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ABSTRACT INFORMATION

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Unclassified Abstract
(250-300 words; do not include figures or tables)

NASA Marshall Space Flight Center is designing and developing the Main Propulsion System (MPS) for Ares launch vehicles. The objective of this study is to calculate the sloshing forces and moments in the LH2 and LO2 propellant tanks using a CFD/VOF analysis under realistic flight conditions. Propellant sloshing in the liquid hydrogen (LH2) and the liquid oxygen (LO2) propellant tanks after Main Engine Cut Off (MECO) was modeled using the Volume of Fluid (VOF) module of the computational fluid dynamics code, CFD-ACE+. The present simulation shows that there are substantial sloshing side forces acting on the LH2 tank during the deceleration of the vehicle after MECO. The LH2 tank features a side wall drain pipe. The side loads result from the residual propellant mass motion in the LH2 tank which is initiated by the stop of flow into the drain pipe at MECO. The simulations show that radial force on the LH2 tank wall is less than 50 lbf and the radial moment calculated based up the center of gravity of the vehicle is predicted to be as high as 300 lbf-ft. The LO2 tank features a bottom dome drain system and is equipped with sloshing baffles. The remaining LO2 in the tank slowly forms a liquid column along the centerline of tank under the zero gravity environments. The radial force on the LO2 tank wall is predicted less than 100 lbf. The radial moment calculated based on the center of gravity of the vehicle is predicted as high as 4500 lbf-ft just before MECO and dropped down to near zero after propellant draining stopped completely.