Aerodynamic Measurements in a Wind Tunnel on Scale Models of a 777 Main Landing Gear

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(Abstract)

Aerodynamic measurements were taken over models of the Boeing 777 high fidelity isolated landing gear in the 6- by 6-foot Virginia Tech Stability Wind Tunnel (VT-SWT) at a free-stream Mach number of 0.16. Noise control devices (NCD) were developed at Virginia Tech [9] to reduce noise by shielding gear components, reducing wake interactions and by streamlining the flow around certain landing gear components. Aerodynamic measurements were performed to understand the flow over the landing gear and also changes in the flow between ‘Baseline’ and ‘NCD’ configurations (without and with Noise Control Devices respectively). Hot-film, Pitot-static measurements and flow visualization using tufts were performed over an isolated 26% scale-model high fidelity landing gear for the ‘Baseline’ and ‘NCD’ configurations. Contours of turbulence intensity, normalized wake velocity and normalized total pressure loss for both configurations are compared. The ‘Baseline’ configuration was also compared with the NASA Ames study conducted by Horne et al [7]. Hot-film measurements are also compared to Microphone Phased Array results which were acquired at Virginia Tech by Ravetta [8]. A novel technique for processing hot-film measurements by breaking turbulence into octave bands as acoustic measurements is presented.

Particle Image Velocimetry (PIV) measurements were taken at six different locations over the 13% scale-model landing gear with no door and at a truck angle of zero degrees. Results are compared to PIV measurements taken over the wheels of a four-wheel landing gear by Lazos [10-12]. PIV results such as average velocity contours and vectors, streamlines and instantaneous velocity contours and vectors are presented. Results presented from PIV and flow visualization are in good agreement with results from Lazos [10-12].

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Nomenclature

E_W	Actual Anemometer Output Voltage
G	Gain
E_G	Recorded Voltage
E_{off}	Offset
T_w	Operating Wire Resistance Temperature
$T_{a,r}$	Referenced Flow Temperature
T_a	Recorded Temperature
$E_{w,r}$	Referenced Output Voltage
X	Total Velocity
$\overline{X}$	Mean Velocity
x'	Unsteady Velocity
N	Number of Samples
T	Total Sample Time
SR	Sampling Rate
Δt	Time Interval between Samples
Tu	Turbulence Intensity
X_{RMS}	Root Mean Square Velocity
X_∞	Free-stream Velocity
f_c	Center Frequency for $1/12^{th}$ Octave Bands
f_u	Upper Frequency for $1/12^{th}$ Octave Bands
f_l	Lower Frequency for $1/12^{th}$ Octave Bands
BN	Band Number
w_i	Vorticity (i-direction)
ε_{ijk}	Alternating Unit Tensor
∂_j	Differential Operator (j-direction)
v_k	Velocity (k-direction)
M	Magnification
Δx	Displacement