EXPERIMENTAL MODEL STUDIES OF THE DYNAMIC VELOCITY FLUCTUATIONS EXISTING IN THE AIR WAKE OF AN AIRCRAFT CARRIER

Part II: APPENDIX (GRAPHS OF EXPERIMENTAL DATA)

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Prepared For:
Office of Naval Research
Department of the Navy
Washington, D. C. 20360

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APPENDIX (GRAPHS OF EXPERIMENTAL DATA) TO EXPERIMENTAL MODEL STUDIES OF THE DYNAMIC VELOCITY FLUCTUATIONS EXISTING IN THE AIR WAKE OF AN AIRCRAFT CARRIER

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APPENDIX MATERIAL

Horizontal Velocity; Pitch Transfer Function Amplitude
- Wind 3° Port: A-1 to A-3
- Wind 10° Port: A-9 to A-16

Horizontal Velocity; Pitch Transfer Function Phase
- Wind 3° Port: A-17 to A-20
- Wind 10° Port: A-21 to A-24

Vertical Velocity; Pitch Transfer Function Amplitude
- Wind 3° Port: A-25 to A-32
- Wind 10° Port: A-33 to A-40

Vertical Velocity; Pitch Transfer Function Phase
- Wind 3° Port: A-41 to A-44
- Wind 10° Port: A-45 to A-48

Horizontal Power Spectra
- Wind 3° Port: A-49 to A-52
- Wind 10° Port: A-53 to A-56

Vertical Power Spectra
- Wind 3° Port: A-57 to A-58
- Wind 10° Port: A-59 to A-60

NOTE: Wind orientation is from the keel-line of the ship; i.e. wind 3° port is 3° port of the ship's keel, wind 10° port is 10° port of the ship's keel.

Distances are given in feet aft of the touchdown point. For Forrestal class carriers, the touchdown point is considered 150 feet ahead of the trailing edge of the ramp. To determine distances aft of the ramp, subtract 150 feet from distances given in the figures.
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE

WIND 3° PORT

3° Glide Path
4° Glide Path
5° Glide Path

\[ \frac{u}{v} \backslash \theta \]

0 1 2 3 4 5 6 7 8 9 10

\( \omega \), FULL SCALE

226 FEET AFT OF TOUCHDOWN POINT, 47 FEET PORT OF GLIDE PATH

OCEANICS
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 3° PORT

226 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE.

226 FEET AFT OF TOUCHDOWN POINT, 47 FEET STARBOARD OF GLIDE PATH.
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE

WIND 3° PORT

\[ \frac{u}{\theta} \]

\[ \Omega \]

485 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

\[ \frac{\omega}{\Omega} \]

\[ \omega \]

485 FEET AFT OF TOUCHDOWN POINT, 47 FEET STARBOARD OF GLIDE PATH

OCEANICS...
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE

WIND 3° PORT

0 3° GLIDE PATH

0 4° GLIDE PATH

0 5° GLIDE PATH

ω/υ

0 6

0 4

0 2

0 1

0 0

0 1 2 3 4 5 6 7 8 9 10

(A) FULL SCALE

764 FEET AFT OF TOUCHDOWN POINT, 97 FEET PORT OF GLIDE PATH

OCEANICS
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 3° PORT

α 3° GLIDE PATH
α 4° GLIDE PATH
α 5° GLIDE PATH

764 FEET AFT OF TOUCHDOWN, 107 FEET STARBOARD OF GLIDE PATH CENTERLINE

α 3° GLIDE PATH
α 4° GLIDE PATH
α 5° GLIDE PATH

764 FEET AFT OF TOUCHDOWN POINT, 47 FEET STARBOARD OF GLIDE PATH
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 3° PORT

φ 2° GLIDE PATH
φ 4° GLIDE PATH
φ 5° GLIDE PATH

(\frac{v}{u}) FULL SCALE
1040 FEET AFT OF TOUCHDOWN POINT, 47 FEET PORT OF GLIDE PATH
HORIZONTAL VELOCITY - HORIZONTAL VELOCITY TRANSFER FUNCTION AMPLITUDE

WIND 3° PORT

\( \theta \): 3° GLIDE PATH
\( \Delta \): 4° GLIDE PATH
\( \Theta \): 5° GLIDE PATH

