	18	0.276	45,000	4.67	0.083	21.2	1/10/2041
5018+76	431	18	0.276	45,000	4.31	0.108	26.7	7/9/2046
4464+86	335	18	0.276	45,000	6.32	0.108	28.2	1/24/2048
5776+42	374	18	0.276	45,000	2.07	0.102	29.3	2/14/2049
5472+17	481	18	0.276	45,000	3.60	0.094	29.6	6/21/2049
5461+55	451	18	0.276	45,000	5.61	0.083	29.7	7/13/2049
5668+47	413	18	0.276	45,000	2.66	0.094	30.7	7/21/2050
5874+66	308	18	0.276	45,000	2.66	0.083	31.1	12/24/2050
5080+54	397	18	0.276	45,000	3.49	0.108	31.4	4/16/2051
5307+23	448	18	0.276	45,000	5.14	0.088	31.6	6/12/2051
5776+42	374	18	0.276	45,000	1.83	0.102	33.3	2/16/2053
5781+10	373	18	0.276	45,000	2.42	0.088	33.6	6/21/2053
5401+22	494	18	0.276	45,000	4.19	0.088	33.9	9/13/2053
5781+13	373	18	0.276	45,000	4.78	0.069	35.8	8/11/2055
5566+17	524	18	0.276	45,000	3.13	0.088	36.2	1/23/2056
5881+58	326	18	0.276	45,000	1.83	0.088	38.3	2/20/2058
5952+41	343	18	0.276	45,000	2.90	0.069	38.7	8/6/2058
4938+66	436	18	0.276	45,000	5.02	0.094	39.3	3/13/2059
5894+47	320	18	0.276	45,000	3.01	0.069	40.3	2/8/2060
5484+39	501	18	0.276	45,000	3.01	0.088	40.5	5/20/2060
5901+47	305	18	0.276	45,000	2.31	0.075	40.8	9/1/2060
5893+29	321	18	0.276	45,000	3.72	0.064	41.5	5/6/2061
5883+73	328	18	0.276	45,000	2.66	0.069	44.1	12/4/2063
5258+91	392	18	0.276	45,000	2.90	0.094	44.8	8/8/2064
5822+06	371	18	0.276	45,000	2.31	0.075	45.1	12/10/2064
5605+17	479	18	0.276	45,000	3.25	0.075	46.7	8/7/2066
5748+89	369	18	0.276	45,000	1.13	0.116	47.5	5/7/2067
4970+51	378	18	0.276	45,000	4.55	0.088	49.2	1/27/2069
4913+29	380	18	0.276	45,000	6.08	0.083	50.7	7/16/2070
5671+85	414	18	0.276	45,000	2.31	0.075	53.8	8/27/2073
5799+32	371	18	0.276	45,000	2.66	0.064	55.7	8/6/2075
4920+84	386	18	0.276	45,000	1.95	0.122	55.8	8/22/2075
4997+35	404	18	0.276	45,000	4.55	0.083	56.4	4/7/2076
5825+43	371	18	0.276	45,000	1.95	0.069	58.3	2/14/2078
4980+64	399	18	0.276	45,000	2.90	0.094	60.8	8/27/2080
4496+72	367	18	0.276	45,000	6.08	0.088	62.5	4/23/2082
4975+29	390	18	0.276	45,000	2.19	0.102	67.6	6/28/2087
5781+14	373	18	0.276	45,000	1.95	0.064	68.8	8/7/2088
5749+69	362	18	0.276	45,000	1.24	0.083	69.6	6/10/2089
5341+46	442	18	0.276	45,000	3.49	0.069	70.6	5/27/2090
4502+47	343	18	0.276	45,000	19.41	0.069	72.0	10/23/2091
5141+78	395	18	0.276	45,000	5.02	0.069	72.1	11/29/2091
4883+39	347	18	0.276	45,000	2.66	0.094	72.7	7/5/2092
5757+09	352	18	0.276	45,000	1.83	0.064	73.3	3/12/2093
3618+43	173	18	0.276	45,000	3.72	0.094	73.7	7/8/2093
3680+61	175	18	0.276	45,000	5.85	0.083	77.9	9/13/2097
5566+95	522	18	0.276	45,000	2.07	0.069	78.9	10/8/2098

Table D-10 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Warda to Buckhorn – ILI Date November 7, 2019 (pg. 2 of 3)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
5307+79	446	18	0.276	45,000	3.96	0.064	80.1	12/13/2099
5707+85	394	18	0.276	45,000	1.72	0.064	81.3	2/27/2101
4580+52	340	18	0.276	45,000	3.84	0.088	82.3	3/4/2102
5662+83	399	18	0.276	45,000	1.72	0.064	85.6	7/1/2105
5335+20	457	18	0.276	45,000	2.07	0.075	86.7	7/10/2106
5165+83	375	18	0.276	45,000	2.54	0.075	88.1	12/25/2107
4426+77	287	18	0.276	45,000	8.09	0.075	89.8	8/18/2109
5625+88	435	18	0.276	45,000	1.24	0.075	93.0	11/3/2112
4584+22	323	18	0.276	45,000	2.31	0.102	93.4	3/28/2113
5460+05	447	18	0.276	45,000	2.19	0.064	93.6	5/29/2113
4970+57	378	18	0.276	45,000	2.31	0.083	97.1	12/13/2116
4935+93	421	18	0.276	45,000	2.42	0.083	97.9	9/24/2117
4981+51	396	18	0.276	45,000	2.90	0.075	98.5	5/18/2118
3875+95	262	18	0.276	45,000	3.96	0.088	98.9	9/22/2118
4912+43	380	18	0.276	45,000	3.13	0.075	100.4	3/25/2120
4579+80	341	18	0.276	45,000	5.14	0.075	102.2	1/5/2122
4177+99	212	18	0.276	45,000	12.81	0.069	103.0	11/2/2122
5419+55	479	18	0.276	45,000	1.48	0.075	103.1	12/12/2122
3625+65	165	18	0.276	45,000	1.95	0.108	104.0	11/18/2123
4849+11	354	18	0.276	45,000	3.25	0.075	104.2	1/17/2124
4848+46	353	18	0.276	45,000	2.31	0.083	110.0	10/27/2129
5358+36	473	18	0.276	45,000	1.72	0.069	111.0	10/28/2130
5547+87	490	18	0.276	45,000	1.13	0.075	112.5	5/21/2132
4430+69	304	18	0.276	45,000	5.26	0.075	112.8	9/12/2132
5371+83	485	18	0.276	45,000	1.60	0.069	115.8	9/2/2135
5367+04	474	18	0.276	45,000	1.36	0.075	117.0	11/2/2136
4502+43	343	18	0.276	45,000	10.92	0.064	118.4	4/18/2138
3971+26	267	18	0.276	45,000	3.72	0.083	123.7	7/7/2143
5165+62	375	18	0.276	45,000	2.31	0.064	123.7	8/1/2143
4518+26	364	18	0.276	45,000	9.15	0.064	125.7	7/20/2145
3625+61	165	18	0.276	45,000	3.84	0.075	125.8	8/17/2145
5202+50	340	18	0.276	45,000	1.48	0.075	126.8	8/21/2146
4965+07	400	18	0.276	45,000	3.25	0.064	127.3	3/13/2147
5556+04	521	18	0.276	45,000	1.24	0.064	127.7	7/13/2147
4911+17	380	18	0.276	45,000	2.78	0.069	127.7	7/28/2147
4846+61	347	18	0.276	45,000	3.49	0.064	137.9	9/15/2157
4288+24	208	18	0.276	45,000	2.54	0.088	140.8	8/8/2160
4503+39	341	18	0.276	45,000	3.25	0.075	143.5	5/23/2163
4311+63	251	18	0.276	45,000	3.84	0.075	144.7	7/6/2164
4846+52	347	18	0.276	45,000	3.01	0.064	149.1	12/1/2168
4705+84	268	18	0.276	45,000	1.83	0.083	152.6	6/14/2172
4328+40	273	18	0.276	45,000	3.37	0.075	156.2	1/17/2176
4139+84	291	18	0.276	45,000	2.42	0.083	174.3	2/12/2194
4418+06	310	18	0.276	45,000	2.66	0.075	174.7	7/12/2194
4288+25	208	18	0.276	45,000	2.90	0.075	175.3	2/8/2195
3655+52	160	18	0.276	45,000	3.84	0.064	180.5	4/21/2200
5141+68	395	18	0.276	45,000	1.36	0.064	180.9	10/1/2200

