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An Efficient Approach for Benchmarking High-Reynolds Number Axial Flow-Induced Vibration for Nuclear Applications

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Abstract – *Fretting wear at the spacer grid in fuel assemblies, due to flow-induced vibration (FIV), is one of the main causes of fuel failures in Light Water Reactors (LWRs). Therefore, accurately predicting FIV is crucial for mitigating this issue, and a computationally efficient simulation method is necessary. In this regard, the Unsteady Reynolds-Averaged Navier-Stokes (URANS) approach is applied as a promising and efficient simulation method for FIV prediction. While previous studies have primarily relied on Large Eddy Simulation (LES) for the fluid domain, URANS provides an attractive alternative due to its lower computational demands, especially for strong 2-way Fluid-Structure Interaction (FSI) coupling. This paper aims to explore efficient approaches for benchmarking axial FIV for nuclear applications by examining the self-exciting axial FIV over a cantilevered rod and comparing it with experimental measurements at the University of Manchester (UoM) using different URANS models and divergence schemes for the convection term in the fluid momentum equations. In both variations of the URANS model closure, the eddy viscosity model (EVM) k- SST model and the Reynolds Stresses Model (RSM) Launder, Reece, and Rodi (LRR) model, accurately predicted the mean RMS amplitude and frequency of vibration for flow with annulus Reynolds number between 16,400 and 61,730.*

Keywords: Flow-Induced Vibration (FIV), Fluid-Structure Interaction (FSI), Nuclear Fuel