\( u \): FULL SCALE
1040 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

\( u \): FULL SCALE
1040 FEET AFT OF TOUCHDOWN POINT, 147 FEET STARBOARD OF GLIDE PATH

OCEANICS
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 10° PORT

- 2° GLIDE PATH
- 4° GLIDE PATH
- 6° GLIDE PATH

\( \frac{w}{U} \cdot \frac{\theta}{\Theta} \)

FULL SCALE
226 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

OCEANICS...
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 10° PORT

3 3° Glide Path
△ 4° Glide Path
□ 5° Glide Path

ω/κ

1

u/λ

0 1 2 3 4 5 6 7 8 9 1.0
(ω) FULL SCALE

226 FEET AFT OF TOUCHDOWN POINT, 47 FEET PORT OF GLIDE PATH

2 3° Glide Path
△ 4° Glide Path
□ 5° Glide Path

ω/κ

1

0 1 2 3 4 5 6 7 8 9 1.0
(ω) FULL SCALE

226 FEET AFT OF TOUCHDOWN POINT, 47 FEET STARBOARD OF GLIDE PATH

OCEANICS
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE

WIND 20° PORT

0° Glide Path
4° Glide Path
8° Glide Path

0.5 FULL SCALE
416 Feet AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 10° PORT

\[ \frac{\omega}{\omega_0} \]

\[ \frac{\omega}{\omega_0} \]

0 1 2 3 4 5 6 7 8 9 10
\( \omega \) FULL SCALE

485 FEET AFT OF TOUCHDOWN POINT, 47 FEET PORT OF GLIDE PATH

\( \frac{\omega}{\omega_0} \)

\( \frac{\omega}{\omega_0} \)

0 1 2 3 4 5 6 7 8 9 10
\( \omega \) FULL SCALE

485 FEET AFT OF TOUCHDOWN POINT, 47 FEET STARBOARD OF GLIDE PATH
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE

WIND 16° PORT

0.1° GLIDE PATH
8.8° GLIDE PATH
9.3° GLIDE PATH

\( \frac{\text{W}^2}{\text{V}^2} \)

FULL SCALE
744 FEET AFT OF TOUCHDOWN POINT OR GLIDE PATH CENTERLINE
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE

WIND 10° PORT

1° GLIDE PATH
4° GLIDE PATH
8° GLIDE PATH

\[ \frac{u}{\gamma} \]

0 1 2 3 4 5 6 7 8 9 10

(\# FULL SCALE)

764 FEET AFT OF TOUCHDOWN POINT, 47 FEET STARBOARD OF GLIDE PATH

1° GLIDE PATH
4° GLIDE PATH
8° GLIDE PATH

\[ \frac{v}{\gamma} \]

0 1 2 3 4 5 6 7 8 9 10

(\# FULL SCALE)

764 FEET AFT OF TOUCHDOWN POINT, 47 FEET STARBOARD OF GLIDE PATH

- OCEANICS -
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE

WIND 10° PORT

1 4° GLIDE PATH
4 0° GLIDE PATH
6 8° GLIDE PATH

\( \alpha/u \)

\( \delta \)

1

0 1 2 3 4 5 6 7 8 9 1.0

(\( u \)) FULL SCALE

10,480 FEET AFT OF TOUCHDOWN POINT, 47 FEET PORT OF GLIDE PATH

1 6.3° GLIDE PATH
2 4° GLIDE PATH
3 8° GLIDE PATH

\( \alpha/u \)

\( \delta \)

1

0 1 2 3 4 5 6 7 8 9 1.0

(\( u \)) FULL SCALE

10,480 FEET AFT OF TOUCHDOWN POINT, 47 FEET STARBOARD OF GLIDE PATH
HORIZONTAL VELOCITY + PITCH TRANSFER FUNCTION PHASE
485 FEET AFT OF TOUCHDOWN
WIND 3° PORT

