Pipeline Pressure Cycle Management

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Introduction

This recommended practice (RP) provides guidance to the pipeline industry for assessment and management of pressure cycling in liquid and gas pipeline systems. The pressure cycle management RP includes:

— Overview and Leadership Commitment (Section 4)

— Communication and Engagement Strategies (Section 5)

— Factoring in Fatigue Life on Pipeline Design (Section 6)

— Development of Metrics and Measures (Section 7)

— Approaches to Fill Knowledge Gaps on Historical Operation (Section 8)

— Pressure Cycling Analytics to Identify At-Risk Assets (Section 9)

— Cross Functional Teams (Section 10)

— Management of Change (Section 11)

— Consistency and Repeatability (Section 12)

— Parameters that Impact Integrity Sensitivity to Pressure Cycling (Section 13)

— Establishing Thresholds or Actionable Levels (Section 14)

— Cyclic Operational Pressure Severity Analysis and Trending (Section 15)

— Methodologies for Reducing Pressure Cycles (Section 16)

This RP is intended for use by operators in planning, implementing, and improving a pipeline pressure cycle management program.

The information and procedures provided in this document are applicable to both gas and liquid pipelines located in any location or under any jurisdiction.

The information provided in this document may be used to support pipeline operational and integrity management programs. Pressure cycle management may be used to consider the life assessment of pipeline anomalies that respond, accumulate damage or grow due to pipeline internal pressure cycling.

Pipeline Pressure Cycle Management

1 Scope

This recommended practice (RP) was developed to support the management of hazardous liquid or natural gas pipeline systems; however, the processes and procedures are applicable to any pressure retaining system subjected to internal pressure fluctuations. This RP includes detailed technical discussion on data collection, analysis and interpretation of operational internal pressure cycling to support the development, implementation and execution of a Pressure Cycle Management (PCM) program. This RP describes preventive and mitigative measures that pipeline operators can apply to manage the potential threats of cyclic operating pressure in pipes, fittings and vessels. The in-service monitoring and response to pressure cycling is discussed in detail.

The factors that promote internal operational pressure cycling as a threat to asset integrity or reduce asset life are discussed in detail. Methods for collecting operating pressure data and developing metrics that characterize the rate of resulting crack initiation and growth are presented. The benefits of applying the PCM techniques presented in this RP are applicable to the mitigation of all features that have the potential to form cracks due to cyclic loading such as dents, and weld anomalies. In addition, PCM may be of particular interest to pipeline systems in environments or transporting fluids that make them more susceptible to fatigue, such as hydrogen service, While the primary focus of this RP is on pipe internal pressure cyclic loading, the concepts that are presented may be applied to other cyclic load effects such as those associated with temperature fluctuation.

This RP is specifically designed to provide the operator with guidelines on industry-proven practices related to PCM. The guidance is largely targeted to the onshore line pipe and weldments along the right-of-way, but some of the processes and approaches can be applied to pipeline facilities, including pipeline stations, terminals, and delivery facilities associated with pipeline systems. The techniques may also be of interest for offshore pipeline assets with additional attention paid to the differences from onshore assets in terms additional loading and unique operational challenges.

This RP includes a guidance related to development of multi-disciplinary PCM program team, program and its results. Good practice in system design for fatigue resistance or operational pressure cycle tolerance is provided along with suggested approaches to reduce operational pressure cycling in pipeline systems.

2 Normative References

ASTM Standard E 1049, *Standard Practices for Cycle Counting in Fatigue Analysis, 1985, Reapproved 1997* [1].

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
cycle counting
Technique to estimate the number of known amplitude cycles in a variable amplitude loading time history.

3.1.2
cyclic pressure spectrum
Statistical representation (histogram or load table) of the frequency of pressure changes observations.

3.1.3
fatigue crack growth threshold
Defines the conditions under which a crack in a material will not propagate under cyclic loading. In fracture mechanics, no significant crack growth occurs below the stress intensity factor threshold range (ΔK_{th}).