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CONSIDERATIONS FOR AN INTEGRATED SYSTEM INCORPORATING PREDICTIVE MODELS FOR GEOHAZARD MANAGEMENT

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ABSTRACT

Geohazards are a significant threat to pipeline systems, particularly those operating in challenging mountainous terrain with severe climatic and seismic conditions. Various approaches to manage geohazards have been proposed and implemented on major transmission pipeline systems. These approaches include qualitative description, numeric indexing, and quantitative estimation of probability of failure to classify geohazard threat severity. The evolution of pipeline geohazard management toward a quantitative definition of threat severity, referred to as susceptibility, is documented in the 2019 ASME book "Pipeline Geohazards: Planning, Design, Construction and Operations" (Rizkalla and Read, eds., 2019). A framework for applying this approach is described in several papers, including the 2017 IPG paper IPG2017-2505 (Read, Malpartida and Massucco, 2017) related to potential application to the Camisea pipeline in Perú. The geohazard assessment framework is robust in that it is applied identically to all types of geohazards but is flexible in that the models and engineering judgment required to inform estimations within the framework are left to the practitioner to develop or adopt based on available information and the needs related to a particular new project or operating pipeline. For preliminary system-wide screening, susceptibility estimates are often based on expert judgment, sometimes with limited information as a basis. This necessitates adoption of reasonable conservatism and recognition that accuracy of susceptibility estimates for geohazards is at best order-of-magnitude at the screening stage. As a project matures, and for operating pipelines, site-specific analysis based on detailed characterization and monitoring data should replace preliminary screening results. To achieve this functional upgrade, predictive models that inform susceptibility estimates are required. These models and the data acquisition and processing systems to feed them must be adaptive to account for inherent complexities of in situ conditions, and ideally must operate in near-real time to function effectively as predictive tools. Mechanistic models that simulate the physics associated with particular geohazards, even in a simplified manner, are critical components of this predictive system. Understanding the essential variables associated with these models, and differentiating between "static" and "dynamic" variables, is a first step in developing an integrated system that can ultimately incorporate machine learning and artificial intelligence coupled with "big data" to develop an early warning system. This paper discusses some considerations for an integrated system that incorporates quantitative predictive models for geohazard management.