Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Self-Sustained Oscillations of Flow Past Sequential Cavities: Effects of Gravity Wave Coupling BURAK A. TUNA, DONALD ROCKWELL, Lehigh University — Shallow flow past successive cavities can lead to highly coherent oscillations, due to coupling between: the inherent instability of the separated shear layer along the opening of each cavity; and a gravity standing wave mode within the cavity. As the flow velocity is varied, this coupling is associated with different orientations of the gravity standing wave, i.e., it can occur in either the transverse or the streamwise direction. The flow structure along the separated shear layer and within the cavity is, in turn, a strong function of the orientation and phase of the standing wave. When the oscillation amplitude of the coupled instability- cavity mode becomes large, as indicated by the amplitude of deflection of the free-surface, enhanced coherence and scale of the phase-averaged vortex formation occurs in the separated shear layer along the opening of the cavity. This coherent vortex formation results in a large increase in the magnitude of the turbulent shear stresses in the separated shear layer and, as a consequence, an increase of the time-averaged exchange velocity and mass exchange coefficient along the opening of the cavity. Furthermore, the flow structure and mass exchange along each of the sequential cavities may be either substantially different or very similar, depending on the orientation and phase of the gravity standing wave within the cavity, that is, a streamwise-oriented versus a transverse-oriented gravity standing wave, as well as the phase shift of the oscillations occurring in adjacent (sequential) cavities.

Burak A. Tuna
Lehigh University

Date submitted: 30 Jul 2013 Electronic form version 1.4