

# **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].

# Table of Contents

<b>Abstract</b>	<b>ii</b>
<b>Table of Contents</b>	<b>iii</b>
<b>List of Figures</b>	<b>v</b>
<b>List of Tables</b>	<b>xi</b>
<b>Nomenclature</b>	<b>xii</b>
<b>1 Introduction</b>	<b>1</b>
1.1 Background and Motivation	1
<b>2 Experimental Setup</b>	<b>6</b>
2.1 Wind Tunnel Test Facility	6
2.2 Test Configurations	7
2.3 Hot-film Measurements	9
2.4 Pitot-static Probe Measurements	13
2.5 Tuft Flow Visualization	16
2.6 Particle Image Velocimetry	17
<b>3 Data Reduction</b>	<b>29</b>
3.1 Hot-film Measurements	29
3.2 Pitot-static Measurements	37
3.3 Flow Visualization	38
3.4 Particle Image Velocimetry	39
<b>4 Experimental Results and Conclusions</b>	<b>41</b>
4.1 Results	41
4.2 Conclusions	87

<b>5</b>	<b>References</b>	<b>90</b>
	<b>Appendix A: Uncertainty Calculations</b>	<b>92</b>
	<b>Appendix B: Basic Principles</b>	<b>94</b>
	B.1    Hot-wire Anemometry	94
	B.2    Pitot-static Pressure Measurements	97
	B.3    Flow Visualization	98
	<b>Appendix C: 1/12<sup>th</sup> Octave Bands</b>	<b>100</b>
	<b>Appendix D: Hot film and Pitot Scanning Plane and Truck and Braces Grid Locations</b>	<b>102</b>

## List of Figures

### *Chapter 1*

Figure 1.1	Low Fidelity 26% Scale Model of the 777 Main Landing Gear	3
Figure 1.2	High Fidelity 26 % Scale Model of the 777 Main Landing Gear	3
Figure 1.3	High Fidelity Model of the 777 Landing Gear showing Noise Control Devices	4

### *Chapter 2*

Figure 2.1	Virginia Tech Stability Tunnel	7
Figure 2.2	26% High Fidelity Landing Gear (Baseline Configuration) in VT-SWT	8
Figure 2.3	26% High Fidelity landing gear (NCD configuration) in VT-SWT	8
Figure 2.4	Model 1201 Cylindrical Hot-film Probe	9
Figure 2.5	Hot-film Probe Support	10
Figure 2.6	Traverse Installed in the VT-SWT	11
Figure 2.7	Dantec 5501 CTA Hot-wire Anemometer	12
Figure 2.8	Nicolet BE256-LE Data Acquisition System	12
Figure 2.9	United Sensor Corporation PAE-12-M Pitot-static Probe	13
Figure 2.10	MKS Baratron Type 223 Pressure Transducers and Display Box	14
Figure 2.11	National Instruments USB-6008 Data Acquisition System	15
Figure 2.12	Flow Visualization over the Braces Region with Gear in 'Baseline' Configuration	16
Figure 2.13	Flow Visualization over the Braces Region with Gear in 'NCD' Configuration	17
Figure 2.14	Measurement Principles of a PIV System (Dantec Dynamics)	18
Figure 2.15	New Wave Research Nd:YAG Laser	19
Figure 2.16	Seeder Rod in the VT-SWT with 13% Gear	20
Figure 2.17	Experimental Setup for 'Large View between Braces'	21

Figure 2.18	Superimposed Pair of Recorded Images for ‘Large View between Braces’	21
Figure 2.19	Experimental Setup for ‘Vertical Plane Close View’	22
Figure 2.20	Pair of Superimposed Images for ‘Vertical Plane Close View’	23
Figure 2.21	Setup for ‘Vertical Plane Wheels View’	23
Figure 2.22	Image Captured by CCD camera for ‘Vertical Plane Close View’	24
Figure 2.23	Setup for ‘Back Wheel View Vertical Plane’	25
Figure 2.24	Image captured for ‘Back Wheel View Vertical Plane’	25
Figure 2.25	Experimental Setup for ‘Inclined Plane 13 Degrees Front’	26
Figure 2.26	Experimental Setup for ‘Inclined Plane 13 Degrees Front’ (Back View)	26
Figure 2.27	Image Captured for ‘Inclined Plane 13 Degrees Front’	27
Figure 2.28	Experimental Setup for ‘View from Top’	27
Figure 2.29	Image Captured by CCD Camera for ‘View from Top’	28

### *Chapter 3*

Figure 3.1	4 <sup>th</sup> Order Calibration Curve for Hot-film Probe	31
Figure 3.2	Sample Velocity Spectrum in the Wake of the Landing Gear	34
Figure 3.3	Sample Velocity Spectra Contour Plot for $f_c=4.6$ kHz (1/12 <sup>th</sup> Octave Bands, BN =146)	35
Figure 3.4	Sum of the 176 Spectra Contour Plots (Frequency Domain) is Proportional to the Turbulence Intensity (Time Domain)	35
Figure 3.5	Projection of Beamforming Grid (Truck Region) on the Hot-film Scanning Grid	36
Figure 3.6	Contour Plots of Velocity Spectra Broken into 1/12 <sup>th</sup> Octave Bands for both Configurations	37
Figure 3.7	Linear Calibration Curve for MKS Transducers	38

