NASA CONTRACTOR REPORT

NASA CR-1900

NASA CR-1900

DEVELOPMENT OF CONTROL SYSTEMS FOR SPACE SHUTTLE VEHICLES

Volume II - Appendixes

by C. R. Stone, T. W. Chase, B. M. Kiziloz, and M. D. Ward

Prepared by
HONEYWELL, INC.
SYSTEMS AND RESEARCH CENTER
Minneapolis, Minn.
for George C. Marshall Space Flight Center

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • SEPTEMBER 1971

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. NASA CR-1900	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE DEVELOPMENT OF CONTROL SYSTEMS FOR SPACE SHUTTLE VEHICLES Volume II: Appendixes		5. REPORT DATE September 1971
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) C. R. Stone, T. W. Chase, B. M. Kiziloz, and M. D. Ward		8. PERFORMING ORGANIZATION REPORT # 14257-FR
9. PERFORMING ORGANIZATION NAME AND ADDRESS Honeywell, Inc. Systems and Research Center Minneapolis, Minnesota		10. WORK UNIT NO.
		11. CONTRACT OR GRANT NO. NAS8-25181
12. SPONSORING AGENCY NAME AND ADDRESS NASA Washington, D. C. 20546		13. TYPE OF REPORT & PERIOD COVERED CONTRACTOR REPORT
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

Control of winged two-stage space shuttle vehicles was investigated. Control requirements were determined and systems capable of meeting these requirements were synthesized. Control requirements unique to shuttle were identified. It is shown that these requirements can be satisfied by conventional control logics. Linear gain schedule controllers predominate. Actuator saturations require nonlinear compensation in some of the control systems.

17. KEY WORDS Covariance analysis, entry control system, control surface displacement, dynamic derivatives	18. DISTRIBUTION STATEMENT Unclassified - Unlimited

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassied	341	$6.00

*For sale by the National Technical Information Service, Springfield, Virginia 22151

NOTICE

Because of a waiver initiated and signed in compliance with NASA Policy Directive (NPD) 2220.4, para. 5-b, the International System of Units of measurement has not been used in this document.

FOREWORD

This report fulfills the final reporting requirements for "Development of Control Systems for Space Shuttle Vehicles" performed under National Aeronautics and Space Administration Contract NAS8-25181. The program was conducted under the direction of John M. Livingston of the Aero-Astro Dynamics Laboratory, George C. Marshall Space Flight Center. The Honeywell Systems and Research Center work was managed by Dr. Grant B. Skelton with C. R. Stone as principal investigator. T.W. Chase was co-investigator.

The report is presented in two volumes. Volume I contains the ten sections for the main body of the report. Detailed derivations and data are presented in eight appendixes of Volume II.

Section I was developed by Drs. G. B. Skelton and E. E. Yore and Messrs. J.G. Rupert, T.W. Chase, R.K. Phelps, A.J. Pejsa and C.R. Stone. Sections II and III were prepared by C. R. Stone (covariance analyses) and T.W. Chase (conventional analyses).

M.D. Ward generated the covariance data and performed quadratic syntheses in these sections. T.W. Chase prepared Sections IV, V, and VI and Appendixes B, G, and H. Section VI was adapted from work performed by M.W. Reed. Dr. G. Stein prepared Section VII, C.R. Stone prepared Sections VIII, IX, and X, and Appendixes A, C, D, E, and F. E.D. Skelley synthesized the quadratic controllers and obtained the covariance results of Section XIII.

MSFC provided the trajectory, aerodynamic, and mass properties data for Vehicle B. Data for the North American orbiters 130G and 134C were used without restriction by permission of Mr. A.B. Kehlet of the North American-Rockwell Corporation. Messrs. Stone and Chase and Mrs. B.M. Kizilos estimated missing data by use of the DATCOM Handbook, slender body theory, and impact theory.

CONTENTS

ILLUSTRATIONS

TABLES

APPENDIX A

LAUNCH PHASE RANDOM NORMAL WIND MODEL

The random wind model used in Sections II and III is discussed. This wind model is used as the "normal" wind for pitch plane studies and as the side wind for the lateral investigations.

The random wind model is the Skelton differential fit (ref. 6) of Vaughan wind data (ref. 5). This wind model will be referred to as the Vaughan-Skelton model.

The Vaughan-Skelton model is used in two different ways in this report. First, the differential equation model is used directly in covariance analyses in Sections II and III and for the quadratic control synthesis in Section II. Second, an analog simulation of the differential equation was performed to generate typical samples. One of these (Figure 7) was stored on magnetic tape and used in the manner of a "synthetic wind" for the analog simulation studies of Sections II and III.

The wind v_W is taken as made up of a mean $\bar{v}_W$ and a random component $\tilde{v}_W$ (page 29 of ref. 6).

$$\begin{aligned} v_W &= \bar{v}_W + \tilde{v}_W \\ &= \bar{v}_W + \sigma\omega \end{aligned} \tag{A1}$$

where

$$\begin{Bmatrix} \dot{\omega} \\ \dot{x} \end{Bmatrix} = \begin{bmatrix} 0 & c_3\dot{h} \\ -c_5\dot{h} & -c_4\dot{h} \end{bmatrix} \begin{Bmatrix} \omega \\ x \end{Bmatrix} + \begin{Bmatrix} c_1\sqrt{\dot{h}} \\ c_2\sqrt{\dot{h}} \end{Bmatrix} \eta \tag{A2}$$

σ = standard deviation of the random component

h = altitude

η = unity white noise

a_1 = $0.95 \cdot 10^{-4}/m$

$$a_2 = 0.735 \cdot 10^{-4}/m$$

$$a_3 = -0.91 \cdot 10^{-8}$$

$$c_1 = \sqrt{2(a_1 - a_2 a_3)}$$

$$= [2(0.95 \times 10^{-4} + 0.735 \cdot 0.91 \times 10^{-12})]^{1/2}$$

$$= +1.378 \times 10^{-2}/m^{1/2}$$

$$c_2 = [2(a_1 + a_2 a_3) c_5]^{1/2} - 2a_1 c_1$$

$$\doteq [2(0.95 \times 10^{-4})(1.442 \times 10^{-8})]^{1/2} - 2(0.95 \cdot 10^{-4})(1.378 \cdot 10^{-2})$$

$$= -0.965 \times 10^{-6}/m^{3/2}$$

$$c_3 = +1$$

$$c_4 = 2a_1 = 1.9 \cdot 10^{-4}/m$$

$$c_5 = a_1^{\,2} + a_2^{\,2}$$

$$= 10^{-8} (0.95^2 + 0.735^2)$$

$$= 1.44 \times 10^{-8}/m^2$$

For altitudes up to 32 km, the mean wind is taken as the E-W component at Cape Canaveral during March (page 13 of ref. 5. It is plotted in Figure A1. For altitudes greater than 37 km, $\bar{v}_\omega$ is taken as 20 m/sec.

Similarly, for altitudes up to 30 km, the standard deviation σ is taken as the E-W component at Cape Canaveral during March (page 13 of ref. 5). These data were smoothed as is shown on Figure A2. For altitudes greater than 30 km, it is assumed $\sigma = 5.7 - (1/6000)(h - 30,000)$ for $h > 30,000$ m where σ is in m/sec.

The a's are taken from page 23 of ref. 6, and the formulae for the c's from pages B-6 and B-7 of ref. A1.

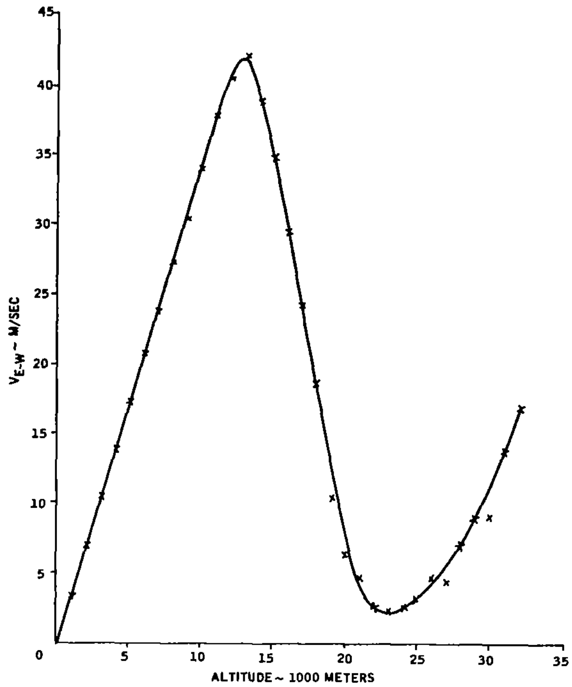


Figure A1. Mean Value of E-W March Wind

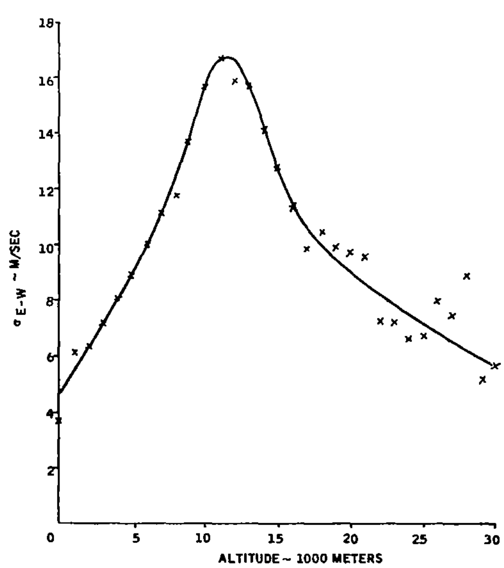


Figure A2. Standard Deviation of E-W March Wind

Equations (A3) and (A4) which follow are an alternative (which was used in this report) to Equations (A1) and (A2). Equations (A3) and (A4) were derived under the false premise that $\dot{v}_w$ would be required at some place in the study. Equations (A1) and (A2) are the preferred form because less work is required to obtain them.

Differentiation of Equation (A1) and use of Equation (A2) yields

$$\dot{v}_w = \dot{\bar{v}}_w + \dot{\tilde{v}}_w \tag{A3}$$

$$\dot{\tilde{v}}_w = \sigma\dot{\omega} + \dot{\sigma}\omega$$

$$= \sigma\left(c_3\,\dot{h}x + c_1\sqrt{\dot{h}}\,\eta\right) + \dot{\sigma}/\sigma\tilde{v}$$

$$\dot{x} = -c_5\dot{h}\omega - c_4\,\dot{h}x + c_2\sqrt{\dot{h}}\,\eta$$

$$= -\frac{c_5\dot{h}}{\sigma}\tilde{v} - c_4\dot{h}x + c_2\sqrt{\dot{h}}\,\eta$$

Hence,

$$\begin{Bmatrix} \dot{\tilde{v}} \\ \dot{x} \end{Bmatrix} = \begin{bmatrix} \dot{\sigma}/\sigma & c_3\sigma\dot{h} \\ -\dfrac{c_5\dot{h}}{\sigma} & -c_4\dot{h} \end{bmatrix} \begin{Bmatrix} \tilde{v} \\ x \end{Bmatrix} + \begin{Bmatrix} \sigma c_1\sqrt{\dot{h}} \\ c_2\sqrt{\dot{h}} \end{Bmatrix} \eta \tag{A4}$$

For simulation purposes $\dot{\bar{v}}_w$ [Equation (A3)] and the coefficients of Equation (A4) are needed as functions of time. Most of these are calculated in Table A1.

Columns 1, 2, and 3 are taken from Table 1 (3.0g limit trajectory) of ref. 18. Column 6 is taken from Table 3 of ref. 18.

$\dot{h} = V_R \cos\gamma_R$ is presented in column 4 (V_R = relative velocity;
γ_R = flight path angle)

σ (column 7) is read from Figure A2, corresponding to the altitude in column 6.

The data of Figure A2 were differentiated and plotted as Figure A3.

Table A1. Coefficients of the Differential Equation

1 t Sec	2 V_R m/sec	3 γ_R deg	4 $\dot{h}$ m/sec	5 $\sqrt{\dot{h}}$ $(m/sec)^{\frac{1}{2}}$	6 h m	7 σ m/sec	8 $d\sigma/dh$ (m/sec)/m	9 $\dot{\sigma}$ m/sec^2
0.0	0.	90.0	0.0	0.0	0.	4.7	.00078	.00000
4.0	19.6	89.8	19.6	4.43	38.	4.7	.00078	.01530
8.0	40.1	89.8	40.1	6.34	158.	4.7	.00078	.0312
12.0	61.5	89.8						
16.0	83.9	88.7	83.9	9.17	651.	5.1	.00080	.0671
20.0	107.4	85.8						
24.0	132.3	82.4	131.0	11.44	1509.	5.5	.00081	.106
28.0	159.0	78.8						
32.0	187.7	75.4	181.5	13.48	2758.	6.95	.00087	.158
36.0	218.5	72.1						
40.0	251.5	69.0	234.5	15.3	4424.	8.5	.00095	.223
44.0	286.3	65.8						
48.0	320.6	62.6	284.5	16.88	6511.	10.7	.00117	.333
52.0	354.8	59.4						
56.0	389.9	56.3	325.0	18.00	8955.	14.1	.00157	.510
60.0	426.8	53.1						
63.9	465.4	50.1	357.0	18.9	11662.	16.7	-.00014	-.050
66.0	487.4	48.6						
72.0	557.5	44.2	388.5	19.72	14681.	13.4	-.00144	-.560
78.0	638.8	40.1			17086.			
84.0	732.1	36.3	434.0	20.85	19628.	9.2	-.00041	-.178
90.0	837.7	32.8						
96.0	954.9	29.7	473.0	21.8	25094.	6.9	-.00032	-.151
102.0	1083.3	26.9						
108.0	1222.6	24.4	505.0	22.5	30997.	5.5	-.00017	-.0841
114.0	1372.8	22.1						
120.0	1528.3	20.1	525.0	22.95	37222.	4.5	-.00017	-.0875
126.0	1685.7	18.2						
132.0	1844.8	16.5	524.0	22.9	43581.	3.5	-.00017	-.0874
138.0	2005.4	15.0						
144.0	2167.5	13.6	510.0	22.55	49858.	2.5	-.00017	-.0850
150.0	2330.9	12.3	501.0		52910.	1.88		
156.0	2495.6	11.1	481.0	21.95	55879.	1.4	-.00017	-.0801
162.0	2661.4	10.0	466.0		58749.	.9	-.00017	-.0793
168.0	2828.3	9.0	443.0	21.05	61506.	0.4	-.00017	-.0740
169.8	2879.7	8.7	437.0		62326.	.32	-.00017	-.0734

Table A1. (Concluded)

10 $\dot{\sigma}/\sigma$ 1/sec	11 $c_3\sigma\dot{h}$ ft^2/sec^2	12 $c_1\sigma\sqrt{\dot{h}}$ $ft/sec^{3/2}$	13 $10^6(c_5\dot{h})/\sigma$ $1/ft^2$	14 $c_4\dot{h}$ 1/sec	15 $-10^6 c_2\sqrt{\dot{h}}$ $1/ft\ sec^{\frac{1}{2}}$	16 $\bar{v}_{E-W}$ ft/sec	17 v_s ft/sec
.0000	0.	0.	.0	.0	0	0.	0.
.0033	1003.	.940	.00417	.0037	1.307	.4	
.0065	2055.	1.35	.0114	.0076	1.87	1.8	2.4
.0132	4620.	2.12	.0219	.0159	2.7	7.4	10.1
.0193	7780.	2.85	.0318	.0249	3.37	17.1	23.35
.0228	13620.	4.23	.0349	.0345	3.965	31.3	42.7
.0263	21550.	5.87	.0369	.0445	4.51	50.1	68.5
+.0311	32900.	8.16	.0354	.0540	4.97	73.6	101.
+.0362	49500.	11.48	.0307	.0617	5.30	101.5	246.
-.0030	64300.	14.30	.0285	.0678	5.55	130.	246.
-.0417	56300.	11.95	.03865	.0738	5.80	113.5	223.
						74.5	163.
-.0193	43100.	8.67	.0629	.0825	6.15	29.5	94.
-.0219	35200.	6.80	.0915	.0896	6.43	10.2	0
-.0153	30000.	5.59	.1224	.0958	6.63	45.5	
-.0194	25550.	4.66	.1555	.0996	6.75	65.5	
-.0257	19200.	3.51	.2055	.0995	6.74	65.5	
-.0340	13780.	2.55	.272	.0969	6.65	65.5	
			.355				
-.0571	7270.	1.39	.459	.0914	6.46	65.5	
-.0872			.690				
-.185	1912.		1.475	.0841	6.21	65.5	
-.229			1.818				

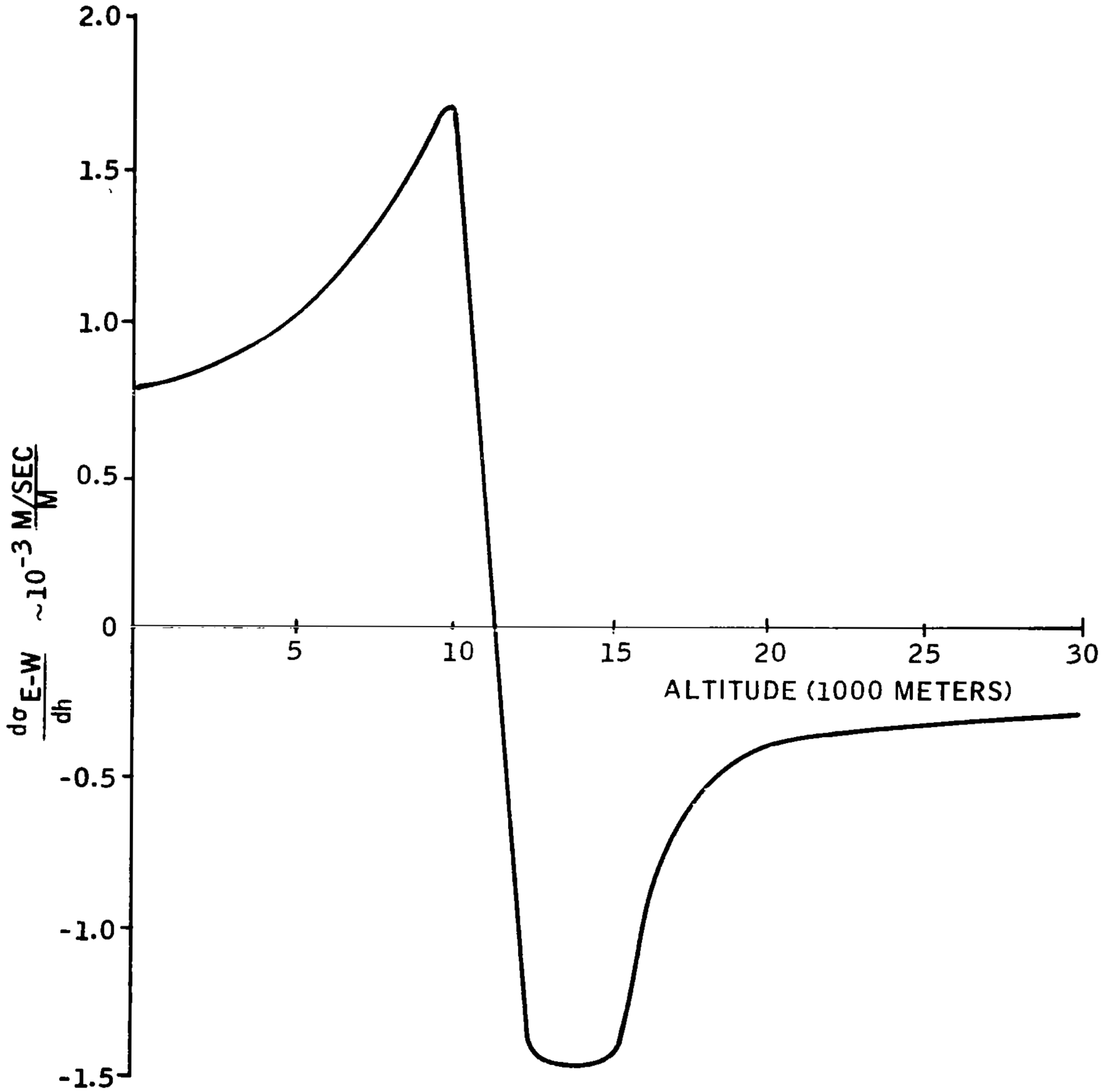


Figure A3. Deviation Rate of E-W March Wind

$d\sigma/dh$ (column 8) is read from Figure A3, corresponding to the altitude in column 6:

$$\dot{\sigma} = \dot{h}\frac{d\sigma}{dh} \text{ is tabulated in column 9.}$$

$\dot{h}$ and $d\sigma/dh$ are from columns 4 and 8.

$\dot{\sigma}/\sigma$ in column 10 is the quotient of $\dot{\sigma}$ and σ from columns 9 and 7. $\dot{\sigma}/\sigma$ is required in Equation (A4).

The remainder of the coefficients in Equation (A4) are tabulated in columns 11 through 15. Conversion from m to ft is made during these calculations. The coefficients of Equation (A4) are presented in Figures A7 through A12.

Finally, $\dot{\bar{v}}$ is required. $\bar{v}$ as a function of time (column 16) is obtained from Figure A1 and h (column 6). $\bar{v}(t)$ is plotted in Figure A5. $\dot{\bar{v}}$ is obtained by differentiating the data of Figure A5. $\dot{\bar{v}}$ is plotted in Figure A4.

All of the data required are contained in Figures A4 through A12.

For the covariance analyses Figures A5 through A12 (for the mean wind and for the coefficients of Equation (A4) were tabulated at 5-second intervals (Table A2).

The analog simulation is presented as Figure A13. $\dot{v}_S$ at the top left is the synthetic wind rate; its simulation was provided for but not used. Function switches 20 and 21 provide for selecting combinations of the synthetic, Vaughan-mean, and Vaughan-random winds.

Amplifier 10 (on the left near the bottom) generates time. It drives the servos (SM2, 3, 4).

Pot SM4A generates the mean wind rate. Pot SM4B generates $(\dot{\sigma}/\sigma)\tilde{v}$, etc.

Figures A5 through A12 contain the values for the analog simulation.

Figure A14 presents a typical recording. The top trace is the output of amplifier 80 (lower right corner of Figure A12). The amplitude of the analog room white noise generator changes over a period of weeks. Pot 4 was adjusted to 0.311 to yield peak (3σ) values of 7.5 volts from amplifier 80.

The remainder ot the traces of Figure A14 are self explanatory. For the single sample analyses of Sections II and III, the analog simulation was used to generate the sample presented as Figure 1 ; it is also stored on magnetic tape in the Honeywell analog room.