Table D-10 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Warda to Buckhorn – ILI Date November 7, 2019 (pg. 3 of 3)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
4341+50	283	18	0.276	45,000	3.01	0.069	197.4	3/18/2217
4609+61	363	18	0.276	45,000	1.24	0.094	199.6	6/21/2219
4589+30	299	18	0.276	45,000	1.24	0.094	201.7	7/22/2221
4541+60	329	18	0.276	45,000	2.90	0.064	202.6	6/12/2222
3988+90	293	18	0.276	45,000	2.54	0.075	203.8	9/6/2223
4353+02	312	18	0.276	45,000	1.13	0.088	225.2	1/29/2245
3709+78	183	18	0.276	45,000	2.19	0.064	225.2	1/29/2245
5062+57	379	18	0.276	45,000	1.13	0.064	225.2	1/29/2245
4349+95	313	18	0.276	45,000	1.24	0.069	225.2	1/29/2245
4694+95	312	18	0.276	45,000	1.13	0.064	225.2	1/29/2245
4494+61	371	18	0.276	45,000	1.13	0.064	225.2	1/29/2245
4543+55	332	18	0.276	45,000	1.95	0.069	225.2	1/29/2245
3625+65	165	18	0.276	45,000	1.13	0.083	225.2	1/29/2245
4609+60	363	18	0.276	45,000	1.83	0.069	225.2	1/29/2245
3889+84	287	18	0.276	45,000	1.36	0.083	225.2	1/29/2245
4473+98	363	18	0.276	45,000	1.72	0.064	225.2	1/29/2245
4143+80	288	18	0.276	45,000	1.24	0.069	225.2	1/29/2245
4064+66	280	18	0.276	45,000	1.60	0.075	225.2	1/29/2245

Table D-11. Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Buckhorn to Satsuma – ILI Date December 5, 2019 (pg. 1 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
3007+90	107	18	0.285	45,000	7.40	0.107	27.7	8/9/2047
3512+93	69	18	0.285	45,000	6.69	0.082	32.0	12/10/2051
3502+52	72	18	0.266	45,000	5.51	0.068	38.7	8/24/2058
3518+43	68	18	0.285	45,000	5.51	0.076	42.4	4/18/2062
3445+54	58	18	0.266	45,000	1.84	0.095	45.4	5/5/2065
3518+82	68	18	0.285	45,000	8.23	0.067	49.6	7/16/2069
3462+42	58	18	0.266	45,000	4.68	0.063	52.3	3/16/2072
3105+21	78	18	0.266	45,000	2.55	0.095	55.6	7/16/2075
3402+96	48	18	0.266	45,000	3.26	0.068	58.4	5/9/2078
3484+54	72	18	0.266	45,000	2.55	0.068	60.3	3/27/2080
3462+17	58	18	0.266	45,000	3.38	0.063	60.9	11/9/2080
3518+81	68	18	0.285	45,000	4.32	0.067	62.7	8/17/2082
2954+08	119	18	0.266	45,000	6.45	0.076	63.2	3/3/2083
3565+60	58	18	0.285	45,000	2.43	0.076	64.5	6/3/2084
2170+24	55	18	0.285	45,000	6.57	0.116	65.2	2/1/2085
3105+11	78	18	0.266	45,000	3.85	0.076	65.8	9/20/2085
1934+25	37	18	0.256	45,000	4.44	0.103	67.8	9/20/2087
3391+88	51	18	0.285	45,000	5.51	0.067	68.3	3/24/2088
3239+53	67	18	0.285	45,000	9.05	0.067	73.5	6/21/2093
2702+88	89	18	0.266	45,000	6.81	0.081	75.2	2/25/2095
3108+95	78	18	0.266	45,000	4.68	0.068	75.9	11/8/2095
3463+75	59	18	0.266	45,000	1.84	0.068	77.4	5/8/2097
3354+05	52	18	0.295	45,000	3.73	0.074	84.4	4/29/2104

Table D-11 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Buckhorn to Satsuma – ILI Date December 5, 2019 (pg. 2 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
3514+10	68	18	0.266	45,000	1.72	0.063	84.4	5/10/2104
3494+24	75	18	0.285	45,000	3.38	0.062	84.5	6/18/2104
3462+41	58	18	0.266	45,000	1.60	0.068	85.7	9/4/2105
2825+08	93	18	0.256	45,000	3.97	0.074	86.1	1/2/2106
3255+15	71	18	0.285	45,000	2.43	0.082	89.9	11/2/2109
2300+79	60	18	0.285	45,000	6.69	0.102	94.1	1/9/2114
2368+15	65	18	0.285	45,000	8.23	0.096	95.1	1/6/2115
3136+90	78	18	0.295	45,000	2.90	0.089	96.6	7/24/2116
3085+10	80	18	0.266	45,000	4.20	0.063	97.8	9/30/2117
3397+97	51	18	0.285	45,000	3.26	0.062	99.1	1/21/2119
3179+68	67	18	0.285	45,000	4.56	0.067	102.1	1/21/2122
3486+86	74	18	0.266	45,000	1.13	0.068	108.6	6/29/2128
3188+40	67	18	0.295	45,000	4.80	0.068	114.0	11/23/2133
3564+02	58	18	0.285	45,000	1.60	0.062	115.8	9/28/2135
2531+64	76	18	0.266	45,000	6.69	0.076	116.9	11/12/2136
2959+22	120	18	0.285	45,000	3.73	0.076	123.6	7/12/2143
2968+72	120	18	0.285	45,000	3.61	0.076	124.2	2/20/2144
2568+46	74	18	0.266	45,000	5.03	0.076	128.2	2/11/2148
3261+04	49	18	0.295	45,000	3.85	0.063	129.8	9/10/2149
2951+31	119	18	0.285	45,000	2.67	0.082	134.9	10/29/2154
3412+86	60	18	0.295	45,000	1.13	0.089	142.2	2/24/2162
2417+21	67	18	0.266	45,000	3.14	0.089	146.8	9/6/2166
3294+84	51	18	0.285	45,000	1.13	0.087	147.9	11/15/2167
2205+79	55	18	0.266	45,000	3.14	0.095	151.3	3/11/2171
2531+63	76	18	0.266	45,000	3.97	0.076	154.7	7/31/2174
2838+89	95	18	0.266	45,000	3.61	0.063	155.0	12/3/2174
2986+58	117	18	0.295	45,000	3.49	0.074	155.3	4/3/2175
2080+15	46	18	0.266	45,000	5.51	0.081	157.2	2/14/2177
2711+40	89	18	0.266	45,000	5.15	0.063	161.2	2/1/2181
3281+24	51	18	0.295	45,000	1.25	0.083	172.1	1/11/2192
2964+75	120	18	0.266	45,000	2.07	0.063	175.2	2/17/2195
2620+69	79	18	0.266	45,000	1.48	0.103	175.3	3/22/2195
3153+88	65	18	0.285	45,000	2.19	0.062	177.8	9/16/2197
1900+36	35	18	0.266	45,000	5.62	0.076	179.3	3/16/2199
2953+97	119	18	0.266	45,000	1.25	0.081	180.5	6/12/2200
2358+64	65	18	0.266	45,000	7.99	0.068	181.7	8/21/2201
3084+96	80	18	0.295	45,000	3.26	0.063	184.1	1/5/2204
2363+76	65	18	0.266	45,000	4.09	0.076	185.5	5/23/2205
1899+95	35	18	0.285	45,000	5.62	0.087	186.3	3/24/2206
1970+89	36	18	0.266	45,000	3.97	0.081	192.4	5/9/2212
3108+97	78	18	0.266	45,000	1.13	0.068	192.9	10/18/2212
2402+24	66	18	0.266	45,000	10.47	0.063	196.0	12/5/2215
1961+01	39	18	0.285	45,000	7.40	0.082	196.0	12/20/2215
3160+47	66	18	0.285	45,000	1.25	0.076	196.7	8/14/2216
3028+64	94	18	0.295	45,000	3.38	0.063	197.7	8/12/2217
2823+35	93	18	0.295	45,000	2.55	0.083	198.5	6/19/2218
2171+81	54	18	0.285	45,000	4.80	0.087	206.1	1/5/2226