On Centerline

PHASE ANGLE LAG (DEGREES) FROM MAXIMUM PITCH CONDITION

-100 0 1 2 3 4 5 6 7 8 9 10

47 Feet Starboard of Centerline

-100 0 1 2 3 4 5 6 7 8 9 10

47 Feet Port of Centerline

FULL SCALE

OCEANICS
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION PHASE
764 FEET AFT OF TOUCHDOWN
WIND 3° PORT

- Phase angle lag (degrees) from maximum pitch condition

- Wind 3° port

- 3° glide path

- 4° glide path

- 5° glide path

- Full scale

Oceanics
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION PHASE

226 FEET AFT OF TOUCHDOWN

WIND 10° PORT

47 Feet Starboard of Centerline

47 Feet Port of Centerline

FULL SCALE

OCEANICS
HORIZONTAL VELOCITY - PITCH TRANSFER FUNCTION PHASE
485 FEET AFT OF TOUCHDOWN
WIND 10° PORT

- 3° GLIDE PATH
- 4° GLIDE PATH
- 5° GLIDE PATH

PHASE ANGLE LAG (DEGREES) FROM MAXIMUM PITCH CONDITION

47 Feet Starboard of Centerline

47 Feet Port of Centerline

FULL SCALE

OCEANICS
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 30 PORT

0 3° GLIDE PATH
4 4° GLIDE PATH
7 5° GLIDE PATH

Ω FULL SCALE
226 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 3° PORT

226 FEET AFT OF TOUCHDOWN POINT, 47 FEET STABOARD OF GLIDE PATH

OCEANICS
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 3° PORT

- 3° GLIDE PATH
- 4° GLIDE PATH
- 5° GLIDE PATH

\( \frac{\Delta t}{\Delta \theta} \)

FULL SCALE
485 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

OCEANICS...
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 3° PORT

485 FEET AFT OF TOUCHDOWN POINT, 47 FEET PORT OF GLIDE PATH

485 FEET AFT OF TOUCHDOWN POINT, 47 FEET PORT OF GLIDE PATH

OCEANICS
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMMITUDE
WIND 3° PORT

- 3° GLIDE PATH
- 4° GLIDE PATH
- 5° GLIDE PATH

\( \frac{w}{u} \) FULL SCALE

764 FEET AFT OF TOUCHDOWN POINT, 47 FEET STARBOARD OF GLIDE PATH

\( \frac{\mu r}{\mu} \) FULL SCALE

764 FEET AFT OF TOUCHDOWN POINT, 47 FEET PORT OF GLIDE PATH

OCEANICS
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 3° PORT

○ 3° GLIDE PATH
△ 4° GLIDE PATH
□ 5° GLIDE PATH

\(\omega \frac{r}{v_f}\)

\(\omega \) FULL SCALE
764 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

Oceanics
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 3° PORT

- 1° GLIDE PATH
- 3° GLIDE PATH
- 4° GLIDE PATH

1040 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 3° PORT

1040 FEET AFT OF TOUCHDOWN POINT, 47 FEET STARBOARD OF GLIDE PATH

1040 FEET AFT OF TOUCHDOWN POINT, 47 FEET PORT OF GLIDE PATH
VERTICAL VELOCITY = PITCH TRANSFER FUNCTION AMPLITUDE
WIND 10° PORT

○ 3° GLIDE PATH
△ 4° GLIDE PATH
□ 5° GLIDE PATH

\[ \frac{\text{ft/}^2}{\text{s}} \]

FULL SCALE
226 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE

WIND 10° PORT

0.3° GLIDE PATH

4.4° GLIDE PATH

6.5° GLIDE PATH

\[ \frac{\Delta v}{v} \]

- Full Scale

485 Feet Alt. of Touchdown Point on Glide Path Centerline

OCEANICS
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 10° PORT

485 FEET AFT OF TOUCHDOWN POINT, 47 FEET PORT OF GLIDE PATH

485 FEET AFT OF TOUCHDOWN POINT, 47 FEET STARBOARD OF GLIDE PATH
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND: 10° PORT

© 3° GLIDE PATH
△ 4° GLIDE PATH
© 5° GLIDE PATH

ω FULL SCALE
764 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 10° PORT

\[ \frac{\omega}{U} \]

\[ \frac{\omega}{\Theta} \]

\( \Theta \)

