Assessment and Management of Pipeline Dents

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Introduction

This Recommended Practice (RP) provides guidance to the pipeline industry for assessing and managing dents present in pipeline systems as a result of mechanical contact by rocks, machinery, or other forces. Emphasis is placed on conditions where dents are either closely aligned or coincident with other threats, and the applicable data screening and assessment methods available to guide decision making on mitigation, remediation, or repair. Additional emphasis is placed on the pipeline operational parameters and the influence of those parameters on dent fatigue.

The RP presents comprehensive guidance for developing a dent assessment and management program including:

1) Selecting suitable methods for inspecting and characterizing the condition of the pipeline with respect to dents;

2) Establishing data screening processes to evaluate dents relative to extent and degree of deformation and operational severity;

3) Provide response criteria for dents based upon the dent shape and profile as determined by in-line inspection;

4) Applying engineering assessment methods to evaluate fitness-for-service of dents including reassessment interval;

5) Presenting remediation and repair options to address dents;

6) Developing preventive and mitigative measures for dents in lieu of, or in addition to, periodic dent integrity assessment, including pressure reductions and pressure cycle management.

This document provides guidance on elements of an engineering critical assessment for dents to determine fitness- for-service.

This RP may be used to supplement requirements included in 49 *CFR* 195, 49 *CFR* 192, CSA Z662, SOR/99-294, and other integrity management codes and standards. The RP provides the process and tools to conduct screening and engineering assessment (e.g., fitness for purpose, engineering critical assessment) for dents. These processes and tools represent criteria for the assessment of dents accounting for the factors that lead to pipeline failures caused by dents.

While this RP is generally applicable to all pipeline systems, it does not:

— include detailed requirements for new construction to prevent dents. For information on this, reference API 1169 and API 1177,

— provide guidance on prevention of dents in-service,

— outline design precautions for preventing and limiting susceptibility to denting,

— provide guidance on the assessment of wrinkles, ripples, long seam misalignment, ovalized bends, or buckles, and

— explicitly identify the differences between onshore and offshore pipeline systems.

This RP is intended for use by pipeline operators to support planning, developing, implementing, and improving a pipeline dent management program. This RP is closely aligned with and augments the API 1160 RP for liquid hazardous pipeline integrity management. It is also equally applicable to natural gas pipeline systems, and is written as a framework for both hazard liquid and gas pipelines.

This RP provides guidance based upon an understanding of the current state of industry knowledge and expertise. Research to improve upon the current state of knowledge continues and it is expected that this RP will be updated to incorporate future enhancements in industry knowledge and expertise.

A prior API publication, API Publication 1156, described the effects of dents on liquid petroleum pipelines but was issued prior to the hazardous liquids pipeline integrity management rule. The RP provides the current industry understanding of dent formation and post-formation behavior and response to environmental and operational factors. This understanding is based on the practical experience of pipeline operators that have been managing dents under the pipeline integrity management regulations included in 49 CFR §192 and §195 and integration of over 20 years of research on dents through work completed by the pipeline industry.

Assessment and Management of Pipeline Dents

1 Scope

This recommended practice (RP) is applicable to any pipeline system used to transport hazardous liquid or natural gas. This RP includes detailed technical discussion on dent formation, strain and fatigue, and failure modes and mechanisms. These details are provided to give pipeline operators the information and knowledge necessary to make informed integrity management decisions regarding the management of dents on their systems. This RP describes preventive and mitigative measures that pipeline operators can apply to manage dents after detection. The in-service response of dents to a range of loading conditions is discussed in detail.

Mechanisms that promote denting are discussed, methods to inspect dents are described, and approaches and tools to estimate dent fitness-for-service (i.e., dent formation induced cracking, failure pressure, and pressure cycling fatigue life) are presented. Selection of the appropriate dent integrity assessment methods and integration of pipeline operating data is also discussed.

This RP is specifically designed to provide the operator with guidelines on industry-proven practices in the integrity management of dents. The guidance is largely targeted to the line pipe 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.

This RP includes a review of currently available in-line inspection (ILI) technologies for detecting and characterizing dents, and provides guidelines for collecting data in the ditch when excavation is performed based on ILI data review and the pipeline and dent is exposed. Data integration practices are also addressed. Mitigation and repair techniques and approaches are discussed.

This RP provides general information on the dent formation process and describes approaches to evaluate fitness-for-service of dents regarding their potential to reach a structural limit state. A limit state represents an operator-defined condition where the pipe is no longer fit for purpose. This document provides tools to address three primary limit states: formation strain, failure pressure, and fatigue damage. The document provides screening tools and detailed assessment methods to address each of these limit states. This methodology is consistent with other design and fitness-for-service codes that address both static and fatigue limit states[1].

In the context of plain dents, the assessment of formation strain is considered to be an indication of the potential for cracking due to dent formation, and has been included as part of ASME B31.8 since 2006.

The assessment of failure pressure is typically not performed for most dents. Plain dents regardless of shape with depths up to 10 % of the pipe diameter, without coincident features such as metal loss, welds, or cracks have been shown in testing to have the same failure pressure as plain line pipe[2]. Consequently, failure pressure is typically addressed for dents with coincident features or in detailed fitness-for-service assessments.

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[1] ASME *Boiler and Pressure Vessel Code*

[2] Bood, R., Gali, M., Marewski, U., Steiner, M., Zarea, M., “EPRG Methods for Assessing the Tolerance of and Resistance of Pipelines to External Damage (Parts 1 + 2),” European Pipeline Research Group (EPRG)