Managing System Integrity for Hazardous Liquid Pipelines

Pipeline Segment

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FOREWORD

Regulatory Requirements for Pipeline Integrity Management

This standard—Managing Pipeline System Integrity for Hazardous Liquid Pipelines—provides guidance to the pipeline industry for managing integrity. It is important that operators using this standard understand the Federal pipeline safety requirements for pipeline integrity management in high consequence areas when establishing or enhancing their integrity management programs. Although pipeline operators must comply with the pipeline safety regulations, a robust, high quality pipeline integrity program requires more than a compliance approach to managing pipeline integrity. Operators should build upon the foundation established by the regulations to develop an integrity management program that best serves their unique operational needs. To assist users of the standard, this foreword provides a summary of the regulatory requirements for integrity management.

Effective May 29, 2001, the *Code of Federal Regulations (CFR)* governing hazardous liquid pipeline operation and maintenance was amended to establish new requirements for "*Pipeline Integrity Management in High Consequence Areas*" (49 *CFR* 195.452, referred to here as "the rule")[1] . The purpose of these new requirements is to enhance and validate pipeline integrity, and provide improved protection for high consequence areas that could be affected by an unintended release of hazardous liquids from a pipeline system.

High consequence areas are defined in 49 *CFR* 195.450 as:

1. A *high population area*, which means an urbanized area, as defined and delineated by the U.S. Census Bureau, that contains 50,000 or more people and has a population density of at least 1,000 people per square mile.
2. An *other populated area*, which means a place, as defined and delineated by the U.S. Census Bureau, that contains a concentrated population, such as an incorporated or unincorporated city, town, village, or other designated residential or commercial area.
3. A *commercially navigable waterway*, which means a waterway where a substantial likelihood of commercial navigation exists. These waterways are identified in the National Waterways Network, a geographic database created by the National Waterways GIS Design Committee.
4. An *area of the environment that has been designated as unusually sensitive to oil spills* (an "unusually sensitive area" or USA). USAs are defined in 49 *CFR* 195.6.

This API standard includes guidance for complying with these requirements based on proven industry practices for managing pipeline system integrity. The following discussion provides a description of the requirements in 49 *CFR* 195.452, and identifies the location in this standard where guidance and information is provided to facilitate operator compliance.

The rule requires that operators develop and implement a written integrity management program. This integrity management program must include:

- An identification of all pipeline segments that could affect a high consequence area in the event of a pipeline failure.
- A plan for conducting baseline assessments of the line pipe in these segments.
- A framework that addresses how each element of the operator's integrity management program will be implemented.

Pipeline segments that could impact high consequence areas must be identified by December 31, 2001. The Baseline Assessment Plan and framework must be completed by March 31, 2002. Section 5 of this standard provides an overview of a pipeline integrity management program, and the steps necessary to craft the required framework.

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[1]This rule applies to operators who own or operate 500 or more miles of hazardous liquid pipeline. At the time this standard was being prepared, a similar rule covering other hazardous liquid pipeline operators was in preparation.

The Baseline Assessment Plan for assessing the condition of line segments that could affect high consequence areas must:

1. Identify all line segments that could affect a high consequence area. Section 6 of this standard describes where to get information on the location of high consequence areas and how to determine if a line or line segment could affect a high consequence area.
2. Specify the method(s) used to assess pipeline integrity for each segment. The acceptable methods for conducting integrity assessments are pressure testing, instrumented internal inspection[2], or another technology that the operator demonstrates can provide an equivalent understanding of the pipe's condition.
3. Provide a schedule for completing the initial integrity assessment for each segment.
4. Explain the technical basis for the integrity assessment method(s) selection and the evaluation of risk factors considered in scheduling the assessment. Sections 7 and 8 of this standard provide guidance for selecting important risk factors and prioritizing segments for scheduling integrity assessments. Section 9 describes the different integrity assessment methods and tools, and important considerations in determining the appropriate approach for a particular situation.

