EVALUATING THE PERFORMANCE OF A PIPELINE PROTECTION SYSTEM TO PREVENT DAMAGE TO SUBSEA PIPELINES FROM DROPPED OBJECTS

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ABSTRACT

One of the primary concerns for subsea pipeline involves damage from dropped objects. Using risk analysis modeling, it is possible to estimate the likelihood of impact, as well as the consequence of damage. Chevron Energy Technology Company, Stress Engineering Services, Inc. (SES) and Geoscience Earth & Marine Services, Inc. (GEMS) conducted a study to evaluate the effectiveness of a pipeline protection system (PPS) designed to protect a subsea 16-inch products pipeline off the coast of Angola in West Africa in approximately 400 feet of water beneath the South Nemba platform. The plan prior to the study was for platform upgrades to be made and concerns existed regarding the potential for dropped objects. Chevron specified that the PPS be designed to withstand a minimum impact of 3 MJ, with the possibility for extending this to 5 MJ if possible.

The work involved a combination of testing and analysis methods. Chevron developed the basic design of the PPS that included a large diameter upper (60-inch diameter) and a lower (72-inch diameter) half-pipe assemblies placed over the top of the 16-inch diameter pipeline. Preliminary analyses calculated the potential energy absorption capacity of the design considering variations in thickness of the PPS structural members. Using insights gained from the preliminary analysis, full-scale drop tests were performed on prototype PPS pieces fabricated from rolled and welded steel plate. These drop tests released a 23,850 lbs weight dropped from 25.2 feet, resulting in impact energies of 815 kJ. Significant deformation was inflicted to the PPS tests pieces during the drop tests; however, the 16-inch diameter pipe placed beneath the protection was untouched for all tests except the one that did not include the upper half-pipe shell.

Once the full-scale testing efforts were completed, finite element modeling was used to evaluate the PPS to soil interaction. The West Africa soil is rather compliant and concerns existed prior to the final phase of this study regarding the level of rigidity that could be expected from the soil. The ABAQUS Explicit finite element software was used to simulate impact with a dropped object having energy levels up to 5 MJ. Results showed that with contribution from the surrounding soil the system design, including the PPS pieces and the mud mats, can withstand impact energies of 5 MJ when the thickness of the upper shell is 1.25 inches. The results of this study demonstrate that the Chevron energy design requirement can be satisfied using the appropriate PPS design.

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