### *Chapter 4*

Figure 4.1	Contours of Normalized Wake Velocity; Comparison between NASA Ames and VT-SWT	42
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Figure 4.2	Contours of Total Normalized Pressure Loss; Comparison between NASA Ames and VT- SWT	43
Figure 4.3	Contours of Turbulence Intensity (%); Comparison between NASA Ames and VT-SWT	44
Figure 4.4	Contours of Normalized Wake Velocity; Comparison between VT-Baseline and VT-NCD	45
Figure 4.5	Contours of Turbulence Intensity (%); Comparison between VT-Baseline and VT-NCD	45
Figure 4.6	Contours of Normalized Total Pressure Loss; Comparison of VT-Baseline and VT-NCD	46
Figure 4.7	Turbulence Intensity Contours for VT-Baseline Showing different spectra zones	47
Figure 4.8	Velocity Spectra at a Sample Point in Zone 1 (in Free-stream)	47
Figure 4.9	Velocity Spectra at a Sample Point in Zone 2 (Behind Braces)	48
Figure 4.10	Velocity Spectra at a Sample Point in Zone 3 (Behind Truck)	48
Figure 4.11	Velocity Spectra at a Sample Point in Zone 4 (Behind Door)	49
Figure 4.12	Velocity Spectra at a Sample Point in Zone 5 (Behind Main Strut)	49
Figure 4.13	Comparison of Hot-film Data with MPA data	50
Figure 4.14	Flow Visualization over the Front Wheel	52
Figure 4.15	Flow Visualization over the Middle Wheel	52
Figure 4.16	Flow Visualization over the Back Wheel	53
Figure 4.17	Flow Visualization over the Gear Door	55
Figure 4.18	Tecplot Model of the Landing Gear (and Close-up of the Door) Looking Downstream (Flow in the Page)	56
Figure 4.19	Flow Visualization over the Gear Door (Back End)	56
Figure 4.20	Flow Visualization over the Braces and the Lock Link	57
Figure 4.21	Flow Visualization using Tuft under the Wheels	58
Figure 4.22	Flow Visualization over the Truck (View from ground looking towards the wing)	58
Figure 4.23	Landing Gear with Flow Vectors seen from the Braces Side	61

Figure 4.24	Landing Gear with Flow Vectors seen from the Door Side	62
Figure 4.25	Landing gear with Flow Vectors seen from the Ground side	62
Figure 4.26	Flow Visualization using Tuft over Braces Noise Control Devices	63
Figure 4.27	Flow Visualization using Tuft over Truck Noise Control Devices	64
Figure 4.28	Flow Visualization using Tuft over Strut Noise Control Devices	64
Figure 4.29	Average Velocity Contours (with Streamlines) for ‘Large View between Braces’ (8- by 8-inch Window)	66
Figure 4.30	Root Mean Square Velocity Contours Calculated from 300 Samples $U_{RMS}$ (left) and $V_{RMS}$ (right) for ‘Large View between Braces’ (8- by 8-inch Window)	67
Figure 4.31	Instantaneous Velocity Contours for ‘Large View between Braces’ (8- by 8-inch Window)	67
Figure 4.32	Instantaneous Velocity Vectors for ‘Large View between Braces’ (8- by 8-inch Window)	68
Figure 4.33	Vortex Shed from the Front Brace towards the Back Brace in ‘Large View between Braces’ (8- by 8-inch Window) determined from PIV Data	69
Figure 4.34	Average Velocity Contours (with Streamlines) for ‘Vertical Plane Close View’ (2- by 2-inch Window)	70
Figure 4.35	Root Mean Square Velocity contours calculated from 300 samples. $U_{RMS}$ (left) and $V_{RMS}$ (right) for ‘Vertical Plane Close View’ (2- by 2-inch Window)	70
Figure 4.36	Instantaneous Velocity Contours (with Streamlines) for ‘Vertical Plane Close View’ (2- by 2-inch Window)	71
Figure 4.37	Instantaneous Velocity Vectors for ‘Vertical Plane Close View’ (2- by 2-inch Window)	71
Figure 4.38	Instantaneous Vortex Shed from the Front Brace as seen in ‘Vertical Plane Close View’ (2- by 2-inch Window)	72
Figure 4.39	Average Velocity Contours (with Streamlines) for ‘Vertical Plane Wheels View’ (3.5- by 3.5-inch Window)	73