Table D-11 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Buckhorn to Satsuma – ILI Date December 5, 2019 (pg. 3 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
2673+20	88	18	0.266	45,000	1.96	0.076	209.7	9/5/2229
1991+40	40	18	0.285	45,000	3.49	0.096	211.6	7/3/2231
1919+72	35	18	0.266	45,000	3.38	0.081	212.2	2/4/2232
2715+08	85	18	0.285	45,000	1.72	0.096	212.4	4/18/2232
2839+00	95	18	0.266	45,000	1.72	0.068	213.9	11/8/2233
2821+48	93	18	0.295	45,000	3.97	0.068	220.4	4/22/2240
2536+77	76	18	0.285	45,000	3.14	0.082	222.3	3/17/2242
2554+74	73	18	0.266	45,000	1.37	0.068	225.2	2/26/2245
2371+28	65	18	0.285	45,000	2.31	0.082	225.2	2/26/2245
2102+08	48	18	0.285	45,000	7.99	0.076	225.2	2/26/2245
2823+87	93	18	0.295	45,000	3.38	0.068	225.2	2/26/2245
3361+94	53	18	0.305	45,000	1.13	0.063	225.2	2/26/2245
2174+59	54	18	0.285	45,000	3.97	0.087	225.2	2/26/2245
2433+72	67	18	0.266	45,000	1.72	0.089	225.2	2/26/2245
2301+97	60	18	0.285	45,000	1.25	0.062	225.2	2/26/2245
2087+34	46	18	0.285	45,000	1.25	0.076	225.2	2/26/2245
2087+36	46	18	0.285	45,000	1.13	0.067	225.2	2/26/2245
2414+36	63	18	0.266	45,000	1.60	0.076	225.2	2/26/2245
2414+51	63	18	0.266	45,000	2.07	0.076	225.2	2/26/2245
1975+48	40	18	0.285	45,000	6.81	0.067	225.2	2/26/2245
1898+77	35	18	0.285	45,000	1.13	0.062	225.2	2/26/2245
1817+22	25	18	0.266	45,000	2.67	0.063	225.2	2/26/2245
2666+41	85	18	0.266	45,000	1.25	0.063	225.2	2/26/2245
2198+42	54	18	0.285	45,000	2.19	0.062	225.2	2/26/2245
2739+49	88	18	0.295	45,000	1.25	0.068	225.2	2/26/2245
2823+46	93	18	0.295	45,000	2.55	0.063	225.2	2/26/2245
2082+35	46	18	0.266	45,000	4.09	0.068	225.2	2/26/2245
2112+83	47	18	0.285	45,000	1.96	0.062	225.2	2/26/2245
2418+81	66	18	0.285	45,000	1.60	0.076	225.2	2/26/2245
2362+57	65	18	0.266	45,000	1.37	0.063	225.2	2/26/2245
2192+94	55	18	0.285	45,000	3.38	0.076	225.2	2/26/2245
3169+51	68	18	0.285	45,000	1.13	0.067	225.2	2/26/2245
1924+56	35	18	0.285	45,000	5.03	0.082	225.2	2/26/2245
1936+74	37	18	0.285	45,000	1.37	0.062	225.2	2/26/2245
3179+70	67	18	0.285	45,000	1.13	0.062	225.2	2/26/2245
2074+57	46	18	0.266	45,000	2.31	0.068	225.2	2/26/2245
2339+76	63	18	0.266	45,000	2.43	0.068	225.2	2/26/2245
2301+58	60	18	0.285	45,000	1.13	0.067	225.2	2/26/2245
1878+16	33	18	0.285	45,000	2.67	0.067	225.2	2/26/2245
2986+92	117	18	0.295	45,000	1.37	0.074	225.2	2/26/2245
2527+30	77	18	0.266	45,000	1.13	0.095	225.2	2/26/2245
2367+73	65	18	0.285	45,000	3.73	0.067	225.2	2/26/2245
2164+29	52	18	0.285	45,000	1.13	0.067	225.2	2/26/2245
2170+63	55	18	0.285	45,000	5.27	0.076	225.2	2/26/2245
1936+26	37	18	0.266	45,000	1.13	0.063	225.2	2/26/2245
2036+81	44	18	0.285	45,000	1.25	0.067	225.2	2/26/2245
2986+70	117	18	0.295	45,000	1.37	0.063	225.2	2/26/2245

Table D-11 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Buckhorn to Satsuma – ILI Date December 5, 2019 (pg. 4 of 4)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
2178+16	54	18	0.285	45,000	2.90	0.082	225.2	2/26/2245
2107+89	48	18	0.285	45,000	2.31	0.082	225.2	2/26/2245
2499+22	81	18	0.266	45,000	3.26	0.063	225.2	2/26/2245
2078+78	46	18	0.285	45,000	2.55	0.076	225.2	2/26/2245
2083+91	46	18	0.266	45,000	1.84	0.068	225.2	2/26/2245
3029+03	94	18	0.295	45,000	2.55	0.063	225.2	2/26/2245
2290+70	60	18	0.285	45,000	1.60	0.062	225.2	2/26/2245
2097+56	46	18	0.285	45,000	2.19	0.076	225.2	2/26/2245
1918+91	36	18	0.266	45,000	1.13	0.068	225.2	2/26/2245
2177+77	54	18	0.285	45,000	4.91	0.067	225.2	2/26/2245
2823+20	93	18	0.295	45,000	1.60	0.083	225.2	2/26/2245
2301+77	60	18	0.285	45,000	5.03	0.062	225.2	2/26/2245
2415+65	65	18	0.295	45,000	1.13	0.068	225.2	2/26/2245
2556+26	75	18	0.285	45,000	1.72	0.067	225.2	2/26/2245
2164+68	52	18	0.285	45,000	4.09	0.082	225.2	2/26/2245
2094+32	46	18	0.285	45,000	2.31	0.067	225.2	2/26/2245
1975+54	40	18	0.295	45,000	2.19	0.074	225.2	2/26/2245
1923+09	35	18	0.266	45,000	5.86	0.063	225.2	2/26/2245
1874+84	33	18	0.285	45,000	1.48	0.141	225.2	2/26/2245
2361+37	65	18	0.285	45,000	2.78	0.067	225.2	2/26/2245
1964+77	39	18	0.266	45,000	3.85	0.063	225.2	2/26/2245
2163+10	53	18	0.285	45,000	4.32	0.067	225.2	2/26/2245

Table D-12. Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Satsuma to East Houston – ILI Date August 16, 2019 (pg. 1 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
1679+53	116	20	0.305	35,000	5.38	0.115	26.6	3/29/2046
1752+00	123	20	0.295	35,000	5.62	0.101	27.3	11/21/2046
1729+58	119	20	0.305	35,000	3.14	0.121	37.8	5/17/2057
1598+51	111	20	0.315	35,000	3.25	0.140	38.4	12/25/2057
1632+14	112	20	0.305	35,000	4.67	0.109	39.3	11/24/2058
1675+02	116	20	0.305	35,000	5.85	0.094	47.2	10/17/2066
1643+16	111	20	0.305	35,000	2.54	0.128	49.3	11/14/2068
1485+41	105	20	0.305	35,000	3.02	0.128	53.1	9/7/2072
1711+20	117	20	0.295	35,000	2.54	0.107	53.3	11/22/2072
1728+75	118	20	0.295	35,000	8.10	0.074	57.7	5/2/2077
1653+96	112	20	0.305	35,000	4.55	0.094	58.1	9/20/2077
939+66	67	20	0.315	35,000	5.50	0.146	61.2	10/20/2080
1771+12	121	20	0.305	35,000	2.31	0.109	62.0	8/14/2081
1684+38	116	20	0.305	35,000	2.78	0.103	67.4	1/10/2087
1653+52	112	20	0.305	35,000	3.37	0.094	73.2	11/7/2092
1684+70	116	20	0.305	35,000	3.02	0.094	75.9	7/10/2095
1745+85	121	20	0.305	35,000	3.14	0.088	76.0	8/2/2095
1709+88	117	20	0.295	35,000	3.02	0.083	77.9	7/23/2097
1471+69	105	20	0.315	35,000	2.90	0.121	80.7	5/4/2100