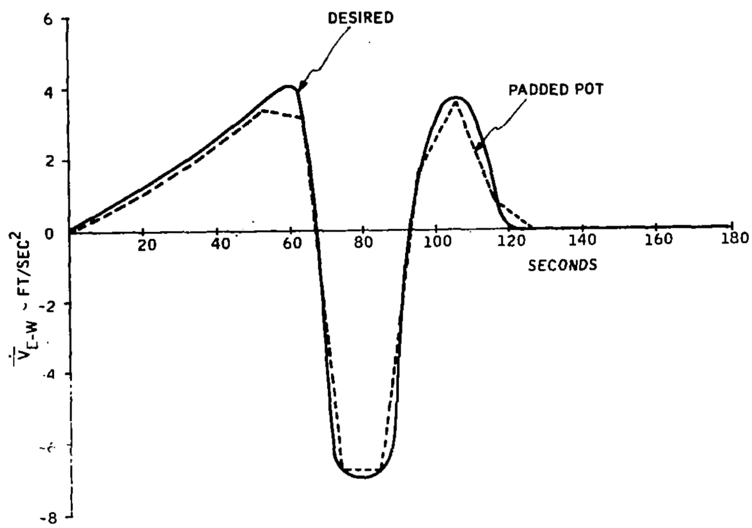


Figure A4. Mean Rate of E-W March Wind

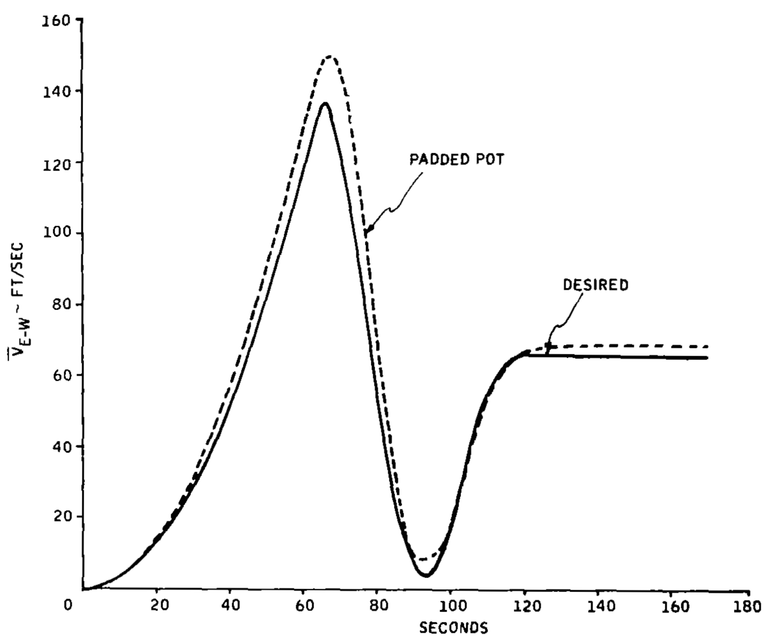


Figure A5. Mean Value of E-W March Wind

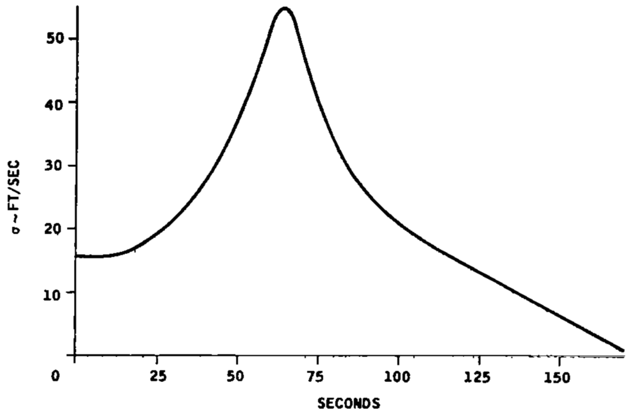


Figure A6. Standard Deviation of E-W March Wind

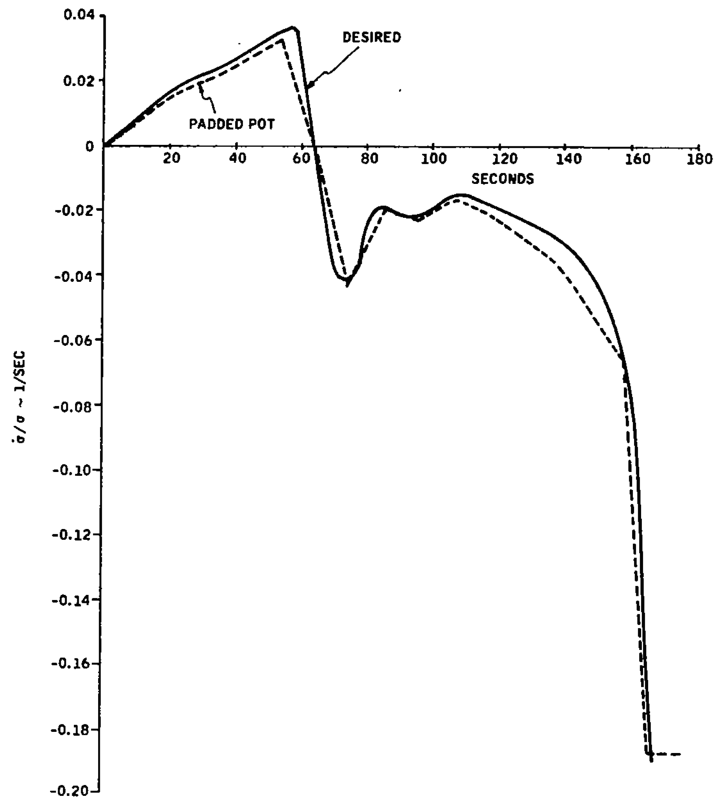


Figure A7. $\dot{\sigma}/\sigma$

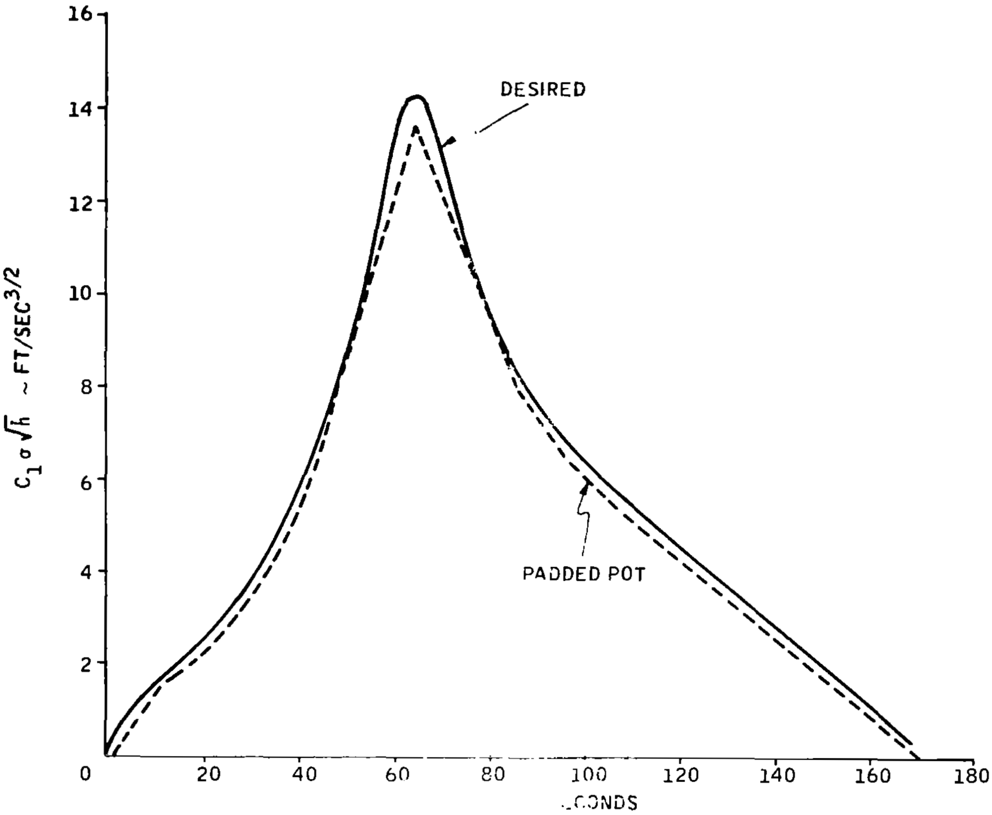


Figure A8. $C_1 \sigma \sqrt{\dot{h}}$

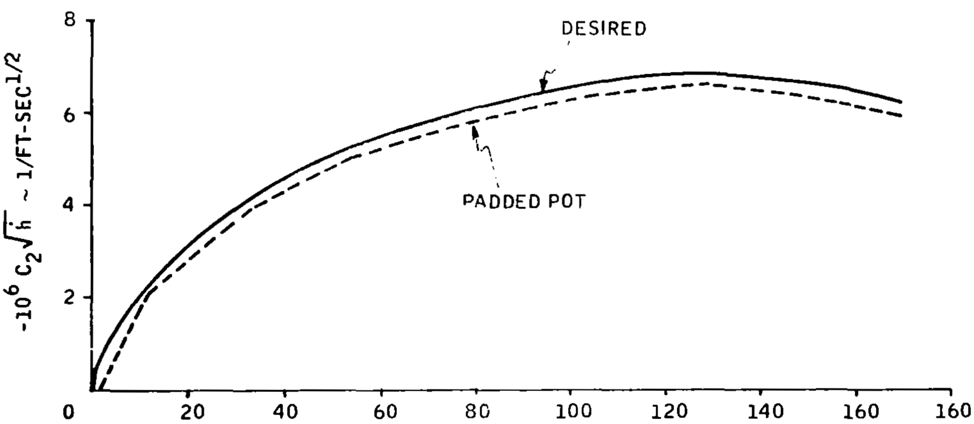


Figure A9. $C_2 \sqrt{\dot{h}}$

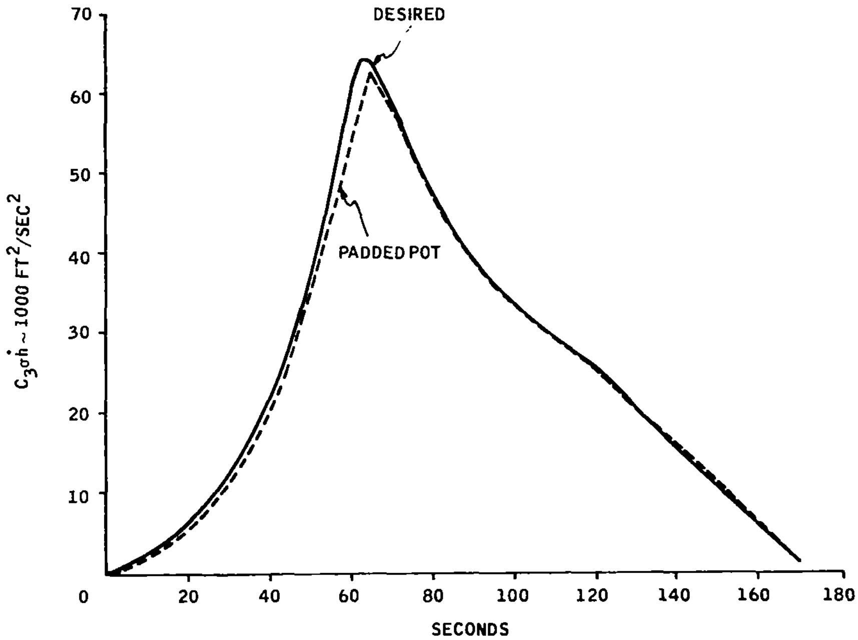


Figure A10. $C_3\sigma\ \dot{h}$

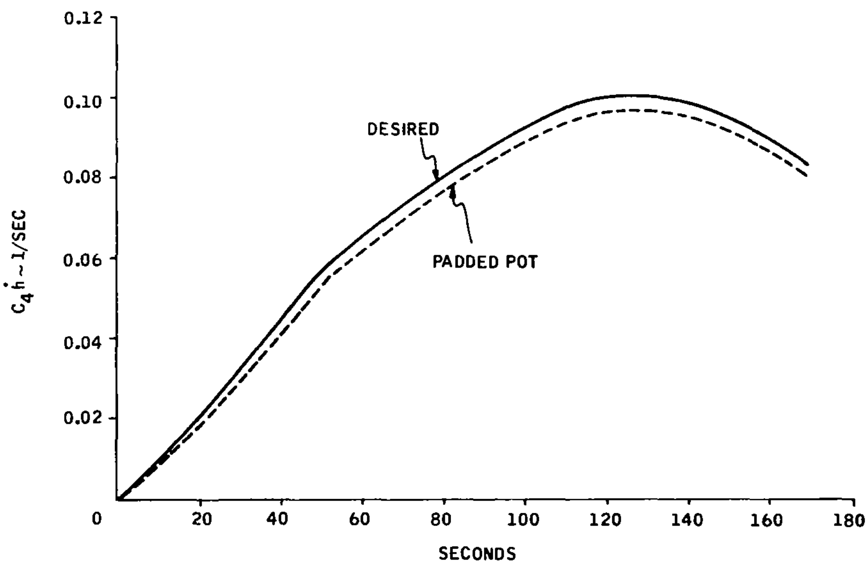


Figure A11. $C_4\ \dot{h}$

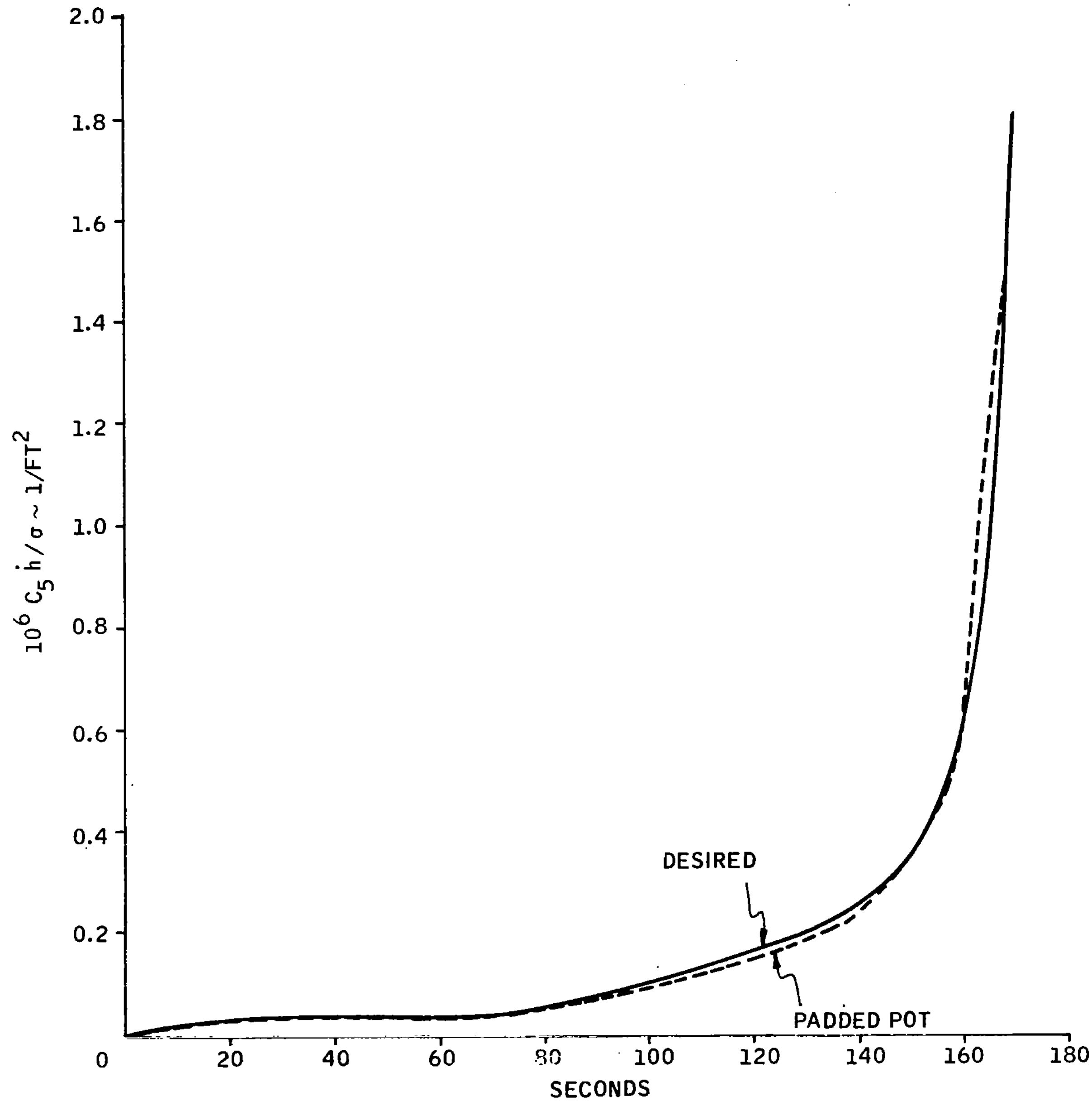


Figure A12. $C_5\ \dot{h}/\sigma$

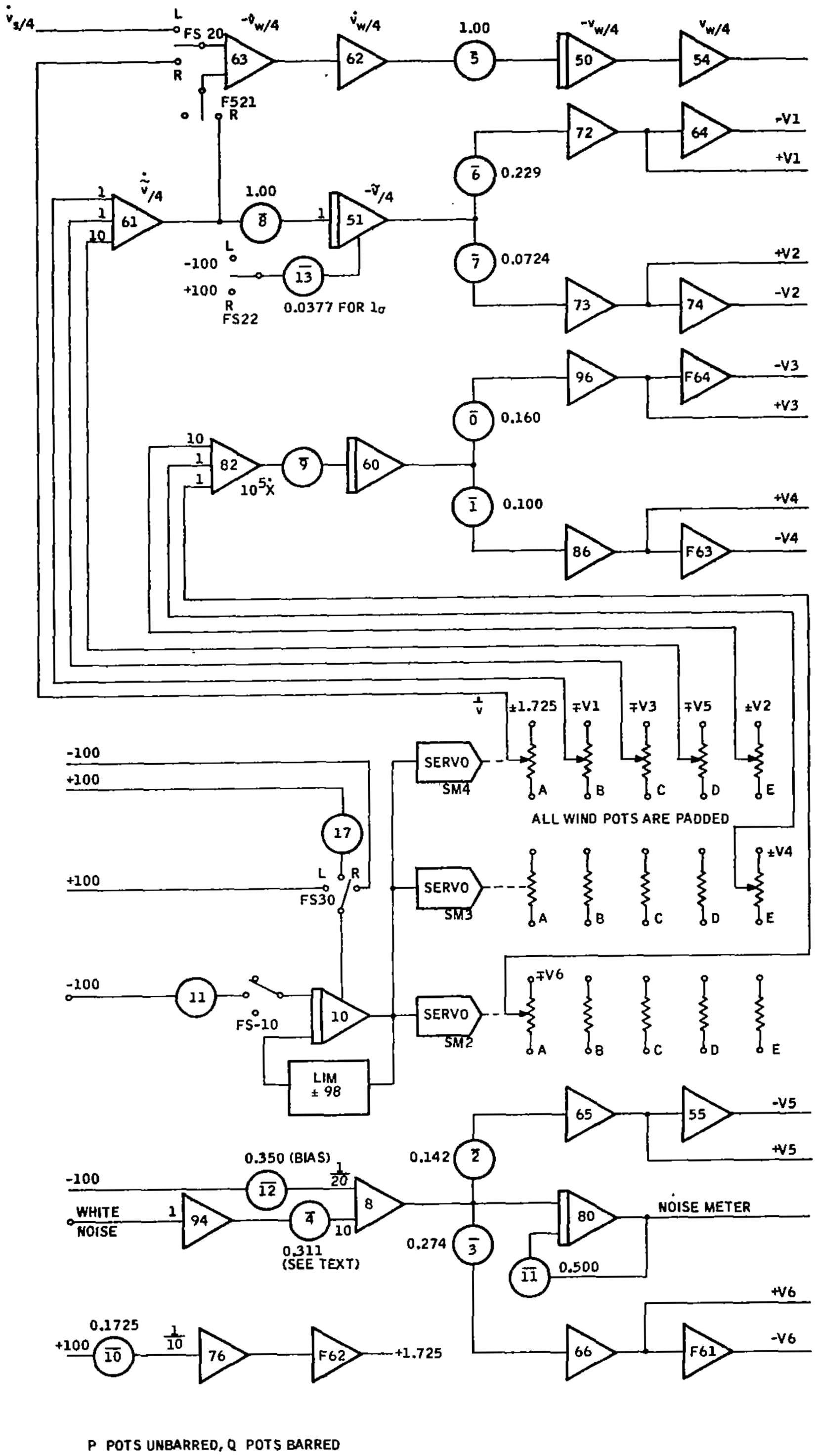


Figure A13. Analog Diagram for Vaughn-Skelton Wind

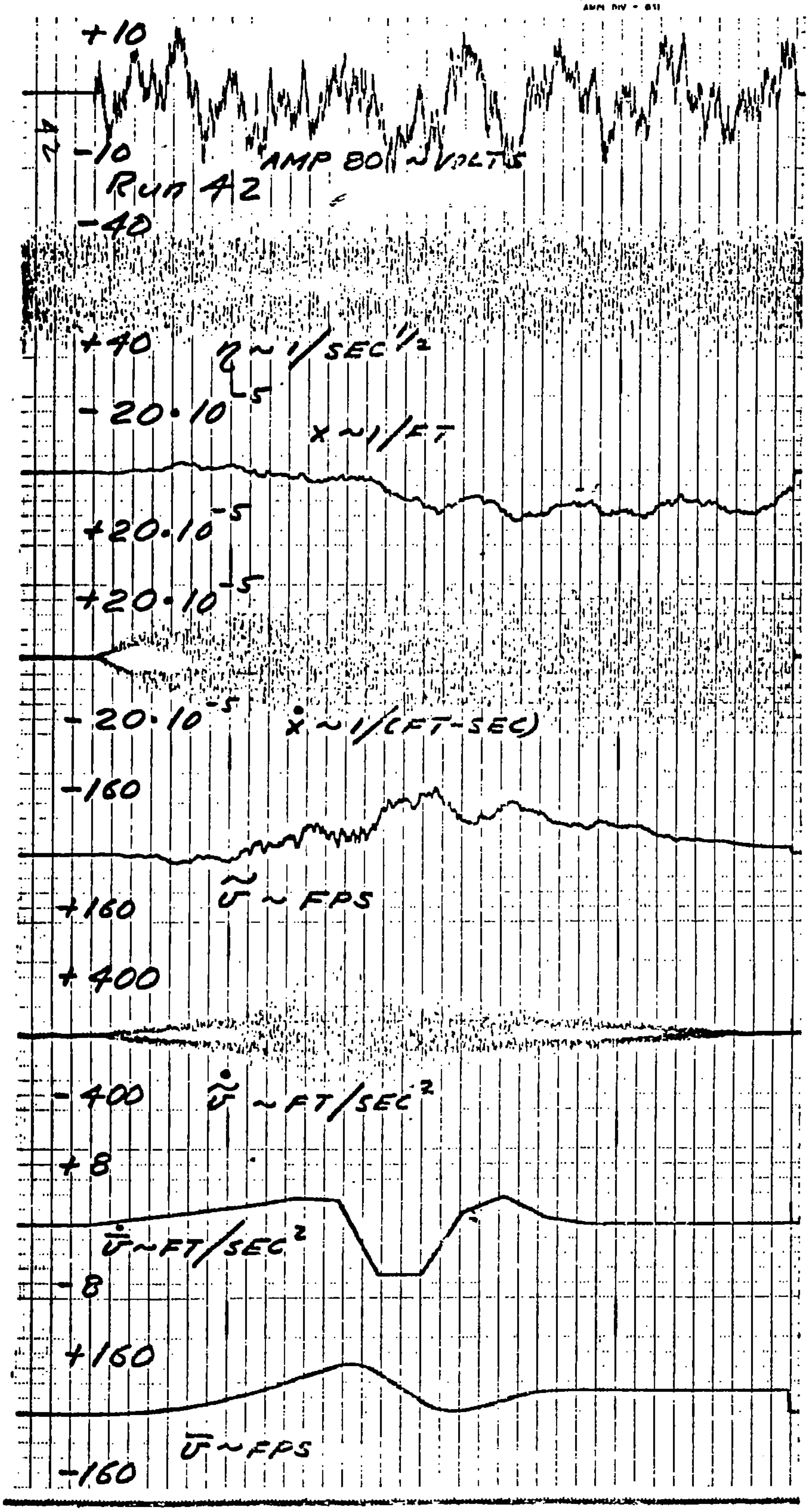


Figure A14. Simulated Wind

Table A2. Interpolated Wind Data

$c_1 \sigma \sqrt{\dot h}$	$c_2 \sqrt{\dot h}$	$c_3 \sigma \sqrt{\dot h}$	$c_4 \dot h$	$\frac{c_5 \dot h}{\sigma}$	$\dot \nu / \sigma$	$\bar \nu$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
.10820374E 01	-.15071135E-05	.12555344E 04	.46549826E-02	.58113625E-08	.41036039E-02	.64667113E 00
.15278645E 01	-.20748258E-05	.26524554E 04	.96140281E-02	.14541286E-07	.81347159E-02	.28542543E 01
.20279125E 01	-.26010943E-05	.42888222E 04	.14824705E-01	.20673621E-07	.12347064E-01	.64892161E 01
.24461378E 01	-.30552883E-05	.59839900E 04	.20316386E-01	.27271141E-07	.16523451E-01	.11701041E 02
.29857845E 01	-.34462563E-05	.83538353E 04	.26069286E-01	.32551303E-07	.19847599E-01	.18628005E 02
.38452125E 01	-.38199523E-05	.11939223E 05	.32047960E-01	.34457560E-07	.21989842E-01	.27332469E 02
.48106218E 01	-.41766140E-05	.16326898E 05	.38233935E-01	.35750056E-07	.24171994E-01	.37771359E 02
.58700000E 01	-.45100000E-05	.21550000E 05	.44500000E-01	.36900000E-07	.26300000E-01	.50100000E 02
.71938670E 01	-.48114902E-05	.28101492E 05	.50593973E-01	.36461587E-07	.28245285E-01	.64404950E 02
.88865514E 01	-.50641504E-05	.36529247E 05	.56112526E-01	.34411297E-07	.34152265E-01	.79890598E 02
.11004029E 02	-.52646777E-05	.47124992E 05	.60842082E-01	.31351431E-07	.37650936E-01	.97447523E 02
.13358246E 02	-.54306652E-05	.58941463E 05	.64894305E-01	.28498717E-07	.20700551E-01	.11858061E 03
.14258429E 02	-.55836747E-05	.64468107E 05	.68610404E-01	.29150206E-07	-.10012253E-01	.13110340E 03
.12769456E 02	-.57382402E-05	.59419078E 05	.72308361E-01	.35267868E-07	-.36381934E-01	.12269797E 03
.10877721E 02	-.58915939E-05	.52120907E 05	.76049768E-01	.44155589E-07	-.41818923E-01	.94381030E 02
.95097554E 01	-.60391135E-05	.46601270E 05	.79732630E-01	.54211855E-07	-.29530865E-01	.56300969E 02
.84814833E 01	-.61764465E-05	.42307724E 05	.83153736E-01	.65144389E-07	-.17902946E-01	.24353951E 02
.76337293E 01	-.63003208E-05	.38733698E 05	.86212929E-01	.76755601E-07	-.17648978E-01	.90847814E 01
.69266290E 01	-.64098607E-05	.35737869E 05	.89045832E-01	.88984034E-07	-.21493652E-01	.87673040E 01
.63369727E 01	-.65047508E-05	.33228514E 05	.91792023E-01	.10175118E-06	-.20998089E-01	.19714494E 02
.58453254E 01	-.65864219E-05	.31115225E 05	.94384559E-01	.11471638E-06	-.17113033E-01	.36018227E 02
.54333842E 01	-.66569750E-05	.29304929E 05	.96663734E-01	.12744593E-06	-.14917164E-01	.50855833E 02
.50610690E 01	-.67141469E-05	.27577923E 05	.98461586E-01	.14045649E-06	-.16378800E-01	.60547083E 02
.46600000E 01	-.67500000E-05	.25550000E 05	.99600000E-01	.15550000E-06	-.19400000E-01	.65500000E 02
.41852524E 01	-.67591619E-05	.22978566E 05	.99967327E-01	.17402203E-06	-.22107769E-01	.65500000E 02
.36932846E 01	-.67480366E-05	.20231455E 05	.99720500E-01	.19591246E-06	-.24615898E-01	.65500000E 02
.32601122E 01	-.67253700E-05	.17793875E 05	.99071576E-01	.22068979E-06	-.27507173E-01	.65500000E 02
.28751335E 01	-.66909006E-05	.15623838E 05	.98052717E-01	.24813490E-06	-.30949843E-01	.65500000E 02
.24612601E 01	-.66374577E-05	.13274708E 05	.96557804E-01	.27829155E-06	-.34800702E-01	.65500000E 02
.19803648E 01	-.65630183E-05	.10542561E 05	.94520045E-01	.32412592E-06	-.40530958E-01	.65500000E 02
.14850739E 01	-.64774424E-05	.77857787E 04	.91968334E-01	.42742430E-06	-.53232105E-01	.65500000E 02
.10330448E 01	-.63894156E-05	.53776117E 04	.88976780E-01	.64066162E-06	-.79451022E-01	.65500000E 02
.62836345E 00	-.62870614E-05	.32179279E 04	.85857943E-01	.10660333E-05	-.13287049E 00	.65500000E 02
.25000000E 00	-.61500000E-05	.10000000E 04	.83000000E-01	.18180000E-05	-.22900000E 00	.65500000E 02

APPENDIX B

EQUATIONS, DATA, AND SIMULATIONS FOR CONVENTIONAL LAUNCH STUDY

This appendix presents the equations, data, and simulations used in Sections II and III. Figure B1 gives the reference trajectory used in these studies, supplied by MSFC.

EQUATIONS

References 19 and 20 provide the basic equations. Appendix H gives nomenclature for this appendix. The 6-degree-of-freedom rigid body equations were decoupled into:

- Longitudinal trim equations
- Longitudinal perturbations
- Lateral perturbations

The longitudinal trim equations were used to estimate the required angle of attack and composite pitch gimbal deflection needed to fly the reference trajectory. The force normal to the trajectory is:

$$0 = -\frac{13F_E}{m}\left(\alpha_o + \delta_{y_o}\right) + \cos\gamma_R\left(g - \frac{u_o^2}{r}\right) + u_o\dot{\gamma}_R - \frac{qS}{m}\left(C_{N_o} + C_{N_\alpha}\alpha_o\right) \tag{B1}$$

The moment equation is:

$$0 = 13F_E\left[\left(x_{CG} - x_\delta\right)\delta_{y_o} + z_{CG} - z_\delta\right] + qS\ell\left(C_{m_o} + C_{m_\alpha}\alpha_o\right) \tag{B2}$$

Table B1 includes the data needed to compute these trim requirements. α_o and δ_o versus time are plotted in Figure B2. The actual δ_o is shown by the dashed line. The δ_o shown by the solid line would occur in vacuum; the deflection needed to track the cg.

