Comments on PHMSA’s Proposed Integrity Verification Process (IVP) for Oil and Gas Pipelines

Fahmy Haggag, CEO, ABI Services (ABIS), LLC

Background: The explosion of a transmission gas pipeline of 2010 in San Bruno, California, cost PG&E more than $2B and resulted in several fatalities and the destruction of many homes. The simple cause of this, and other, accidents was increased transmission pressure beyond the strength capability of an undocumented pipeline (the operator increased the operating pressure several times due to the increased customer demand in winter). In response to this incident, PHMSA published the draft integrity verification process (IVP) in the summer of 2013 to protect the public and to preserve our environment and infrastructure. The IVP requires all pipeline operators in the U.S. to document the basis used to establish a pipeline’s maximum allowable operating pressure (MAOP). If the owner/operator cannot provide documentation of the proper/verified material grade, testing is needed to establish a pipeline’s MAOP.

The conventional way of obtaining material tensile properties is by cutting out a coupon from the steel pipeline and carrying out a tensile test of a dog-bone-like/strap tensile specimen in the laboratory. However, obtaining a coupon from an in-service pipeline poses certain challenges and have several disadvantages (e.g., cost of disruption, loss of transmission service, cost of time required to machine and test the destructive strap specimens, and the repair cost following coupon extraction). Other methods exist, such as (1) hydro-testing and (2) in-situ materials characterization (the innovative ABI® testing of ABI Services, LLC of Oak Ridge, Tennessee), both have advantages and disadvantages. The main disadvantages are related to the need to have multiple access points to the pipeline, multiple excavations, and the storage and disposal of huge amounts of water used in hydro-testing. A brief description and comments on these two techniques are given below.

1. **Hydro-testing of Pipelines:** This technique is used mostly on newly-constructed pipelines prior to placement in service to verify proper welding of all pipe joints and to discover critical-size flaws/cracks resulting in water leak during the test. It involves isolating a pipe segment (e.g., 1-5 miles depending on the pipe outer diameter and tanks for storing the water required for hydro-testing) and pumping/pressurizing it with water to 110% or 120% of the MAOP for a short period. When leaks occur, they are welded/repaired and the hydro-test is repeated until no leaks occur.

2. **Automated Ball Indentation® (ABI®) Test:** This nondestructive technique has been used successfully worldwide on in-service oil and gas pipelines since 1996. It provides accurate-direct-measurements of tensile and fracture toughness properties that are equal to or better than those from destructive testing.

Benefits, Disadvantages, and Limitations of Hydro-Testing of In-Service Pipelines:

The hydro-test is currently proposed by PHMSA to be used on undocumented in-service pipelines to verify their MAOP. Although this approach might be beneficial to indirectly provide some information on the material yield strength (YS), it cannot provide the ultimate tensile strength (UTS) or the ductility, or fracture toughness of the pipeline steel (49CFR Parts 192 and 195 require the measurements of YS, UTS and their maximum ratio to determine the pipe grade based on key mechanical properties). Also, for cracks/flaws that are below the critical size, the hydro-test will grow these cracks to a larger length within a relatively short time (e.g., a 30-minutes hydro-test might grow a crack from 80% before the test...
to 90 - 95% after the test instead of the same crack growth over a 3-years of service life). And the expensive hydro-test will disrupt the transmission services and the used water will be considered contaminated, requiring a high-cost of disposal plus potential damage to the environment.

The initial-value of the water pressure of the hydro-test depends on the YS, the wall thickness of the pipe, and the outer diameter of the pipe. The pipe thickness and diameter can be easily determined before the test. However, the YS would be unknown without verified grade certificate. Hence, another “catch 22” disadvantage of the hydro-test is that for undocumented pipes, the pipeline operator must make a blind guess of the YS for conducting the first hydro-test. If the guessed-value is higher than the actual YS, the pipe will, at least, bulge and might leak. Hence, the hydro-test must be repeated at another guessed pressure value (based on the second-guessed YS value of the pipeline). This process and the number of hydro-tests is inefficient and costly.

Benefits and Limitations of Non-destructive In-Situ Automated Ball Indentation® (ABI®) Testing of In-Services Oil and Gas Pipelines:

The major benefits of ABI testing are: highly-accurate (equal to or better than the destructive testing of the allowed strap tensile samples machined from extracted coupons of the in-service pipeline), it is nondestructive, performed in-situ, it provides from each test both the tensile properties (YS, UTS, and ratio of YS/UTS), and the pipe fracture toughness value (a key property not available even for documented/certified pipelines). Fracture toughness is essential to evaluate cracks/flaws developed in service to determine accurate fitness-for-service per Level III of ASME Fitness-for-Service “FFS-1”. And finally, the significant advantage is that each in-situ ABI test is conducted quickly and all test results are calculated on site.

Currently, the limitation of the in-situ (in ditch) ABI testing is the cost of multiple excavations at various locations of the pipeline. To address this limitation, ABIS is currently developing an ABI® In-Line Tool for testing long pipelines (hundreds of miles) and for testing pipelines crossing rivers or freeways. In addition to the above advantages of the in-situ ABI testing over hydro-testing, the cost of a 100-mile pipeline segment will be a fraction (10 to 30%) of the cost of hydro-testing the same pipeline segment.

Proof of the Great Success of ABI® testing: Thousands of tests have been successfully conducted in 23 countries over the past 20 years, most of Major U.S. Oil and Gas Companies have been using the in-situ ABI® services on their pipelines since 1996. Following the San Bruno accident of 2010, PG&E conducted 95 successful hydro-tests on various pipeline segments in 2011 and 2012 based on the YS values measured from in-situ ABI® tests. This proves the accuracy/validity of the ABI test and its value for conducting or replacing the hydro-test (saving money and environment). Other in-situ ABI tests were conducted in France and in the U.S. to measure the YS prior-to and during hydro-testing with great success.

Finally, ABI testing is environmentally safe as compared to hydro-testing, does not disrupt the transmission service, and is economically better.