Table D-12 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Satsuma to East Houston – ILI Date August 16, 2019 (pg. 2 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
1712+44	117	20	0.305	35,000	2.90	0.088	85.3	12/18/2104
1736+11	120	20	0.305	35,000	4.08	0.076	88.1	10/10/2107
1723+67	119	20	0.295	35,000	1.84	0.095	89.5	2/7/2109
1657+46	113	20	0.305	35,000	3.02	0.088	91.1	9/8/2110
1618+48	113	20	0.305	35,000	1.84	0.115	92.3	12/3/2111
1477+77	106	20	0.315	35,000	2.31	0.127	92.5	2/15/2112
1632+04	112	20	0.305	35,000	2.19	0.103	92.5	2/16/2112
982+92	70	20	0.305	35,000	3.61	0.140	93.0	8/7/2112
1447+79	105	20	0.315	35,000	6.44	0.090	93.3	11/22/2112
1483+79	106	20	0.315	35,000	4.32	0.096	94.8	5/22/2114
1695+61	115	20	0.305	35,000	1.72	0.109	94.9	7/29/2114
1239+99	87	20	0.305	35,000	3.14	0.121	95.8	5/23/2115
1658+61	114	20	0.315	35,000	2.19	0.108	96.5	2/10/2116
1654+28	113	20	0.305	35,000	1.95	0.103	99.4	12/27/2118
1089+63	79	20	0.305	35,000	6.80	0.103	102.3	12/16/2121
1696+43	116	20	0.315	35,000	2.07	0.102	105.5	2/19/2125
1347+08	87	20	0.305	35,000	4.43	0.094	105.7	4/21/2125
1692+74	117	20	0.295	35,000	5.14	0.063	105.9	7/8/2125
1483+02	106	20	0.315	35,000	2.78	0.108	105.9	7/10/2125
1717+61	118	20	0.305	35,000	1.60	0.103	107.8	6/3/2127
1544+58	109	20	0.305	35,000	2.66	0.094	108.4	1/16/2128
1759+74	124	20	0.305	35,000	3.25	0.070	112.5	2/22/2132
1641+92	112	20	0.295	35,000	3.84	0.068	112.7	4/13/2132
1731+29	118	20	0.305	35,000	1.95	0.088	113.2	10/19/2132
1301+14	88	20	0.305	35,000	3.02	0.109	113.3	11/26/2132
1674+30	115	20	0.305	35,000	2.19	0.088	113.6	4/7/2133
1401+21	99	20	0.315	35,000	2.19	0.127	113.9	7/12/2133
1713+88	117	20	0.305	35,000	1.95	0.088	116.6	3/17/2136
1203+57	87	20	0.295	35,000	1.95	0.133	120.0	8/23/2139
1256+98	89	20	0.305	35,000	1.60	0.155	123.7	4/15/2143
1729+13	118	20	0.295	35,000	1.60	0.083	123.8	6/6/2143
1551+52	108	20	0.305	35,000	1.84	0.103	126.3	12/16/2145
1657+39	113	20	0.305	35,000	2.78	0.076	127.1	10/4/2146
1775+82	123	20	0.305	35,000	1.36	0.094	130.7	5/11/2150
1678+02	116	20	0.315	35,000	1.84	0.096	133.7	4/29/2153
1687+28	117	20	0.305	35,000	1.72	0.088	135.4	1/15/2155
1097+90	79	20	0.295	35,000	4.67	0.095	136.6	3/21/2156
1627+77	112	20	0.305	35,000	1.36	0.109	136.6	4/5/2156
887+08	60	20	0.295	35,000	9.04	0.095	137.3	12/21/2156
1744+30	121	20	0.295	35,000	2.43	0.063	137.4	1/2/2157
939+67	67	20	0.315	35,000	3.49	0.140	137.5	2/20/2157
1476+08	104	20	0.305	35,000	2.66	0.088	139.9	7/24/2159
742+35	57	20	0.305	35,000	7.39	0.115	140.3	12/9/2159
1737+32	119	20	0.295	35,000	1.95	0.068	141.4	12/30/2160
1512+75	106	20	0.315	35,000	2.43	0.096	142.0	8/10/2161
1487+09	106	20	0.315	35,000	2.90	0.090	145.9	7/4/2165
1610+10	112	20	0.305	35,000	2.54	0.076	146.6	4/1/2166

Table D-12 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Satsuma to East Houston – ILI Date August 16, 2019 (pg. 3 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
1609+58	111	20	0.305	35,000	1.84	0.088	146.8	6/10/2166
1632+18	112	20	0.305	35,000	1.36	0.103	147.2	10/25/2166
1510+93	107	20	0.315	35,000	2.31	0.096	148.7	4/30/2168
1478+76	106	20	0.315	35,000	1.95	0.108	149.9	7/15/2169
1516+22	107	20	0.305	35,000	2.19	0.088	151.3	11/16/2170
1666+98	115	20	0.325	35,000	1.36	0.121	152.1	9/23/2171
1461+18	105	20	0.305	35,000	3.73	0.076	152.3	12/9/2171
1320+67	88	20	0.295	35,000	2.31	0.095	154.4	1/24/2174
1471+75	105	20	0.315	35,000	1.72	0.115	154.9	6/30/2174
985+35	71	20	0.305	35,000	4.43	0.109	155.8	6/10/2175
1697+43	117	20	0.315	35,000	1.36	0.102	156.7	4/10/2176
1481+59	106	20	0.315	35,000	2.31	0.096	157.1	9/28/2176
1075+65	77	20	0.305	35,000	2.78	0.121	158.0	8/6/2177
1632+14	112	20	0.305	35,000	1.60	0.088	158.6	3/30/2178
1632+09	112	20	0.305	35,000	1.60	0.088	158.6	4/7/2178
853+16	59	20	0.305	35,000	7.86	0.103	158.8	6/22/2178
1713+49	117	20	0.295	35,000	1.48	0.074	159.0	7/31/2178
1717+46	118	20	0.305	35,000	1.48	0.082	161.2	11/8/2180
1776+39	123	20	0.305	35,000	1.72	0.070	161.5	2/14/2181
1551+32	108	20	0.305	35,000	1.84	0.088	163.2	11/2/2182
1632+08	112	20	0.305	35,000	1.72	0.082	165.7	5/1/2185
1447+77	105	20	0.315	35,000	8.57	0.068	167.7	4/23/2187
1684+70	116	20	0.305	35,000	1.48	0.082	170.6	3/30/2190
1501+47	106	20	0.295	35,000	2.78	0.068	173.4	1/23/2193
1548+95	110	20	0.305	35,000	1.72	0.088	173.5	2/22/2193
945+55	68	20	0.305	35,000	7.86	0.094	175.5	1/29/2195
1512+30	106	20	0.305	35,000	2.54	0.076	175.5	2/1/2195
808+97	63	20	0.315	35,000	2.54	0.168	176.1	9/19/2195
1509+45	107	20	0.305	35,000	4.91	0.063	177.2	11/1/2196
1464+95	105	20	0.305	35,000	2.31	0.082	180.3	11/18/2199
1755+70	123	20	0.295	35,000	1.48	0.063	182.2	10/15/2201
1541+21	108	20	0.305	35,000	1.48	0.094	182.3	12/15/2201
1632+12	112	20	0.305	35,000	1.72	0.076	184.8	5/19/2204
1248+51	87	20	0.305	35,000	2.07	0.109	184.9	7/9/2204
1260+44	87	20	0.295	35,000	11.99	0.063	185.4	12/24/2204
1741+81	119	20	0.315	35,000	1.25	0.090	185.6	3/24/2205
1610+76	112	20	0.305	35,000	1.25	0.094	188.6	4/4/2208
1713+79	117	20	0.305	35,000	1.60	0.070	188.7	5/17/2208
881+98	60	20	0.305	35,000	2.54	0.140	194.1	9/8/2213
785+44	64	20	0.305	35,000	3.25	0.134	195.6	3/28/2215
1680+35	116	20	0.315	35,000	2.19	0.068	197.5	2/10/2217
1289+55	87	20	0.305	35,000	2.31	0.094	201.2	10/29/2220
1510+84	107	20	0.315	35,000	3.73	0.068	201.5	2/14/2221
1187+21	86	20	0.305	35,000	6.56	0.076	202.2	11/3/2221
1478+69	106	20	0.315	35,000	1.72	0.096	203.8	5/21/2223
1628+50	112	20	0.315	35,000	1.25	0.096	208.1	9/25/2227
1705+62	116	20	0.305	35,000	1.25	0.076	208.5	2/17/2228

