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SOME PRACTICAL BENEFITS OF DETAILED FORENSIC ANALYSIS

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ABSTRACT

Integrity threats can be difficult to manage in cases where the condition assessment leads to sometimes uncertain results, and/or the mechanisms affecting that condition are complex, and so are sometimes poorly characterized. Clarity in such cases derives from forensic analysis, as illustrated in this paper, which presents and discusses such work to: 1) better understand the scope and nature of the threat involved, 2) quantify a case-specific speed of crack growth, 3) establish the viability of the predictive tools being used, and 4) establish whether a once active threat had been effectively dealt with by the operational and maintenance changes that were made to manage it.

The results of two recent laboratory hydrotests are summarized concerning pups containing SCC colonies, as are the details of forensic analyses of the cracking exposed by that testing. The high-level goals were to: establish the form(s) of SCC active on the pipeline; quantify its average cracking speed (ACS) relative to published guidance; and determine whether the changes that had been made to manage that SCC had proven effective through evidence of dormant cracking.

Fractography and metallography done to identify traits characteristic of SCC clearly showed intergranular features and other key traits of high-pH cracking. As expected, the SCC colonies showed a wide range of crack sizes. The fractography also showed clear evidence of a prior hydrotest that along with other benchmarks over time led to a case-specific ACS, which was slower than published industry guidance. Comparison of predictions concerning failure pressure and other aspects made prior to the hydrotests established the viability of the predictive tools that had been used. Finally, indicators of dormancy such as heavily corroded intergranular features that continued down secondary cracking were used to establish that the SCC local to the dig sites considered had been mitigated.

Keywords: SCC, hydrotest, forensic analysis, predictive technology, cracking speed, mitigate, dormancy.

NOMENCLATURE

ACS	average cracking speed
AYS	actual yield stress
CMOD	crack-mouth opening displacement
CVN/SA	Charpy-vee notch / shear area
EMAT	electro-magnetic acoustic transducer
FS/UTS	flow stress / ultimate tensile stress
IG/TG	intergranular / transgranular
ID/OD	inside diameter / outside diameter
J-R	*J*-integral-based (NLFM) crack resistance
LN	liquid Nitrogen
L vs R	leak versus rupture
MPI	magnetic-particle inspection
MOP	maximum operating pressure
MVNC	micro-void-nucleation, growth, and coalescence
NLFM	nonlinear fracture mechanics
OM/SOM	optical microscopy / stereo OM
PA	phased-array
P-V	pressure - volume
SEM	scanning electron microscopy
TW/TWC	through-wall / TW crack
UT	ultrasonic technology
SCC	stress-corrosion cracking
SMYS	specified minimum yield stress

1. INTRODUCTION

During the course of rehabilitation unrelated to SCC the bell-hole technician working an excavation noticed what appeared to be a small bulge, which after further inspection showed what appeared to be SCC. This occurred on a vintage coal-tar coated natural gas pipeline operating since 2015 under reverse flow conditions at 72% SMYS. Given the nature of the rehabilitation then underway the pipe joint containing that suspected SCC was cutout. Other sites where SCC was deemed plausible also were daylighted and examined, with two