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Flow-Induced Vibrations of Subsea Jumpers due to Internal Multi-Phase Flow

Subsea jumpers are steel pipe sections that connect hardware components on the seafloor (e.g. trees, manifolds, and sleds) and typically operate in multi-phase flow. They are designed with bends to accommodate limited expansion due to variations in temperature and pressure. Under certain conditions significant fluctuating forces can be induced in flow-turning elements like bends and tees. These fluctuating forces may cause severe piping vibrations and weld fatigue damage. This paper presents a flow-induced vibration screening procedure based on the 3-D numerical simulation of unsteady internal multi-phase flow in subsea well jumpers, the prediction of associated flow-induced forces in flow-turning elements, and the prediction of structural response, including fatigue life estimates. We consider a 6 inch (nominal) diameter well jumper with six turning elements (i.e. six blind Tees), having 70 feet of suspended span, and perform simulations for two different flow conditions representative of early- and mid-life production. We find that the dominant frequencies of flow-induced vibration are those associated with modes 1 through 4 and that stresses are highest in mid-life flow conditions when the gas volumetric void fraction is 55%.

Author Name:
Juan P. Pontaza
Raghu G. Menon
Industries:
Oil and Gas [1]
Oil and Gas - Sub-Industry [2]
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STAR-CCM+® [3]
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