The perturbation longitudinal equations were in body axes, although often described as stability axes because the unperturbed x axis was chosen to lie on the reference trajectory, rather than the body x axis. Figure B3 shows the launch vehicle reference pitch geometry, while Figure B4 gives

PARAMETER	AT q MAX	AT STAGE
MACH	1.56	9.27
ACCEL	58.4	51
h, FT	38,262	204,487
q (PSF)	786	21.4
TIME	64	170

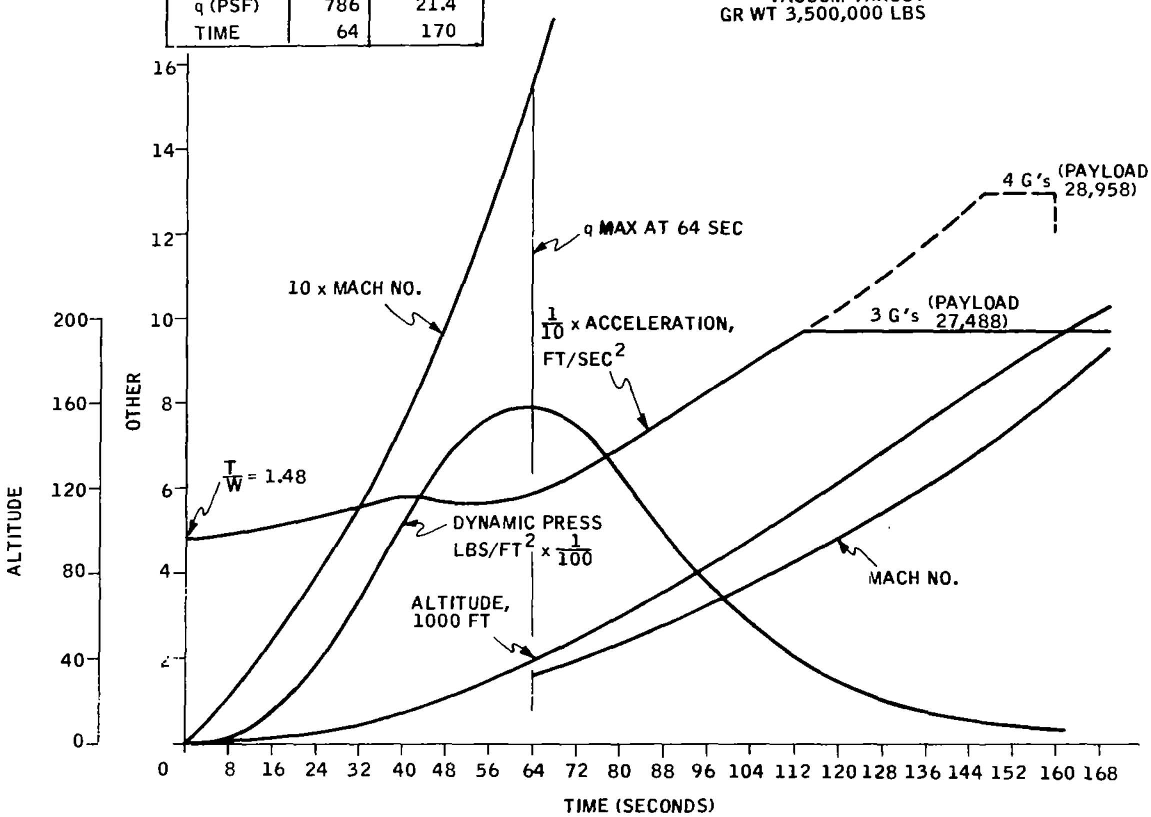


Figure B1. Launch Trajectories, 3 and 4 g's

Table B1. Pitch Simulation Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Trim Data 20	21	22	23
Time	$W10^{-6}$	$m10^{-6}$	I_y10^{-8}	x_{CG}	$T10^{-6}$	$\bar{q}$	$\bar{q}S/m$	$\frac{\bar{q}S\ell}{I_y}$	M_α	u_o ft/sec	$10^4 M_w$	Z_α	Z_w	M_δ (4g's)	Z_δ (4g's)	A_x (ft/sec^2)	γ_R (deg)	$\dot{\gamma}_R$ (deg/sec)	C_{N_o}	C_{m_o}	C_{N_α}	C_{m_α}
0	3.5	0.109	3.71	91	5.2	0	0	0	--	--	--	--	--	--	--	--	90	--	--	--	--	--
3	3.46	0.107	3.66	92	5.2	5	0.5	0.03	-0.03	60	-5.0	-1.5	-0.027	-1.43	-49	48	90	--	+0.02	-0.028	2.9	-1.0
13	3.32	0.103	3.51	94	5.23	45	4.5	0.28	-0.27	210	-13.0	-13.1	-0.063	-1.49	-5	50	90	0	+0.02	-0.028	2.9	-0.96
23	3.19	0.099	3.36	97	5.34	188	19.3	1.21	-1.1	330	-33.0	-56.0	-0.170	-1.54	-54	53	82	-0.87	+0.02	-0.027	2.9	-0.90
33	3.05	0.095	3.20	99	5.44	366	39.6	2.48	-2.2	640	-34.0	-115.0	-0.180	-1.61	-57	55	75	-0.85	+0.02	-0.027	2.9	-0.89
43	2.91	0.090	3.05	101	5.61	590	67.3	4.20	-3.15	920	-34.0	-168.0	-0.183	-1.71	-62	58	69	-0.79	-0.01	-0.007	2.5	-0.75
53	2.78	0.086	2.90	105	5.72	728	87.0	5.35	-5.3	1195	-44.0	-270.0	-0.226	-1.76	-66	56	63	-0.78	-0.04	+0.014	3.1	-0.99
63	2.64	0.082	2.74	107	5.87	793	99.0	6.27	-4.7	1500	-31.0	-248.0	-0.165	-1.86	-72	58	50	-0.76	-0.04	+0.006	2.5	-0.75
73	2.50	0.078	2.58	110	5.94	750	99.0	6.30	-3.4	1870	-18.0	-198.0	-0.106	-1.93	-76	64	44	-0.71	-0.04	0	2.0	-0.54
83	2.37	0.074	2.41	114	6.0	590	82.0	5.30	-2.0	2370	-8.4	-140.0	-0.059	-1.99	-81	74	35	-0.60	-0.04	-0.002	1.7	-0.38
93	2.23	0.069	2.24	117	6.03	437	65.0	4.21	-1.1	2943	-3.8	-98.0	-0.033	-2.08	-87	80	30	-0.52	-0.04	-0.005	1.5	-0.26
103	2.09	0.065	2.06	121	6.04	317	50.0	3.33	-0.5	3600	-1.4	-62.0	-0.017	-2.15	-93	88	25	-0.45	-0.04	-0.005	1.2	-0.15
113	1.96	0.061	1.86	125	6.05	220	37.0	2.56	-0.2	4180	-0.5	-37.0	-0.0089	-2.24	-100	96	21	-0.37	-0.033	-0.007	1.0	-0.08
123	1.83	0.057	1.66	129	6.05	150	27.0	1.96	-0.12	5325	-0.2	-24.0	-0.0045	-2.37	-106	104	18	-0.31	-0.03	-0.007	0.9	-0.06
133	1.70	0.053	1.46	133	6.05	103	19.7	1.53	-0.05	6324	0	-17.0	-0.0027	-2.53	-114	113	15	-0.26	-0.03	-0.008	0.85	-0.03
143	1.54	0.048	1.15	140	6.05	72	15.4	1.36	0	7440	0	-12.0	-0.0016	-2.84	-126	125	13	-0.22	-0.03	-0.008	0.8	0
153	1.42	0.044	0.91	145	5.71	53	12.3	1.27	+0.05	8650	0	-9.0	-0.001	-3.07	-129	129	11	-0.20	-0.03	-0.009	0.7	+0.014
160	1.33	0.041	0.74	150	5.35	42	10.5	1.84	+0.07	9512	0	-6.0	-0.0006	-3.18	-129	129	10	-0.17	-0.03	-0.010	0.6	+0.06

$S = 10{,}250\ ft^2$ $S\ell = 2.17 \times 10^6$

$\ell = 211\ ft$

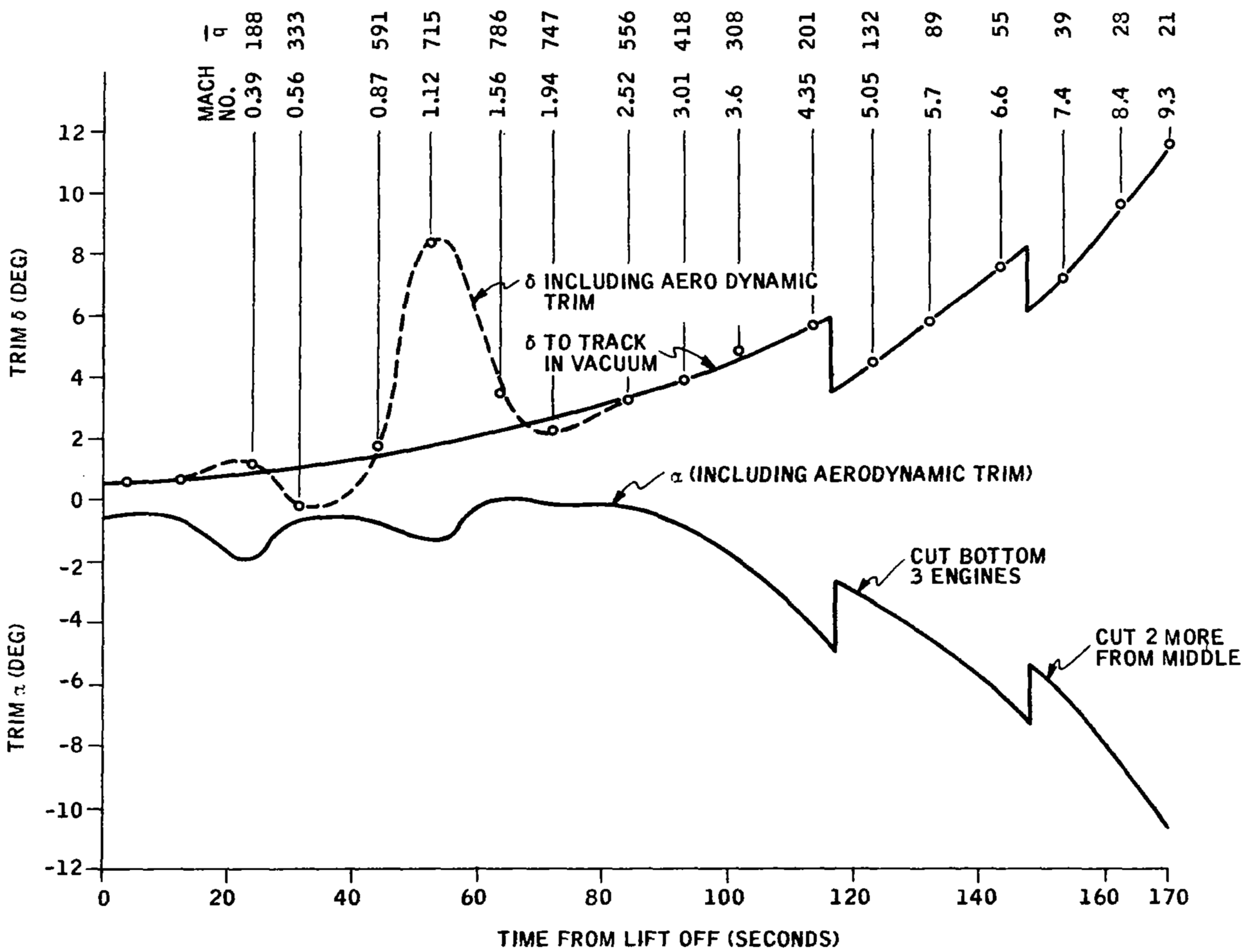
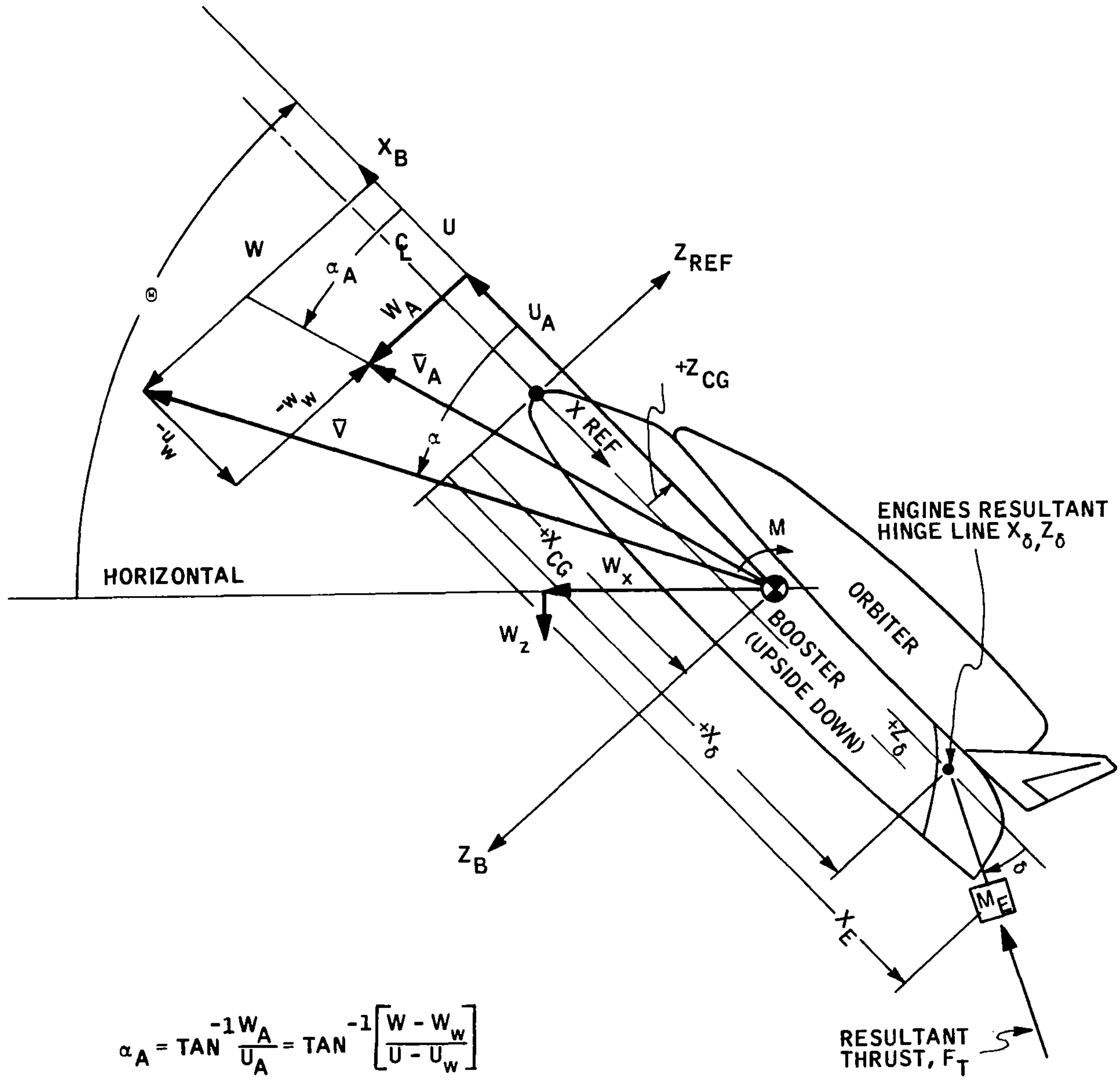


Figure B2. Trim Angles of Attack and Gimbal Angle

NOTE THAT THE REFERENCE AXES FOR PHYSICAL LOCATIONS (C.G., HINGE LINE ETC) ARE POSITIVE X AFT, Y INTO PAPER, AND Z UP AS GIVEN BY MSFC. THE C.G. CENTERED AXES FOR ANALYSIS ARE X FWD, Y INTO PAPER, AND Z DOWN



$$\alpha_A = \mathrm{TAN}^{-1}\frac{W_A}{U_A} = \mathrm{TAN}^{-1}\left[\frac{W - W_w}{U - U_w}\right]$$

Figure B3. Launch Vehicle Geometry

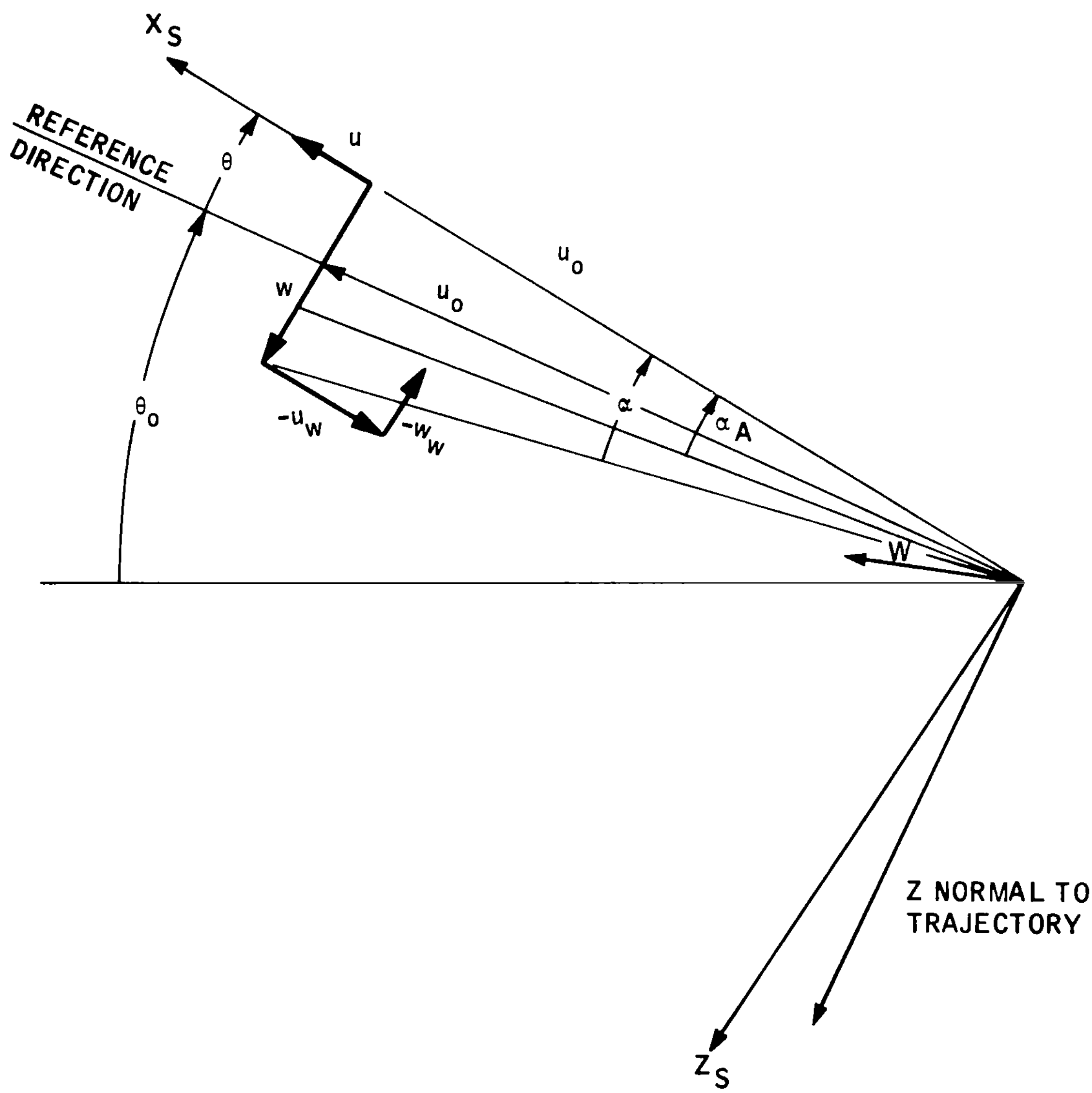


Figure B4. Launch Vehicle Perturbation Geometry; Stability Axes perturbation geometry. The simulations ignored the longitudinal perturbation u. The resulting 2-degree-of-freedom perturbation equations used were:

Pitch acceleration

$$\dot{\theta} = \dot{q} = M_q q + M_w w_A + M_\delta \delta + M_{\ddot{\delta}} \ddot{\delta} \qquad \text{(B3)}$$

Inertial z axis acceleration

$$\dot{w} = q\, u_o - g \sin \gamma_R\, \theta + a_{CG} \qquad \text{(B4)}$$

Where the acceleration due to normal forces was:

$$a_{CG} = Z_w w_A + z_\delta \delta + Z_{\ddot{\delta}} \ddot{\delta} \qquad \text{(B5)}$$

The acceleration normal to the trajectory

$$\dot{V}_N = a_{CG} - A_x\, \theta \qquad \text{(B6)}$$

Accelerometer at station 0

$$a_z = a_{CG} + \dot{q}(x_A - x_{CG}) \qquad \text{(B7)}$$

Normal component of velocity with respect to the air mass

$$w_A = w + \sin \gamma_R\, w_w \qquad \text{(B8)}$$

Gimbal acceleration

$$\ddot{\delta} = -2\zeta\omega_n \dot{\delta} - \omega_n^2(\delta - \delta_i) + \frac{\partial \ddot{\delta}}{\partial \dot{q}}\, \dot{q} + \frac{\partial \ddot{\delta}}{\partial a_{CG}}\, a_{CG} \qquad \text{(B9)}$$

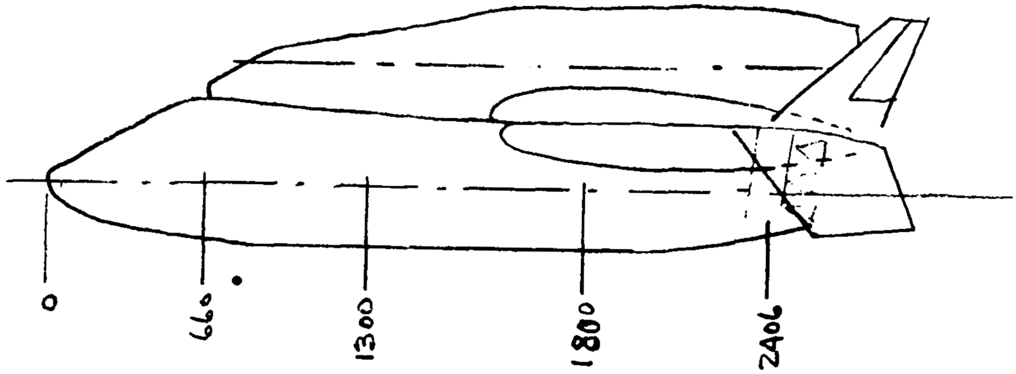
Bending moment data supplied by MSFC are shown in Table B2. The pitch bending moment offsets were not considered, consequently, the equations used were of the form:

$$M' = M'_\alpha \alpha + M'_\delta \delta \qquad \text{(B10)}$$

The bending moments were computed at three distances from the nose: 660 inches, 1,300 inches, and 1,880 inches.

Table B2. MSFC Bending Moments

Station



Pitch:

$$M' = M'_{\alpha}\alpha + M'_{\delta}\delta$$

Station	10^{-6} M'_{δ}, in. lbs/deg	10^{-6} M'_{α}, in. lb/deg		10^{-6} M′ offset, in. lbs
		for $+\alpha$	for $-\alpha$	
660	- 1.62	-5.72	- 6.72	7.98
1300	-15.05	-3.17	-11.2	104.2
1880	-22.8	+5.84	-10.1	182.1

Yaw:

$$N' = N'_{\beta}\beta + N'_{\delta_z}\delta_z$$

Station	$10^{-6} x N'_{\beta}$ in. lb/deg	$10^{-6} x N'_{\delta_z}$ in. lb/deg
660	- 8.96	- 1.62
1800	-19.5	-22.8

The angle-of-attack bending data supplied by MSFC (Table B2) were for the max q condition. The derivative M'_α was therefore assumed proportional to the normal acceleration derivative Z_w, for which aero data were available along the trajectory. The following substitution was then made in the bending moment equation:

$$M'_\alpha \alpha = \left(\frac{M'_\alpha}{u_o}\right)_{\substack{at \\ max\ q}} \left(\frac{Z_w w_A}{Z_{w_{at\ max\ q}}}\right)$$

The lateral perturbation equations had three degrees of freedom. These equations have no apparent product of inertia effects. This is done by modifying the stability derivatives as explained in Table B3. The product-of-inertia effect is included in the primed derivatives of Table B4:

Roll acceleration

$$\dot{p} = L'_v v_A + L'_p p + L'_r r + L'_{\delta_a} \delta_a + L'_{\delta_x} \delta_x + L'_{\ddot{\delta}_x} \ddot{\delta}_x + L'_{\ddot{\delta}_a} \ddot{\delta}_a + L'_{\delta_z} \delta_z + L'_{\ddot{\delta}_z} \ddot{\delta}_z \tag{B11}$$

$$\dot{r} = N'_v v_A + N'_p p + N'_r r + N'_{\delta_a} \delta_a + N'_{\delta_x} \delta_x + N'_{\ddot{\delta}_x} \ddot{\delta}_x \tag{B12}$$

Lateral acceleration

$$\dot{v} = -u_o r + A_{CG} + g \sin \gamma_R \psi + g \cos \gamma_R \phi \tag{B13}$$

Acceleration due to lateral forces

$$A_{CG} = Y_v v_A + Y_{\delta_z} \delta_z + Y_{\ddot{\delta}_z} \ddot{\delta}_z \tag{B14}$$

Acceleration normal to the trajectory

$$\dot{V}_N = A_{CG} + \psi A_x + g \cos \gamma_R \phi \tag{B15}$$

Acceleration at station 0

$$A_y = A_{CG} + \dot{r} \left(x_{CG_o} - x_o + \dot{x}_{CG} t \right) \tag{B16}$$

Table B3. Honeywell Definitions

Mnemonic	Symbol	Description	Computation
ALTITUDE	h	Altitude	
MACH	M	Mach number	
WEIGHT	w	Vehicle weight	$g * m$
C.G.		Distance from aerodynamic reference to center of gravity along the X body axis	
ALPHA T	α_T	Total angle of attack	$\alpha_a * 57.296$
DEL E T	δ_{e_T}	Total elevon deflection	$\delta_e * 57.296$
EAS		Equivalent airspeed	
VELOCITY	V_a	Vehicle velocity	
DYN PRES	$\bar{q}$	Dynamic pressure	
Q SUB C	$\bar{q}_c$	Pitot differential pressure	
P SUB S	P_s	Static pressure	
L' SUB B	L'_β	Prime Derivatives	$\left(L_\beta + \frac{I_{XZ}}{I_X} N_\beta\right) \Big/ \left(1 - \frac{I_{XZ}^2}{I_X I_Z}\right)$
L' B DOT	$L'_{\dot\beta}$		$\left(L_{\dot\beta} + \frac{I_{XZ}}{I_X} N_{\dot\beta}\right) \Big/ \left(1 - \frac{I_{XZ}^2}{I_X I_Z}\right)$
L' SUB P	L'_p		$\left(L_p + \frac{I_{XZ}}{I_X} N_p\right) \Big/ \left(1 - \frac{I_{XZ}^2}{I_X I_Z}\right)$
L' SUB R	L'_r		$\left(L_r + \frac{I_{XZ}}{I_X} N_r\right) \Big/ \left(1 - \frac{I_{XZ}^2}{I_X I_Z}\right)$
L' DEL AI	$L'_{\delta_{ai}}$	Aileron	$\left(L_{\delta_{ai}} + \frac{I_{XZ}}{I_X} N_{\delta_{ai}}\right) \Big/ \left(1 - \frac{I_{XZ}^2}{I_X I_Z}\right)$
L' DEL AG	L'_{δ_x}	(Primed gimbal	$\left(L_{\delta_{ao}} + \frac{I_{XZ}}{I_X} N_{\delta_{ao}}\right) \Big/ \left(1 - \frac{I_{XZ}^2}{I_X I_Z}\right)$
L' DEL RG	L'_{δ_z}	Derivatives)	$\left(L_{\delta_r} + \frac{I_{XZ}}{I_X} N_{\delta_r}\right) \Big/ \left(1 - \frac{I_{XZ}^2}{I_X I_Z}\right)$
I Y	I_Y	Moment of inertia about Y axis	
I XX	I_X	Moment of inertia about any axis system (i.e., principal, stability, body, etc.)	
I ZZ	I_Z		
I X	I_X	Moments of inertia about a new axis system rotated in the XZ-plane by an angle η.	$I_{XX}\cos^2\eta + I_{XZ}\sin 2\eta + I_{ZZ}\sin^2\eta$
I Z	I_Z		$I_{ZZ}\cos^2\eta - I_{XZ}\sin 2\eta + I_{XZ}\sin^2\eta$
I XZ	I_{XZ}		$I_{XZ}\cos 2\eta - (I_{XX} - I_{ZZ})\ 1/2 \sin 2\eta$

Table B3. (Continued)

