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Forced Response Analysis of a Radial Inflow Turbine using STAR-CCM+

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Radial inflow turbines are subjected to high engine order excitation that causes high cycle fatigue. In order to fulfill endurance and integrity requirements, it is necessary to determine the high engine order excitation that depends on structural as well as aerodynamic operating conditions. The lifetime limiting dynamic stresses induced by blade vibration due to high engine order excitation can be estimated by evaluating the forced response function of the tuned system. In order to calculate the forced response function, it is necessary to predict aerodynamic excitation forces and aerodynamic damping according to the considered vibration mode at specific operating conditions.

Aiming at the numerical prediction of aerodynamic damping and forcing the unidirectional methods which are used to determine modal excitation forces, aerodynamic damping and vibration amplitudes are explained. Furthermore, the setup of a forced response simulation and an aerodynamic damping calculation are presented. For the evaluation of the modal excitation forces and aerodynamic damping, the unsteady time accurate solver has been used. Additionally, harmonic balance flutter simulations have been used for the prediction of aerodynamic damping which will be compared to the time accurate solutions in terms of quality and effectiveness.

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