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Detecting Unsteady Blade Row Interaction in a Francis Turbine using a Phase-Lag Boundary Condition[1] ALEX WOUDEN, JOHN CIMBALA, BRYAN LEWIS, Pennsylvania State University — For CFD simulations in turbomachinery, methods are typically used to reduce the computational cost. For example, the standard periodic assumption reduces the underlying mesh to a single blade passage in axisymmetric applications. If the simulation includes only a single array of blades with an uniform inlet condition, this assumption is adequate. However, to compute the interaction between successive blade rows of differing periodicity in an unsteady simulation, the periodic assumption breaks down and may produce inaccurate results. As a viable alternative the phase-lag boundary condition assumes that the periodicity includes a temporal component which, if considered, allows for a single passage to be modeled per blade row irrespective of differing periodicity. Prominently used in compressible CFD codes for the analysis of gas turbines/compressors, the phase-lag boundary condition is adapted to analyze the interaction between the guide vanes and rotor blades in an incompressible simulation of the 1989 GAMM Workshop Francis turbine using OpenFOAM. The implementation is based on the "direct-storage" method proposed in 1977 by Erdos and Alzner. The phase-lag simulation is compared with available data from the GAMM workshop as well as a full-wheel simulation.

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