Mnemonic	Symbol	Description	Computation
IXZ/IZ			I_{XZ}/I_Z
IXZ/IX			I_{XZ}/I_X
THRUS'I Z	T_z	Normal component of trim thrust	
THRUST T	T_X	Total thrust along the X axis	
OMEGA SQ	ω^2		$-M_\alpha + Z_W * M_q$
2 ZET OM	$2\zeta\omega$	$2\zeta\omega$	$-M_{\dot\alpha} - M_q - Z_W$
T SUB A	T_A		$1.0 / \left[-Z_W - \left(\frac{Z_{\delta_{ei}} + Z_{\delta_{eo}}}{U1} \right) * M_\alpha / (M_{\delta_{ei}} + M_{\delta_{eo}}) \right]$
OMEGA A	ω_A		$\sqrt{\omega^2}$
ZETA A	ζ_A		$2\zeta\omega/2\omega$
Y SUB B	Y_β	Dimensional derivatives	$C_{Y_\beta} \bar{q}\ S/m$
Y B DOT	$Y_{\dot\beta}$		$C_{Y_{\dot\beta}} \bar{q}\ Sb/2U1m$
Y SUB P	Y_p		$C_{Y_p} \bar{q}\ Sb/2U1m$
Y SUB R	Y_r		$C_{Y_r} \bar{q}\ Sb/2U1m$
Y DEL AI	$Y_{\delta_{ai}}$		$C_{Y_{\delta_{ai}}} \bar{q}\ S/m$
Y DEL AO	$Y_{\delta_{ao}}$		$C_{Y_{\delta_{ao}}} \bar{q}\ S/m$
Y DEL R	Y_{δ_r}		$C_{Y_{\delta_r}} \bar{q}\ S/m$
X SUB M	X_M		$C_{X_M} \bar{q}\ S/m$
X SUB A	X_α		$C_{X_\alpha} \bar{q}\ S/m$
X A DOT	$X_{\dot\alpha}$		$C_{X_{\dot\alpha}} \bar{q}\ Sc/2m\ U1$
X SUB Q	X_q		$C_{X_q} \bar{q}\ Sc/2m\ U1$
X DEL EI	$X_{\delta_{ei}}$		$C_{X_{\delta_{ei}}} \bar{q}\ S/m$
X DEL EO	$X_{\delta_{eo}}$		$C_{X_{\delta_{eo}}} \bar{q}\ S/m$
Y SUB V	Y_V	Dimensional derivatives	$C_{Y_\beta} \bar{q}\ S/m\ U1$

Table B3. (Continued)

Mnemonic	Symbol	Description	Computation
Y V DOT	$Y_{\dot{V}}$	Dimensional derivatives ↕	$C_{Y_{\dot{\beta}}} \bar{q}\, Sb/2mU1^2$
N' SUB V			N'_{β}/U
L' SUB V			L'_{β}/U
Y DAI/U1	$Y_{\delta_{ai}}/U1$		$C_{Y_{\delta_{ai}}} \bar{q}\, S/mU1$
IXZ UNTR		I_{xz} as input	
Y DR/U1	$Y_{\delta_r}/U1$		$C_{Y_{\delta_r}} \bar{q}\, S/m\, U1$
L SUB B	L_{β}		$C_{L_{\beta}} \bar{q}\, Sb/I_X$
L B DOT	$L_{\dot{\beta}}$		$C_{L_{\dot{\beta}}} \bar{q}\, Sb^2/2I_X U1$
L SUB P	L_p		$C_{L_p} \bar{q}\, Sb^2/2I_X U1$
L SUB R	L_r		$C_{L_r} \bar{q}\, Sb^2/2I_X U1$
L DEL AI	$L_{\delta_{ai}}$		$C_{L_{\delta_{ai}}} \bar{q}\, Sb/I_X$
L DEL AG	L_{δ_x}		
L DEL RG	L_{δ_z}		
N SUB B	N_{β}		$C_{N_{\beta}} \bar{q}\, Sb/I_Z$
N B DOT	$N_{\dot{\beta}}$		$C_{N_{\dot{\beta}}} \bar{q}\, Sb^2/2I_Z U1$
N SUB P	N_p		$C_{N_p} \bar{q}\, Sb^2/2I_Z U1$
N SUB R	N_r		$C_{N_r} \bar{q}\, Sb^2/2I_Z U1$
N DEL AI	$N_{\delta_{ai}}$		$C_{N_{\delta_{ai}}} \bar{q}\, Sb/I_Z$
N DEL AG	N_{δ_x}		
N DEL RG	N_{δ_z}		
N' SUB B	N'_{β}	Primed derivatives ↕	$(N_{\beta} + K_1{}^{*} L_{\beta}) / K_2{}^{*}$
N' B DOT	$N'_{\dot{\beta}}$		$(N_{\dot{\beta}} + K_1 L_{\dot{\beta}}) / K_2$
N' SUB P	N'_p	Primed derivatives	$(N_p + K_1 L_p) / K_2$

* $K_1 = I_{XZ}/I_Z$; $K_2 = 1.0 - I_{XZ}^2 / I_X I_Z$

Table B3. (Concluded)

Mnemonic	Symbol	Description	Computation
N' SUB R	N'_r	Primed derivatives	$(N_r + K_1 L_r) / K_2$
N' DEL AI	$N'_{\delta_{ai}}$	↕	$(N_{\delta_{ai}} + K_1 L_{\delta_{ai}}) / K_2$
N' DEL AG	N'_{δ_x}	↕	
N' DEL RG	N'_{δ_z}		
X M/U1	$X_M/U1$	Dimensional derivatives	$C_{X_M} \bar{q} S/mU1$
X SUB W	X_W	↕	$C_{X_\alpha} \bar{q} S/mU1$
X W DOT	$X_{\dot{W}}$	↕	$C_{X_{\dot{\alpha}}} \bar{q} Sc/2mU1$
X Q/U1	$X_q/U1$	↕	$C_{X_q} \bar{q} Sc/2mU1$
X DEI	$X_{\delta_{ei}}/U1$	↕	$C_{X_{\delta_{ei}}} \bar{q} S/mU1$
X DEO/U1	$X_{\delta_{eo}}/U1$	↕	$C_{X_{\delta_{eo}}} \bar{q} S/mU1$
Z M/U1	$Z_M/U1$	↕	$C_{Z_M} \bar{q} S/mU1$
Z SUB W	Z_W	↕	$C_{Z_\alpha} \bar{q} S/mU1$
Z W DOT	Z_W	↕	$C_{Z_{\dot{\alpha}}} \bar{q} Sc/2mU1$
Z Q/U1	$Z_q/U1$	↕	$C_{Z_q} \bar{q} Sc/2m U1$
Z DEI/U1	$Z_{\delta_{ei}}/U1$	↕	$C_{Z_{\delta_{ei}}} \bar{q} S/mU1$
Z DEO/U1	$Z_{\delta_{eo}}/U1$	↕	$C_{Z_{\delta_{eo}}} \bar{q} S/m U1$
M SUB M	M_M	↕	$C_{M_M} \bar{q} Sc/I_Y$
M SUB AL	M_α	↕	$C_{M_\alpha} \bar{q} Sc/I_Y$
M AL DOT	$M_{\dot{\alpha}}$	↕	$C_{M_{\dot{\alpha}}} \bar{q} Sc^2/2I_YU1$
M SUB Q	M_q	↕	$C_{M_q} \bar{q} Sc^2/2I_YU1$
M DEL EI	$M_{\delta_{ei}}$	↕	$C_{M_{\delta_{ei}}} \bar{q} Sc/I_Y$
M DEL EO	$M_{\delta_{eo}}$	Dimensional derivatives	$C_{M_{\delta_{eo}}} \bar{q} Sc/I_Y$

Table B4. Numerical Values for the Dimensional Stability Derivatives

FLT CON 4

ALTITUDE	126.00000	Y SUB V	-.00642233	-.920000E 00
MACH	.05600	N' SUB V	-.00002997	.000000E-80
WEIGHT	3499999.99998	L' SUB V	-.00023003	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-.45837	Y DAI/U1	.00000000	.000000E-80
DEL E T	.48393	IXZ UNTR	47000000.00000000	.000000E-80
EAS	62.40411	Y DR/U1	.00000000	.000000E-80
VELOCITY	62.51930	L SUB B	-.01148512	-.460000E-01
CAS	62.42969	L B DOT	.00000000	.000000E-80
DYN PRES	4.62815	L SUB P	.00000000	.000000E-80
Q SUB C	4.63178	L SUB R	.00000000	.000000E-80
P SUB S	2106.58236	L DEL A	-.02496764	-.100000E 00
L'SUB B	-.01438	L DEL AG	-2.20386876	.000000E-80
L' B DOT	.00000	L DEL RG	-.01222307	.000000E-80
L' SUB P	.00000	N SUB B	.00000000	.000000E-80
L' SUB R	-.05211	N B DOT	.00000000	.000000E-80
L'DEL A	-.03123	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.72362	N SUB R	-.02691910	-.100000E 01
L'DEL RG	-2.81692	N DEL A	.00001809	.860000E-03
I Y	366500000.00000	N DEL AG	.01861453	.000000E-80
I XX	30400000.00000	N DEL RG	-1.44715166	.000000E-80
I ZZ	360800000.00000	N'SUB B	-.00187343	
I X	30399999.99976	N'B DOT	.00000000	
I Z	360799999.99609	N'SUB P	.00000000	
I XZ	46999999.99976	N'SUB R	-.03370778	
IXZ/IZ	.13027	N'DEL A	-.00405001	
IXZ/IX	1.54605	N'DEL AG	-.33618107	
THRUST Z	43919.17818	N'DEL RG	-1.81410650	
THRUST T	5200000.00000			
OMEGA SQ	.02731	X U/U1	-.00069808	-.500000E-01
2 ZET OM	.02024	X SUB W	-.00020244	-.290000E-01
T SUB A	49.39661	X W DOT	.00000000	.000000E-80
OMEGA A	.16526	X Q/U1	.00000000	.000000E-80
ZETA A	.06125	X DEI/U1	.00000000	.000000E-80
Y SUB B	-.40152	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00000000	.000000E-80
Y SUB P	.00000	Z SUB W	-.02024430	-.290000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-.08729	M SUB U	-.00152942	-.280000E-01
X SUB A	-.01266	M SUB AL	-.02731113	-.100000E 01
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	M DEL EO	.00000000	.000000E-80

LAT DEN S4= -.798602 S3= -.032048 S2= .001323 S1= -.005915 S0= -.000159
(-.02672, .00000) (-.20349, .00000) (.09504, .16623) (.09504, -.16623)

LON DEN S4= 1.000000 S3= .020322 S2= .027313 S1= -.000046 S0= .000001
(.00086, .00565) (.00086, -.00565) (-.01102, .16491) (-.01102, -.16491)

(4 SEC)

Table B4. (Continued)

FIT CON 12

ALTITUDE	1180.00000	Y SUB V	-.02100924	-.920000E 00
MACH	.18000	N' SUB V	-.00011625	.000000E-80
WEIGHT	3321999.99998	L' SUB V	-.00074987	.030000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-.45837	Y DAI/U1	.00000000	.000000E-80
DEL E T	.52327	IXZ UNTR	45000000.00000000	.000000E-80
EAS	196.78398	Y DR/U1	.00000000	.000000E-80
VELOCITY	200.22484	L SUB B	-.11534415	-.460000E-01
CAS	196.89685	L B DOT	.00000000	.000000E-80
DYN PRES	46.02146	L SUB P	.00000000	.000000E-80
Q SUB C	46.39544	L SUB R	.00000000	.000000E-80
P SUB S	2027.50807	L DEL A	-.25074815	-.100000E 00
L'SUB B	-.15014	L DEL AG	-2.22582079	.000000E-80
L' B DOT	.00000	L DEL RG	-.01361193	.000000E-80
L' SUB P	.00000	N SUB B	-.00371476	-.170000E-01
L' SUB R	-.16210	N B DOT	.00000000	.000000E-80
L'DEL A	-.31110	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.72648	N SUB R	-.08730798	-.100000E 01
L'DEL RG	-2.78404	N DEL A	.00016170	.740000E-03
I Y	350900000.00000	N DEL AG	.02032870	.000000E-80
I XX	30100000.00000	N DEL RG	-1.49039096	.000000E-80
I ZZ	345400000.00000	N'SUB B	-.02327580	
I X	30099999.99976	N'B DOT	.00000000	
I Z	345399999.99609	N'SUB P	.00000000	
I XZ	44999999.99976	N'SUB R	-.10842699	
IXZ/IZ	.13028	N'DEL A	-.04036978	
IXZ/IX	1.49502	N'DEL AG	-.33488774	
THRUST Z	47764.24829	N'DEL RG	-1.85310547	
THRUST T	5230000.00000			
OMEGA SQ	.27230	X U/U1	-.00228361	-.500000E-01
2 ZET OM	.06622	X SUB W	-.00066225	-.290000E-01
T SUB A	15.10009	X W DOT	.00000000	.000000E-80
OMEGA A	.52183	X Q/U1	.00000000	.000000E-80
ZETA A	.06345	X DEI/U1	.00000000	.000000E-80
Y SUB B	-4.20657	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00000000	.000000E-80
Y SUB P	.00000	Z SUB W	-.06622478	-.290000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-.91447	M SUB U	-.01588442	-.280000E-01
X SUB A	-.13260	M SUB AL	-.27230435	-.960000E 00
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.805224 S3= -.104225 S2= .016908 S1= -.019443 S0= -.001620
(-.07713, .00000)(.14613, .23307)(.14613, -.23307)(-.34458, .00000)

LON DEN S4= 1.000000 S3= .067047 S2= .272359 S1= -.000686 S0= .000030
(.00127, .01050)(.00127, -.01050)(-.03480, .52078)(-.03480, -.52078)

(12 SEC)

Table B4. (Continued)

FIT CON 24

ALTITUDE	4950.00000	Y SUB V	-.04184694	-.920000E 00
MACH	.39000	N' SUB V	-.00025324	.000000E-80
WEIGHT	3185999.99998	L' SUB V	-.00147697	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-2.00535	Y DAI/U1	.00000000	.000000E-80
DEL E T	1.14745	IXZ UNTR	43000000.00000000	.000000E-80
EAS	397.70459	Y DR/U1	.00000000	.000000E-80
VELOCITY	428.11476	L SUB B	-.47586914	-.460000E-01
CAS	399.07537	L B DOT	.00000000	.000000E-80
DYN PRES	187.97588	L SUB P	.00000000	.000000E-80
Q SUB C	195.23279	L SUB R	.00000000	.000000E-80
P SUB S	1764.08752	L DEL A	-1.03449814	-.100000E 00
L'SUB B	-.63231	L DEL AG	-2.24787129	.000000E-80
L' B DOT	.00000	L DEL RG	-.03090810	.000000E-80
L' SUB P	.00000	N SUB B	-.02612846	-.250000E-01
L' SUB R	-.30976	N B DOT	.00000000	.000000E-80
L'DEL A	-1.27253	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.68762	N SUB R	-.17435553	-.100000E 01
L'DEL RG	-2.77956	N DEL A	.00065314	.700000E-03
I Y	335600000.00000	N DEL AG	.04502356	.000000E-80
I XX	29800000.00000	N DEL RG	-1.54313807	.000000E-80
I Z7	330400000.00000	N'SUB B	-.10841773	
I X	29799999.99976	N'B DOT	.00000000	
I 7	330399999.99609	N'SUB P	.00000000	
I X7	42999999.99976	N'SUB R	-.21466897	
IX7/IZ	.13015	N'DEL A	-.16496041	
IXZ/IX	1.44295	N'DEL AG	-.30475782	
THRUST Z	106935.65330	N'DEL RG	-1.90488214	
THRUST T	5340000.00000			
OMEGA SQ	1.09026	X U/U1	-.00545830	-.600000E-01
2 ZET OM	.13191	X SUB W	-.00909716	-.200000E 00
T SUB A	7.58099	X W DOT	.00000000	.000000E-80
OMEGA A	1.04415	X Q/U1	.00000000	.000000E-80
ZETA A	.06317	X DEI/U1	.00000000	.000000E-80
Y SUB B	-17.91529	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00727773	.800000E-01
Y SUB P	.00000	Z SUB W	-.13190884	-.290000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-4.67355	M SUB U	-.06541544	-.270000E-01
X SUB A	-3.89463	M SUB AL	-1.09025731	-.900000E 00
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.812206 S3= -.208344 S2= .080761 S1= -.038627 S0= -.006240
(-.12406, .00000)(.20827, .26350)(.20827, -.26350)(-.54900, .00000)

LON DEN S4= 1.000000 S3= .136166 S2= 1.090845 S1= -.006793 S0= .000020
(.00311, .00299)(.00311, -.00299)(-.07120, 1.04242)(-.07120,-1.04242)

(24 SEC)

Table B4. (Continued)

FIT CON 32

ALTITUDE	9050.00000	Y SUB V	-.05098174	-.860000E 00
MACH	.56000	N' SUB V	-.00034728	.000000E-80
WEIGHT	3048999.99997	L' SUB V	-.00048266	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-.58755	Y DAI/U1	.00000000	.000000E-80
DEL E T	-.09177	IXZ UNTR	41000000.00000000	.000000E-80
EAS	528.30268	Y DR/U1	.00000000	.000000E-80
VELOCITY	605.69312	L SUB B	.00000000	.000000E-80
CAS	534.08128	L B DOT	.00000000	.000000E-80
DYN PRES	331.70082	L SUB P	.00000000	.000000E-80
Q SUB C	358.32804	L SUB R	.00000000	.000000E-80
P SUB S	1509.79401	L DEL A	-1.84403166	-.100000E 00
L'SUB B	-.29234	L DEL AG	-2.27118353	.000000E-80
L' B DOT	.00000	L DEL RG	.00258265	.000000E-80
L' SUB P	.00000	N SUB B	-.17236671	-.100000E 00
L' SUB R	-.38613	N B DOT	.00000000	.000000E-80
L'DEL A	-2.24850	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.77778	N SUB R	-.22766210	-.100000E 01
L'DEL RG	-2.73171	N DEL A	.00108591	.630000E-03
I Y	320500000.00000	N DEL AG	-.00363767	.000000E-80
I XX	29500000.00000	N DEL RG	-1.61247843	.000000E-80
I ZZ	315600000.00000	N'SUB B	-.21034559	
I X	29499999.99976	N'B DOT	.00000000	
I Z	315599999.99609	N'SUB P	.00000000	
I XZ	40999999.99976	N'SUB R	-.27782463	
IXZ/IZ	.12991	N'DEL A	-.29101954	
IXZ/IX	1.38983	N'DEL AG	-.36450269	
THRUST Z	-8713.03366	N'DEL RG	-1.96735870	
THRUST T	5440000.00000			
OMEGA SQ	1.99212	X U/U1	-.00829935	-.700000E-01
2 ZET OM	.17192	X SUB W	-.00343830	-.580000E-01
T SUB A	5.81682	X W DOT	.00000000	.000000E-80
OMEGA A	1.41142	X Q/U1	.00000000	.000000E-80
ZETA A	.06090	X DEI/U1	.00000000	.000000E-80
Y SUB B	-30.87929	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00177843	.150000E-01
Y SUB P	.00000	Z SUB W	-.17191517	-.290000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-10.05372	M SUB U	-.12087002	-.270000E-01
X SUB A	-2.08256	M SUB AL	-1.99211696	-.890000E 00
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.819445 S3= -.269439 S2= .160760 S1= -.012736 S0= .000000
(.00000, .00000)(.10214, .00000)(.23017, .00000)(-.66111, .00000)

LON DEN S4= 1.000000 S3= .181210 S2= 1.993718 S1= -.022348 S0= .000513
(.00561, .01502)(.00561, -.01502)(-.09622, 1.40938)(-.09622, -1.40938)

(32 SEC)

Table B4. (Continued)

FIT COF 44

ALTITUDE	17800.00000	Y SUB V	-.05626162	-.800000E 00
MACH	.87000	N' SUB V	-.00056735	.000000E-80
WEIGHT	2912999.99997	L' SUB V	.00084586	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-.97403	Y DAI/U1	.00000000	.000000E-80
DEL E T	2.25025	IXZ UNTR	39000000.00000000	.000000E-80
EAS	689.51638	Y DR/U1	.00000000	.000000E-80
VELOCITY	910.30534	L SUB B	1.45978506	.460000E-01
CAS	719.02222	L B DOT	.00000000	.000000E-80
DYN PRES	565.02815	L SUB P	.00000000	.000000E-80
Q SUB C	680.18908	L SUB R	.00000000	.000000E-80
P SUB S	1065.56217	L DEL A	-3.17344578	-.100000E 00
L'SUB B	.76999	L DEL AG	-2.29275116	.000000E-80
L' B DOT	.00000	L DEL RG	-.06712096	.000000E-80
L' SUB P	.00000	N SUB B	-.61632602	-.200000E 00
L' SUB R	-.43750	N B DOT	.00000000	.000000E-80
L'DEL A	-3.83551	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.62759	N SUB R	-.27082166	-.100000E 01
L'DEL RG	-2.84063	N DEL A	.00175653	.570000E-03
I Y	305200000.00000	N DEL AG	.09009254	.000000E-80
I XX	29200000.00000	N DEL RG	-1.70815097	.000000E-80
I ZZ	300700000.00000	N'SUB B	-.51646000	
I X	29199999.99976	N'B DOT	.00000000	
I Z	300699999.99609	N'SUB P	.00000000	
I XZ	38999999.99976	N'SUB R	-.32756430	
IXZ/IZ	.12970	N'DEL A	-.49569897	
IXZ/IX	1.33562	N'DEL AG	-.25069880	
THRUST Z	220272.22443	N'DEL RG	-2.07657263	
THRUST T	5610000.00000			
OMEGA SQ	3.00298	X U/U1	-.01265886	-.900000E-01
2 ZET OM	.18285	X SUB W	-.00794695	-.113000E 00
T SUB A	5.46896	X W DOT	.00000000	.000000E-80
OMEGA A	1.73291	X Q/U1	.00000000	.000000E-80
ZETA A	.05276	X DEI/U1	.00000000	.000000E-80
Y SUB B	-51.21525	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00745466	.530000E-01
Y SUB P	.00000	Z SUB W	-.18285027	-.260000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-23.04686	M SUB U	-.05605572	-.700000E-02
X SUB A	-7.23415	M SUB AL	-3.00298485	-.750000E 00
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.826774 S3= -.317337 S2= .411759 S1= .022519 S0= .013984
(-.03361, .17211)(-.03361, -.17211)(.60006, .00000)(-.91667, .00000)

LON DEN S4= 1.000000 S3= .204877 S2= 3.007064 S1= -.068258 S0= -.000373
(-.2043[illegible], .00000)(.02721, .00000)(-.11376, 1.73188)(-.11376,-1.73188)

(44 sec)

Table B4. (Continued)

FLT CON 52

ALTITUDE	25200.00000	Y SUB V	-.09725918	-.136000E 01
MACH	1.12000	N' SUB V	-.00006369	.000000E-80
WEIGHT	2775999.99998	L' SUB V	-.00203638	.000000E-80
C.G.	.30000	Y R/U1	.00000000	.000000E-80
ALPHA T	-1.31780	Y DAI/U1	.00000000	.000000E-80
DEL E T	7.99025	IXZ UNTR	38000000.00000000	.000000E-80
EAS	758.72474	Y DR/U1	.00000000	.000000E-80
VELOCITY	1137.41249	L SUB B	-2.22062704	-.570000E-01
CAS	824.64789	L B DOT	.00000000	.000000E-80
DYN PRES	684.14697	L SUB P	.00000000	.000000E-80
Q SUB C	923.47456	L SUB R	.00000000	.000000E-80
P SUB S	778.50351	L DEL A	-3.89583692	-.100000E 00
L'SUB B	-2.31621	L DEL AG	-2.30380371	.000000E-80
L' B DOT	.00000	L DEL RG	-.24418367	.000000E-80
L' SUB P	.00000	N SUB B	.23563200	.600000E-01
L' SUB R	-.44203	N B DOT	.00000000	.000000E-80
L'DEL A	-4.72318	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.27667	N SUB R	-.27621993	-.100000E 01
L'DEL RG	-3.08003	N DEL A	.00117816	.300000E-03
I Y	289800000.00000	N DEL AG	.32337860	.000000E-80
I XX	28800000.00000	N DEL RG	-1.73960566	.000000E-80
I ZZ	285700000.00000	N'SUB B	-.07243881	
I X	28799999.99976	N'B DOT	.00000000	
I Z	285699999.99609	N'SUB P	.00000000	
I XZ	37999999.99976	N'SUB R	-.33501300	
IXZ/IZ	.13301	N'DEL A	-.62703560	
IXZ/IX	1.31944	N'DEL AG	.02056675	
THRUST Z	795105.93509	N'DEL RG	-2.14926953	
THRUST T	5720000.00000			
OMEGA SQ	5.05467	X U/U1	-.02860564	-.200000E 00
2 ZET OM	.23600	X SUB W	-.01358768	-.190000E 00
T SUB A	4.23735	X W DOT	.00000000	.000000E-80
OMEGA A	2.24826	X Q/U1	.00000000	.000000E-80
ZETA A	.05248	X DEI/U1	.00000000	.000000E-80
Y SUB B	-110.62380	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.01573310	.110000E 00
Y SUB P	.00000	Z SUB W	-.23599654	-.330000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-65.07283	M SUB U	.14296028	.140000E-01
X SUB A	-15.45480	M SUB AL	-5.05466692	-.990000E 00
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.824505 S3= -.356411 S2= .032861 S1= -.054064 S0= -.017365
(-.24355, .00000)(-.58647, .00000)(.19887, .32848)(.19887, -.32848)

LON DEN S4= 1.000000 S3= .300073 S2= 5.070028 S1= -.317178 S0= -.003591
(-.00979, .00000)(.07201, .00000)(-.18115, 2.24955)(-.18115,-2.24955)

(52 sec)

Table B4. (Continued)

IT CON 64

ALTITUDE	38300.00000	Y SUB V	-.08158099	-.136000E 01
MACH	1.56000	N' SUB V	-.00016907	.000000E-80
WEIGHT	2638999.99998	L' SUB V	-.00148838	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	.00000	Y DAI/U1	.00000000	.000000E-80
DEL E T	3.29413	IXZ UNTR	36000000.00000000	.000000E-80
EAS	780.85472	Y DR/U1	.00000000	.000000E-80
VELOCITY	1510.81639	L SUB B	-1.92488476	-.460000E-01
CAS	898.99716	L B DOT	.00000000	.000000E-80
DYN PRES	724.63848	L SUB P	.00000000	.000000E-80
Q SUB C	1125.39080	L SUB R	.00000000	.000000E-80
P SUB S	425.04401	L DEL A	-2.09226604	-.500000E-01
L'SUB B	-2.24867	L DEL AG	-2.35525693	.000000E-80
L' B DOT	.00000	L DEL RG	-.10705983	.000000E-80
L' SUB P	.00000	N SUB B	.04394997	.100000E-01
L' SUB R	-.35489	N B DOT	.00000000	.000000E-80
L'DEL A	-2.51625	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.62671	N SUB R	-.23272169	-.100000E 01
L'DEL RG	-2.96534	N DEL A	.00052740	.120000E-03
I Y	274100000.00000	N DEL AG	.13556097	.000000E-80
I XX	28400000.00000	N DEL RG	-1.86007367	.000000E-80
I ZZ	270400000.00000	N'SUB B	-.25542869	
I X	28399999.99976	N'B DOT	.00000000	
I Z	270399999.99609	N'SUB P	.00000000	
I XZ	35999999.99976	N'SUB R	-.27997067	
IXZ/IZ	.13314	N'DEL A	-.33447631	
IXZ/IX	1.26761	N'DEL AG	-.21414947	
THRUST Z	337299.98183	N'DEL RG	-2.25486786	
THRUST T	5870000.00000			
OMEGA SQ	4.28825	X U/U1	-.02639385	-.220000E 00
2 ZET OM	.16196	X SUB W	-.00239944	-.400000E-01
T SUB A	6.17428	X W DOT	.00000000	.000000E-80
OMEGA A	2.07081	X Q/U1	.00000000	.000000E-80
ZETA A	.03911	X DEI/U1	.00000000	.000000E-80
Y SUB B	-123.25389	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00479889	.400000E-01
Y SUB P	.00000	Z SUB W	-.16196226	-.270000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-79.75252	M SUB U	.06861198	.600000E-02
X SUB A	-3.62511	M SUB AL	-4.25824849	-.750000E 00
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.831236 S3= -.300535 S2= .193336 S1= -.039838 S0= -.009547
(-.13681, .00000)(.25603, .21999)(.25603, -.21999)(-.73679, .00000)

