Assessment and Management of Cracking in Pipelines

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Introduction

This recommended practice (RP) provides guidance to the pipeline industry for assessment and management of crack-related anomalies, with emphasis on contributing threats and appropriate assessment methods. The RP offers detailed guidance for developing a comprehensive crack management program, including the following:

— selecting appropriate methods to assess pipeline condition with respect to applicable forms of cracking;

— establishing response criteria for in-line inspection (ILI) results and determining a pressure reduction where the excavation is delayed;

— determining appropriate hydrostatic test levels and duration when necessary;

— calculating the remaining life of anomalies to schedule reassessment or remediation when necessary;

— developing preventive and mitigative measures for cracking-related conditions in lieu of or in addition to periodic integrity assessment.

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

The genesis and structure of this RP is the API 1160, *Managing System Integrity for Hazardous Liquid Pipelines*, for liquid hazardous pipelines regulated under U.S. Department of Transportation (DOT) 49 C*ode of Federal Regulations* (*CFR*) 195.452. This RP is written as a broadly applicable framework for both hazardous liquid and gas pipelines located in any location or under any jurisdiction. It augments API 1160 in aiding the development of integrity management programs (IMPs) that are required under U.S. federal pipeline safety regulations.

This RP is meant to be current as of the date of publication, but management of cracking threats is an active topic of industry research. Readers are encouraged to consult recent industry research, which is often funded by organizations such as Pipeline Research Council International (PRCI) and API, as well as individual pipeline and oil and gas companies, for more recent findings and recommendations.

Assessment and Management of Cracking in Pipelines

1 Scope

This recommended practice (RP) is applicable to any pipeline system used to transport hazardous liquid or natural gas, including those defined in U.S. Department of Transportation (DOT) Title 49 *Code of Federal Regulations (CFR)* Parts 195 and 192, respectively.

This RP summarizes industry-proven practices, and it provides background knowledge needed to manage cracks and threats that cause cracking on pipelines. The guidance in this RP targets pipelines along the right-of-way (ROW), but some of the processes and approaches can be applied to pipeline facilities, such as stations, terminals, and delivery facilities associated with pipeline systems.

This RP provides pipeline industry's current understanding of pipeline cracking. It gives guidance on mechanisms that cause cracking, how to estimate crack growth, and how to estimate the pressure capacity of cracked pipe. It discusses selection of appropriate integrity assessment methods for various types of cracking, operating conditions, and pipeline characteristics, and it reviews current knowledge about in-line inspection (ILI) technology and in-the-ditch (ITD) nondestructive evaluation technology. A methodology for responding to ILI-reported features, specific criteria for when to respond to certain results, and applicable repair techniques are reviewed. The RP discusses reassessment interval determination and appropriate preventive and mitigative measures. Finally, some meaningful performance metrics for measuring the effectiveness of a crack management program are discussed.

The document uses the terms *limit state* and *loss of containmen*t in place of *failure*. Limit state refers to any situation or event that may prevent the pipeline from operating as intended. Examples include situations that may lead to releases, such as leaks or ruptures, and conditions or events that may preclude operations, such as buckling that reduces the pipeline diameter below acceptable limits. Consequently, common industry terms, such as *failure pressure ratio,* have been replaced with *limit state pressure ratio* (LSPR).

This RP does not cover defects associated with the seam of lap-welded (LW) pipe and selective seam weld corrosion (SSWC). Defects associated with the seam of LW pipe require additional considerations not covered here. SSWC has sometimes been treated as a crack by the pipeline industry, but whether it should be treated as a crack and which material properties to use is a subject of active research. Dents and other forms of mechanical damage are also not covered in detail. Additional guidance for assessing mechanical damage is given in API 1183. See API 1160 for guidance on these and other defects that could be considered crack-like but are not covered in this document.

While the principles in this document may apply to pipelines carrying hydrogen, hydrogen blends, CO_2, or other non-hydrocarbon products, threats unique to those products are not considered. See API 1192 for additional guidance on CO_2 pipelines. Guidance regarding hydrogen, hydrogen blend, and other non-hydrocarbon pipelines can be found in other industry standards and RPs or is in development.