Table D-12 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Satsuma to East Houston – ILI Date August 16, 2019 (pg. 4 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
1729+13	118	20	0.295	35,000	1.13	0.068	212.3	11/21/2231
1006+86	70	20	0.295	35,000	5.50	0.083	217.4	1/25/2237
1512+49	106	20	0.305	35,000	1.60	0.082	218.4	1/2/2238
1374+72	94	20	0.305	35,000	1.72	0.094	218.7	5/11/2238
1097+89	79	20	0.295	35,000	3.84	0.083	220.4	12/30/2239
1717+71	118	20	0.305	35,000	1.13	0.076	222.3	12/1/2241
1666+35	114	20	0.305	35,000	1.25	0.076	223.1	9/16/2242
1556+18	107	20	0.315	35,000	3.73	0.061	223.5	2/22/2243
940+60	67	20	0.305	35,000	1.60	0.094	225.2	11/7/2244
1462+20	105	20	0.305	35,000	1.72	0.076	225.2	11/7/2244
940+03	67	20	0.315	35,000	1.13	0.061	225.2	11/7/2244
1523+47	107	20	0.305	35,000	1.95	0.070	225.2	11/7/2244
870+10	61	20	0.295	35,000	3.25	0.074	225.2	11/7/2244
1156+67	85	20	0.305	35,000	1.48	0.063	225.2	11/7/2244
665+51	52	20	0.295	35,000	1.72	0.095	225.2	11/7/2244
1207+91	87	20	0.305	35,000	1.48	0.094	225.2	11/7/2244
1207+92	87	20	0.305	35,000	1.13	0.082	225.2	11/7/2244
641+90	50	20	0.315	35,000	2.19	0.061	225.2	11/7/2244
1251+54	87	20	0.315	35,000	1.25	0.083	225.2	11/7/2244
508+18	41	20	0.295	35,000	2.54	0.101	225.2	11/7/2244
796+00	64	20	0.305	35,000	2.66	0.088	225.2	11/7/2244
1581+56	109	20	0.305	35,000	1.25	0.063	225.2	11/7/2244
1258+58	89	20	0.315	35,000	2.54	0.074	225.2	11/7/2244
733+74	57	20	0.295	35,000	1.36	0.074	225.2	11/7/2244
735+78	56	20	0.315	35,000	1.48	0.074	225.2	11/7/2244
736+10	53	20	0.305	35,000	2.31	0.103	225.2	11/7/2244
544+13	40	20	0.315	35,000	3.73	0.108	225.2	11/7/2244
1126+83	83	20	0.315	35,000	3.02	0.090	225.2	11/7/2244
1041+74	70	20	0.305	35,000	3.02	0.063	225.2	11/7/2244
1130+14	82	20	0.305	35,000	3.37	0.063	225.2	11/7/2244
1227+91	86	20	0.315	35,000	1.13	0.083	225.2	11/7/2244
849+48	62	20	0.305	35,000	1.36	0.070	225.2	11/7/2244
648+16	51	20	0.315	35,000	1.48	0.074	225.2	11/7/2244
514+07	41	20	0.315	35,000	2.43	0.061	225.2	11/7/2244
1188+37	87	20	0.295	35,000	1.13	0.063	225.2	11/7/2244
970+12	69	20	0.305	35,000	1.36	0.063	225.2	11/7/2244
547+96	42	20	0.305	35,000	2.07	0.088	225.2	11/7/2244
548+22	42	20	0.315	35,000	3.25	0.127	225.2	11/7/2244
856+11	59	20	0.305	35,000	3.25	0.076	225.2	11/7/2244
1237+09	86	20	0.305	35,000	1.25	0.088	225.2	11/7/2244
1239+30	87	20	0.295	35,000	1.60	0.089	225.2	11/7/2244
856+86	59	20	0.305	35,000	2.31	0.088	225.2	11/7/2244
1008+81	70	20	0.315	35,000	3.02	0.074	225.2	11/7/2244
811+65	61	20	0.315	35,000	2.43	0.083	225.2	11/7/2244
1052+39	72	20	0.315	35,000	3.02	0.096	225.2	11/7/2244
517+73	40	20	0.315	35,000	1.36	0.102	225.2	11/7/2244
517+95	40	20	0.315	35,000	2.90	0.090	225.2	11/7/2244

Table D-12 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Satsuma to East Houston – ILI Date August 16, 2019 (pg. 5 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
1011+66	71	20	0.315	35,000	1.95	0.096	225.2	11/7/2244
1525+59	106	20	0.315	35,000	2.43	0.068	225.2	11/7/2244
977+81	70	20	0.305	35,000	1.60	0.076	225.2	11/7/2244
817+69	60	20	0.305	35,000	1.72	0.063	225.2	11/7/2244
554+95	43	20	0.305	35,000	1.72	0.082	225.2	11/7/2244
1017+86	70	20	0.305	35,000	1.25	0.076	225.2	11/7/2244
937+83	67	20	0.315	35,000	1.25	0.068	225.2	11/7/2244
1292+79	87	20	0.305	35,000	2.78	0.070	225.2	11/7/2244
939+85	67	20	0.315	35,000	1.48	0.083	225.2	11/7/2244
939+85	67	20	0.315	35,000	4.20	0.083	225.2	11/7/2244
1251+17	88	20	0.305	35,000	1.48	0.063	225.2	11/7/2244
1477+96	106	20	0.315	35,000	1.84	0.068	225.2	11/7/2244
1482+04	106	20	0.305	35,000	1.48	0.063	225.2	11/7/2244
633+06	49	20	0.305	35,000	1.13	0.076	225.2	11/7/2244
1487+92	106	20	0.305	35,000	1.25	0.076	225.2	11/7/2244
788+96	65	20	0.305	35,000	3.84	0.094	225.2	11/7/2244
493+73	40	20	0.315	35,000	1.95	0.061	225.2	11/7/2244
564+86	43	20	0.305	35,000	1.72	0.070	225.2	11/7/2244
1261+03	88	20	0.305	35,000	1.13	0.070	225.2	11/7/2244
1545+07	109	20	0.295	35,000	1.60	0.063	225.2	11/7/2244
636+78	50	20	0.315	35,000	1.13	0.061	225.2	11/7/2244
1121+28	82	20	0.305	35,000	1.25	0.076	225.2	11/7/2244
665+38	52	20	0.295	35,000	1.13	0.074	225.2	11/7/2244
1077+56	77	20	0.305	35,000	1.36	0.063	225.2	11/7/2244
879+97	60	20	0.295	35,000	1.13	0.074	225.2	11/7/2244
879+98	60	20	0.295	35,000	3.25	0.063	225.2	11/7/2244
1548+94	110	20	0.305	35,000	1.13	0.063	225.2	11/7/2244
1551+35	108	20	0.305	35,000	1.36	0.063	225.2	11/7/2244
1223+33	87	20	0.305	35,000	1.25	0.103	225.2	11/7/2244
1226+64	87	20	0.305	35,000	1.13	0.063	225.2	11/7/2244
1227+08	86	20	0.315	35,000	1.60	0.061	225.2	11/7/2244
1403+90	100	20	0.305	35,000	1.72	0.088	225.2	11/7/2244
501+75	40	20	0.315	35,000	1.36	0.074	225.2	11/7/2244
1400+92	99	20	0.315	35,000	1.36	0.115	225.2	11/7/2244
1400+93	99	20	0.315	35,000	2.19	0.083	225.2	11/7/2244
1598+97	111	20	0.315	35,000	1.48	0.074	225.2	11/7/2244
674+77	53	20	0.305	35,000	2.31	0.070	225.2	11/7/2244
1089+28	79	20	0.295	35,000	1.36	0.063	225.2	11/7/2244
642+16	51	20	0.315	35,000	1.60	0.068	225.2	11/7/2244
886+57	60	20	0.305	35,000	1.72	0.076	225.2	11/7/2244
1513+21	107	20	0.315	35,000	1.60	0.074	225.2	11/7/2244
1097+94	79	20	0.295	35,000	1.72	0.101	225.2	11/7/2244
1098+95	79	20	0.295	35,000	1.95	0.068	225.2	11/7/2244
537+82	40	20	0.305	35,000	1.36	0.103	225.2	11/7/2244
965+29	69	20	0.295	35,000	1.60	0.074	225.2	11/7/2244
965+41	69	20	0.295	35,000	1.48	0.127	225.2	11/7/2244
1241+15	87	20	0.305	35,000	1.36	0.076	225.2	11/7/2244