LON DEN S4= 1.000000 S3= .244311 S2= 4.301604 S1= -.350594 S0= -.001054
(-.00290, .00000)(.08389, .00000)(-.16265, 2.07406)(-.16265,-2.07406)

(64 sec)

Table B4. (Continued)

FLT CON 72

ALTITUDE	48200.00000	Y SUB V	-.06401320	-.131000E 01
MACH	1.94000	N' SUB V	-.00032843	.000000E-80
WEIGHT	2502999.99998	L' SUB V	-.00192505	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-.17189	Y DAT/U1	.00000000	.000000E-80
DEL E T	2.94028	IXZ UNTR	34000000.00000000	.000000E-80
EAS	765.40913	Y DR/U1	.00000000	.000000E-80
VELOCITY	1878.83577	L SUB B	-2.86487629	-.700000E-01
CAS	906.31510	L B DOT	.00000000	.000000E-80
DYN PRES	696.25478	L SUB P	.00000000	.000000E-80
Q SUB C	1146.71497	L SUB R	.00000000	.000000E-80
P SUB S	264.07448	L DEL A	-1.39151134	-.340000E-01
L'SUB B	-3.61686	L DEL AG	-2.39827230	.000000E-80
L' B DOT	.00000	L DEL RG	-.09920232	.000000E-80
L' SUB P	.00000	N SUB B	-.13444166	-.300000E-01
L' SUB R	-.27769	N B DOT	.00000000	.000000E-80
L'DEL A	-1.66134	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.68473	N SUB R	-.19081856	-.100000E 01
L'DEL RG	-2.92922	N DEL A	.00026868	.600000E-04
I Y	258000000.00000	N DEL AG	.12318176	.000000E-80
I XX	27900000.00000	N DEL RG	-1.93140752	.000000E-80
I ZZ	254800000.00000	N'SUB B	-.61706804	
I X	27899999.99976	N'B DOT	.00000000	
I Z	254799999.99805	N'SUB P	.00000000	
I XZ	33999999.99976	N'SUB R	-.22787011	
IXZ/IZ	.13344	N'DEL A	-.22141675	
IXZ/IX	1.21864	N'DEL AG	-.23506310	
THRUST Z	304662.84961	N'DEL RG	-2.32227627	
THRUST T	5940000.00000			
OMEGA SQ	3.15173	X U/U1	-.01563681	-.160000E 00
2 ZET OM	.10750	X SUB W	-.00263871	-.540000E-01
T SUB A	9.30206	X W DOT	.00000000	.000000E-80
OMEGA A	1.77531	X Q/U1	.00000000	.000000E-80
ZETA A	.03028	X DEI/U1	.00000000	.000000E-80
Y SUB B	-120.27029	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00449558	.460000E-01
Y SUB P	.00000	Z SUB W	-.10750309	-.220000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-58.75801	M SUB U	.00000000	.000000E-80
X SUB A	-4.95771	M SUB AL	-3.15172678	-.540000E 00
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.837387 S3= -.244419 S2= .504510 S1= -.051907 S0= -.009369
(-.09329, .00000)(.22936, .00000)(.54010, .00000)(-.96806, .00000)

LON DEN S4= 1.000000 S3= .168174 S2= 3.158272 S1= -.191218 S0= -.000471
(-.00257, .00000)(.06264, .00000)(-.11422, 1.77740)(-.11422,-1.77740)

(72 SEC)

Table B4. (Continued)

FIT CON 84

ALTITUDE	64400.00000	Y SUB V	-.04003334	-.131000E 01
MACH	2.50000	N' SUB V	-.00025919	.000000E-80
WEIGHT	2366999.99997	L' SUB V	-.00148331	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-.28648	Y DAI/U1	.00000000	.000000E-80
DEL E T	3.20919	IXZ UNTR	32000000.00000000	.000000E-80
EAS	668.20177	Y DR/U1	.00000000	.000000E-80
VELOCITY	2421.18011	L SUB B	-2.85845891	-.900000E-01
CAS	820.42647	L B DOT	.00000000	.000000E-80
DYN PRES	530.63533	L SUB P	.00000000	.000000E-80
Q SUB C	913.00660	L SUB R	.00000000	.000000E-80
P SUB S	121.19309	L DEL A	-.73049565	-.230000E-01
L'SUB B	-3.59136	L DEL AG	-2.44142082	.000000E-80
L' B DOT	.00000	L DEL RG	-.11136066	.000000E-80
L' SUB P	.00000	N SUB B	-.14589136	-.400000E-01
L' SUB R	-.16688	N B DOT	.00000000	.000000E-80
L'DEL A	-.86586	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.70528	N SUB R	-.12051260	-.100000E 01
L'DEL RG	-2.88237	N DEL A	.00021884	.600000E-04
I Y	241300000.00000	N DEL AG	.13688938	.000000E-80
I XX	27400000.00000	N DEL RG	-1.98610553	.000000E-80
I ZZ	238600000.00000	N'SUB B	-.62754948	
I X	27399999.99976	N'B DOT	.00000000	
I Z	238599999.99805	N'SUB P	.00000000	
I XZ	31999999.99976	N'SUB R	-.14289435	
IXZ/IZ	.13412	N'DEL A	-.11590662	
IXZ/IX	1.16788	N'DEL AG	-.22593138	
THRUST Z	335889.76946	N'DEL RG	-2.37267639	
THRUST T	6000000.00000			
OMEGA SQ	1.80729	X U/U1	-.00916794	-.150000E 00
2 ZET OM	.05501	X SUB W	-.00177247	-.580000E-01
T SUB A	18.17929	X W DOT	.00000000	.000000E-80
OMEGA A	1.34436	X Q/U1	.00000000	.000000E-80
ZETA A	.02046	X DEI/U1	.00000000	.000000E-80
Y SUB B	-96.92793	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00293374	.480000E-01
Y SUB P	.00000	Z SUB W	-.05500764	-.180000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-44.39447	M SUB U	-.01902415	-.200000E-02
X SUB A	-4.29147	M SUB AL	-1.80729378	-.380000E 00
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.843369 S3= -.154275 S2= .524431 S1= -.040281 S0= -.004581
(-.06241, .00000)(.14758, .00000)(.64554, .00000)(-.91363, .00000)

LON DEN S4= 1.000000 S3= .100847 S2= 1.809828 S1= -.083563 S0= -.000141
(-.00164, .00000)(.04763, .00000)(-.07342, 1.34583)(-.07342,-1.34583)

(84 sec)

Table B4. (Continued)

FIT CON 93

ALTITUDE	77700.00000	Y SUB V	-.02443848	-.119000E 01
MACH	3.00000	N' SUB V	-.00019386	.000000E-80
WEIGHT	2229999.99997	L' SUB V	-.00096673	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-.97463	Y DAI/U1	.00000000	.000000E-80
DEL E T	3.80692	IXZ UNTR	28000000.00000000	.000000E-80
EAS	582.42487	Y DR/U1	.00000000	.000000E-80
VELOCITY	2905.41614	L SUB B	-2.22030328	-.900000E-01
CAS	732.17047	L B DOT	.00000000	.000000E-80
DYN PRES	403.14450	L SUB P	.00000000	.000000E-80
Q SUB C	707.93570	L SUB R	.00000000	.000000E-80
P SUB S	63.94107	L DEL A	-.56741084	-.230000E-01
L'SUB B	-2.80876	L DEL AG	-2.49448364	.000000E-80
L' B DOT	.00000	L DEL RG	-.13768470	.000000E-80
L' SUB P	.00000	N SUB B	-.20866090	-.700000E-01
L' SUB R	-.09878	N B DOT	.00000000	.000000E-80
L'DEL A	-.65340	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.67371	N SUB R	-.08207761	-.100000E 01
L'DEL RG	-2.64886	N DEL A	.00017885	.600000E-04
I Y	223900000.00000	N DEL AG	.16598610	.000000E-80
I XX	26800000.00000	N DEL RG	-2.06916248	.000000E-80
I ZZ	221800000.00000	N'SUB B	-.56323854	
I X	26799999.99976	N'B DOT	.00000000	
I Z	221799999.99829	N'SUB P	.00000000	
I XZ	27999999.99976	N'SUB R	-.09454773	
IXZ/IZ	.12624	N'DEL A	-.08230663	
IXZ/IX	1.04478	N'DEL AG	-.17154227	
THRUST Z	400358.48516	N'DEL RG	-2.40355429	
THRUST T	6030000.00000			
OMEGA SQ	1.01248	X U/U1	-.00575023	-.140000E 00
2 ZET OM	.03286	X SUB W	-.00184829	-.900000E-01
T SUB A	30.43356	X W DOT	.00000000	.000000E-80
OMEGA A	1.00622	X Q/U1	.00000000	.000000E-80
ZETA A	.01633	X DEI/U1	.00000000	.000000E-80
Y SUB B	-71.00396	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00266975	.650000E-01
Y SUB P	.00000	Z SUB W	-.03285846	-.160000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-33.41363	M SUB U	-.03894153	-.550000E-02
X SUB A	-5.37005	M SUB AL	-1.01247967	-.260000E 00
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.868108 S3= -.103293 S2= .486946 S1= -.027023 S0= -.002020
(-.04230, .00000)(.10067, .00000)(.65576, .00000)(-.83311, .00000)

LON DEN S4= 1.000000 S3= .067360 S2= 1.013628 S1= -.036443 S0= -.000047
-.00125, .00000)(.03707, .00000)(-.05159, 1.00733)(-.05159,-1.00733)

(93 sec)

Table B4. (Continued)

FLT CON 102

ALTITUDE	91800.00000	Y SUB V	-.01516990	-.115000E 01
MACH	3.60000	N' SUB V	-.00011901	.000000E-80
WEIGHT	2093999.99998	L' SUB V	-.00058728	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-2.23454	Y DAI/U1	.00000000	.000000E-80
DEL E T	4.78037	IXZ UNTR	25000000.00000000	.000000E-80
EAS	500.53704	Y DR/U1	.00000000	.000000E-80
VELOCITY	3557.71754	L SUB B	-1.68383374	-.900000E-01
CAS	641.51215	L B DOT	.00000000	.000000E-80
DYN PRES	297.75109	L SUB P	.00000000	.000000E-80
Q SUB C	530.33818	L SUB R	.00000000	.000000E-80
P SUB S	32.79208	L DEL A	-.43031307	-.230000E-01
L'SUB B	-2.08939	L DEL AG	-2.55812025	.000000E-80
L' B DOT	.00000	L DEL RG	-.17880633	.000000E-80
L' SUB P	.00000	N SUB B	-.16747587	-.700000E-01
L' SUB R	-.05838	N B DOT	.00000000	.000000E-80
L'DEL A	-.48736	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.66600	N SUB R	-.05379882	-.100000E 01
L'DEL RG	-2.52282	N DEL A	.00014355	.600000E-04
I Y	205500000.00000	N DEL AG	.21392878	.000000E-80
I XX	26100000.00000	N DEL RG	-2.13813258	.000000E-80
I ZZ	204100000.00000	N'SUB B	-.42340343	
I X	26099999.99976	N'B DOT	.00000000	
I Z	204099999.99829	N'SUB P	.00000000	
I XZ	24999999.99976	N'SUB R	-.06094986	
IXZ/IZ	.12249	N'DEL A	-.05955210	
IXZ/IX	.95785	N'DEL AG	-.11262687	
THRUST Z	503352.07888	N'DEL RG	-2.44715022	
THRUST T	6040000.00000			
OMEGA SQ	.47004	X U/U1	-.00342972	-.130000E 00
2 ZET OM	.01715	X SUB W	-.00184677	-.140000E 00
Z SUB A	58.31385	X W DOT	.00000000	.000000E-80
OMEGA A	.68560	X Q/U1	.00000000	.000000E-80
ZETA A	.01251	X DEI/U1	.00000000	.000000E-80
Y SUB B	-53.97083	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00224251	.850000E-01
Y SUB P	.00000	Z SUB W	-.01714859	-.130000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-24.40393	M SUB U	-.03133631	-.500000E-02
X SUB A	-6.57029	M SUB AL	-.47004465	-.150000E 00
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.882673 S3= -.067189 S2= .372911 S1= -.016692 S0= -.000820
(-.02955, .00000) (.07582, .00000) (.58558, .00000) (-.70797, .00000)

LON DEN S4= 1.000000 S3= .041843 S2= .470483 S1= -.012837 S0= -.000017
(-.00129, .00000) (.02842, .00000) (-.03451, .68644) (-.03451, -.68644)

(102 sec)

Table B4. (Continued)

FLT CON 113

ALTITUDE	110000.00000	Y SUB V	-.00773648	-.107000E 01
MACH	4.30000	N' SUB V	-.00006270	.000000E-80
WEIGHT	1957999.99998	L' SUB V	-.00030228	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-4.01070	Y DAI/U1	.00000000	.000000E-80
DEL E T	5.65108	IXZ UNTR	21000000.00000000	.000000E-80
EAS	398.65948	Y DR/U1	.00000000	.000000E-80
VELOCITY	4403.44211	L SUB B	-1.10192225	-.900000E-01
CAS	520.59342	L B DOT	.00000000	.000000E-80
DYN PRES	188.87963	L SUB P	.00000000	.000000E-80
Q SUB C	339.68921	L SUB R	.00000000	.000000E-80
P SUB S	14.58038	L DEL A	-.28160235	-.230000E-01
L'SUB B	-1.33108	L DEL AG	-2.63535099	.000000E-80
L' B DOT	.00000	L DEL RG	-.22088328	.000000E-80
L' SUB P	.00000	N SUB B	-.12530849	-.750000E-01
L' SUB R	-.02781	N B DOT	.00000000	.000000E-80
L'DEL A	-.31073	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.66992	N SUB R	-.03035407	-.100000E 01
L'DEL RG	-2.28894	N DEL A	.00010025	.600000E-04
I Y	186100000.00000	N DEL AG	.26077085	.000000E-80
I XX	25300000.00000	N DEL RG	-2.23224714	.000000E-80
I ZZ	185400000.00000	N'SUB B	-.27607781	
I X	25299999.99976	N'B DOT	.00000000	
I Z	185399999.99854	N'SUB P	.00000000	
I XZ	20999999.99976	N'SUB R	-.03350403	
IXZ/IZ	.11327	N'DEL A	-.03509611	
IXZ/IX	.83004	N'DEL AG	-.04164726	
THRUST Z	595744.62007	N'DEL RG	-2.49151180	
THRUST T	6050000.00000			
OMEGA SQ	.17560	X U/U1	-.00187989	-.130000E 00
2 ZET OM	.00795	X SUB W	-.00130146	-.180000E 00
T SUB A	125.73247	X W DOT	.00000000	.000000E-80
OMEGA A	.41905	X Q/U1	.00000000	.000000E-80
ZETA A	.00949	X DEI/U1	.00000000	.000000E-80
Y SUB B	-34.06716	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00144607	.100000E 00
Y SUB P	.00000	Z SUB W	-.00795340	-.110000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-16.55600	M SUB U	-.03073075	-.700000E-02
X SUB A	-5.73092	M SUB AL	-.17560426	-.800000E-01
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.905983 S3= -.037363 S2= .249887 S1= -.008818 S0= -.000245
(-.01827, .00000)(.05433, .00000)(.48435, .00000)(-.56165, .00000)

LON DEN S4= 1.000000 S3= .024120 S2= .175741 S1= -.003977 S0= -.000000
(-.00008, .00000)(.02257, .00000)(-.82331, .41982)(-.02331, -.41982)

(113 sec)

Table B4. (Continued)

FLT CON 123

ALTITUDE	127000.00000	Y SUB V	-.00429928	-.100000E 01
MACH	5.00000	N' SUB V	-.00002577	.000000E-80
WEIGHT	1827999.99998	L' SUB V	-.00013743	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-4.01070	Y DAI/U1	.00000000	.000000E-80
DEL E T	4.38362	IXZ UNTR	17000000.00000000	.000000E-80
EAS	325.31585	Y DR/U1	.00000000	.000000E-80
VELOCITY	5282.00911	L SUB B	-.63143754	-.750000E-01
CAS	429.73996	L B DOT	.00000000	.000000E-80
DYN PRES	125.77414	L SUB P	.00000000	.000000E-80
Q SUB C	227.53645	L SUB R	.00000000	.000000E-80
P SUB S	7.18078	L DEL A	-.19364085	-.230000E-01
L'SUB B	-.72590	L DEL AG	-2.72669393	.000000E-80
L' B DOT	.00000	L DEL RG	-.17935769	.000000E-80
L' SUB P	.00000	N SUB B	-.06198005	-.500000E-01
L' SUB R	-.01402	N B DOT	.00000000	.000000E-80
L'DEL A	-.20836	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.77863	N SUB R	-.01877469	-.100000E 01
L'DEL RG	-1.94038	N DEL A	.00007438	.600000E-04
I Y	166200000.00000	N DEL AG	.20902351	.000000E-80
I XX	24500000.00000	N DEL RG	-2.33970585	.000000E-80
I ZZ	166400000.00000	N'SUB B	-.13614077	
I X	24499999.99976	N'B DOT	.00000000	
I Z	166399999.99878	N'SUB P	.00000000	
I XZ	16999999.99976	N'SUB R	-.02020715	
IXZ/IZ	.10216	N'DEL A	-.02121236	
IXZ/IX	.69388	N'DEL AG	-.07485110	
THRUST Z	458603.81414	N'DEL RG	-2.53794162	
THRUST T	6000000.00000			
OMEGA SQ	.09820	X U/U1	-.00111781	-.130000E 00
Z ZET OM	.00430	X SUB W	-.00064489	-.150000E 00
T SUB A	232.59706	X W DOT	.00000000	.000000E-80
OMEGA A	.31337	X Q/U1	.00000000	.000000E-80
ZETA A	.00686	X DEI/U1	.00000000	.000000E-80
Y SUB B	-22.70884	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00068788	.800000E-01
Y SUB P	.00000	Z SUB W	-.00429928	-.100000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-11.80860	M SUB U	-.02291367	-.700000E-02
X SUB A	-3.40633	M SUB AL	-.09820145	-.600000E-01
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.929111 S3= -.022769 S2= .126409 S1= -.004112 S0= -.000072
(-.01265, .00000)(.04604, .00000)(.33762, .00000)(-.39552, .00000)

LON DEN S4= 1.000000 S3= .015477 S2= .098252 S1= -.001870 S0= .000001
(.01839, .00000)(.00059, .00000)(-.01720, .31400)(-.01720, -.31400)

(123 sec)

Table B4. (Continued)

FLT CON 132

ALTITUDE	143000.00000	Y SUB V	-.00291763	-.107000E 01
MACH	5.70000	N' SUB V	-.00001227	.000000E-80
WEIGHT	1704999.99998	L' SUB V	-.00006307	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-4.58366	Y DAI/U1	.00000000	.000000E-80
DEL E T	5.63389	IXZ UNTR	14000000.00000000	.000000E-80
EAS	270.83572	Y DR/U1	.00000000	.000000E-80
VELOCITY	6190.00019	L SUB B	-.34530232	-.570000E-01
CAS	360.42431	L B DOT	.00000000	.000000E-80
DYN PRES	87.17517	L SUB P	.00000000	.000000E-80
Q SUB C	158.31828	L SUB R	.00000000	.000000E-80
P SUB S	3.82969	L DEL A	-.13933251	-.230000E-01
L'SUB B	-.39037	L DEL AG	-2.82526937	.000000E-80
L' B DOT	.00000	L DEL RG	-.21437138	.000000E-80
L' SUB P	.00000	N SUB B	-.03884980	-.400000E-01
L' SUB R	-.00789	N B DOT	.00000000	.000000E-80
L'DEL A	-.14763	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.81898	N SUB R	-.01255244	-.100000E 01
L'DEL RG	-1.59339	N DEL A	.00005827	.600000E-04
I Y	146100000.00000	N DEL AG	.27870727	.000000E-80
I XX	23600000.00000	N DEL RG	-2.17309328	.000000E-80
I ZZ	147200000.00000	N'SUB B	-.07597775	
I X	23599999.99976	N'B DOT	.00000000	
I Z	147199999.99878	N'SUB P	.00000000	
I XZ	13999999.99994	N'SUB R	-.01330300	
IXZ/IZ	.09511	N'DEL A	-.01398235	
IXZ/IX	.59322	N'DEL AG	.01059751	
THRUST Z	513437.03703	N'DEL RG	-2.32463896	
THRUST T	5230000.00000			
OMEGA SQ	.03871	X U/U1	-.00070881	-.130000E 00
2 ZET OM	.00273	X SUB W	-.00054524	-.200000E 00
T SUB A	366.81114	X W DOT	.00000000	.000000E-80
OMEGA A	.19676	X Q/U1	.00000000	.000000E-80
ZETA A	.00693	X DEI/U1	.00000000	.000000E-80
Y SUB B	-18.05643	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00054524	.100000E 00
Y SUB P	.00000	Z SUB W	-.00272620	-.100000E 01
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-8.77509	M SUB U	-.02064757	-.800000E-02
X SUB A	-3.37503	M SUB AL	-.03871419	-.300000E-01
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.943580 S3= -.015305 S2= .071654 S1= -.001916 S0= -.000023
(-.00884, .00000)(.03632, .00000)(.25182, .00000)(-.29552, .00000)

LON DEN S4= 1.000000 S3= .010807 S2= .038738 S1= -.000989 S0= .00001
(.00110, .00000)(.02390, .00000)(-.01790, .19821)(-.01790, -.19821)

(132 sec)

Table B4. (Continued)

FLT CON 144

ALTITUDE	164000.00000	Y SUB V	.00000000	-.107000E 01
MACH	6.57000	N' SUB V	.00000000	.000000E-80
WEIGHT	1589999.99998	L' SUB V	.00000000	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-6.30254	Y DAI/U1	.00000000	.000000E-80
DEL E T	7.46891	IXZ UNTR	9000000.00000000	.000000E-80
EAS	.00000	Y DR/U1	.00000000	.000000E-80
VELOCITY	7267.66678	L SUB B	.00000000	-.570000E-01
CAS	.00000	L B DOT	.00000000	.000000E-80
DYN PRES	.00000	L SUB P	.00000000	.000000E-80
Q SUB C	.00000	L SUB R	.00000000	.000000E-80
P SUB S	.00000	L DEL A	.00000000	-.230000E-01
L'SUB B	.00000	L DEL AG	-2.93944870	.000000E-80
L' B DOT	.00000	L DEL RG	-.27739102	.000000E-80
L' SUB P	.00000	N SUB B	.00000000	.000000E-80
L' SUB R	.00000	N B DOT	.00000000	.000000E-80
L'DEL A	.00000	N SUB P	.00000000	.000000E-80
L'DEL AG	-2.86637	N SUB R	.00000000	-.100000E 01
L'DEL RG	-1.15231	N DEL A	.00000000	.600000E-04
I Y	125700000.00000	N DEL AG	.38536344	.000000E-80
I XX	22600000.00000	N DEL RG	-2.11586417	.000000E-80
I ZZ	127800000.00000	N'SUB B	.00000000	
I X	22599999.99976	N'B DOT	.00000000	
I Z	127799999.99902	N'SUB P	.00000000	
I XZ	8999999.99995	N'SUB R	.00000000	
IXZ/IZ	.07042	N'DEL A	.00000000	
IXZ/IX	.39823	N'DEL AG	.18350633	
THRUST Z	622643.78261	N'DEL RG	-2.19701259	
THRUST T	4790000.00000			
OMEGA SQ	.00000	X U/U1	.00000000	-.140000E 00
2 ZET OM	.00000	X SUB W	.00000000	-.260000E 00
T SUB A	.00000	X W DOT	.00000000	.000000E-80
OMEGA A	.00000	X Q/U1	.00000000	.000000E-80
ZETA A	.00000	X DEI/U1	.00000000	.000000E-80
Y SUB B	.00000	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00000000	.130000E 00
Y SUB P	.00000	Z SUB W	.00000000	-.950000E 00
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	.00000	M SUB U	.00000000	-.800000E-02
X SUB A	.00000	M SUB AL	.00000000	.000000E-80
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.971956 S3= .000000 S2= .000000 S1= .000000 S0= .000000
.00000, .00000)(.00003, -.00003)(.00001, .00001)(-.00001, .00000)

LON DEN S4= 1.000000 S3= .000000 S2= .000000 S1= .000000 S0= .000000
.00000, .00000)(.00003, -.00003)(-.00001, -.00001)(-.00000, .00001)

(144 sec)

Table B4. (Continued)

FLT CON 153

ALTITUDE	178000.00000	Y SUB V	-.00117763	-.107000E 01
MACH	7.40000	N' SUB V	-.00000583	.000000E-80
WEIGHT	1481999.99998	L' SUB V	-.00002065	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-6.30254	Y DAI/U1	.00000000	.000000E-80
DEL E T	6.84950	IXZ UNTR	7000000.00000000	.000000E-80
EAS	183.69265	Y DR/U1	.00000000	.000000E-80
VELOCITY	8114.66545	L SUB B	-.15223852	-.500000E-01
CAS	246.79174	L B DOT	.00000000	.000000E-80
DYN PRES	40.10185	L SUB P	.00000000	.000000E-80
Q SUB C	73.21194	L SUB R	.00000000	.000000E-80
P SUB S	1.06564	L DEL A	-.07002972	-.230000E-01
L'SUB B	-.16757	L DEL AG	-3.07971348	.000000E-80
L' B DOT	.00000	L DEL RG	-.26017643	.000000E-80
L' SUB P	.00000	N SUB B	-.03646971	-.600000E-01
L' SUB R	-.00198	N B DOT	.00000000	.000000E-80
L'DEL A	-.07152	N SUB P	.00000000	.000000E-80
L'DEL AG	-3.02321	N SUB R	-.00599239	-.100000E 01
L'DEL RG	-.98272	N DEL A	.00003647	.600000E-04
I Y	105200000.00000	N DEL AG	.36993213	.000000E-80
I XX	21600000.00000	N DEL RG	-2.16598883	.000000E-80
I ZZ	108200000.00000	N'SUB B	-.04731070	
I X	21599999.99976	N'B DOT	.00000000	
I Z	108199999.99902	N'SUB P	.00000000	
I XZ	6999999.99997	N'SUB R	-.00612072	
IXZ/IZ	.06470	N'DEL A	-.00459034	
IXZ/IX	.32407	N'DEL AG	.17434536	
THRUST Z	536677.65547	N'DEL RG	-2.22956597	
THRUST T	4500000.00000			
OMEGA SQ	-.01154	X U/U1	-.00030817	-.140000E 00
2 ZET OM	.00099	X SUB W	-.00028615	-.260000E 00
T SUB A	1009.55997	X W DOT	.00000000	.000000E-80
OMEGA A	.00000	X Q/U1	.00000000	.000000E-80
ZETA A	.00000	X DEI/U1	.00000000	.000000E-80
Y SUB B	-9.55608	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00028615	.130000E 00
Y SUB P	.00000	Z SUB W	-.00099053	-.900000E 00
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-5.00131	M SUB U	-.01483978	-.900000E-02
X SUB A	-2.32204	M SUB AL	.01154205	.140000E-01
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.979034 S3= -.007145 S2= .046312 S1= -.000651 S0= -.000004
(.01847, .00000)(-.00427, .00000)(.20612, .00000)(-.22763, .00000)

