Multi-physics Computational Fluid Dynamics (CFD) for
Two-Phase Jet Fire and Radiation

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ABSTRACT

A Computational Fluid Dynamics (CFD) study has been carried out to model fire and radiation due to a two-phase hydrocarbon release from the overboard diverter line on an Oil & Gas drillship. During the course of any drilling operation, there is a potential for well control issues. The diverter system is provided on many drill rigs to provide a means of addressing certain well control scenarios and is critical safety device in this regard. The diverter is used to mitigate the potential consequence of a loss of well control by directing the well fluids away from the drillship. During the diverting operation, if the fluids are ignited, hazardous thermal radiation levels could be experienced by personnel on the drillship as a result of the jet flame being blown towards the platform. The objective of this study was therefore to assess the thermal radiation hazard posed to the drillship from a resulting fire during the act of a diverter operation. Since the jet fire occurs near the drilling deck, to accurately predict radiation flux iso-surfaces within a short range, detailed combustion modeling is needed for prediction of flame shape and temperature. Additionally, detailed solid modeling of drillship structure is needed which contributes to flow turbulence and blocks radiation. Flame temperature will also be sensitive to phase compositions and release characteristics. Therefore, two of the major challenges in two-phase jet-fire modeling are accurate representation of the liquid hydrocarbon release and turbulent combustion. In this work, liquid phase is modeled as a Lagrangian spray with multi-component droplet evaporation. Turbulent combustion is modeled using a non-premixed presumed probability distribution approach to account for equilibrium chemistry and species concentration fluctuation for accurate prediction of flame temperature. To assess radiation, combustion products are modeled as grey gases with Discrete Ordinate Method to include directionality in radiation flux and simulate blockage by drill-ship structures. Result shows high level of radiation around the jet-fire and low intensity at locations that are away from the fire or blocked by larger objects. Overall, CFD is demonstrated as an effective modeling technique in consequence analysis of accidental jet fire radiation. However, comparison with experimentally measured data will be needed to benchmark accuracy.