Table D-12 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Satsuma to East Houston – ILI Date August 16, 2019 (pg. 6 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
1051+84	73	20	0.295	35,000	2.90	0.068	225.2	11/7/2244
1052+80	73	20	0.315	35,000	1.60	0.074	225.2	11/7/2244
965+55	68	20	0.305	35,000	3.84	0.094	225.2	11/7/2244
971+31	69	20	0.295	35,000	1.36	0.068	225.2	11/7/2244
1193+78	87	20	0.305	35,000	1.84	0.109	225.2	11/7/2244
1193+79	87	20	0.305	35,000	1.36	0.076	225.2	11/7/2244
1146+26	83	20	0.315	35,000	1.48	0.090	225.2	11/7/2244
1142+04	84	20	0.315	35,000	1.48	0.090	225.2	11/7/2244
1012+82	71	20	0.305	35,000	2.07	0.094	225.2	11/7/2244
480+77	39	20	0.305	35,000	1.48	0.063	225.2	11/7/2244
1151+04	85	20	0.295	35,000	1.25	0.063	225.2	11/7/2244
1249+21	87	20	0.305	35,000	1.25	0.063	225.2	11/7/2244
1157+16	85	20	0.305	35,000	1.95	0.070	225.2	11/7/2244
903+71	61	20	0.305	35,000	1.36	0.082	225.2	11/7/2244
904+20	60	20	0.295	35,000	3.37	0.089	225.2	11/7/2244
1442+68	103	20	0.315	35,000	1.36	0.083	225.2	11/7/2244
1396+18	99	20	0.315	35,000	1.72	0.061	225.2	11/7/2244
1499+60	106	20	0.295	35,000	1.25	0.083	225.2	11/7/2244
786+87	64	20	0.305	35,000	1.84	0.076	225.2	11/7/2244
1407+41	99	20	0.315	35,000	1.25	0.068	225.2	11/7/2244
1226+82	87	20	0.305	35,000	1.72	0.103	225.2	11/7/2244
1649+14	112	20	0.305	35,000	1.13	0.063	225.2	11/7/2244
1654+27	113	20	0.305	35,000	1.36	0.063	225.2	11/7/2244
792+29	65	20	0.315	35,000	1.72	0.102	225.2	11/7/2244
731+22	57	20	0.305	35,000	1.25	0.070	225.2	11/7/2244
561+20	43	20	0.315	35,000	3.14	0.083	225.2	11/7/2244
881+98	60	20	0.305	35,000	1.25	0.088	225.2	11/7/2244
832+63	57	20	0.315	35,000	1.84	0.074	225.2	11/7/2244
798+47	62	20	0.305	35,000	2.54	0.109	225.2	11/7/2244
1422+10	98	20	0.315	35,000	1.36	0.074	225.2	11/7/2244
961+67	68	20	0.295	35,000	3.49	0.095	225.2	11/7/2244
732+33	57	20	0.305	35,000	1.60	0.063	225.2	11/7/2244
732+34	57	20	0.305	35,000	2.07	0.070	225.2	11/7/2244
1477+86	106	20	0.315	35,000	2.43	0.068	225.2	11/7/2244
845+45	58	20	0.315	35,000	1.25	0.102	225.2	11/7/2244
1054+82	73	20	0.295	35,000	1.84	0.068	225.2	11/7/2244
673+91	52	20	0.315	35,000	1.36	0.068	225.2	11/7/2244
1013+90	70	20	0.305	35,000	1.36	0.109	225.2	11/7/2244
853+44	59	20	0.305	35,000	2.43	0.063	225.2	11/7/2244
1013+46	71	20	0.295	35,000	1.25	0.083	225.2	11/7/2244
896+23	61	20	0.305	35,000	1.72	0.088	225.2	11/7/2244
1499+41	106	20	0.295	35,000	1.48	0.068	225.2	11/7/2244
1549+78	109	20	0.305	35,000	1.48	0.063	225.2	11/7/2244
811+17	61	20	0.315	35,000	1.60	0.083	225.2	11/7/2244
1256+81	88	20	0.305	35,000	1.84	0.063	225.2	11/7/2244
1501+72	107	20	0.295	35,000	2.07	0.063	225.2	11/7/2244
1501+73	107	20	0.295	35,000	1.36	0.068	225.2	11/7/2244

Table D-12 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Satsuma to East Houston – ILI Date August 16, 2019 (pg. 7 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
1740+10	120	20	0.305	35,000	1.36	0.063	225.2	11/7/2244
1259+57	88	20	0.305	35,000	1.60	0.070	225.2	11/7/2244
505+07	41	20	0.305	35,000	5.50	0.088	225.2	11/7/2244
939+95	67	20	0.315	35,000	1.25	0.068	225.2	11/7/2244
1265+49	88	20	0.295	35,000	1.25	0.116	225.2	11/7/2244
1121+31	82	20	0.305	35,000	1.84	0.063	225.2	11/7/2244
1029+37	71	20	0.305	35,000	1.13	0.094	225.2	11/7/2244
991+37	71	20	0.305	35,000	1.36	0.070	225.2	11/7/2244
947+16	67	20	0.305	35,000	1.60	0.063	225.2	11/7/2244
947+16	67	20	0.305	35,000	2.78	0.063	225.2	11/7/2244
1520+37	107	20	0.305	35,000	1.25	0.076	225.2	11/7/2244
995+31	70	20	0.305	35,000	1.36	0.076	225.2	11/7/2244
1471+72	105	20	0.315	35,000	1.25	0.083	225.2	11/7/2244
875+34	61	20	0.315	35,000	1.36	0.074	225.2	11/7/2244
1241+10	87	20	0.305	35,000	1.48	0.082	225.2	11/7/2244
836+54	58	20	0.315	35,000	2.54	0.083	225.2	11/7/2244
731+09	57	20	0.315	35,000	1.25	0.090	225.2	11/7/2244
762+34	63	20	0.315	35,000	2.07	0.121	225.2	11/7/2244
1145+34	83	20	0.315	35,000	1.25	0.074	225.2	11/7/2244
697+57	52	20	0.305	35,000	2.31	0.082	225.2	11/7/2244
1145+24	83	20	0.315	35,000	3.02	0.090	225.2	11/7/2244
929+37	63	20	0.305	35,000	1.13	0.109	225.2	11/7/2244
1062+00	75	20	0.305	35,000	1.60	0.128	225.2	11/7/2244
1153+65	85	20	0.295	35,000	1.72	0.089	225.2	11/7/2244
849+49	62	20	0.305	35,000	1.36	0.076	225.2	11/7/2244
849+57	62	20	0.305	35,000	1.13	0.070	225.2	11/7/2244
849+64	62	20	0.305	35,000	2.66	0.103	225.2	11/7/2244
732+71	57	20	0.305	35,000	1.48	0.094	225.2	11/7/2244
735+28	53	20	0.305	35,000	1.36	0.082	225.2	11/7/2244
1253+10	87	20	0.315	35,000	3.12	0.068	225.2	11/7/2244
568+22	43	20	0.315	35,000	2.78	0.083	225.2	11/7/2244
853+17	59	20	0.305	35,000	2.54	0.103	225.2	11/7/2244
494+73	41	20	0.305	35,000	1.60	0.063	225.2	11/7/2244
808+84	63	20	0.315	35,000	2.66	0.096	225.2	11/7/2244
1168+59	85	20	0.295	35,000	1.60	0.068	225.2	11/7/2244
771+89	65	20	0.305	35,000	4.79	0.076	225.2	11/7/2244
643+60	50	20	0.315	35,000	1.13	0.068	225.2	11/7/2244
646+07	50	20	0.315	35,000	2.19	0.090	225.2	11/7/2244
987+52	70	20	0.315	35,000	1.25	0.102	225.2	11/7/2244
1027+67	70	20	0.295	35,000	2.66	0.089	225.2	11/7/2244
746+69	59	20	0.305	35,000	1.36	0.070	225.2	11/7/2244
865+86	60	20	0.295	35,000	2.78	0.074	225.2	11/7/2244
991+55	70	20	0.305	35,000	1.13	0.070	225.2	11/7/2244
680+73	52	20	0.295	35,000	4.08	0.083	225.2	11/7/2244
680+89	52	20	0.295	35,000	3.61	0.063	225.2	11/7/2244
1187+19	86	20	0.305	35,000	3.49	0.063	225.2	11/7/2244
784+32	64	20	0.315	35,000	2.90	0.083	225.2	11/7/2244

Table D-12 (continued). Pressure-Cycle-Induced Fatigue Cracking Analysis of ILI-Indicated Anomalies Satsuma to East Houston – ILI Date August 16, 2019 (pg. 8 of 8)