LON DEN S4= 1.000000 S3= .005551 S2= -.011537 S1= -.000415 S0= .000001
(.00199, .00000)(-.04300, .00000)(-.08338, .00000)(.11959, .00000)

(152 sec)

Table B4. (Continued)

FLT CON 162

ALTITUDE	193000.00000	Y SUB V	-.00082809	-.107000E 01
MACH	8.40000	N' SUB V	-.00000640	.000000E-80
WEIGHT	1382999.99998	L' SUB V	-.00001193	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-8.59437	Y DAI/U1	.00000000	.000000E-80
DEL E T	9.17182	IXZ UNTR	3000000.00000000	.000000E-80
EAS	155.93156	Y DR/U1	.00000000	.000000E-80
VELOCITY	8910.69035	L SUB B	-.10582382	-.460000E-01
CAS	210.02672	L B DOT	.00000000	.000000E-80
DYN PRES	28.89675	L SUB P	.00000000	.000000E-80
Q SUB C	52.84588	L SUB R	.00000000	.000000E-80
P SUB S	.59589	L DEL A	-.05291191	-.230000E-01
L'SUB B	-.10635	L DEL AG	-3.21084421	.000000E-80
L' B DOT	.00000	L DEL RG	-.36660991	.000000E-80
L' SUB P	.00000	N SUB B	.00000000	.000000E-80
L' SUB R	-.00070	N B DOT	.00000000	.000000E-80
L'DEL A	-.05317	N SUB P	.00000000	.000000E-80
L'DEL AG	-3.15087	N SUB R	-.00479676	-.100000E 01
L'DEL RG	-.70073	N DEL A	.00003206	.600000E-04
I Y	84600000.00000	N DEL AG	.51842263	.000000E-80
I XX	20600000.00000	N DEL RG	-2.27059401	.000000E-80
I ZZ	88700000.00000	N'SUB B	-.00359688	
I X	20599999.99976	N'B DOT	.00000000	
I Z	88699999.99927	N'SUB P	.00000000	
I XZ	2999999.99998	N'SUB R	-.00482050	
IXZ/IZ	.03382	N'DEL A	-.00176622	
IXZ/IX	.14563	N'DEL AG	.41185446	
THRUST Z	674243.44784	N'DEL RG	-2.29429403	
THRUST T	4230000.00000			
OMEGA SQ	-.02955	X U/U1	-.00021670	-.140000E 00
Z ZET OM	.00066	X SUB W	-.00027087	-.350000E 00
T SUB A	1520.14808	X W DOT	.00000000	.000000E-80
OMEGA A	.00000	X Q/U1	.00000000	.000000E-80
ZETA A	.00000	X DEI/U1	.00000000	.000000E-80
Y SUB B	-7.37888	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00026313	.170000E 00
Y SUB P	.00000	Z SUB W	-.00065783	-.850000E 00
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DEL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DEL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-3.86184	M SUB U	-.01477457	-.100000E-01
X SUB A	-2.41365	M SUB AL	.02954915	.400000E-01
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DEL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4= -.995074 S3= -.005621 S2= .003575 S1= -.000382 S0= -.000002
(-.00460, .00000)(.04458, .04957)(.04458, -.04957)(-.09020, .00000)

LON DEN S4= 1.000000 S3= .004298 S2= -.029546 S1= -.000375 S0= .000001
(.00129, .00000)(-.01402, .00000)(-.16736, .00000)(.17579, .00000)

(162 SEC)

Table B4. (Concluded)

FIT CON 170

ALTITUDE	204000.00000	Y SUB V	-.00063291	-.107000E 01
MACH	9.30000	N' SUB V	.00000000	.000000E-80
WEIGHT	1307999.99998	L' SUB V	-.00000902	.000000E-80
C.G.	.00000	Y R/U1	.00000000	.000000E-80
ALPHA T	-10.88620	Y DAI/U1	.00000000	.000000E-80
DEL E T	11.35963	IXZ UNTR	.00000000	.000000E-80
EAS	137.70739	Y DR/U1	.00000000	.000000E-80
VELOCITY	9614.07108	L SUB B	-.08674431	-.460000E-01
CAS	185.76023	L B DOT	.00000000	.000000E-80
DYN PRES	22.53696	L SUB P	.00000000	.000000E-80
Q SUB C	41.28035	L SUB R	.00000000	.000000E-80
P SUB S	.37913	L DFL A	-.04337216	-.230000E-01
L'SUB B	-.08674	L DEL AG	-3.35140218	.000000E-80
L' B DOT	.00000	L DEL RG	-.48448605	.000000E-80
L' SUB P	.00000	N SUB B	.00000000	.000000E-80
L' SUB R	.00000	N B DOT	.00000000	.000000E-80
L'DFL A	-.04337	N SUB P	.00000000	.000000E-80
L'DFL AG	-3.35140	N SUB R	-.00419011	-.100000E 01
L'DFL RG	-.48449	N DEL A	.00003021	.600000E-04
I Y	68300000.00000	N DEL AG	.67330437	.000000E-80
I XX	19600000.00000	N DEL RG	-2.41155068	.000000E-80
I ZZ	73400000.00000	N'SUB B	.00000000	
I X	19599999.99976	N'B DOT	.00000000	
I Z	73399999.99927	N'SUB P	.00000000	
I XZ	.00000	N'SUB R	-.00419011	
IXZ/IZ	.00000	N'DEL A	.00003021	
IXZ/IX	.00000	N'DEL AG	.67330437	
THRUST Z	787866.60831	N'DEL RG	-2.41155068	
THRUST T	4000000.00000			
OMEGA SQ	-.04282	X U/U1	-.00017745	-.150000E 00
2 ZET OM	.00044	X SUB W	-.00025435	-.430000E 00
T SUB A	2254.12850	X W DOT	.00000000	.000000E-80
OMEGA A	.00000	X Q/U1	.00000000	.000000E-80
ZETA A	.00000	X DEI/U1	.00000000	.000000E-80
Y SUB B	-6.08487	X DEO/U1	.00000000	.000000E-80
Y B DOT	.00000	Z U/U1	.00023660	.200000E 00
Y SUB P	.00000	Z SUB W	-.00044363	-.750000E 00
Y SUB R	.00000	Z W DOT	.00000000	.000000E-80
Y DEL AI	.00000	Z Q/U1	.00000000	.000000E-80
Y DFL AO	.00000	Z DEI/U1	.00000000	.000000E-80
Y DFL R	.00000	Z DEO/U1	.00000000	.000000E-80
X SUB U	-3.41208	M SUB U	-.01570015	-.110000E-01
X SUB A	-2.44532	M SUB AL	.04281858	.600000E-01
X A DOT	.00000	M AL DOT	.00000000	.000000E-80
X SUB Q	.00000	M SUB Q	.00000000	.000000E-80
X DFL EI	.00000	M DEL EI	.00000000	.000000E-80
X DEL EO	.00000	MDEL EO	.00000000	.000000E-80

LAT DEN S4=-1.000000 S3= -.004823 S2= -.000003 S1= -.000291 S0= -.000001
(-.00419, .00000)(-.06644, .00000)(.03291, .05736)(.03291, -.05736)

LON DEN S4= 1.000000 S3= .003744 S2= -.042817 S1= -.000385 S0= .000001
(.00129, .00000)(-.01022, .00000)(-.20416, .00000)(.20942, .00000)

(170 SEC)

Lateral component of relative wind

$$v_A = v - v_w \qquad \text{(B17)}$$

The lateral bending moments were computed at stations 660 and 1800. The same process as used in pitch was used to compute bending due to sideslip at conditions apart from max q.

$$N' = N'_\beta \beta + N'_{\delta_z} \delta_z \qquad \text{(B18)}$$

where

$$N'_\beta \beta = \left(\frac{N'_\beta}{u_{o \text{ at max } q}} \right) \left(\frac{Y_v v_A}{Y_v \text{ at max } q} \right)$$

The gimbal actuator dynamics were assumed similar to those used in reference ref. 21. In pitch:

$$\ddot{\delta}_y = - 2\delta \, \omega_n \dot{\delta}_y - \omega^2 (\delta_y \delta_{yi}) + \frac{\partial \ddot{\delta}}{\partial \dot{q}} \dot{q} + \frac{\partial \ddot{\delta}}{\partial A_{CG}} A_{CG} \qquad \text{(B19)}$$

where

$$\zeta = 0.4$$

$$\omega_n = 33$$

Lateral

$$\ddot{\delta}_z = - 2\zeta \, \omega_n \dot{\delta}_z - \omega^2 \left(\delta_z - \delta_{z_c} \right) + \frac{\partial \ddot{\delta}}{\partial \dot{r}} \dot{r} + \frac{\partial \ddot{\delta}}{\partial A_{CG}} A_{CG}'' \qquad \text{(B20)}$$

Roll gimbal control

$$\ddot{\delta}_x = - 2\zeta \, \omega_n \dot{\delta}_x - \omega^2 \left(\delta_x - \delta_{x_c} \right) + \frac{\partial \ddot{\delta}}{\partial \dot{p}} \dot{p} \qquad \text{(B21)}$$

Roll aileron control

$$\ddot{\delta}_a = -2\zeta \omega_n \dot{\delta}_a - \omega^2 \left(\delta_a - \delta_{a_c}\right) + \frac{\partial \ddot{\delta}_a}{\partial \dot{p}} \dot{p} \qquad \text{(B22)}$$

$\zeta = 0.4$

$\omega_n = 10$

Aerodynamic hinge moment data were not available, thus neglected. They should be used if available.

THE STABILITY DERIVATIVES

Table B4 contains the pitch derivatives and other data needed for pitch analysis. Pitch (and lateral) tail wag dog (TWD) and dog wag tail (DWT) data are given in Table B5 for three times of flight: lift off, max q, and cutoff. These derivatives were obtained as follows:

$$Z_\delta = \frac{-13F_E}{m}$$

$$Z_{\ddot{\delta}} = \frac{13m_E}{m} (x_\delta - x_E)$$

$$M_\delta = \frac{13F_E}{I_y} (x_{CG} - x_\delta)$$

$$M_{\ddot{\delta}} = \frac{-13}{I_y} [m_E(x_\delta - x_E)(x_{CG} - x_E) + I_E]$$

$$\frac{\partial \ddot{\delta}}{\partial \dot{q}} = \left(\frac{1}{I_E}\right) [m_E(x_\delta - x_E)(x_{CG} - x_E) + I_{EO}]$$

$$\frac{\partial \ddot{\delta}}{\partial A_{CG}} = \frac{m_E}{I_E} (x_\delta - x_E)$$

Table B5. Tail Wag Dog and Dog Wag Tail Stability Derivatives

Stability Derivatives	Lift off	Max q	Cut off
$10^{+3} \times M_{\ddot{\delta}}$	-1.13	-1.3	-2.4
$10^{+3} \times Z_{\ddot{\delta}}$	-37.0	-49.0	-100.0
$\ddot{\delta}_{\dot{q}}$	-44.0	-38.0	-19.0
$\ddot{\delta}_{A_{cg}}$	-0.43	-0.43	-0.43
$L_{\ddot{\delta}_x} \times 10^3$	-1.5	-1.6	-2.3
$L_{\ddot{\delta}_a} \times 10^3$	-2.2	-2.3	-3.3
$\partial \ddot{\delta}_x / \partial \dot{p}$	-4.8	-4.8	-4.6
$\partial \ddot{\delta}_a / \partial \dot{p}$	-4.6	-4.6	-4.6
$10^3 N_{\ddot{\delta}_z}$	-1.13	-1.3	-2.4
$10^3 Y_{\ddot{\delta}_z}$	+37.0	+49.0	+100.0
$\partial \ddot{\delta}_z / \partial \dot{r}$	-44.0	-38.0	-19.0
$\partial \ddot{\delta}_z / \partial a_y$	+0.43	+0.43	+0.43
$10^3 N'_{\ddot{\delta}_a}$	-0.29	-0.29	0
$10^3 N'_{\ddot{\delta}_x}$	-0.18	-0.13	+0.46
$10^3 L'_{\ddot{\delta}_z}$	-1.75	-2.0	-0.48

The following values were estimated for the 450,000-pound thrust engine:

$$m_E = 144 \text{ slugs}$$

$$I_E = 724 \text{ slug ft}^2$$

$$I_{EO} = 50 \text{ slug ft}^2$$

$$x_\delta = 194 \text{ ft}$$

$$x_\delta - x_E = -2.2 \text{ ft}$$

x_{CG} is given in Table B1.

Yaw DWT and TWD terms were derived by similarity to the longitudinal terms:

$$Y_{\delta_z} = -Z_\delta$$

$$Y_{\ddot{\delta}_z} = -Z_{\ddot{\delta}}$$

$$N_{\delta_z} = M_\delta$$

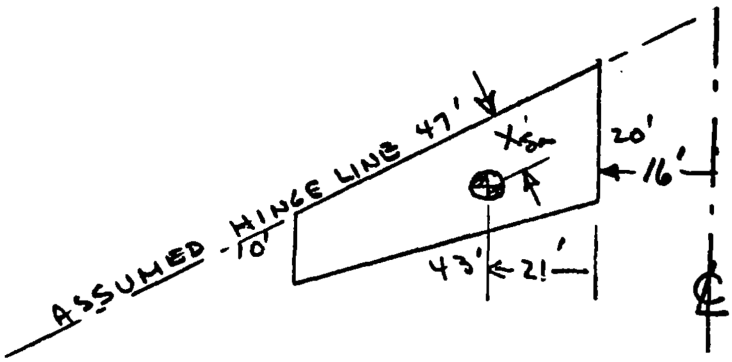
$$N_{\ddot{\delta}_z} = M_{\ddot{\delta}}$$

$$O = L_{\dot{\delta}_z} = L_{\ddot{\delta}_z}$$

$$\ddot{\delta}_{z_{\dot{r}}} = \ddot{\delta}_{\dot{q}}$$

$$\ddot{\delta}_{z_{A_y}} = -\ddot{\delta}_{A_{CG}}$$

The roll control terms made use of the lateral geometry shown in Figure B5 which includes the ailerons. An aileron planform is, roughly, looking down:



Phase A reports were used to estimate, for one aileron:

mass, m_{δ_a} = 110 slugs

x_{δ_a} = 8 ft (mass offset, no balance)

y_{δ_a} = 21.5 + 16 = 37.5 ft from vehicle centerline to mass center

These data yield (for two ailerons)

$$L_{\ddot{\delta}_a} = -\left(\frac{1}{I_x}\right)\left(x_{\delta_a}\right)\left(y_{\delta_a}\right)\left(m_{\delta_a}\right) = \frac{-66,000}{I_x}$$

The engine roll control terms assumed (see Figure B5) all engines except No. 8 gimballed in pitch and yaw to produce as much torque as possible about No. 8.

Under this assumption the average moment arm is 11.1 feet. The roll torque for 13 engines is $(11.1)(13)(F_T) = -67 \times 10^6$ ft lb/rad

The roll control derivative is:

$$L_{\delta_x} = \frac{-67x10^6}{I_x}$$

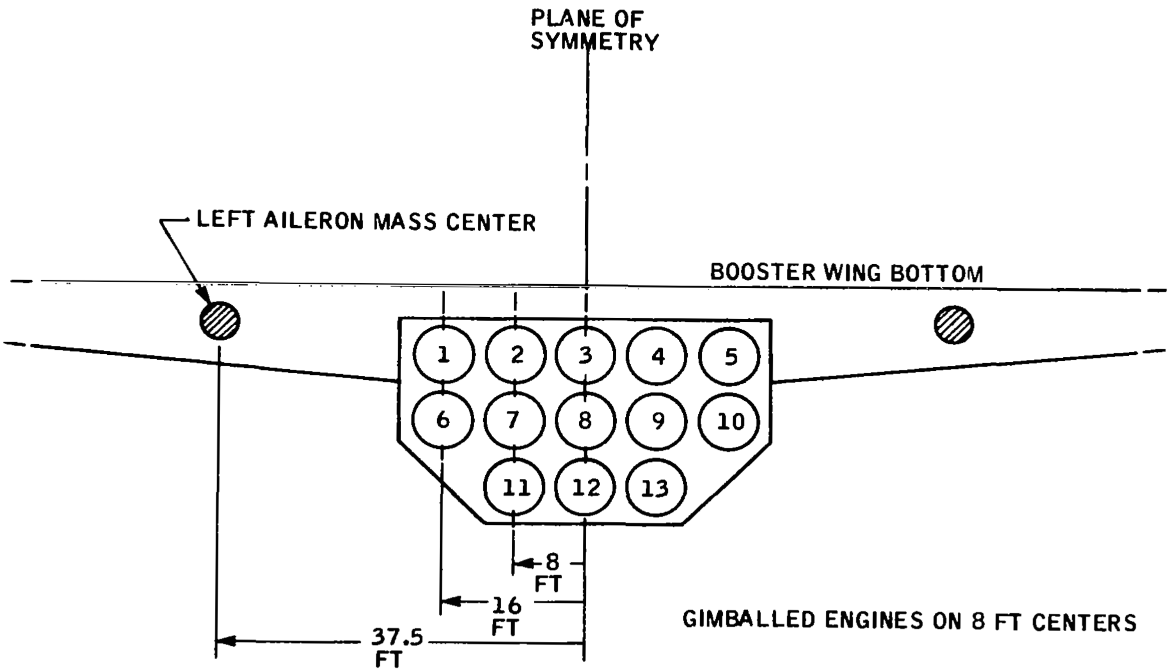


Figure B5. Rear View of Booster Showing Launch Configuration Engine and Aileron Mass Centers

The roll TWD term is:

$$L_{\ddot{\delta}_x} = \left(\frac{11.1\text{x}13}{I_x}\right)\left(m_E\right)\left(x_\delta - x_E\right) = \frac{-46,000}{I_x}\ \frac{\sec^2}{\text{rad}}$$

The roll DWT terms are

$$\frac{\partial\ddot{\delta}_x}{\partial\dot{p}} = (11.1)\left(\frac{\partial\ddot{\delta}_y}{\partial\dot{w}}\right) = -4.8$$

$$\frac{\partial\ddot{\delta}_a}{\partial\dot{p}} = -\left(\frac{1}{I_{\delta_a}}\right)\left(x_{\delta_a}\right)\left(Y_{\delta_a}\right)\left(m_{\delta_a}\right) = \frac{-Y_{\delta_a}}{x_{\delta_a}} = \frac{-37.5}{8} = -4.6$$

Table B4 presents most of the lateral stability data, as well as some longitudinal data which duplicated Table B1. The primed derivatives have the product of inertia accounted for, as explained in Table B3.

THE PITCH SIMULATION

Figures B6 and B7 are the analog computer diagrams for the pitch simulation. Time-varying coefficients in the diagram were obtained with padded potentiometers, driven by the time servomultipliers SM2 and SM3. Figure B8 plots M_{δ_y}, A_x, and γ_R. Figure B9 plots u_o and z_w. The derivatives Z_{δ_y} and M_w were scaled from the M_{δ_y} and Z_w pots, respectively:

$$Z_{\delta_y} = 44\ M_{\delta_y}$$

$$M_w = \left(\frac{1}{57}\right) Z_w$$

The 7 control systems examined in this study are shown in Figure B10. The first two (minimum drift and attitude hold) had constant gains. The remaining five had time-scheduled gains K_θ and K_A.