Figure 4.40	Average Velocity and Streamlines in the DPIV Plane from Lazos [5], (NASA Langley, 2002). Red Box shows the Area Analyzed in ‘Vertical Plane Wheels View’ (VT-SWT Data)	73
Figure 4.41	Root Mean Square Velocity contours calculated from 300 samples. $U_{RMS}$ (left) and $V_{RMS}$ (right) for ‘Vertical Plane Wheels View’ (3.5- by 3.5-inch Window)	74
Figure 4.42	Instantaneous Velocity Contours (with Streamlines) for ‘Vertical Plane Wheels View’ (3.5- by 3.5-inch Window)	75
Figure 4.43	Instantaneous Velocity Vectors for ‘Vertical Plane Wheels View’ (3.5- by 3.5-inch Window)	75
Figure 4.44	Non-Stationary Instantaneous Vortex at Different Locations Between the Wheels as seen in ‘Vertical Plane Wheels View’ (3.5- by 3.5-inch Window)	76
Figure 4.45	Mean Vorticity Field in the Mid-Plane of Wheels from Lazos (NASA Langley, 2002)	77
Figure 4.46	Mean Vorticity Calculated from 300 Instantaneous Samples of ‘Vertical Plane Wheels View’ (VT-SWT Data)	77
Figure 4.47	Average Velocity Contours (with Streamlines) and Average Velocity Vectors for ‘Back Wheel View Vertical Plane’ (3.5- by 3.5-inch Window)	78
Figure 4.48	Root Mean Square Velocity contours calculated from 300 samples. $U_{RMS}$ (left) and $V_{RMS}$ (right) for ‘Back Wheel View Vertical Plane’ (3.5- by 3.5-inch Window)	79
Figure 4.49	Instantaneous Velocity Contours (with Streamlines) for ‘Back Wheel View Vertical Plane’ (3.5- by 3.5-inch Window)	79
Figure 4.50	Instantaneous Velocity Vectors for ‘Back Wheel View Vertical Plane’ (3.5- by 3.5-inch Window)	80
Figure 4.51	Average Velocity Contours (with Streamlines) and Average Velocity Vectors for ‘Inclined Plane 13 Degrees Front’ (3.5- by 3.5-inch Window)	81
Figure 4.52	Root Mean Square Velocity contours calculated from 300 samples. $U_{RMS}$ (left) and $V_{RMS}$ (right) for ‘Inclined Plane 13 Degrees Front’ (3.5- by 3.5-inch Window)	82

Figure 4.53	Instantaneous Velocity Contours (with Streamlines) for ‘Inclined Plane 13 Degrees Front’ (3.5- by 3.5-inch Window)	82
Figure 4.54	Instantaneous Velocity Vectors for ‘Inclined Plane 13 Degrees Front’ (3.5- by 3.5-inch Window)	83
Figure 4.55	Average Velocity Contours (with Streamlines) and Average Velocity Vectors for ‘View from Top’ (3.5- by 3.5-inch Window)	84
Figure 4.56	Root Mean Square Velocity contours calculated from 300 samples. $U_{RMS}$ (left) and $V_{RMS}$ (right) for ‘View from Top’ (3.5- by 3.5-inch Window)	84
Figure 4.57	Instantaneous Velocity Contours (with Streamlines) for ‘View from Top’ (3.5- by 3.5-inch Window)	85
Figure 4.58	Instantaneous Velocity Vectors for ‘View from Top’ (3.5- by 3.5-inch Window)	86
Appendix B		
Figure B2.1	Schematic of a Hot-wire Sensor and a Cylindrical Hot-film Sensor	95
Figure B2.2	Schematic of a CTA circuitry	96
Figure B2.3	Typical 4 <sup>th</sup> Order Hot-wire Calibration Curve	97
Figure B2.4	Typical Pitot-static Probe	98
Appendix D		
Figure D4.1	Hot film and Pitot-static Probe Scanning Plane and Grid Location for Truck NCD	102
Figure D4.2	Hot film and Pitot-static Probe Scanning Plane and Grid Location for Braces NCD	103

## List of Tables

### *Chapter 2*

Table 2.1	Six Measurement Planes and their corresponding Run Numbers	20
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### *Chapter 3*

Table 3.1	Calibration Factors for PIV Data Reduction using DPIV software	39
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## Nomenclature

$E_w$	Actual Anemometer Output Voltage
$G$	Gain
$E_G$	Recorded Voltage
$E_{\text{off}}$	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
$\bar{X}$	Mean Velocity
$x'$	Unsteady Velocity
$N$	Number of Samples
$T$	Total Sample Time
$SR$	Sampling Rate
$\Delta t$	Time Interval between Samples
$T_u$	Turbulence Intensity
$X_{\text{RMS}}$	Root Mean Square Velocity
$X_{\infty}$	Free-stream Velocity
$f_c$	Center Frequency for 1/12 <sup>th</sup> Octave Bands
$f_u$	Upper Frequency for 1/12 <sup>th</sup> Octave Bands
$f_l$	Lower Frequency for 1/12 <sup>th</sup> Octave Bands
$BN$	Band Number
$w_i$	Vorticity (i-direction)
$\epsilon_{ijk}$	Alternating Unit Tensor
$\partial_j$	Differential Operator (j-direction)
$v_k$	Velocity (k-direction)
$M$	Magnification
$\Delta x$	Displacement