Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

The Nearfield of a Shallow Angle Plunging Jet - Periodicity of Air Cavity Formation SURAJ S. DESHPANDE, MARIO F. TRUJILLO, University of Wisconsin - Madison — The plunging of a water jet into a quiescent water pool is investigated computationally, using the Volume-of-Fluid methodology in the framework of the open source utilities of OpenFOAM. For the shallow angle plunges ($\theta <\sim 20^\circ$), our computations and previous experiments at Dynaflow Inc. revealed a distinct periodicity in the formation of large air cavities in the nearfield. In this work, we analyze the periodicity and present a closed form expression to describe it. Our analysis, based on potential flow treatment, regards the cavity as a Rankine body [Oguz et al., JFM 1995] and its motion as that of a standing wave. For the jets considered ($Fr \sim O(10)$, $Re \sim O(10^5)$, $We \sim O(10^3)$ and $\theta <\sim 20^\circ$.), the frequency of cavity formation was found to be related to the jet diameter and gravity, independent of viscous and surface tension effects. Our analysis, which is valid only for shallow plunges, is in excellent agreement with this observation. For steeper jets, we demonstrate that this periodicity vanishes and small air cavities are chaotically drawn into the pool.

Suraj S. Deshpande
University of Wisconsin - Madison

Date submitted: 09 Aug 2011 Electronic form version 1.4