PD-PR/2014/1019
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Design and Development of Test Rig for High Speed Alternator

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PD-PR/2014/1019
December 2014

ISO 9001: 2008
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DOCUMENTATION SHEET

National Aerospace Laboratories

Class: Restricted

No. Copies: 5

Title: Design and Development of Test Rig for High Speed Alternator

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Division: PR			**Project No:** P-1-341	
Document No: PD-PR/2014/1019			**Date of Issue:** December 2014	
Contents:	Pages: 30	Figures: 27	Tables: 1	References: 8

External Participation : Gas Turbine Research Establishment

Sponsor : Gas Turbine Research Esta

Approval : Head, PR

Remarks :

Keywords : High Speed Alternator, Stress Analysis, Rotor-dynamic Analysis, Measurements

Abstract : This report briefly presents the design and development aspects of the test rig to evaluate the performance of high speed alternators with power rating of 5 kW at rated speed of 55000 rpm. Major part of the report covers detailed mechanical design of the drive turbine and the other rig systems. The test rig is designed and developed at Propulsion Division, NAL-CSIR to map the electrical characteristics of the AC alternator to be used in a Small Turbo Fan Engine (STFE) which is being developed by Gas Turbine Research Establishment. An air turbine drive was designed to develop 20 kW power at 53000 rpm to drive the alternator. A parabolic solid disc configuration is arrived at to keep the stress minimum. Cyclic symmetry stress analysis is carried out on the sector model (1/27th) carved out from the blisk. The air turbine shaft is designed to be inserted in to the bore of the alternator hallow shaft and is to be fastened at the other end with a lock nut. The rotor-dynamic analysis is carried out for the rotor in overhang configuration with bearing support stiffness ranging from 17.5 to 175 MN/m and critical speeds of the rotor-bearing system is predicted. A lubrication system with an in-built reservoir tank is designed to provide cooling to the stator core and to lubricate the alternator bearings. Special fixtures are designed to insert and extract the air-turbine shaft into and from the alternator rotor respectively to ensure that the alternator bearings are not unduly loaded during assembly and dis-assembly procedures. The rig is instrumented with pressure, temperature and flow transducers for compressed air and the lubrication oil in addition to speed and vibration pick-ups. As the rotational speed of the rig is extremely high, several safety measures are considered and implemented.