\( \omega \) FULL SCALE

764 FEET AFT OF TOUCHDOWN POINT, 47 FEET PORT OF GLIDE PATH

764 FEET AFT OF TOUCHDOWN POINT, 47 FEET STARBOARD OF GLIDE PATH

1° GLIDE PATH

4° GLIDE PATH

5° GLIDE PATH

OCEANICS
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION AMPLITUDE
WIND 10° PORT

○ 3° GLIDE PATH
△ 4° GLIDE PATH
□ 5° GLIDE PATH

ω FULL SCALE
1040 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

OCEANICS
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION PHASE
226 FEET AFT OF TOUCHDOWN
WIND 3° PORT

0° GLIDE PATH
300° GLIDE PATH
60° GLIDE PATH

100° GLIDE PATH
100° GLIDE PATH
100° GLIDE PATH

On Centerline

47 Feet Port of Centerline

47 Feet Starboard of Centerline

FULL SCALE

OCEANICS
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION PHASE
764 FEET AFT OF TOUCHDOWN
WIND 10° PORT

500  ○ 3° GLIDE PATH
△ 4° GLIDE PATH
400  □ 5° GLIDE PATH

300
200
100
0

0 1 2 3 4 5 6 7 8 9 10
47 Feet Starboard of Centerline

PHASE ANGLE LAG (DEGREES) FROM MAXIMUM PITCH CONDITION

400  ○ 3° GLIDE PATH
△ 4° GLIDE PATH
300  □ 5° GLIDE PATH

200
100
0

0 1 2 3 4 5 6 7 8 9 10
On Centerline

47 Feet Port of Centerline
[w] FULL SCALE
VERTICAL VELOCITY - PITCH TRANSFER FUNCTION PHASE
1040 FEET AFT OF TOUCHDOWN
WIND 10° PORT

° 3° GLIDE PATH
△ 4° GLIDE PATH
□ 5° GLIDE PATH

PHASE ANGLE LAG (DEGREES) FROM MAXIMUM PITCH CONDITION

OCEANICS
HORIZONTAL VELOCITY - POWER SPECTRUM

435 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

WIND 3° PORT

It is believed the measurements at this position were influenced by the wake from the island. Therefore, no curves have been drawn through the data points.

- 3° GLIDE PATH
- 4° GLIDE PATH
- 5° GLIDE PATH

0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

\( \omega \) FULL SCALE
HORIZONTAL VELOCITY - POWER SPECTRUM
754 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE
WIND 3° PORT

- 3° GLIDE PATH
- 4° GLIDE PATH
- 5° GLIDE PATH

10^5 \frac{H_u}{u}

\omega FULL SCALE
HORIZONTAL VELOCITY - POWER SPECTRUM

226 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE.

WIND 10° PORT, I.E., ALONG CENTERLINE OF LANDING DECK

○ 3° GLIDE PATH
△ 4° GLIDE PATH
□ 5° GLIDE PATH

\[ 10^7 \frac{F}{Hz} \]

\[ \Omega \text{ FULL SCALE} \]
HORIZONTAL VELOCITY - POWER SPECTRUM

405 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

WIND 10° PORT, I.E., ALONG CENTERLINE OF LANDING DECK

○ 3° GLIDE PATH
△ 4° GLIDE PATH
□ 5° GLIDE PATH

(\text{HOR}) FULL SCALE
HORIZONTAL VELOCITY - POWER SPECTRUM

10,000 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

WIND 10° PORT, I.E., ALONG CENTERLINE OF LANDING DECK

- 3° GLIDE PATH
- 4° GLIDE PATH
- 5° GLIDE PATH

C° FULL SCALE
VERTICAL VELOCITY - POWER SPECTRUM

WIND 1° PORT

- GLIDE PATH
- GLIDE PATH
- GLIDE PATH

226 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

- GLIDE PATH
- GLIDE PATH
- GLIDE PATH

486 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

-OCEANICS-
VERTICAL VELOCITY - POWER SPECTRUM
WIND 3° PORT

GLIDE PATH

754 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

1040 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE
VERTICAL VELOCITY - POWER SPECTRUM
WIND 10° PORT

0° GLIDE PATH
4° GLIDE PATH
8° GLIDE PATH

228 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE

0° GLIDE PATH
4° GLIDE PATH
8° GLIDE PATH

481 FEET AFT OF TOUCHDOWN POINT ON GLIDE PATH CENTERLINE