The Baseline Assessment Plan must be available for review by the U.S. DOT Office of Pipeline Safety (OPS) during inspections. Operators should periodically review this plan to be sure it continues to reflect the appropriate priorities in conducting integrity assessments for line segments that may impact high consequence areas. If necessary, the Baseline Assessment Plan may be revised to reflect new operating experience, the insights gained from the initial integrity assessments, and other maintenance and surveillance data.

Although the rule requires a Baseline Assessment Plan only for segments that could affect high consequence areas, an operator may find that such a plan is useful for its entire system, and could expand the scope of its program accordingly. The guidance provided in this standard is suitable for complete pipeline systems and is not limited to high consequence areas.

The rule requires operators to perform a baseline integrity assessment by March 31, 2008 for all pipeline segments that could affect a high consequence area. Furthermore, fifty percent of this pipeline mileage must be assessed by September 30, 2004, beginning with the highest risk segments. Operators, who have performed and documented integrity assessments after January 1, 1996, may use these assessments to validate line integrity if the assessment approach and documentation are consistent with the provisions of the rule.

In evaluating the results of the integrity assessment, operators must integrate information from other relevant sources with the inspection or testing results to fully identify and characterize the potential threats to pipeline integrity. Other information sources might include cathodic protection system data, close interval surveys, results of previous internal inspections, operating and leak history, patrolling reports, exposed pipe reports, etc. Section 7 of this standard addresses gathering, reviewing, and integrating information and data. From this evaluation, the operator should identify the location, nature, and relative risk of features that could threaten pipeline integrity. Operators must use a risk-based approach in prioritizing repair and mitigation activities, in which any defects or other features that have the potential to result in a near-term leak or failure are addressed promptly. The rule establishes specific time limits by which certain anomalies identified by in-line inspection must be repaired or mitigated. Section 9 provides additional guidance for prioritizing and scheduling anomalies.

As an integral part of a continuing integrity management program, the rule also requires that operators periodically reassess pipeline integrity on line segments that could affect high consequence areas at intervals not to exceed five years. The risk represented by the segment should be used to establish the appropriate assessment interval within this five-year period. Operators may be allowed variances from this five-year interval if a reliable engineering evaluation in combination with other activities such as external monitoring provide a compa-

[2]For low frequency, electric resistance welded (ERW) pipe or lap welded pipe subject to longitudinal seam failures, an operator must select a method capable of assessing seam integrity, and capable of detecting corrosion and deformation anomalies.

rable understanding of the pipe's condition. The risk assessment methods described in Section 8 provide one approach for establishing a technical justification for longer inspection intervals. Variances may also be allowed if a particular assessment technology desired for a given segment(s) is not available (e.g., new, more sophisticated internal inspection devices). Operators requesting such variances must notify OPS in advance and maintain documentation justifying these decisions.

After completing a baseline assessment, an operator must conduct a risk analysis for the line segments that could affect high consequence areas. This analysis should identify and evaluate the need for additional preventive and mitigative actions to protect high consequence areas. Such actions might include enhancing damage prevention programs, improved cathodic protection monitoring, reducing surveillance and inspection intervals, enhanced training, conducting drills with emergency responders, and other management controls. Section 10 describes a number of common preventive and mitigative risk control measures that can be used to provide additional protection. Operators must also explicitly evaluate the need for Emergency Flow Restricting Devices and enhancements to leak detection systems to protect high consequence areas. The rule provides important factors to be considered in performing these evaluations.

As noted previously, the rule requires an operator to develop and implement an integrity management program. This program must include the following elements:

- A process for determining which pipeline segments could affect a high consequence area (Section 6 of this standard).
- A Baseline Assessment Plan (Section 9).
- A process for periodic integrity assessment and evaluation of segments that could affect high consequence areas (Sections 9 and 11).
- An analytical process that integrates all available information about pipeline integrity and the consequences of a failure (Section 7 discusses information sources, and Section 8 describes a risk assessment process that integrates this data to identify pipeline risks).
- Repair or mitigation to address issues identified by the integrity assessment method (Section 9).
- A process to identify and evaluate preventive and mitigative measures to protect high consequence areas (Section 8 describes a risk-based process for making these determinations).
- Methods to measure the integrity management program's effectiveness (Section 13).
- A process for review of integrity assessment results and data analysis by a qualified individual.