Station Number	Elevation (feet)	OD (inch)	WT (inch)	YS (psi)	ILI Length (inch)	ILI Depth (inch)	Re-assessment Interval (years)	Re-assessment Due Date
682+38	53	20	0.305	35,000	4.67	0.103	225.2	11/7/2244
952+21	68	20	0.295	35,000	2.54	0.068	225.2	11/7/2244
1096+91	79	20	0.295	35,000	2.07	0.083	225.2	11/7/2244
957+06	68	20	0.305	35,000	1.72	0.063	225.2	11/7/2244
957+07	68	20	0.305	35,000	2.43	0.076	225.2	11/7/2244
625+80	48	20	0.305	35,000	3.02	0.094	225.2	11/7/2244
625+81	48	20	0.305	35,000	3.25	0.082	225.2	11/7/2244
832+86	57	20	0.315	35,000	4.43	0.090	225.2	11/7/2244
925+91	61	20	0.305	35,000	3.61	0.076	225.2	11/7/2244
926+27	62	20	0.305	35,000	1.36	0.088	225.2	11/7/2244
965+75	68	20	0.305	35,000	3.84	0.088	225.2	11/7/2244
760+10	62	20	0.305	35,000	3.25	0.088	225.2	11/7/2244
760+49	62	20	0.315	35,000	7.27	0.096	225.2	11/7/2244
796+69	64	20	0.305	35,000	1.72	0.088	225.2	11/7/2244
843+94	59	20	0.305	35,000	1.36	0.070	225.2	11/7/2244
928+50	63	20	0.305	35,000	1.72	0.063	225.2	11/7/2244
973+78	69	20	0.315	35,000	1.36	0.102	225.2	11/7/2244
977+10	70	20	0.315	35,000	1.95	0.061	225.2	11/7/2244
517+62	40	20	0.315	35,000	1.60	0.074	225.2	11/7/2244
636+21	49	20	0.315	35,000	2.31	0.115	225.2	11/7/2244
807+14	62	20	0.305	35,000	1.84	0.088	225.2	11/7/2244
563+10	43	20	0.305	35,000	1.60	0.103	225.2	11/7/2244
704+94	54	20	0.315	35,000	1.60	0.102	225.2	11/7/2244
705+71	54	20	0.295	35,000	1.48	0.068	225.2	11/7/2244
568+21	43	20	0.315	35,000	1.36	0.068	225.2	11/7/2244
525+43	20	20	0.305	35,000	1.95	0.088	225.2	11/7/2244
782+10	65	20	0.315	35,000	1.48	0.090	225.2	11/7/2244
573+12	43	20	0.315	35,000	1.36	0.074	225.2	11/7/2244
719+27	56	20	0.305	35,000	5.03	0.070	225.2	11/7/2244
500+71	40	20	0.315	35,000	1.60	0.108	225.2	11/7/2244
509+33	42	20	0.295	35,000	1.95	0.101	225.2	11/7/2244
543+44	41	20	0.315	35,000	1.36	0.074	225.2	11/7/2244
545+20	42	20	0.315	35,000	3.14	0.061	225.2	11/7/2244
563+85	43	20	0.305	35,000	1.13	0.094	225.2	11/7/2244

APPENDIX E – APPROACH TO API 1163 VERIFICATION

Approach to API 1163 Verification

API 1163 2nd Edition, April 2013, describes methods in Section 7 and Section 8 that can be applied to verify that the ILI tool was working as expected and reported inspection results are within the performance specification for the inspected pipeline. Within the Standard, a distinction is made between results with and without field verification measurements. API 1163 Section 7 provides information about what the ILI Vendor provides regarding pre-, mid-, and post-inspection checks for proper tool runs. API 1163 Section 8 Figure 6 (Figure E-1 in this document) describes a process for validating ILI measurements using three levels of validation, shown in Figure E-2.

The three levels of validation all consist of the following steps:

- A process verification or quality control (§8.2.2 and Annex C.1)
- A comparison with historical data for the pipeline being inspected (§8.2.3)
- A comparison analysis of pipeline component records (§8.2.4)

The validation levels differ based on the risk of the pipeline segment and the amount of validation data.

Validation Level 1 (Annex C):

- A comparison with large-scale historic data for pipeline segments similar to the pipeline being inspected (§8.2.3)

Validation Level 1 only applies to pipelines with anomaly populations with a low risk of consequence or probability of failure. Typically, only a limited number or no validation measurements are taken on the inspected pipeline. A Level 1 validation assumes the ILI specified tool performance is neither proven nor disputed for the ILI run. This assumption means the validity of the ILI run cannot be rejected solely based on a Level 1 validation. A Level 2 or Level 3 validation is required before an ILI run can be rejected.

Validation Level 2 (Annex C):

- A comparison with field excavation results warranted by the reporting of significant indications (§8.2.6)

Validation Level 2 applies to pipelines with a lower risk of consequence or probability of failure that has indications of significance reported by ILI. Typically, enough validation measurements are taken on the inspected pipeline to confidently state whether the ILI tool performs worse than the ILI specification and possibly reject the ILI run. However, a Level 2 validation does not let one confidently state that the ILI tool is performing within ILI specifications. The number of validation measurements will typically be greater than or equal to five but not be statistically significant with which to perform a Level 3 validation. If the ILI tool specification can be rejected, there is the option to progress to a Level 3 validation, requiring additional validation measurements.

Validation Level 3 (Annex C):

- A comparison with field excavation results warranted by the reporting of significant indications (§8.2.6)

Validation Level 3 applies to pipelines with a higher risk of consequence or probability of failure that has indications of significance reported by ILI. Typically, there are a statistically significant number of validation measurements taken on the pipeline being inspected to confidently state an as-run tool performance.

The tool performance can be rejected, accepted, or non-conclusive, depending upon the data analysis using the API 1163 decision chart process. If tool performance is determined to be non-conclusive, it does not mean the inspection failed. Instead, an additional course of action may be required. Some actions to consider are: performing additional validation digs to gather more information to possibly improve the current tool performance, accepting the determined tool performance as-is, adjusting the depth accuracy applied to the reported ILI features, or having the ILI Vendor regrade the data. Figure E-1 shows API 1163 Section 8 Figure 6, which summarizes the system results evaluation process. For clarity of wording in the flow chart, "historical data" is taken to mean the data limited to the particular line, whereas "large-scale historical data" is taken to mean the data on this line, as well as any similar diameter lines with the same ILI tool type used for inspection.

