

AN IO MOSAIC SERVICE

THE CLOCK IS RUNNING FOR HAZARDOUS LIQUID PIPELINE ASSESSMENTS

OVERVIEW

The Office of Pipeline Safety (OPS) Integrity Management (IM) rule (49 CFR 195.452) applies to hazardous liquid pipelines under the jurisdiction of 49 CFR Part 195. The compliance dates for certain provisions depend on the length of the line and the date of ownership. Pipelines are classified as Category 1 or 2, based on the profile of the owner/operator of the lines on May 29, 2001. A company is in Category 1 if they own/operate more than 500 miles (in aggregate) of covered pipelines. Otherwise they are Category 2. The pipeline classification is a Category 3, for owners of new or converted pipelines after that date. The transfer of ownership of an existing pipeline after May 29, 2001 does not affect the initial classification, regardless of the classification on the new owner. A pipeline that was Category 2 on May 29, 2001 remains Category 2, even if later it is acquired by a company with more than 500 miles of covered pipelines.



TABLE 1: TIME TABLE

The compliance dates for completion of various requirements for pipelines affecting high consequence areas (HCAs) differ for each category and

are summarized in the table below. **Note that the due date for baseline assessments for Category 2 pipelines is less than a year away.*

Integrity Management Requirements				
Pipeline	Identification of pipeline segments affecting HCAs	Written integrity management plan	Baseline assessments of 50% of lines affecting HCAs	Complete baseline assessments no later than:
Category 1 Dates:	December 31, 2001	March 31, 2002	September 30, 2004	March 31, 2008
Category 2 Dates:	November 18, 2002	February 18, 2003	August 16, 2005	February 17, 2009
Category 3 Dates:	Date of operation	1 year after startup	Not Applicable	Date of Operation



BASELINE ASSESSMENT REQUIREMENTS

A baseline assessment that complies with the IM rule must include:

1. The methods selected to assess the integrity of the line pipe
 - ◆ internal inspection tools capable of detecting corrosion and deformation anomalies
 - ◆ pressure testing conducted in accordance with subpart E
 - ◆ other demonstrated technology that provides an equivalent understanding of the condition of the line pipe.
2. A schedule for completing the integrity assessment
3. An explanation of the assessment methods selected and evaluation of the risk factors considered in establishing the assessment schedule

In establishing the integrity management assessment schedule, the operator must base the scheduled interval on all risk factors that reflect the risk conditions of the pipeline segment.

The rule also requires the operator to take measures to prevent and mitigate the consequences of pipeline failure that affect a HCA. These measures include conducting a risk analysis of the pipeline segments to identify additional actions to enhance public safety or protect the environment. As part of the risk analysis, an operator must evaluate the likelihood of a pipeline release occurring and how a release could affect an HCA.

Hence, conducting a risk assessment fulfills the requirement for setting the IM assessment interval and for identifying additional preventive and mitigative measures.

RISK ASSESSMENT PROCESS

The methodology for the IM risk assessment generally follows the well established steps of formal quantitative risk assessment with some modifications as noted.

Acquiring Information

The type of information required in paragraphs (e) and (g) of 195.542 is a good starting point. Pipeline operators should be collecting this information to comply with the information analysis and the risk factors that need to be considered. This and other information that will be needed is summarized in Table 2.

Segmentation

The IM rule requires the operator to define pipeline segments that can affect an HCA. The segment size should be determined by whether or not a spill could migrate into and affect an HCA. For some segments (when most of the pipeline is in an HCA), further subdivision of the pipeline route may be appropriate to account for variables that can affect the impacts and risk, such as pipe wall thickness, terrain (sloping, subsea), type of HCA (densely populated vs. environmentally sensitive).

Hazard Analysis (Identification and Risk Ranking)

Most process hazard analysis (PHA) techniques can be employed for the hazard analysis. Since HAZOP is incorporated into many company PHA procedures, it may be selected for consistency. Because pipeline systems are mechanically quite similar, albeit with different MAOPs and control systems, the use of a generic What-if approach can be quite effective. A set of what-if questions for line pipe, pumps, pig launchers/receivers, SCADA systems, etc., can be developed and preloaded into the recording software prior to the hazard analysis session. Additional team generated What-if questions that arise can be added during the review sessions.

The risk level for each What-if that generates a release scenario, needs to be considered and assigned. Typically this is done by applying risk ranking and tolerability criteria developed by the owner/operator, often in the form of a risk matrix. Each scenario is assigned a consequence and likelihood category based on the combined knowledge of the review team. The risk level is then determined from the risk ranking matrix. The assigned consequence category needs to be reviewed again when the results of the consequence analysis are completed.

