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RESPONSES OF PIPELINES IMPACTED BY GEOHAZARDS AND EFFECTIVE INTEGRITY MANAGEMENT STRATEGIES

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ABSTRACT

Geohazards are a major contributor to pipeline incidents. Numerous incidents attributable to geotechnical hazards are listed in advisory bulletins from US DOT PHMSA. In addition to geohazards, hydrotechnical and seismic hazards can damage or cause loss of containment in pipelines.

A pipeline incident occurs when the demand on a pipeline segment exceeds its capacity. The demand is the loading imposed on the pipeline segment, while the capacity is the ability of the pipeline segment to resist the demand before an undesirable event, such as a leak or rupture, occurs. In the context of geohazard-imposed loading, the most relevant demand and capacity are in a pipeline's longitudinal/axial direction.

This paper starts with a few real-world examples of pipeline incidents where geohazards were identified as one of the major contributing factors. The geohazards which provide the strain demand and girth weld characteristics which dominate the capacity are highlighted for each incident. The paper then turns to the fundamentals and key concepts of integrity-centric geohazards management and contrasts this approach with more traditional geohazards management techniques. The other foundational technology to this approach, strain-based FFS (fitness-for-service) assessment is also introduced.

The paper closes with some key elements and steps for the implementation of integrity-centric geohazards management. Practical guidance is provided so pipeline operators can utilize resources that are likely to make the biggest difference.

Keywords: pipelines, geohazards, integrity management

NOMENCLATURE

CSC Compressive strain capacity
 C-SCC Circumferential stress-corrosion cracking
 CSC_{ML} Compressive strain capacity associated with maximum load

CSC_{PML} compressive strain capacity associated with post-maximum-load
 D/t Diameter to wall thickness ratio
 DSAW Double submerged arc weld
 ERW Electric resistance weld
 FFS Fitness-for-service
 HAZ Heat-affected zone
 HDD Horizontal directional drilling
 ILI In-line inspection
 IMU Inertial measurement unit
 LFERW Low frequency electric resistance weld
 MTR Material test report
 OD Outer diameter
 PRCI Pipeline Research Council International
 RP Recommended practice
 SBA Strain-based assessment
 SC Strain capacity
 SCC Stress-corrosion cracking
 SD Strain demand
 SDL Strain demand limit
 SF Safety factor
 SMYS Specified minimum yield stress
 TSC Tensile strain capacity
 US DOT United States Department of Transportation
 PHMSA Pipeline and Hazardous Materials Safety Administration
 WT Wall thickness
 Y/T Yield strength to ultimate tensile strength ratio