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## **Abstract**

Ground movements, such as landslides and subsidence/settlement, can pose serious threats to pipeline integrity. The consequence of these incidents can be severe. In the absence of systematic integrity management, preventing and predicting incidents related to ground movements can be difficult. A ground movement management program can reduce the potential of those incidents.

Some basic concepts and terms relevant to the management of ground movement hazards are introduced first. A ground movement management program may involve a long segment of a pipeline that may have a threat of failure in unknown locations. Identifying such locations and understanding the potential magnitude of the ground movement is often the starting point of a management program. In other cases, management activities may start after an event is known to have occurred. A sample response process is shown to illustrate key considerations and decision points after the evidence of an event is discovered. Such a process can involve fitness-for-service (FFS) assessment when appropriate information is available. The framework and key elements of FFS assessment are explained, including safety factors on strain capacity. The use of FFS assessment is illustrated through the assessment of tensile failure mode. Assessment models are introduced, including key factors affecting the outcome of an assessment. The unique features of girth welds in vintage pipelines are highlighted because the management of such pipelines is a high priority in North America and perhaps in other parts of the world. Common practice and appropriate considerations in a pipeline replacement program in areas of potential ground movement are highlighted. It is advisable to replace pipes with pipes of similar strength and stiffness so the strains can be distributed as broadly as possible. The chemical composition of pipe steels and the mechanical properties of the pipes should be such that the possibility of HAZ softening and weld strength undermatching is minimized. In addition, the benefits and cost of using the workmanship flaw acceptance criteria of API 1104 or equivalent standards in making repair and cutout decisions of vintage pipelines should be evaluated against the possible use of FFS assessment procedures. FFS assessment provides a quantifiable performance target which is not available through the workmanship criteria. However, necessary inputs to perform FFS assessment may not be readily available. Ongoing work intended to address some of the gaps is briefly described.

## **Keywords**

Ground movement, Geohazards, Integrity management, Fitness-for-service assessment, Strain-based design and assessment