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APPLICATION OF STRAIN BASED ASSESSMENT IN SUPPORT OF OPERATIONAL AND MITIGATION DECISIONS

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ABSTRACT

A confirmed pipeline displacement due to ground movements often requires operational decisions regarding flow restriction and/or field mitigation. Some of the more frequently employed techniques for assessing the magnitude of the applied strain (strain demand), such as in-line inertial measurement unit (ILI IMU) or pipe-soil interaction analysis, may not be able to accommodate the timeframe for such decisions. The resulting lack of quantified strain demand and strain demand limit can potentially cause prolonged service interruptions or unnecessary field work under unfavorable access conditions.

A multi-leveled strain-based assessment (SBA) process is presented that was designed to support operational and mitigative decisions after confirmed pipe displacements. At the lower level, the methodology utilizes pipe locator data in conjunction with generalized pipe displacement profiles for quick determination of strain demands. At the higher level, conventional pipe-soil interaction analysis is used to refine the strain demand estimate as additional site data become available. The tensile strain capacity (TSC) is determined using one of three available options based on data availability. Integrity assessments can then be performed for both the current operating condition and future scenarios. For sites deemed safe at the moment of assessment, allowable movements at a future point can be established based on the margins between the strain demand and strain capacity. The allowable movements can be used in conjunction with geotechnical assessment to establish re-assessment intervals and trigger further field verification or mitigation activities.

An example SBA of a landslide in the Appalachian region is presented to illustrate the applications of the multi-leveled process with key considerations and some practical constraints in mind. Two gas transmission pipelines in a shared right of way were displaced after a slope movement. Pipeline A was shut-in immediately due to a larger displacement while Pipeline B remained in operation pending an integrity assessment. An initial lower-level SBA indicated neither pipeline had a sufficient margin between the strain capacity and the strain demand. Pipeline B was shut-in as a result. The initial assessment also pointed to different directions for refined assessments. Pipeline A, with the higher TSC and demand estimates, was subject to a refined pipe-soil interaction analysis to reduce the potential over-estimation of the strain demand. Pipeline B, with the lower TSC and demand estimates, was subject to in-ditch NDE in a controlled excavation, so that the TSC estimate can be updated with accurate weld-specific flaw information. The refined assessment indicated sufficient margins of safety for both pipelines. Consequently, both lines were returned to service, and a slide repair was implemented.

Keywords: Geohazards, ground movements, strain-based assessment, SBA, fitness-for-service assessment, strain demand, strain capacity.