An operator's approach for developing and implementing each of these elements must be addressed in the framework.

Finally, the rule identifies records that must be maintained by the operator. An operator must have a written integrity management program description that includes how each element of its integrity management program is implemented. Documentation supporting the decisions and analyses performed as part of the program are also identified. It is important that the operator have documented technical justification for key integrity management decisions, as well as for any variances or deviations allowed by the rule.

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1 Introduction

1.1 PURPOSE AND OBJECTIVES

The goal of the operator of any pipeline is to operate the pipeline in such a way that there are no adverse effects on employees, the environment, the public, or their customers as a result of their actions. They do this while they fill the needs of the customer and earn a reasonable return on their investment. The goal is error-free, spill-free, and incident-free operation of the pipeline.

An integrity management program provides a means to improve the safety of pipeline systems and to allocate operator resources effectively to:

- Identify and analyze actual and potential precursor events that can result in pipeline incidents.
- Examine the likelihood and potential severity of pipeline incidents.
- Provide a comprehensive and integrated means for examining and comparing the spectrum of risks and risk reduction activities available.
- Provide a structured, easily communicated means for selecting and implementing risk reduction activities.
- Establish and track system performance with the goal of improving that performance.

This standard outlines a process that an operator of a pipeline system can use to assess risks and make decisions about risks in operating a hazardous liquid pipeline in order to reduce both the number of incidents and the adverse effects of errors and incidents. Section 5 describes the integrity management framework that forms the basis of this standard. This framework is illustrated schematically in Figure 5-1. This standard also supports the development of integrity management programs required under Title 49 *CFR* 195.452 of the federal pipeline safety regulations.

This standard is intended for use by individuals and teams charged with planning, implementing, and improving a pipeline integrity management program. Typically a team would include engineers, operating personnel, and technicians or specialists with specific experience or expertise (corrosion, in-line inspection, right-of-way patrolling, etc.). Users of this standard should be familiar with the pipeline safety regulations (Title 49 *CFR* Part 195), including the requirements for pipeline operators to have a written pipeline integrity program, and to conduct a baseline assessment and periodic reassessments of pipeline management integrity.

1.2 GUIDING PRINCIPLES

In developing this standard on managing pipeline system integrity, certain guiding principles underlie the entire document. These principles are reflected in many of the sections and are provided here to give the reader the sense of the need to view pipeline integrity from a broad perspective.

Integrity must be built into pipeline systems from initial planning, design, and construction. Integrity management of a pipeline starts with the sound design and construction of the pipeline. Guidance for new construction is provided in a number of consensus standards, including ASME B31.4, as well as the pipeline safety regulations. As these standards and guidelines are applied to the design of a pipeline, the designer must consider the area the pipeline traverses and the possible impacts that the pipeline may have on that area and the people that reside in its vicinity. New construction is not a subject of this standard, but the design specifications and as-built condition of the pipeline provide important baseline information for an integrity management program.

*System integrity is built on qualified **people**, using defined **processes** to operate maintained **facilities**.* The integrity of the physical facility is only part of the complete system that allows an operator to reduce both the number of incidents and the adverse effects of errors and incidents. The total system also includes the people that operate the facility and the work processes that the employees use and follow. A comprehensive integrity management program should address people, processes, and facilities.

An integrity management program must be flexible. An integrity management program should be customized to support each operator's unique conditions. Furthermore, the program must be continually evaluated and modified to accommodate changes in the pipeline design and operation, changes in the environment in which the system operates, and new operating data and other integrity-related information. Continuous evaluation is required to be sure the program takes appropriate advantage of improved technology and that the program remains integrated with the operator's business practices and effectively supports the operator's integrity goals.

Operators have multiple options available to address risks. Components of the facility or system can be changed; additional training can be provided to the people that operate the system; processes or procedures can be modified; or a combination of actions can be used that will have the greatest impact on reducing risk.

