

**ONE-DIMENSIONAL DYNAMIC WAKE RESPONSE IN AN ISOLATED  
ROTOR DUE TO INLET TOTAL PRESSURE DISTORTION**

by

Shaun M. Boller

Thesis submitted to the Faculty of the  
Virginia Polytechnic Institute and State University  
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Mechanical Engineering

Walter F. O'Brien, Chairman

Clint L. Dancey

Wing F. Ng

October, 1998

Blacksburg, Virginia

Key words: Compressor, Rotor, Wake, Pressure, Distortion, Response

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Committee Chairman: Walter F. O'Brien

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(ABSTRACT)

An experimental investigation of the wake of a low-speed axial-flow compressor rotor was conducted with and without the presence of steady inlet total pressure distortions. The steady three-dimensional rotor inlet flow was obtained by a five-hole pneumatic pressure probe, while the one-dimensional rotor exit data were obtained using a piggyback steady/unsteady total pressure probe in non-nulling mode. Both inlet and exit flow conditions were measured in the stationary frame of reference.

Results indicate increases in wake thickness and magnitude of total pressure defect as blade loading increased into the distortion cycle. The wake suction side jet increased in width and magnitude as blade loading increased, which appears to be a response to flow blockage caused by the growing boundary layer on the blades. Based on one-dimensional exit total pressure conditions with respect to the distortion screen, the dynamic response of the intra-blade passage flow does not appear to be a function of blade loading, measurement span, or distortion intensity within the ranges tested. Unsteady one-dimensional rotor exit suction side jet width and magnitude varied a great deal within and outside of the distorted region, and were only moderately correlated to inlet flow conditions. Changes in the unsteady one-dimensional rotor wake width and magnitude were usually in phase with and strongly correlated to changes in the inlet flow conditions.

## **ACKNOWLEDGEMENTS**

The author wishes to thank the members of his advisory committee, Drs. Walter F. O'Brien, Clint Dancey, and Wing-fai Ng, for their serving in this capacity. Special thanks are extended to Dr. O'Brien for funding and his numerous helpful suggestions throughout the course of this research effort.

The financial and technical support of William T. Cousins and the AlliedSignal Corporation are gratefully acknowledged. Billy Shepherd, Frank Caldwell, and Derwin Stafford of the Mechanical Engineering shops were extremely helpful in matters of equipment and instrumentation setup. Dwight Smith and Nikhil Rao provided the excellent LabView virtual instruments used in this work. Uwe Drost is to be commended for meticulous documentation of the five-hole probe calibration and interpolation codes. Help from former undergraduates Bill Burnet, Marcus Williams, and Barry Riding was greatly appreciated as well.

The friendship and guidance of Dr. Alan Hale, Dr. Tony DiPietro, Jeremy Chan, Joe Cahill, Dario Bersiga, Mac Chiu, Joe Howard, Scott Gallimore, Jeff Schwartz, and all at New Life Campus Fellowship will never be forgotten. Dr. Peter King was a tremendous blessing toward the end of this work for data acquisition help and by allowing the author to live with him until the thesis was complete. The author's family is owed an especially large debt of gratitude for encouragement and financial support throughout this ordeal.

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## NOMENCLATURE

A	Amperes
A	Area
AC	Alternating current
Ann	Annulus
Atm	Atmospheric
Ave	Average
C	Chord length
$C_{p_{static}}$	Five-hole probe static pressure calibration coefficient
$C_{p_{total}}$	Five-hole probe total calibration coefficient
$C_{p_{yaw}}$	Five-hole probe yaw angle calibration coefficient
$C_{p_{pitch}}$	Five-hole probe pitch angle calibration coefficient
$C_x$	Axial velocity
cm	Centimeters
d	Wire diameter
dB	Decibels
DC	Direct current
FM	Frequency modulation
ft	Feet
Hp	Horsepower
H <sub>2</sub> O	Water
i	Blade incidence angle
I/O	Input/Output
IGV	Inlet guide vane
m	Meters
mA	MilliAmperes
med	Median
m	Meridional direction

msec	Milliseconds
P	Pressure
$\bar{P}$	Average of five-hole probe pressures
$p_i$	Five-hole probe pressures
PSD	Power spectral density
Psig	Pounds per square inch of gauge pressure
R	Ideal gas constant
rpm	Revolutions per minute
SS	Steady-state
s	Pitch length
sec	Seconds
T	Temperature
t	Blade thickness
U	Wheel speed
$V_i$	Absolute flow velocity
$W_i$	Relative flow velocity
W	Uncertainty

### **Greek Symbols**

$\alpha_i$	Absolute Flow Angle
$\alpha$	Flow pitch angle
$\beta_i$	Relative Flow Angle
$\beta$	Flow yaw angle
$\theta$	Circumferential direction
$\psi$	Non-dimensionalized machine total pressure rise
$\Omega$	Ohms resistance
$\rho$	Fluid Density
$\xi$	Stagger Angle