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TABLE 2: INFORMATION FOR IM RISK ASSESSMENT

Information Category	Data	Affect on Risk of Pipeline Failure
Design Conditions		
	Product transported (highly volatile, highly flammable and toxic liquids present greater threat)	Consequence
	Design MAOP for each pipe size and wall thickness, Pump capacity/head curve	Consequence
Pipeline		
	Pipe wall thickness (thicker walls give better safety margin)	Frequency
	Size of pipeline and spacing of block valves (i.e., amount of product that could be released)	Consequence
	ROW strip maps, elevation of pipeline	Frequency / Consequence
	Age of pipe	Frequency
	Operating stress levels in pipeline. Exposure of pipeline to exceeding MAOP	Frequency
	Leak history	Frequency
	Know corrosion or condition of pipeline	Frequency / Consequence
	Cathodic protection history	Frequency
	Type, quality, and condition of pipe coating	Frequency
	Results of previous testing and inspection	Frequency
	Time since last internal inspection / pressure testing	Frequency
	Previously discovered defeats / anomalies, including type, growth rate, and size	Frequency / Consequence
	Physical support of the segment such as by cable suspension bridge, free spans	Frequency
	Non-standard or other than recognized industry practice on pipeline installation (e.g., horizontal directional drilling)	Frequency
	Location of pipeline segment as it relates to the ability to detect and respond to a leak (e.g., pipelines deep underground, or in locations that make leak detection difficult without specific sectional monitoring and/or significantly impede access to spill response or any other purpose)	Consequence
SCADA System		
	Functional description, leak detection capability and sensitivity for small and large leaks	Consequence
Location		
	Populated areas, unusually sensitive environmental areas, commercially navigable waters, HCA site summary sheets. Maps showing details of populated areas	Impact
	Location related to potential ground movement (e.g., seismic faults, rock quarries, etc.); climatic (permafrost); geology (landslides or subsidence)	Frequency / Consequence
	Terrain surrounding the pipeline including elevation profile, farm drains tiles, culvers, etc.	Consequence / Impact



Consequence Analysis

Using the results of the PHA, representative release scenarios for each segment are defined by cause and location. A range of leak hole sizes is selected to adequately cover the different scenario causes. Release rates and pool sizes are then determined using flow models contained in SuperChems™. For flammable and or toxic liquids, fire radiation and toxic hazard zones are computed by SuperChems™ hazard models.

The impact of the hazard zones is then determined by overlaying them on maps showing HCAs along the segment ROW. The area of the spill and the potential of impacting human populations (e.g., fire radiation, toxicity) provide a measure of the seriousness of the impact. This information should be recycled back to the prior PHA to allow a reality check on the initial consequence category selected for the scenario.

Risk Presentation

The risk is portrayed by tabulating consequence/frequency pairs for the selected scenarios on each segment, in descending order of consequence or frequency. For each scenario, the hazard zone distance for each outcome (spill, fire, toxic vapor) is presented. For fire and toxic vapor outcomes, the scenario frequency category should be adjusted to account for conditional probabilities such as probability of ignition, and population presence. The derivation of adjustment factors can be depicted by a simple event tree.

Risk Mitigation Actions

By reviewing the risk parameters of each scenario outcome, the high frequency and high consequence releases can be identified and prioritized. The high priority release scenarios should then be reviewed to determine whether there are additional practical engineered or administrative controls that can be applied to further reduce the frequency and/or consequences of potential pipeline failure events.

IO MOSAIC EXPERIENCE

- ◆ *For an independent petroleum company operating in California, our principals conducted risk assessments of two separate hazardous liquid pipeline systems for compliance with 49 CFR 195.542. The hazardous liquids included petroleum emulsion and treated crude oil. For one system, the produced fluids originated from a sour field. During this assignment, our safety engineers reviewed the IM information compiled by the operator, conducted a process hazard analysis, interviewed operations and technical staff, and surveyed the pipeline right-of-way and associated high consequence areas (HCAs).*

The information and knowledge obtained was used in the preparation of the risk assessment, which included the quantification of spill release rates and resulting spill areas and thermal radiation and/or toxic hazard zone. The hazard zone quantification was performed using advanced consequence modeling tools in SuperChems™ (see description below).

Impact frequencies for each release scenario outcome were developed and used in conjunction with the consequence analysis to assess the risk level of each scenario. In some cases, additional engineered or administrative controls were recommended to further reduce the overall risk. Assuming these measures were to be implemented, we recommended an appropriate interval for future IM assessments.

- ◆ *SuperChems™ is an advanced tool for pressure relief design, consequence analysis, and thermal hazards assessment. Developed by ioMosaic, SuperChems™ helps companies meet process safety design objectives and management needs. Its rigorous modeling capabilities enable companies to make technically sound decisions about key process design issues.*

ABOUT US

ioMosaic Corporation was founded by former Arthur D. Little Inc., senior staff to provide process safety and risk technology consulting services and software solutions. Our areas of expertise include runaway reactions, pressure relief design, incident investigation, process hazard analysis, engineering design and support, consequence and risk analysis, and fire and explosion dynamics. We also provide training and litigation support in our areas of expertise. At ioMosaic, we are discovering solutions to safety, risk, and business challenges facing our clients.

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