ABSTRACT

This paper provides an overview of the initial phase of a large-scale testing program that is associated with an ongoing, joint industry research program, which is intended to advance the state-of-the-art in strain-based design as it pertains to the tensile capacity of girth welds in steel line pipe. The testing program has been designed to explore a range of variables that are known to have a significant impact on axial strain capacity including the effects of internal pressure, the strain hardening characteristics of the pipe body material, the degree of weld strength overmatch and the location of the flaw. The paper describes the type of tests performed, the key considerations in the sizing and instrumentation of the test specimens, and provides an overview of the results obtained to date.

KEY WORDS: Pipeline, girth welds, strain capacity, strain-based design, large-scale test, curved wide plate test, biaxial loading.

INTRODUCTION

An accurate characterization of the tensile strain capacity of girth welded line pipe is key to optimizing the design of new pipelines and effectively managing the integrity of existing pipelines where large axial deformations caused by external loads are an issue. Due to the complex nature of the post-yield behaviour of material in the vicinity of welding-induced flaws, most existing tensile strain capacity models rely heavily on experimental data for both calibration and validation. The quality of these models is directly dependent on the quality and applicability of the experimental data set upon which they are based.

Through the efforts of the Pipeline Research Council International (PRCI), a joint government/industry-sponsored research program was initiated in 2006 to examine the effects of parameters that are known to have a significant impact on axial strain capacity. A central objective of the program was to generate and disseminate high quality full-scale test data to validate predictions based on existing strain prediction models and to provide a data set for the development of new and improved prediction models.

EXPERIMENTAL DESIGN

Test Parameters and Material Properties

The primary test parameters for the initial phase of the testing program were internal pressure, pipe body strain hardening characteristics, weld strength overmatch and flaw location (i.e. pipe body, weld metal or heat affected zone).

With regard to pressure, the high pressure pipe tests were performed at an internal pressure chosen to achieve a hoop stress level of approximately 72% of the actual yield strength of the pipe body material. Given that typical line pipe has an average yield strength that