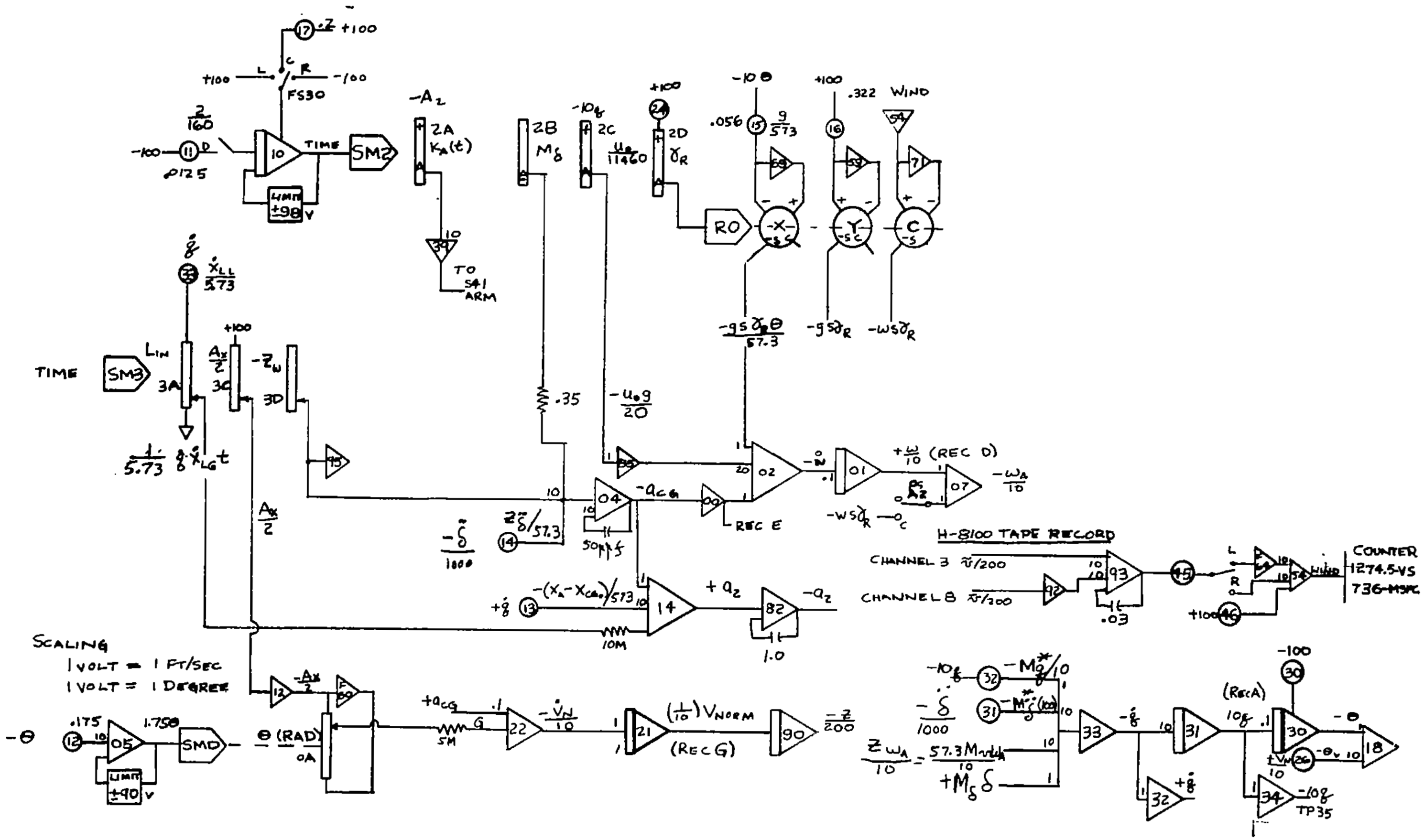


Figure B6. Pitch Time Varying Simulation - Launch

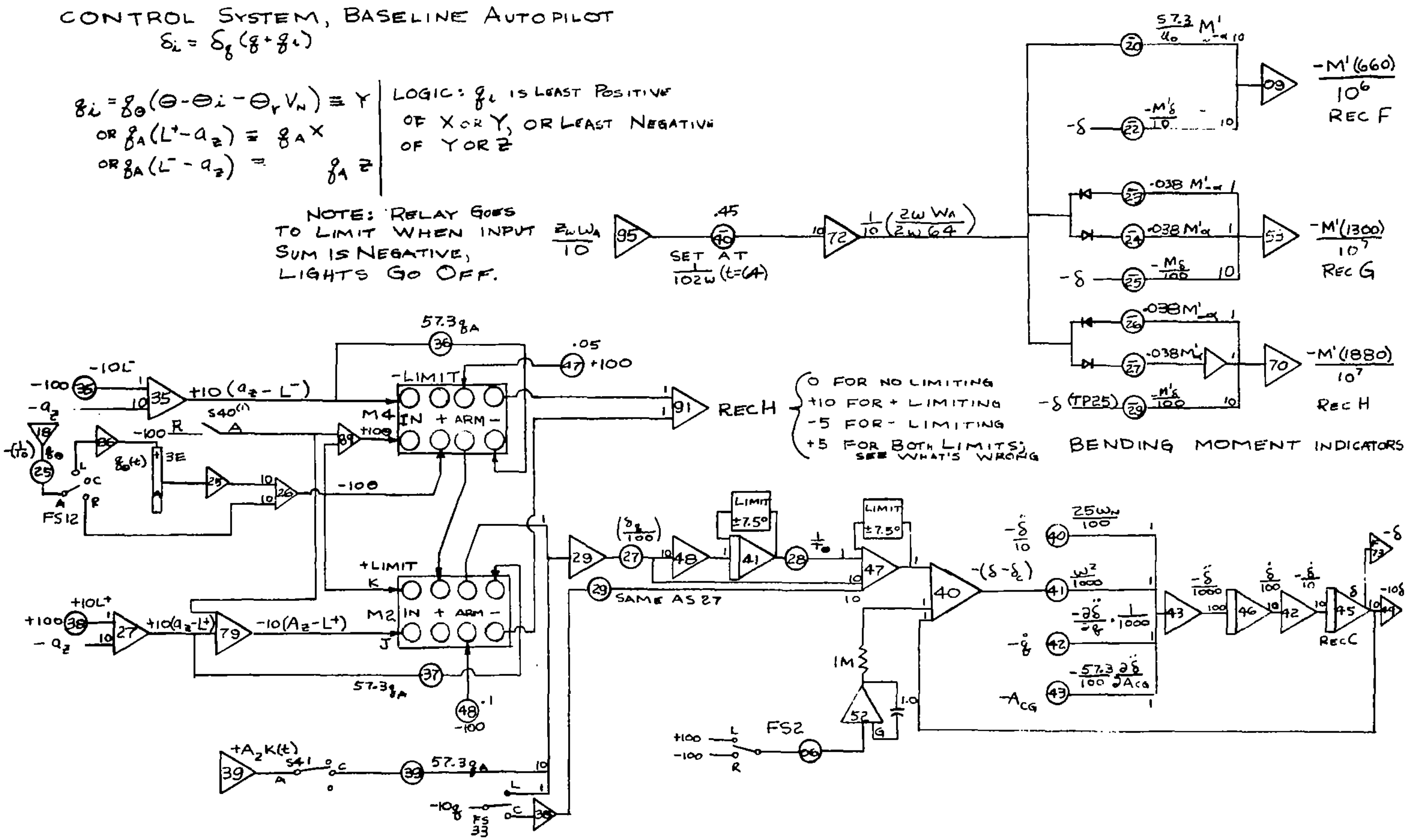


Figure B7. Simulation of Control System for Boost Pitch

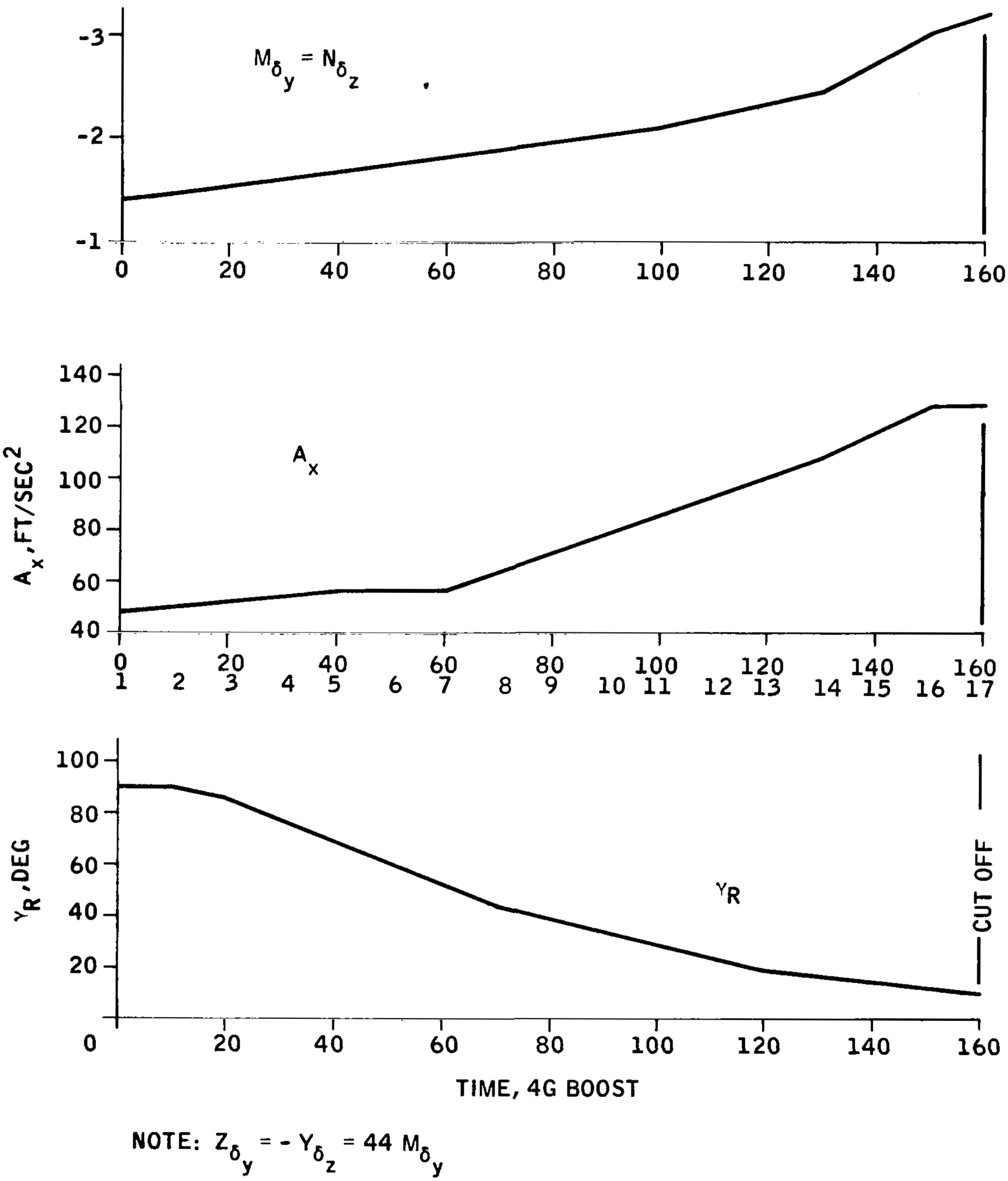


Figure B8. Time Varying Parameters in Simulations

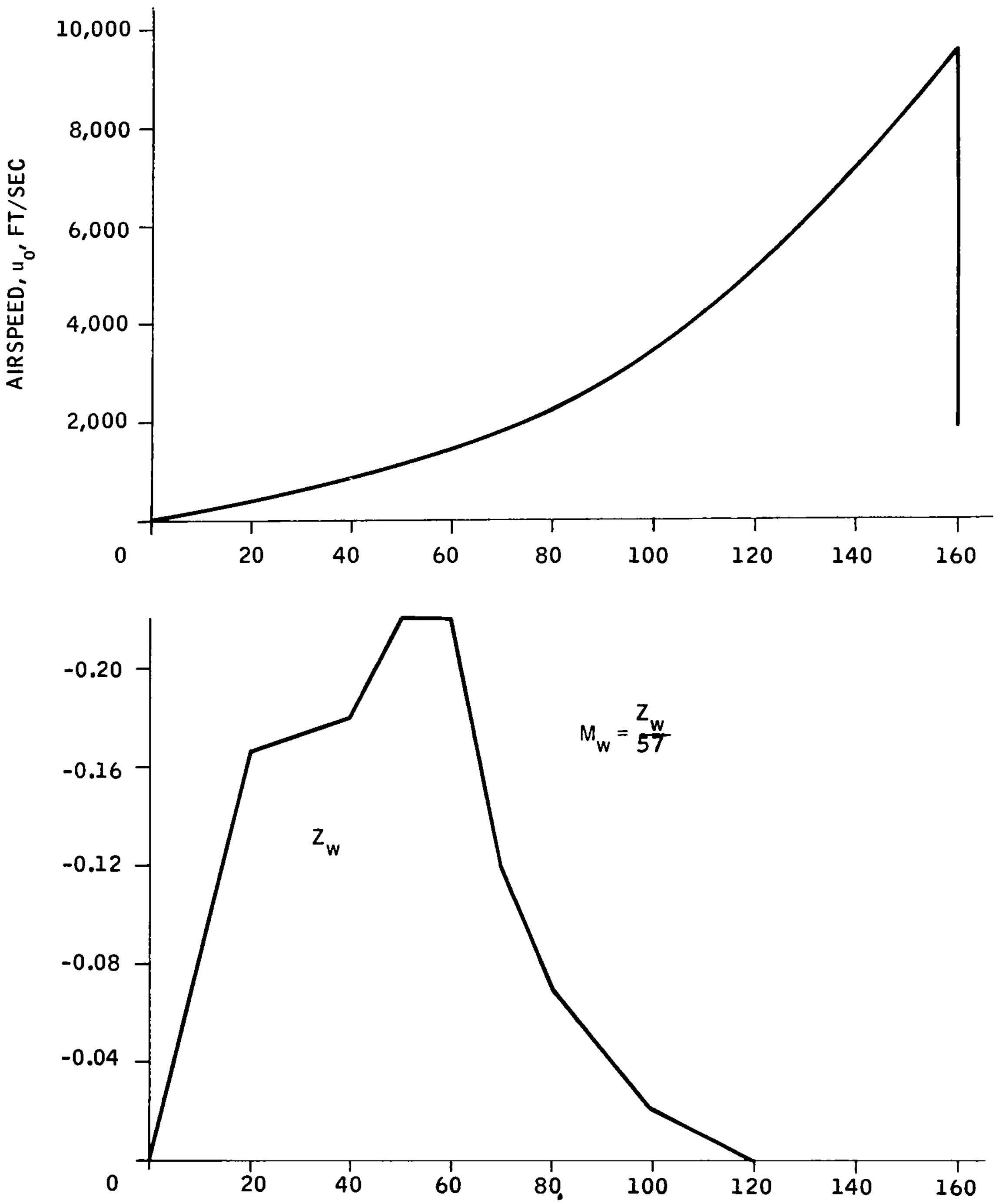
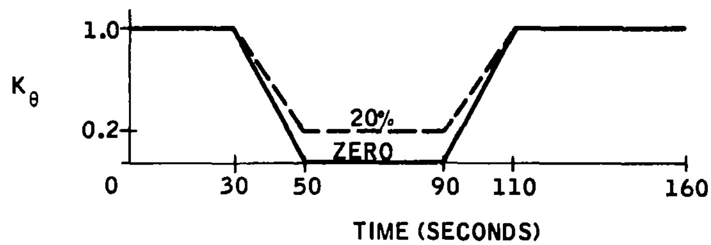


Figure B9. Time Varying Parameters in Simulations

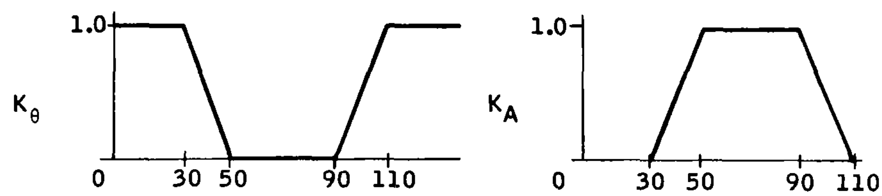
CONTROLLER	CONTROL EQUATION
1 MINIMUM DRIFT	$\delta_i = 2.4q + 2.4\,(\theta - 0.2V_N)(1 + \frac{1}{10S})$
2 ATTITUDE HOLD	$\delta_i = 2.4q + 2.4\theta\,(1 + \frac{1}{10S})$
3 SCHEDULED ATTITUDE	$\delta_i = 2.4q + 2.4\,K_\theta\theta$, WHERE



4 PITCH DAMPER $\delta_i = 2.4q$

5 ACCELEROMETER LOAD RELIEF

$$\delta_i = 2.4q + 2.4\left[K_\theta\theta - \frac{0.01\,K_A A_z}{S+1}\right]$$



6 $q\alpha$ LOAD RELIEF

$$\delta_i = 2.4q + 2.4\left[K_\theta\theta - 0.0035K_A Z_w w_A\right]$$

7 ACCELERATION LIMITER LOAD RELIEF

OFF LIMIT $\delta_i = 2.4q + 2.4\theta\,(1 + \frac{1}{10S})$

ON LIMIT $\delta_i = 2.4q - 0.024\left[\frac{A_z}{S+1} - \text{LIMIT}\right]$

LIMITS = ± 0.5, ± 0.62, ± 0.75, ± 1.0

Figure B10. Bost Pitch Conventional Controls

Figure B11 shows the wind used in all tests. It is a single sample obtained from the wind model described in Appendix A. It has a 3σ peak of 290 ft/sec at 55 seconds.

THE LATERAL SIMULATION

Table B4 shows stability derivative data for the lateral axes as well as pitch. Figures B12 and B13 are the simulation diagrams for this study. The time varying coefficients are shown in Figure B14.

The simulation includes tail-wag-dog and dog-wag-tail terms which can be switched in or omitted. Figure 39 shows the effect of these terms on performance. Close examination of the traces shows a discernible but negligible effect (for example, the bending moment traces with attitude control). Note that higher gains are used with TWD and DWT to get damping performance comparable to that without these terms. The higher gain has negligible effect on the magnitude of the control perturbations in the wind disturbance used in this study. It was concluded that TWD and DWT terms need not be simulated to assess the control authority needed when disturbed by this wind model. The results presented in the body of the report are without TWD and DWT.

The bending equations are given in Table B2. These coefficients for β were assumed to apply at max q, where the airspeed is 1510 ft/sec ($1510\, M'_v = M'_\beta$). In terms of lateral velocity v_A then, the bending moments are:

$$M'(660) = 10^6 \left[-1.62\,\delta_z - 0.0059\, v_A \right]$$

$$M'(1800) = 10^6 \left[-22.8\,\delta_z - 0.013\, v_A \right]$$

The variation in M'_v with q was assumed to be the same as the stability derivative Y_v. Therefore

$$\left(Y_v v_A \right) \left(\frac{1}{Y_v} \right) (64 \text{ sec})$$

was substituted for v_A to compute the bending moments.

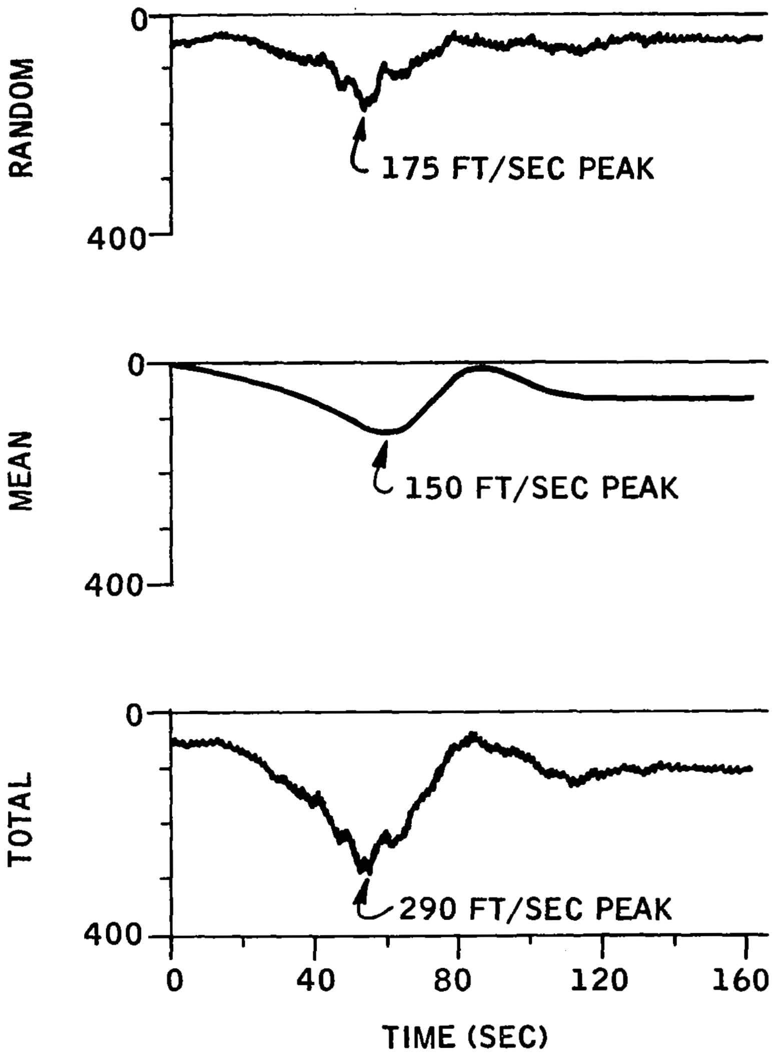


Figure B11. Vaughan-Skelton Wind

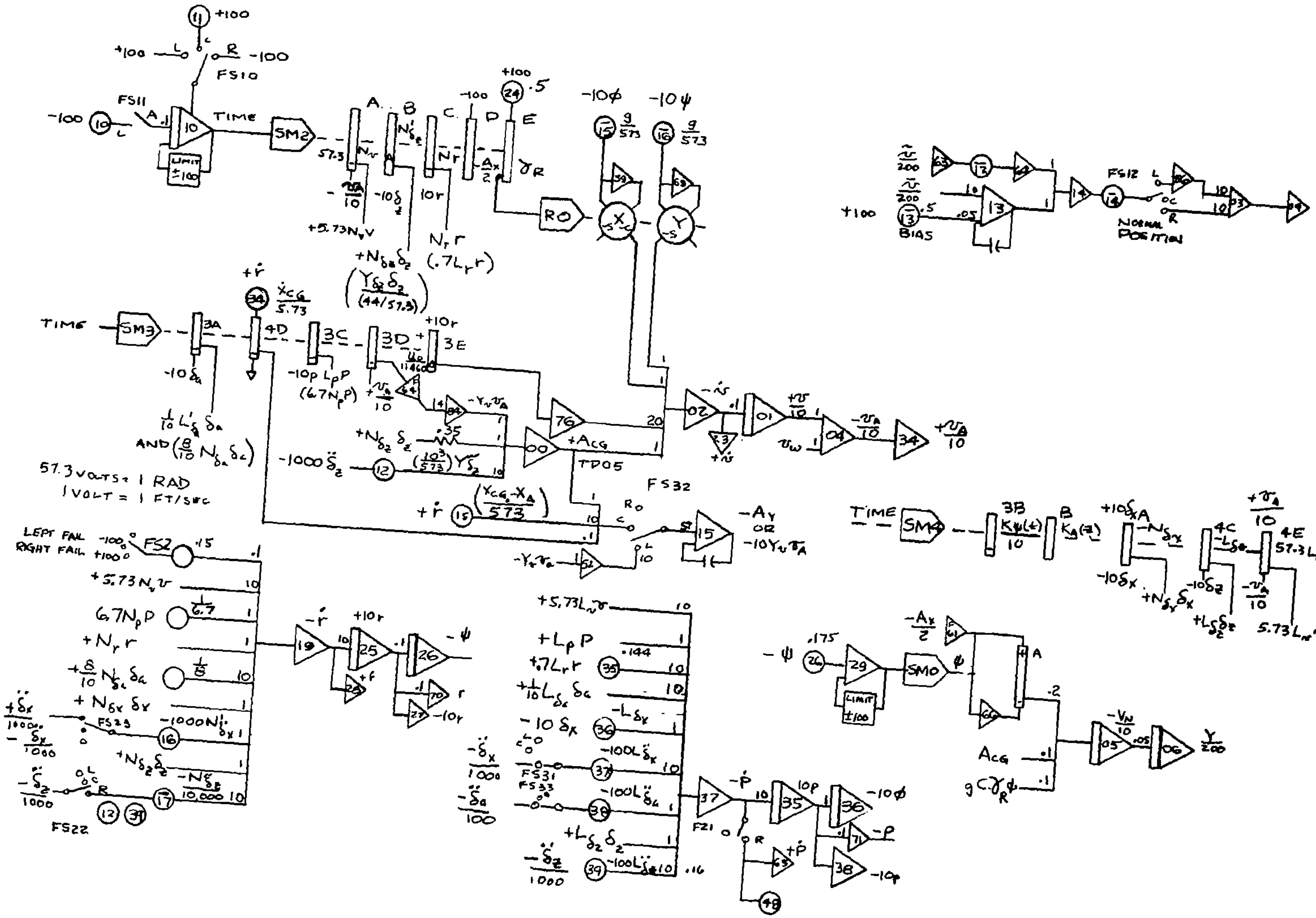


Figure B12. Vehicle B Lateral Boost Simulation

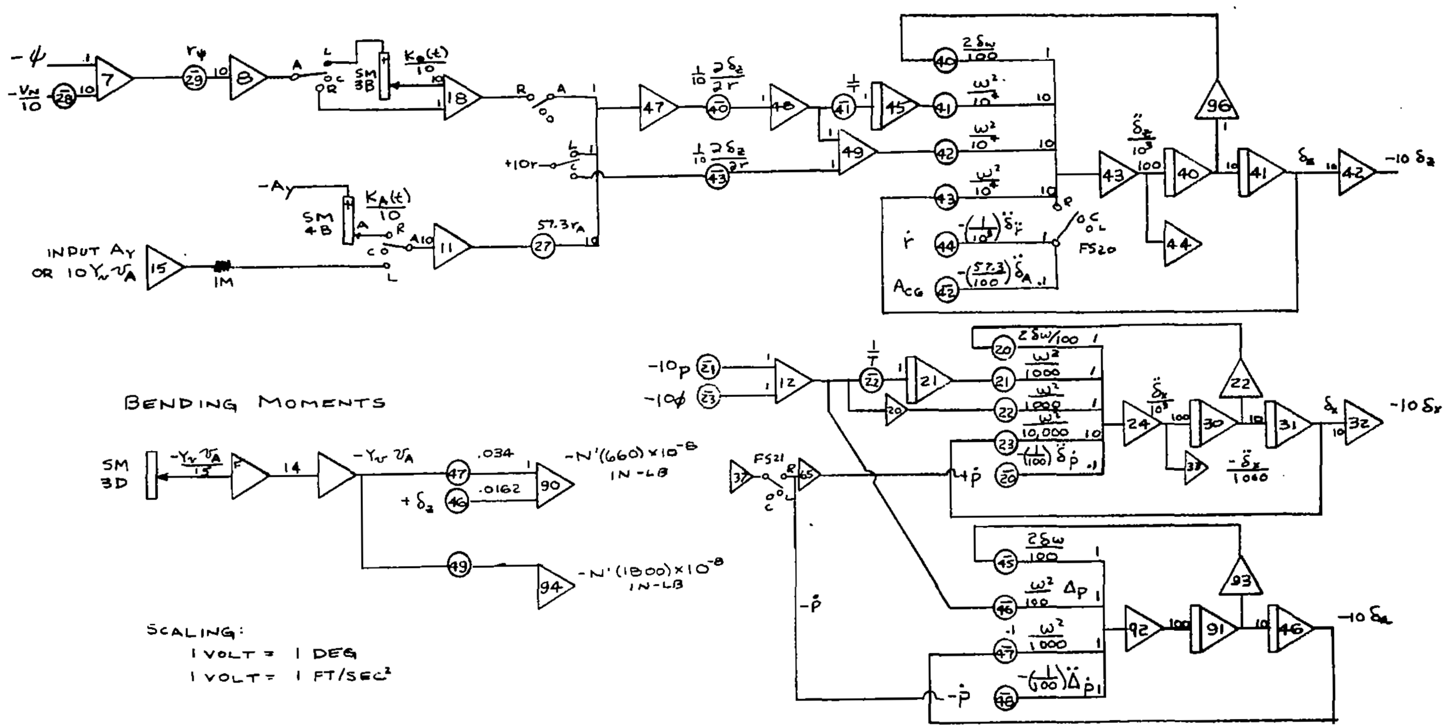


Figure B13. Vehicle B Lateral Boost Simulation

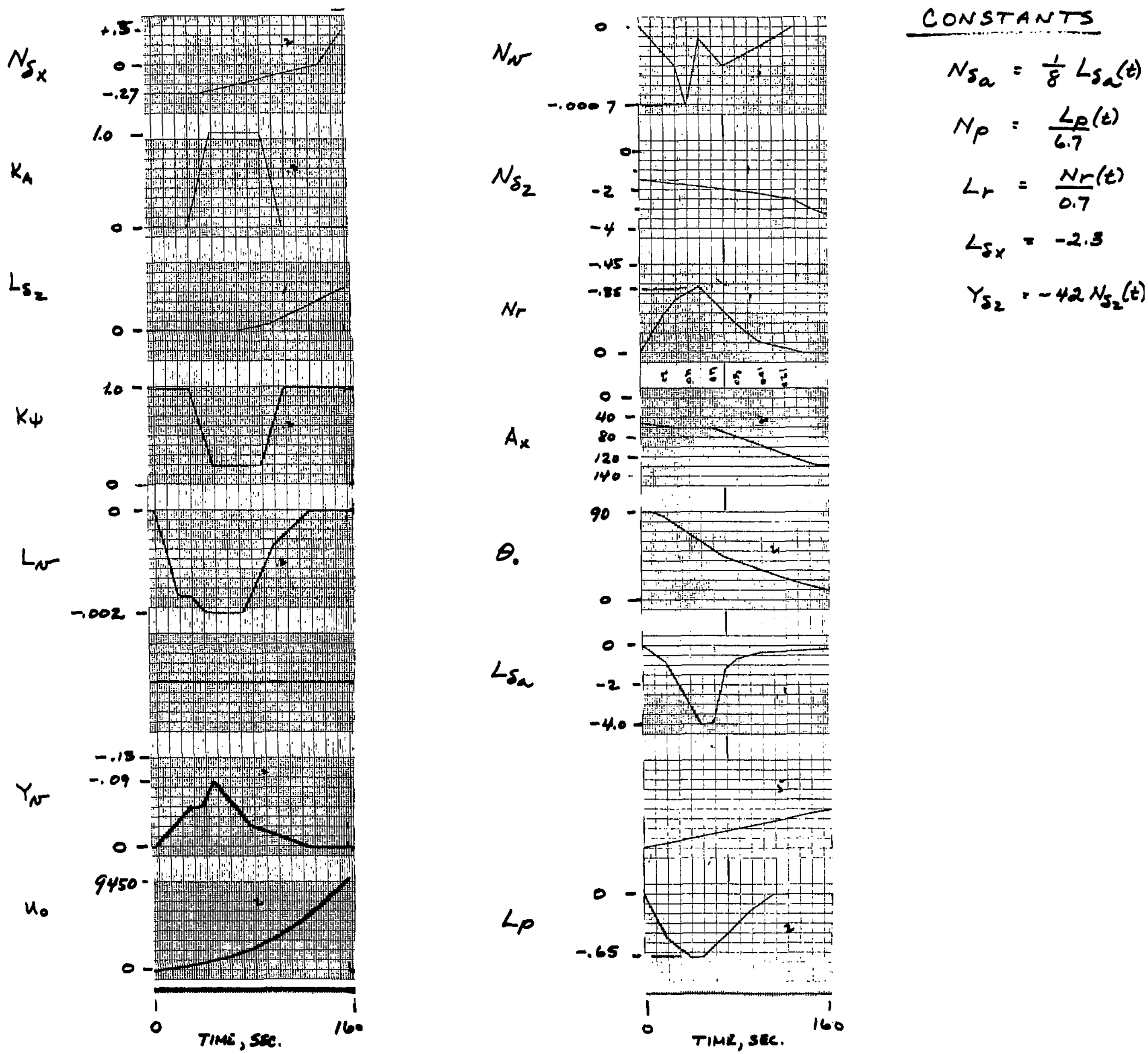


Figure B14. Analog Check of Simulation of Padded Pots

APPENDIX C

PITCH EQUATIONS AND DATA FOR COVARIANCE ANALYSES OF THE LAUNCH PHASE OF MSFC VEHICLE B

This appendix presents the data used to develop the covariance summary results of Section II. Nomenclature, representations, and derivatives are presented below. Computer output covariance data are presented in Tables C8-C16.

