Liu, M., Wang, Y.Y., Sen, M. and Song, P., 2016, Integrity Assessment of Post-Peak-Moment Wrinkles, Proceedings of the 11th International Pipeline Conference, Paper No. IPC2016-64654, September 26-30, 2016, Calgary, AB, Canada.

Abstract

For a pipeline experiencing a ground movement event, high longitudinal strain can be developed in the pipe longitudinal direction. When prerequisite requirements are met, ASME B31.4 allows up to 2% (nominal) longitudinal strain in a pipe. However, such high strain may be beyond the compressive strain capacity (CSC) of the pipe which is defined as the compressive strain corresponding to the maximum bending moment. Furthermore, wrinkles are usually formed at such a high strain level. Excessive local strain can accumulate around the wrinkles when the nominal strain goes beyond the CSC which can lead to significant wrinkle growth or even tearing of the pipe wall. Therefore, integrity of the pipes containing post-peak-moment wrinkles need to be assessed in order to confirm that the 2% nominal strain permitted in the ASME codes can be safely tolerated.

A number of failure modes are possible. Firstly, a pipe must be capable of tolerating the nominal strain up to 2% under static loading without leak or rupture. Secondly, if a buckle or wrinkle is formed in the initial event of ground movement and no leak or rupture occurs, the buckle or wrinkle can be subjected to fatigue loading during the continued operation of the pipeline. The pipe should have sufficient remaining life till the anomalies are discovered (through inline inspection, for example) and mitigated. The fatigue loading can come from fluctuations in operation pressure, temperature, and/or other sources. In this paper, the immediate and long-term integrity of selected pipelines were assessed.

The work has demonstrated that for the selected pipelines: (1) all lines meet the prerequisite conditions outlined in ASME B31.4 for the nominal strain limit up to 2%; (2) all lines are capable of tolerating nominal longitudinal strain up to 2% without immediate negative consequences; (3) for the wrinkles corresponding to nominal strain up to 2%, the wrinkles are expected to have finite fatigue lives and intervention within 5 to 7 years should be sufficient to prevent fatigue failures; and (4) locating and mitigating wrinkles corresponding to nominal longitudinal strain greater than 2% after a ground movement event may be necessary to ensure the safety of the pipelines.

Keywords

Pipeline integrity, Post-peak-moment wrinkles, Leak, Rupture, Fatigue life