ATC Solution to Preventing Low Yield and Tensile Strength Values in High Strength Line Pipe Deliveries or Construction

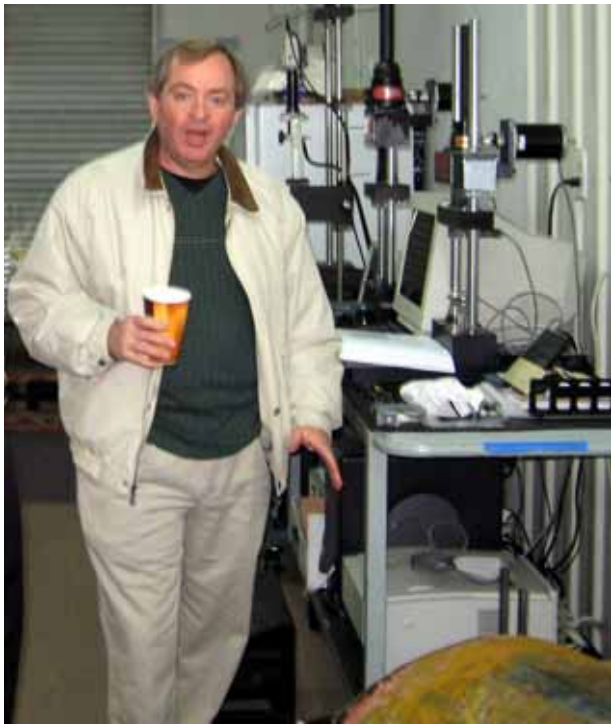
On May 21, 2009 PHMSA issued Advisory Bulletin PHMSA-2009-0148 to owners and operators of natural gas and hazardous liquid pipeline systems of the potential to receive subgrade lengths of Grade X-70 and above microalloyed line pipe. According to the bulletin, "several recently installed natural gas transmission pipeline systems experienced field hydrostatic test failures or excessively expanded pipe joints of large diameter, microalloyed high grade line pipe."

PHMSA has been made aware of several recent projects where pipeline owner/operators received compliant certificates (based on API 5L requirements of one tensile test per heat), but the pipeline manufacturers shipped pipe that was up to 15% lower strength values than the grade specification. If these subgrade pipe lengths had been discovered at the pipe manufacturing facilities, they would not have been shipped. Thus the costs of welding, replacing bulged/failed joints, post-test deformation tool inspection, and repeat hydrotesting would have been dramatically reduced.

ATC's Stress-Strain Microprobe® (SSM) technology using its in-situ/nondestructive Automated Ball Indentation (ABI) testing techniques can be used at the manufacturing facility to measure the yield and tensile strength (YS and TS) values of each pipe length prior to shipment. The SSM system can also be used in the field to verify both base metal and girth weld YS and TS properties in a timely and cost-effective fashion. Each ABI test is completed in less than 2 minutes, and typically 3-5 tests are conducted at each location to quantify material variability.

ATC performed testing on two pipeline sections that were certified as Grade X-70 in February 2009. The following table includes test results that show only one section actually meets the specified properties. For the second section, the ABI-YS is 18% lower than specified and only meets Grade X-56. All ABI tests were witnessed by Mr. Steve Nanney and employees of the pipeline owner. Our ABI test results are in agreement with Mr. Nanney's findings as reported at the PHMSA-- 2009 New Pipeline Construction Workshop, April 23, 2009, in Fort Worth, TX, as well as the PHMSA Advisory Bulletin.

SSM-M1000 System testing a pipeline section



Mr. Steve Nanney, PHMSA, DOT

In-Situ Nondestructive Automated Ball Indentation (**ABI) tests determine the grades of individual lengths** of new construction pipelines in **Perfect Agreement with** grades determined from **Destructive Tensile Specimens.** The two pipeline sections below are from a new construction X70 gas pipeline. The ABI tests were witnessed by Mr. Steve Nanney (PHMSA) at ATC (Oak Ridge, TN) on 2/18/09.

Test Name	Yield Strength (YS) [ksi]	Ultimate Tensile Strength (UTS) [ksi]	Pipe Grade Determination Based on the Specified Minimum YS and UTS per API 5L
Pipe Number 1 meets the minimum values for YS and UTS of X70 (API 5L) from in-situ ABI and tensile tests			
Pipe Number 1, In-Situ ABI Test Results			
BXX-12-01	75.9	94.3	**X70**
BXX-12-02	75.9	89.9	
BXX-12-03	75.4	90.2	API 5L specified YS and UTS minimum values for X70 are 70.0 ksi and 82.0 ksi.
BXX-12-04	72.7	92.2	
BXX-12-05	76.5	94.4	
BXX-12-06	76.9	90.8	
Average	**75.6**	**92.0**	ABI tests were conducted over 0.50 inch diameter area.
Pipe Number 1, Tensile Test Results from One Specimen provided by the pipeline company			
	74.2	**92.4**	**X70**
Pipe Number 1: Comparison of Average ABI Test Results to Tensile Results from One Specimen (% Difference)			
% In-Situ ABI to Destructive Tensile	**1.9**	**1.0**	
Pipe Number 2 failed to meet the new pipeline specification of X70 based on in-situ ABI or tensile tests			
Pipe Number 2, In-Situ ABI Test Results			
BXX-23-01	57.6	77.5	**X56**
BXX-23-02	57.7	76.4	
BXX-23-03	58.5	76.4	API 5L specified YS and UTS minimum values for X56 are 56.0 ksi and 71.0 ksi.
BXX-23-04	56.7	76.6	
BXX-23-05	57.4	76.7	
Average	**57.6**	**76.7**	ABI tests were conducted over 0.50 inch diameter area.
Pipe Number 2, Tensile Test Results from 4 Specimens Tested at an independent laboratory for BXX			
Original	63.9	73.9	**X56**
Spec. 1	62.0	74.3	
Spec. 2	61.1	73.4	Although the YS meets X60, the UTS is less than the specified minimum of 75 ksi. Hence, X56 is the grade determined from the four tensile specimens.
Spec. 3	61.1	73.7	
Average	**62.0**	**73.8**	
Pipe Number 2: Comparison of Average ABI Test Results to Average from 4 Tensile Specimens (% Difference)			
% In-Situ ABI to Destructive Tensile	**-7.1**	**3.9**	

Note: Our **novel ABI test** is a mechanical properties test which samples a very small volume as compared to the destructive tensile test. Hence, the ABI test is more capable of distinguishing the material variation throughout the pipe than the tensile test. The precision values of the yield strength (YS) and Ultimate tensile strength (UTS) from the ABI test are 1.4% and 1.5%, respectively (see page 47 of PRCI Report L52280, April 2007). For extensive comparison of ABI-determined YS and UTS with those from tensile specimens of various pipe grades see pages 75 and 76 of PRCI Report L52280. The difference between the ABI-measured YS and UTS and those from the tensile specimen/s are 1.9% and 1% for Pipe Number 1 and -7.1% and 3.9% for Pipe Number 2, respectively. The small differences of YS and UTS results from the in-situ ABI tests and the destructive tensile specimens are within the steel variability/inhomogenity. The ABI-determined grades (based on the minimum YS and UTS values specified in API 5L) of X70 for pipe Number 1 and X56 for pipe Number 2 are in perfect agreement with the grades determined from the destructive tensile tests.