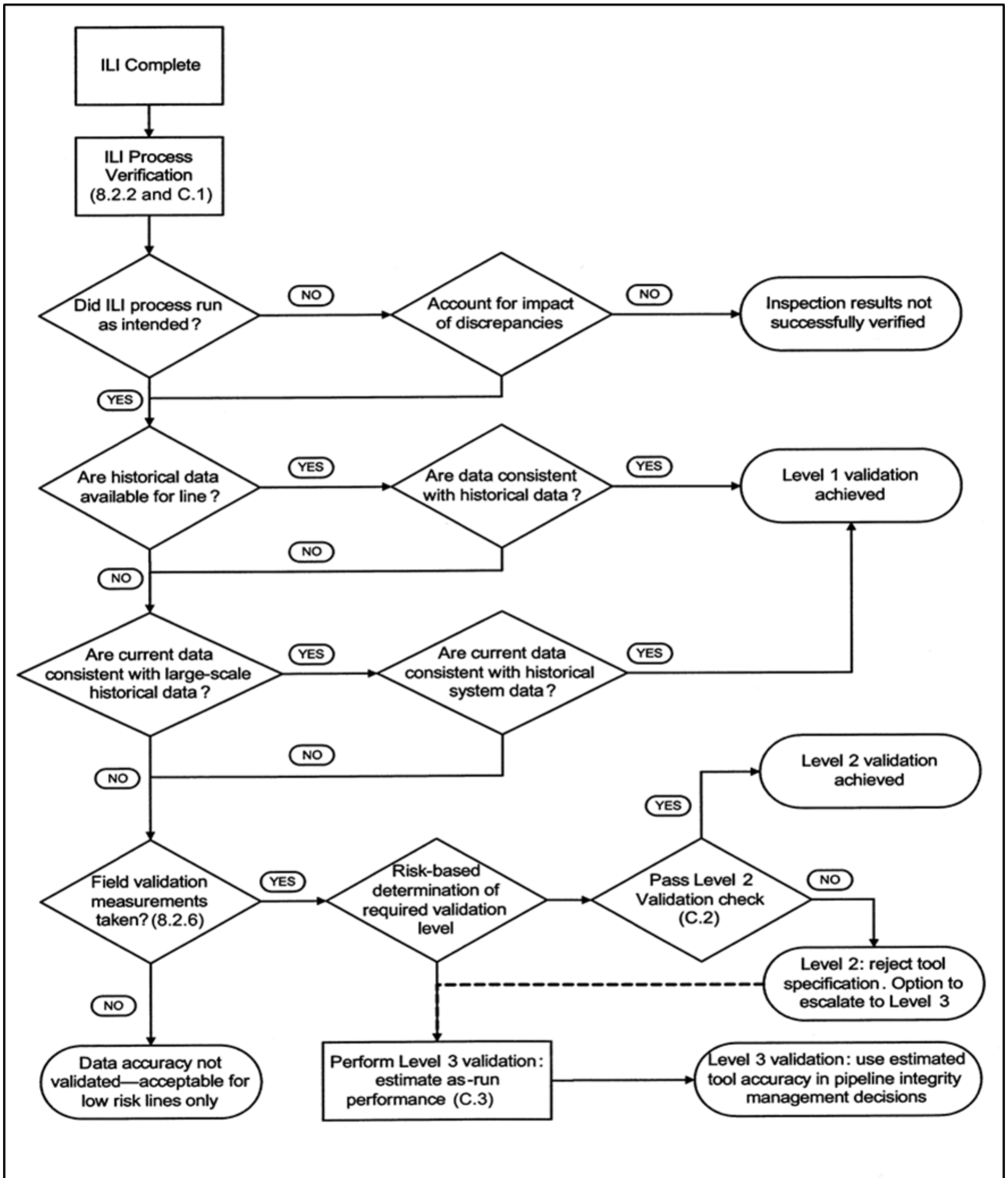

Figure 6—Inspection Results Verification and Validation Process

Figure E-1. Evaluation of System Results from API 1163 Section 8 Figure 6

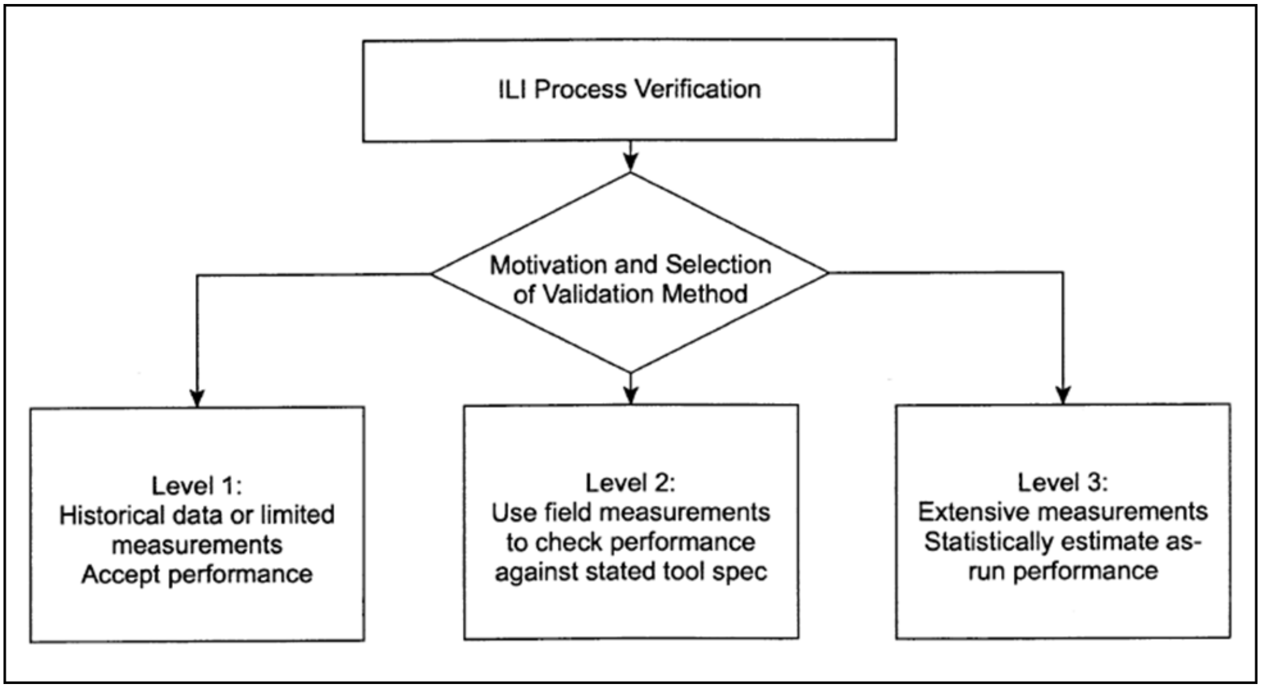

Figure E-2. Overview of Three Levels of Validation

APPENDIX F – STATISTICS BACKGROUND

Introduction to Normal Distribution and Outlier

Before an in-depth probabilistic analysis is performed, some common statistical values should be calculated to determine if any data should be excluded from the analysis. These values include the average, standard deviation, normal distribution, outliers, and extreme values.

Normal Distribution

A normal distribution is a probability distribution commonly referred to as a bell curve which is symmetrical around the mean value. Errors in measurements tend to closely resemble a normal distribution which is why ILI vendors will use normal distributions to explain the ILI tool's sizing accuracy. Some common parameters associated with a normal distribution are the average (or mean), standard deviation, and cumulative probability. The standard deviation is a quantification of how dispersed a set of data is. The cumulative probability is the probability a value is less than or equal to a specified value of the normal distribution. These values can be determined using Equation 1 through Equation 5 and can be calculated in Excel using the Excel functions in Equation 6 through Equation 9.

$X_i =$ the individual value of each measurement in the data set

$n =$ the total number of values in the data set

$\mu =$ the mean value of the data set

$\sigma =$ the standard deviation of the data set

$CDF_i =$ the cumulative probability from the cumulative distribution function of a normal distribution

$erf =$ the error function associated with the cumulative distribution function

$p =$ a specified cumulative probability

$QF_i =$ the data value for a specified cumulative probability

$$\mu = \frac{1}{n}\sum_{i=1}^{n} X_i \quad \textbf{Equation 1}$$

$$\sigma = \sqrt{\frac{\sum_{i+1}^{n}(X_i - \mu)^2}{n-1}} \quad \textbf{Equation 2}$$

$$CDF_i = \frac{1}{2}\left[1 + erf\left(\frac{X_i - \mu}{\sigma\sqrt{2}}\right)\right] \quad \textbf{Equation 3}$$

$$erf(x) = \frac{2}{\sqrt{\pi}}\int_0^x e^{-t^2}\,dt \quad \textbf{Equation 4}$$

$$QF_i = \mu + \sigma\sqrt{2}erf^{-1}(2F - 1)$$ **Equation 5**

$\mu =$ AVERAGE(Range of Values) **Equation 6**

$\sigma =$ *STDEV(Range of Values)* **Equation 7**

$$CDF_i = NORM.DIST(X_{i,}\mu, \sigma, TRUE)$$ **Equation 8**

$$QF = NORM.INV(p, \mu, \sigma)$$ **Equation 9**

Outliers and Extreme Values

An outlier and extreme value is any value observed to lie at an abnormal distance from the other values in a data set. These abnormal distances can be quantified using Tukey's schematic box plot method. This method uses the 25th and 75th percentiles of the normal distribution to define an interquartile range (IQR) encompassing 50% of the population. From the IQR, inner and outer fences can be established outside of the 25th and 75th percentiles. An outlier is considered to be any value that is beyond the inner fence. An extreme value is considered to be any value that is beyond the outer fence. These values can be determined using Equation 10 through Equation 14 and can be calculated in Excel using the Excel functions in Equation 15 and Equation 16.

$\mu =$ the mean value of the data set

$\sigma =$ the standard deviation of the data set

$Q_1 =$ the 25th percentile of the normal distribution (value at the cumulative probability of 0.25)

$Q_3 =$ the 75th percentile of the normal distribution (value at the cumulative probability of 0.75)

$IQR =$ the interquartile range of the normal distribution

$LOF =$ the outside fence of the lower 25th percentile

$LIF =$ the inside fence of the lower 25th percentile

$UIF =$ the inside fence of the upper 75th percentile

$UOF =$ the outside fence of the upper 75th percentile

$$IQR = Q_3 - Q_1$$ **Equation 10**

$$LOF = Q_1 - 3 * IQR$$ **Equation 11**

$$LIF = Q_1 - 1.5 * IQR$$ **Equation 12**

$$UIF = Q_3 - 1.5 * IQR$$

Equation 13

$$UOF = Q_3 - 3 * IQR$$

Equation 14

$$Q_1 = NORM.INV\left(0.25, \mu, \sigma\right)$$

Equation 15

$$Q_3 = NORM.INV\left(0.75, \mu, \sigma\right)$$

Equation 16