The integration of information is a key component for managing system integrity. A key element of the integrity management framework is the integration of all available information in the decision making process. Information that can impact an operator's understanding of the important risks to a pipeline system comes from a variety of sources. The operator is in the best position to gather and analyze this information. By integrating all of the available information,

the operator can determine where the risks of an incident are the greatest, and make prudent decisions to reduce these risks.

Preparing for and conducting a risk assessment is a key element in managing pipeline system integrity. Risk assessment is an analytical process through which an operator determines the types of adverse events or conditions that might impact pipeline integrity, the likelihood that those events or conditions will lead to a loss of integrity, and the nature and severity of the consequences that might occur following a failure. This analytical process involves the integration and analysis of design, construction, operating, maintenance, testing, and other information about a pipeline system. Risk assessments can have varying scopes, varying levels of detail, and use different methods. However, the ultimate goal of assessing risks is to identify and prioritize the most significant risks so that an operator can make informed decisions about these issues.

Assessing risks to pipeline integrity is a continuous process. Analyzing for risks in a pipeline system is an iterative process. The operator will periodically gather additional information and system operating experience. This information should be factored into the understanding of system risks. As the significance and relevance of this additional information to risk is understood, the operator may need to adjust its integrity plan accordingly. This may result in changes to inspection methods or frequency, or additional modifications to the pipeline system in response to the data. As changes are made, different pipelines within a single operating company and different operators will be at different places with regard to the goal of incident-free operation. Each pipeline system and each company will need specific goals and measures to monitor the improvements in integrity and to assess the need for additional changes.

Mitigative actions are taken for injurious defects. Operators should take action to address integrity issues raised from assessments and information analysis. Operators should evaluate anomalies and identify those that are injurious to pipeline integrity. Operators should take action to mitigate or eliminate injurious defects.

New technology should be evaluated and utilized, as appropriate. New technology must be understood and incorporated into integrity management programs. Such new technology can enhance an operator's ability to assess risks and the capability of analytical tools to assess the integrity of system components.

Operators should periodically assess the capabilities of new technologies and techniques that may provide improved understanding about the pipe's condition or provide new opportunities to reduce risk. Knowledge about what is available and effective will allow the operator to apply the most appropriate technologies or techniques to a specific risk to best address potential impacts.

Pipeline system integrity and integrity management programs should be evaluated on a regular basis. The Office of Pipeline Safety provides a periodic review of the integrity management program for the operator through its enforcement personnel. Operators are encouraged to perform internal reviews to ensure the effectiveness of the integrity management program in achieving the program's goals. Some operators may choose to use the services of third parties to assist with such evaluations

2 Scope

This standard is applicable to pipeline systems used to transport hazardous liquids as defined in Title 49 *CFR* 195.2. The use of this standard is not limited to pipelines regulated under Title 49 *CFR* 195.1, and the principles embodied in integrity management are applicable to all pipeline systems.

This standard is specifically designed to provide the operator with a description of industry proven practices in pipeline integrity management. The guidance is specific to the line pipe along the right-of-way, from scraper trap to scraper trap, but the process and approach can and should be applied to all pipeline facilities, including pipeline stations, terminals and delivery facilities associated with pipeline systems. Certain sections of this standard provide guidance specific to pipeline stations, terminals, and delivery facilities.

3 References

3.1 REFERENCED CODES, GUIDES, AND STANDARDS

API	
Std 5T1	*Imperfection Terminology*
RP 1110	*Pressure Testing Liquid Pipelines*
Publ 1156	*Effects of Smooth and Rock Dents on Liquid Petroleum Pipelines*
RP 579	*Fitness for Service*
Std 653	*Tank Inspection, Repair, Alteration, and Reconstruction*
API 570	*Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In-service Piping Systems*
DOT[1]	
49 *CFR* Part 195	*Transportation of Hazardous Liquids by Pipeline*
ASME[2]	
B31.4	*Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids*

[1]U.S. Department of Transportation, 400 7th Street, S.W., Washington D.C. 20590.
[2]ASME International, 3 Park Avenue, New York, New York 10016-0518.