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THE DEVELOPMENT OF AN AIR INJECTION SYSTEM FOR THE FORCED RESPONSE TESTING OF AXIAL COMPRESSORS

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Abstract

A phase-controllable, air injection exciter system was developed to enable measurement of the forced response properties of a transonic axial compressor blisk. The project was performed as part of the FP7 European framework program project FUTURE. The eventual aim of this project is to improve existing turbomachinery blade flutter prediction methods. The development and manufacturing of the exciter system was performed by the Council for Scientific and Industrial Research (CSIR) in Pretoria, South Africa. The exciter system consists of 15 air injectors, each with its own servo motor and controller. The injectors consist of a small rotating disc with a specific number of holes equispaced around the periphery rotating within a pressurised volume. When the holes are rotated, using a servo motor, past an exit tube an air pulse is generated that is injected upstream of the compressor. The controllers enable adjustment of the relative phase angle between the exciters. In this way a pattern that resembles different nodal diameters can be excited on the rotor blisk. Once the construction of the system was completed, it was transferred to Stellenbosch University for sub-scale testing on a low speed compressor. The purpose of the sub-scale tests was to commission and verify the operation of the exciter system. The tests started with simple in-phase tests and then worked towards more complex test parameters that included frequency

sweeps through the natural frequency of the compressor blades. The tests showed that it is possible to generate a blade response of different nodal diameters using the exciters. The blade response was also found to vary depending on the number of rotor holes, air supply pressure and sweep rate used for the exciters. Following completion of the sub-scale tests, the completed system was transferred to the transonic compressor test facility of the Technical University Darmstädt (TUD) where both free flutter and forced response experiments were performed on a purpose designed blisk in the transonic compressor test rig. The experimental campaign was successfully completed with the forced response experiments showing that the air injection system could be used to measure the response characteristics of the blisk.