NOMENCLATURE

A = Matrix [Equation (C1) and Tables C1 and C3]

A[x] = Slender body area [Equation (C9)] ft^2

$\tilde{A}' = \left\{+\left[V\dot{\gamma}_o + \left(g - \frac{V^2}{r}\right)\cos\gamma_o\right]\sin\alpha_o - \left(g - \frac{V^2}{r}\right)\sin\gamma_o + \dot{V}\right\}$ ft/sec^2

$\tilde{B} = \left\{-\left[V\dot{\gamma}_o + \left(g - \frac{V^2}{r}\right)\cos\gamma_o\right]\sin\alpha_o - \dot{V}\right\}$ ft/sec^2

$C_{L_q} = \frac{\bar{c}}{2V} C_{L_{\left(\frac{q\bar{c}}{2V}\right)_{cm}}}$ sec/rad

$C_{L_{\left(\frac{q\bar{c}}{2V}\right)_{cm}}}$ (Figure C1) ---

C_{L_α} (Figure C2) 1/rad

$C_{L_{\alpha_g}}$ (Figure C3) 1/rad

$C_{L_{\dot{\alpha}}} = \frac{\bar{c}}{2V} C_{L_{\left(\frac{\dot{\alpha}\bar{c}}{2V}\right)}}$ sec/rad

$C_{L_{\left(\frac{\dot{\alpha}\bar{c}}{2V}\right)}}$ (Figure C4) ---

$C_{m_q} = \frac{\bar{c}}{2V} C_{m_{\left(\frac{q\bar{c}}{2V}\right)_{cm}}}$ sec/rad

$C_{m_{\left(\frac{q\bar{c}}{2V}\right)_{cm}}}$ (Figure C1) ---

$C_{m_{\alpha_{cm}}} = \left\{\frac{x_{cm} - x_{mrp}}{\bar{c}}\right\} C_{L_\alpha} + C_{m_{\alpha_{mrp}}}$ 1/rad

$C_{m_{\alpha_{mrp}}}$ (Figure C2) 1/rad

$C_{m_{\alpha_{(NOSE)_g}}}$ (Figure C3) 1/rad

$C_{m_{\dot{\alpha}}} = \frac{\bar{c}}{2V} C_{m_{\left(\frac{\dot{\alpha}\bar{c}}{2V}\right)_{cm}}}$ sec/rad

$C_{m_{\left(\frac{\dot{\alpha}\bar{c}}{2V}\right)_{cm}}}$ (Figure C4) ---

D = Matrix [Equation (C2) and Tables C2 and C6]

G = Matrix [Equation (C1) and Tables C1 and C4]

H = Matrix [Equation (C2) and Tables C2 and C5]

IT = Ischial tuberosities (subscript)

I_{yy} = Inertia (Table C7) slug-ft^2

L = Lift lb

L = 209 (gust penetration length) — ft

M = Aerodynamic pitching moment — ft-lb

M = Mach number (Table C7) — ---

$M.R. = \frac{(\ell + 15)^2}{32.17} \frac{d}{dt} W - \frac{d}{dt} I_{yy}$ (inertial rate and jet damping) — slug-ft^2/sec

M_{660} = Bending moment at station 660 — in. -lb

M_{1300} = Bending moment at station 1300 — in. -lb

M_{1880} = Bending moment at station 1880 — in. -lb

$M'_{1\alpha} = -6.72 \times 10^6 \times 57.3$ (M_{660} due to α at $\bar{q}_{max}$) — in. -lb/rad

$M'_{2\alpha} = -11.2 \times 10^6 \times 57.3$ (M_{1300} due to α at $\bar{q}_{max}$) — in. -lb/rad

$M'_{3\alpha} = -10.1 \times 10^6 \times 57.3$ (M_{1880} due to α at $\bar{q}_{max}$) — in. -lb/rad

$M'_{1\delta} = -1.62 \times 10^6 \times 57.3$ (M_{660} due to δ at $\bar{q}_{max}$) — in. -lb/rad

$M'_{2\delta} = -15.05 \times 10^6 \times 57.3$ (M_{1300} due to δ at $\bar{q}_{max}$) — in. -lb/rad

$M'_{3\delta} = -22.80 \times 10^6 \times 57.3$ (M_{1880} due to δ at q_{max}) — in. -lb/rad

S = 10,250 (reference area) — ft^2

T = Thrust (Table C7) — lb

V = Speed relative to earth (Table C7) — ft/sec

W = Weight (Table C7) — lb

a_{ij} = Element of A matrix

ac = Aerodynamic center (subscript)

$\bar{c}$ = 211 (reference length) — ft

cm = Center of mass (subscript)

$c_1 \sigma_w \sqrt{h}$ = Coefficient in random wind model (Figure A8 and Table A2) — ft/sec$^{3/2}$

$c_2\sqrt{\dot{h}}$	= Coefficient in random wind model (Figure A9 and Table A2)	$1/\text{ft sec}^{1/2}$
$c_3\sigma_w\dot{h}$	= Coefficient in random wind model (Figure A10 and Table A2)	ft^2/sec^2
$c_4\dot{h}$	= Coefficient in random wind model (Figure A11 and Table A2)	1/sec
$\frac{c_5\dot{h}}{\sigma_w}$	= Coefficient in random wind model (Figure A12 and Table C1)	$1/\text{ft}^2$
f	= Force vector [Equation (C2) and Table C2]	
$\tilde{f}$	= Force vector [Equation (C1) and Table C1]	
g	= 32.17 = Gravity	ft/sec^2
g	= Gust (subscript)	
g_{ij}	= Element of G matrix	
h	= Altitude	ft
h_{ij}	= Element of H matrix	
$\dot{h}$	= Altitude rate	ft/sec
ℓ	= $x_\delta - x_{cm}$	ft
mrp	= Moment reference point (subscript)	
n	= Normal acceleration at cm	ft/sec^2
n_{IT}	= Normal acceleration at pilot's seat	ft/sec^2
p	= Roll rate	rad/sec
q	= Pitch rate	rad/sec
$\bar{q}$	= Dynamic pressure (Table C7)	lb/ft^2
r	= $h + r_e$ = (Table C7)	ft
r	= Roll rate	rad/sec
r_e	= Earth's radius	ft
r	= Response vector [Equation (C2) and Table C2]	

t	= Time since launch (Table C7)	sec
u	= Input from controller (Tables C1 and C2)	rad/sec
$\overline{v}$	= Mean wind (Figure A5 and Table A2)	ft/sec
$\tilde{v}$	= Random wind (Table C1; Cf Appendix A)	ft/sec
v_w	= $\overline{v} + \tilde{v}$ = Wind (Table C1; Cf Appendix A)	ft/sec
w	= Wind (subscript)	
x	= State vector [Equation (C1) and Table C1]	
x	= Wind state (Table C1; Cf Appendix A)	1/ft
x	= Distance from nose (Figure 1)	ft
x_{cm}	= Center of mass (Table C7)	ft
x_{mrp}	= 155.8	ft
x_p	= x_{cm} - 59.7 = (Pilot's position)	ft
x_δ	= 194 = (gimbal position)	ft
x_1	= First basis element for gust penetration (Table C1)	ft/sec
x_2	= Second basis element for gust penetration	ft/sec
x_3	= Third basis element for gust penetration	ft/sec
z	= Downward distance normal to reference trajectory [Equation (C28) and Figure C5]	ft
Δ	= Perturbation symbol	
Ω	= Earth's rotational rate	rad/sec
α	= Geometric angle of attack (Figure C5 and Table C2); does not include the wind.	rad
α_o	= Angle of attack along reference trajectory (Table C7)	rad
γ	= Flight path angle relative to round earth [Equation (C20) and Table C1]	rad

γ_o = Flight path angle along the reference trajectory (Table C7) — rad

δ = Gimbal deflection [Equation (C1) and Table C1] — rad

δ_o = Gimbal deflection along the reference trajectory (Figure 2) — rad

δ = Gimbal position (subscript)

η = Unity white noise — $1/\sec^{1/2}$

θ = Pitch angle [Equation (C1) and Table C1] — rad

$\theta_o = \alpha_o + \gamma_o$ — rad

μ_i = Lift associated with i^{th} basis element (x_i) of gust penetration; note elements a_{27}, a_{23}, and a_{24} of Table C1. Their determination is presented between Equations (C3) and C15)

μ_{1i} = Moment associated with i^{th} basis element $f(x_i)$ of gust penetration; note elements a_{17}, a_{13}, and a_{14} of Table C1. Their determination is presented between Equations (C3) and (C19)

σ_w = Standard deviation of random wind (Figure A6) — ft/sec

$\dot{\sigma}/\sigma$ = Coefficient in random wind model (Figure A7 and Table A2) — 1/sec

REPRESENTATIONS

The generic forms for the perturbation state transition and response are given by

$$\dot{x} = Ax + G\tilde{f} \tag{C1}$$

$$r = Hx + Df \tag{C2}$$

They are presented explicitly in Tables C1 and C2. These tables and the nomenclature provide for generating all data.

The coefficients a_{55}, a_{56}, a_{65}, a_{66}, g_{53}, g_{63}, and $\bar{v}$ are tabulated in Table A2. The remainder of the coefficients of matrices A, G, H, and D are presented in Tables C3 through C6.

DERIVATIONS

Winds

The wind normal to the vehicle v_W is taken as made up of a mean $\bar{v}_W$ and random $\tilde{v}_W$. The model is discussed in Appendix A.

The mean wind $\bar{v}$ appears as a disturbance forcing function in Tables C1 and C2. Numerical values are shown in Figure A5 and column 2 of Table A2.

The random wind $\tilde{v}$ is generated by the differential equations of rows 5 and 6 of Table C1. Coefficients are plotted in Figure A7 through A12 and columns 4 through 9 of Table A2.

Distributing the Wind Gust Loads

The wind lift force and the moment on the vehicle are the result of the integration of pressures developed by the winds. A lumped parameter representation is required for these distributed forces.

The lift and pitching moment coefficients due to normal gusts are taken to be

$$C_{L_{\alpha_g}} = \frac{C_{L_\alpha}}{V} \left\{ \mu_1 x_1 + \mu_2 x_2 + \mu_3 x_3 \right\} \tag{C3}$$

$$C_{m_{\alpha_g}} = \frac{C_{m_\alpha}}{V} \left\{ \mu_{11} x_1 + \mu_{12} x_2 + \mu_{13} x_3 \right\} \tag{C4}$$

where x_1, x_2, and x_3 are system states driven by the wind, v_W. For constant winds $x_1 = x_2 = x_3 = v_W$. Rows 7, 3, and 4 of Table C1 show this and how the x_is are driven by the wind, v_W. The μ's are constant to the determined.

The step responses of x_1, x_2, and x_3 (called f_1, f_2, and f_3) for a sharp-edged gust are

$$f_1[x] = 1 - e^{-\frac{2.3}{L} x} \tag{C5}$$

$$f_2[x] = 1 - e^{-\frac{2.3}{L} x} \left\{ \cos \frac{2\pi}{L} x - 1.165 \sin \frac{2\pi}{L} x \right\} \tag{C6}$$

$$f_3[x] = 1 - e^{-\frac{2.3}{L}x} \left\{ \cos \frac{2\pi}{L} x + 1.167 \sin \frac{2\pi}{L} x \right\} \qquad (C7)$$

The most gross result of slender body theory (references 22 or 23) yields the step responses for gust penetration as shown in Figure C4.

Determination of μ_1, μ_2, and μ_3 is presented first. The left gust penetration derivative is presented in Figure C4; it can be expressed mathematically.

$$C_{L_{\alpha_g}}[x] = \frac{2}{S} \int_0^x A' \, dx = \frac{2}{S} A[x] \qquad (C8)$$

where

$$A[x] = 0.1682x(122 - \frac{x}{2}) \text{ for } 0 \leq x \leq 122$$

$$(C9)$$

$$A[x] = 12,950 + x(-278.0 + 1.495x) \text{ for } 122 \leq x \leq 209 = L$$

Then let

$$g[x] = \frac{C_{L_{\alpha_g}}[x]}{C_{L_{\alpha_g}}[L]} \qquad (C10)$$

Find $\tilde{\mu}_1$, $\tilde{\mu}_2$, $\tilde{\mu}_3$ from the solution of

$$\tilde{\mu}_1 \int_0^L f_1^2 dx + \tilde{\mu}_2 \int_0^L f_1 f_2 dx + \tilde{\mu}_3 \int_0^L f_1 f_3 dx = \int_0^L f_1 g dx \qquad (C11)$$

$$\tilde{\mu}_1 \int_0^L f_1 f_2 dx + \tilde{\mu}_2 \int_0^L f_2^2 dx + \tilde{\mu}_3 \int_0^L f_2 f_3 dx = \int_0^L f_2 g dx \qquad (C12)$$

$$\tilde{\mu}_1 \int_0^L f_1 f_3 dx + \tilde{\mu}_2 \int_0^L f_2 f_3 dx + \tilde{\mu}_3 \int_0^L f_3^{\,2} dx = \int_0^L f_3 g dx \qquad \text{(C13)}$$

Then

$$\mu_i = k\tilde{\mu}_i \qquad \text{(C14)}$$

where

$$k = \frac{1}{\sum_1^3 \tilde{\mu}_i} \qquad \text{(C15)}$$

Equations (C11) through (13) are solved for $\tilde{\mu}_1$, $\tilde{\mu}_2$, and $\tilde{\mu}_3$ to provide the least squared fit to penetration dynamics. The tilde values of $\tilde{\mu}$ are adjusted to enforce the correct steady-state response μ's by Equations (C14) and (C15).

The gust moment parameters μ_{11}, μ_{12}, and μ_{13} are obtained in a manner similar to the gust lift parameters. g[x] is different and the μ's differ only in notation; i.e., μ_{12} corresponds to μ_2. g[x] is obtained from Equations (C16) through (C19).

$$g[x] = \frac{C_{m_{\alpha_g}}[x]}{C_{m_{\alpha_g}}[L]} \qquad \text{(C16)}$$

where

$$C_{m_{\alpha_g}}[x] = \frac{x_{cm}}{\bar{c}} C_{L_{\alpha_g}}[x] + C_{m_{\alpha(\text{NOSE})_g}}[x] \qquad \text{(C17)}$$

where

x_{cm} = 107.98 ft (for this consideration only the value of 64 sec is taken; x_{cm} is usually taken to have the values of Table C7)

$C_{m_{\alpha_{NOSE_g}}}[x]$ from Figure C3 or

$$C_{m_{\alpha_{NOSE_g}}}[x] = \frac{-2}{S\bar{c}} \int_{o}^{x} xA'dx = -\frac{2}{S\bar{c}} \{m\} \qquad \text{(C18)}$$

$$m = 0.1682x^2 \left(\frac{122}{2} - \frac{x}{3}\right) \quad 0 \le x \le 122$$

$$\text{(C19)}$$

$$m = \ell^2\left[\ell\left(\frac{a}{6} - \frac{d}{3}\right) - \frac{c}{2}\right] + x^2\left(\frac{d}{3}x + \frac{c}{2}\right) \text{ for } 122 \le x \le 209$$

where

ℓ = 122 ft

a = 0.1682

c = -278

d = 2.99

Normal Motion Dynamics

The acceleration normal (upward) to the flight path is given by [Equation 4, page 6, reference 19].

$$n \cong V\dot{\gamma} - \frac{V^2}{r}\cos\gamma - r\Omega^2\cos\gamma - 2\Omega V \qquad \text{(C20)}$$

As written it is for wings level with the velocity in the earth's equatorial plane. The third term is neglected because it is relatively small, i.e.,

$$V\dot{\gamma} \sim (1000)\left(\frac{1.5}{170}\right) = 8.82 \text{ ft/sec}^2$$

$$\frac{V^2}{r}\cos\gamma \sim \frac{(10^4)^2}{2.1\text{x}10^7} = 4.76 \text{ ft/sec}^2$$

$$r\Omega^2\cos\gamma \sim (2.1\text{x}10^7)(7.27\text{x}10^{-5})^2 \cos\gamma = 1.1 \text{ x } 10^{-1}\cos\gamma \text{ ft/sec}^2$$

The fourth term is omitted because it would subsequently be lost in the perturbation; V and Ω are not perturbed.

From Figure C5

$$\frac{W}{g}\left\{V\dot{\gamma} - \frac{V^2}{r}\cos\gamma\right\} = L + T\sin(\alpha+\delta) - W\cos\gamma \tag{C21}$$

or

$$\dot{\gamma} = \frac{g}{WV}L + \frac{g}{WV}T\sin(\alpha+\delta) + \left(\frac{V}{r} - \frac{g}{V}\right)\cos\gamma \tag{C22}$$

Perturbations about a nominal trajectory are taken. Perturbations are restricted to $\dot{\gamma}$, γ, $\dot{\alpha}$, α, q, θ, and v_W; i.e., T, W, V, etc., are not perturbed. The perturbation equation corresponding to Equation (C22) is

$$\Delta\dot{\gamma} = \frac{g}{WV}\bar{q}s\left[C_{L_q}\Delta q + C_{L_{\dot{\alpha}}}\Delta\dot{\alpha} + C_{L_\alpha}\Delta\alpha + \frac{C_{L_\alpha}}{V}(\mu_1 x_1 + \mu_2 x_2 + \mu_3 x_3)\right]$$

$$+ \frac{g}{WV}T\cos(\alpha_o+\delta_o)(\Delta\alpha+\Delta\delta) - \left(\frac{V}{r} - \frac{g}{V}\right)(\sin\gamma_o)\Delta\gamma \tag{C23}$$

Using

$$\alpha = \theta - \gamma \tag{C24}$$

$$\dot{\alpha} = q - \dot{\gamma} \tag{C25}$$

$$\cos(\alpha_o+\delta_o) \cong 1 \tag{C26}$$

in Equation (C23) 2.4 yields

$$\Delta\dot{\gamma} = \left\{\frac{1}{\frac{WV}{g} + \bar{q}SC_{L_{\dot{\alpha}}}}\right\} \left\{\bar{q}S\left(C_{L_{\dot{\alpha}}} + C_{L_q}\right) \Delta q\right.$$

$$+ \left[W \sin\gamma_o \left(1 - \frac{V^2}{gr}\right) - \bar{q}SC_{L_\alpha} - T\right] \Delta\gamma + T\Delta\delta$$

$$\left. + \left(\bar{q}SC_{L_\alpha} + T\right) \Delta\theta + \frac{\bar{q}SC_{L_\alpha}}{V} (\mu_1 x_1 + \mu_2 x_2 + \mu_3 x_3)\right\} \quad \text{(C27)}$$

Equation (C27) corresponds to row 2 of Table C1.

Drift rate ($\dot{z}$) and drift (z) normal to the flight path are also required. z is taken positive downward. Consistent with the approximations taken thus far is the expression [from Equation (C20)].

$$\ddot{z} = -V\dot{\gamma} + \frac{V^2}{r} \cos\gamma \quad \text{(C28)}$$

Previous studies (reference 6, for example) have approximated the content of Equation (C28) by

$$\dot{z} \cong -V\gamma \quad \text{(C29)}$$

This is done here to take advantage of the format of reference 6. Hence,

$$\Delta\dot{z} = -V\Delta\gamma \quad \text{(C30)}$$

which is row 10 of Table C1.

Pitch Rotation Dynamics

Pitch rotation is given by

$$[-I_{xy}\dot{p} + I_{yy}\dot{q} - I_{yz}\dot{r} + (I_{xx}-I_{zz})pr + I_{zx}(p^2-r^2) - I_{xy}qr + I_{yz}pq] =$$

$$M - T\ell \sin\delta + (M.R.)q \quad \text{(C31)}$$

It is assumed that pitch plane and lateral perturbations are uncoupled. Hence, p and r can be considered to be zero.

$$\dot{q} \cong \frac{1}{I_{yy}} M - \frac{T\ell}{I_{yy}} \sin \delta + \frac{(M.R.)}{I_{yy}} q \qquad \text{(C32)}$$

Taking perturbations yields

$$\begin{aligned}
\Delta\dot{q} &= \frac{qS\bar{c}}{I_{yy}} \left\{ C_{m_q} \Delta q + C_{m_{\dot{\alpha}}} \Delta\dot{\alpha} + C_{m_\alpha} \Delta\alpha + \frac{C_{m_\alpha}}{V} (\mu_{11} x_1 + \mu_{12} x_2 + \mu_{13} x_3) \right\} \\
&\quad - \frac{T\ell}{I_{yy}} (\cos \delta_o) \Delta\delta + \frac{M.R.}{I_{yy}} \Delta q \\
&\cong \left\{ \frac{qS\bar{c}}{I_{yy}} \left(C_{m_q} + C_{m_{\dot{\alpha}}} \right) + \frac{M.R.}{I_{yy}} \right\} \Delta q - \frac{qS\bar{c}}{I_{yy}} C_{m_\alpha} \Delta\gamma \\
&\quad - \frac{T\ell}{I_{yy}} \Delta\delta + \frac{qS\bar{c}}{I_{yy}} C_{m_\alpha} \Delta\theta - \frac{qS\bar{c}}{I_{yy}} C_{m_{\dot{\alpha}}} \Delta\dot{\gamma} \\
&\quad + \frac{\bar{q}S\bar{c}}{I_{yy}} (\mu_{11} x_1 + \mu_{12} x_2 + \mu_{13} x_3) \frac{C_{m_\alpha}}{V} \\
&= \left\{ \frac{qS\bar{c}}{I_{yy}} \left[C_{m_q} + C_{m_{\dot{\alpha}}} (1 - a_{21}) \right] + \frac{M.R.}{I_{yy}} \right\} \Delta q \\
&\quad - \frac{qS\bar{c}}{I_{yy}} \left(C_{m_\alpha} + C_{m_{\dot{\alpha}}} a_{22} \right) \Delta\gamma - \left\{ \frac{T\ell}{I_{yy}} + \frac{qS\bar{c}}{I_{yy}} C_{m_{\dot{\alpha}}} a_{28} \right\} \Delta\delta \\
&\quad + \frac{qS\bar{c}}{I_{yy}} \left\{ C_{m_\alpha} - C_{m_{\dot{\alpha}}} a_{29} \right\} \Delta\theta + \frac{qS\bar{c}}{I_{yy}} \frac{C_{m_\alpha}}{V} (\mu_{11} x_1 + \mu_{12} x_2 + \mu_{13} x_3) \\
&\quad - \frac{qS\bar{c}}{I_{yy}} C_{m_{\dot{\alpha}}} \left\{ a_{23} x_2 + a_{24} x_3 + a_{27} x_1 \right\}
\end{aligned} \qquad \text{(C33)}$$

In line 1 the perturbations are taken. In line 2 Equations (C24) and (C25) are used and $\cos \delta_o = 1$. Row 2 of Table C1 is substituted for $\Delta\dot{\gamma}$ to go from line 2 to line 3. The result is row 1 of Table C1.

Mass Rate Effects

Mass rate damping M. R. q is given by (Equation 7. 8-2 of ref. 24) as

$$(M.R.)q = \left\{ \dot{m}\,(\hat{\ell}^2 - k^2) - m\,\frac{d}{dt}\,k^2 \right\} q \tag{C34}$$

where

m = vehicle mass

$\hat{\ell}$ = $x_\delta - x_{cm} + 15$ ft = $\ell + 15$

15 ft = distance from gimbal to end of rocket nozzle

k = pitch radius of gyration

q = Pitch rate

Using

$$\dot{I}_{yy} = \dot{m}k^2 + m\,\frac{d}{dt}\,k^2 \tag{C35}$$

yields

$$\begin{aligned} M.R. &= \dot{m}\,(\ell + 15)^2 - \dot{I}_{yy} \\ &= \frac{(\ell + 15)^2}{32.17}\,\frac{d}{dt}\,w - \frac{d}{dt}\,I_{yy} \end{aligned} \tag{C36}$$

Actuator Dynamics

Appendix B uses the second-order actuator dynamics

$$\ddot{\delta} = -2\zeta\,\omega_n\dot{\delta} - \omega_n^{\,2}\,(\delta - u) \tag{C37}$$

where

ζ = 0.4

$\omega_n^{\,2}$ = 1, 000

Appendix B includes tail-wags-dog (TWD) and dog-wags-tail (DWT) dynamics which are neglected here. Section II shows the TWD and DWT dynamics are of minor importance. Furthermore, based on the considerations of ref. 6, it is is expected the second-order dynamics can be satisfactorily approximated with a first-order actuator with the same break frequency; i.e.,

$$\delta = -31.6\delta + 31.6u \qquad \text{(C38)}$$

This is row 8 of Table C1.

Bending Moments

The bending moments at stations 660, 1300, and 1800 are given by (page 15 of ref. 10). They were calculated by the procedure of ref. 26 as

$$M_{660} = M'_{1\delta}\delta + M'_{1\alpha}\alpha + 7.98 \times 10^6 \qquad \text{(C39)}$$

$$M_{1300} = M'_{2\delta}\delta + M'_{2\alpha}\alpha + 104.2 \times 10^6 \qquad \text{(C40)}$$

$$M_{1800} = M'_{3\delta}\delta + M'_{3\alpha}\alpha + 182.1 \times 10^6 \qquad \text{(C41)}$$

where the numerical values for the maximum dynamic pressure condition are listed in the nomenclature. The perturbation equations corresponding to the above are

$$\Delta M_{660} = M'_{1\delta}\Delta\delta + M'_{1\alpha}\Delta\alpha, \text{ etc.}$$

Two modifications to the above must be made: 1) extension to the entire boost phase flight, and 2) smoothing for gust penetration.

The most desirable extension would utilize the data used in the ref. 26 computations. These were not provided, so the plausible approximations used in Appendix B are used. This has the added advantage in that it permits a direct comparison of results. It is thus assumed that

$$M''_{\alpha}(t)\,\Delta\alpha = \frac{\dfrac{\bar{q}SC_{L_\alpha}}{W}[t]}{\dfrac{\bar{q}SC_{L_\alpha}}{W}[t=64]}\,M'_{\alpha}\,\Delta\alpha$$

$$= \frac{\frac{\bar{q} C_{L_\alpha}}{W}}{\frac{\bar{q}}{W} C_{L_\alpha} [t=64]} M_\alpha' \Delta\alpha$$

$$= \frac{\frac{\bar{q} C_{L_\alpha}}{W}}{\frac{7.86 \times 10^2}{2.63 \times 10^6} 2.52} \qquad M_\alpha' \Delta\alpha$$

$$= \frac{\bar{q} C_{L_\alpha}}{W\ 7.61 \times 10^{-4}} \qquad M_\alpha' \Delta\alpha \tag{C42}$$

The bending moment contribution from gimbal deflection is assumed constant.

For gust penetration it is simply assumed the wind effects are filtered by x_1. Hence, the final bending moment equation for station 660 becomes

$$\Delta M_{660} = \left\{ \frac{\bar{q} C_{L_\alpha} M_{1\alpha}'}{W\ 7.61 \times 10^{-4}} \right\} \left\{ - \Delta\gamma + \Delta\theta + \frac{x_1}{V} \right\} + M_{1\delta}' \Delta\delta \tag{C43}$$

This corresponds to row 3 of Table C2. Similar expressions for ΔM_{1300} and ΔM_{1880} are given in rows 5 and 7.

Differentiation of row 3 of Table C2 yields row 4. Coefficients are taken as constant during the differentiation. Rows 6 and 8 are obtained similarly by differentiation of rows 5 and 7.

Fanny Load

The normal acceleration at the pilot's seat (sensed by the ischial tuberosities, is [from Equation (C20) and Figure C5] approximated by

$$n_{IT} \cong \left(V\dot{\gamma} - \frac{V^2}{r} \cos\gamma + g \cos\gamma \right) \cos\alpha + x_p \dot{q} - \dot{V} \sin\alpha$$

$$= \left[V\dot{\gamma} + \left(g - \frac{V^2}{r} \right) \cos\gamma \right] \cos\alpha + x_p \dot{q} - \dot{V} \sin\alpha \tag{C44}$$

Its perturbation is given by

$$\Delta n_{IT} = \left[V\dot{\gamma}_o + \left(g - \frac{V^2}{r}\right)\cos\gamma_o\right]\left(-\sin\alpha_o\right)\Delta\alpha + x_p\Delta\dot{q} - \dot{V}\cos\alpha_o\Delta\alpha$$

$$- \left(g - \frac{V^2}{r}\right)\sin\gamma_o\cos\alpha_o\Delta\gamma + V\Delta\dot{\gamma}\cos\alpha_o$$

$$= x_p\,\Delta\dot{q} + V\Delta\dot{\gamma}$$

$$+\left\{\left[V\dot{\gamma}_o + \left(g - \frac{V^2}{r}\right)\cos\gamma_o\right]\sin\alpha_o - \left(g - \frac{V^2}{r}\right)\sin\gamma_o + \dot{V}\right\}\Delta\gamma$$

$$+\left\{\left[V\dot{\gamma}_o + \left(g - \frac{V^2}{r}\right)\cos\gamma_o\right]\sin\alpha_o - \dot{V}\right\}\Delta\theta$$

$$\triangleq x_p\,\Delta\dot{q} + V\Delta\dot{\gamma} + \tilde{A}\,\Delta\gamma + \tilde{B}\,\Delta\theta \qquad \text{(C45)}$$

Substituting for $\Delta\dot{q}$ and $\Delta\dot{\gamma}$ by use of rows 1 and 2 of Table C1 in Equation (C45) yields row 9 of Table C2.

Differentiation of row 9 of Table C2 yields row 10. Coefficients of row 9, are taken as constant during the differentiation.

$\bar{q}\alpha$

The term $\bar{q}\alpha$ is used as an indicator of aerodynamic loading. It is most commonly employed in preliminary design where aerodynamic loads due to q, $\dot{\alpha}$, and gust penetration are neglected. Since these latter effects are included here, the $\bar{q}\alpha$ computation used includes q, $\dot{\alpha}$, and gust penetration. This is done by defining a $\bar{q}\alpha$ that meets the intended use of the $\bar{q}\alpha$ indicator; i.e., it is taken to be

$$\bar{q}\alpha = \frac{L}{SC_{L_\alpha}}$$

$$= \frac{\bar{q}}{C_{L_\alpha}}\left\{C_{L_q}q + C_{L_{\dot{\alpha}}}\dot{\alpha} + C_{L_\alpha}\alpha + C_{L_\alpha}\frac{\mu_1}{V}x_1 + C_{L_\alpha}\frac{\mu_2}{V}x_2 + C_{L_\alpha}\frac{\mu_3}{V}x_3\right\} \qquad \text{(C46)}$$

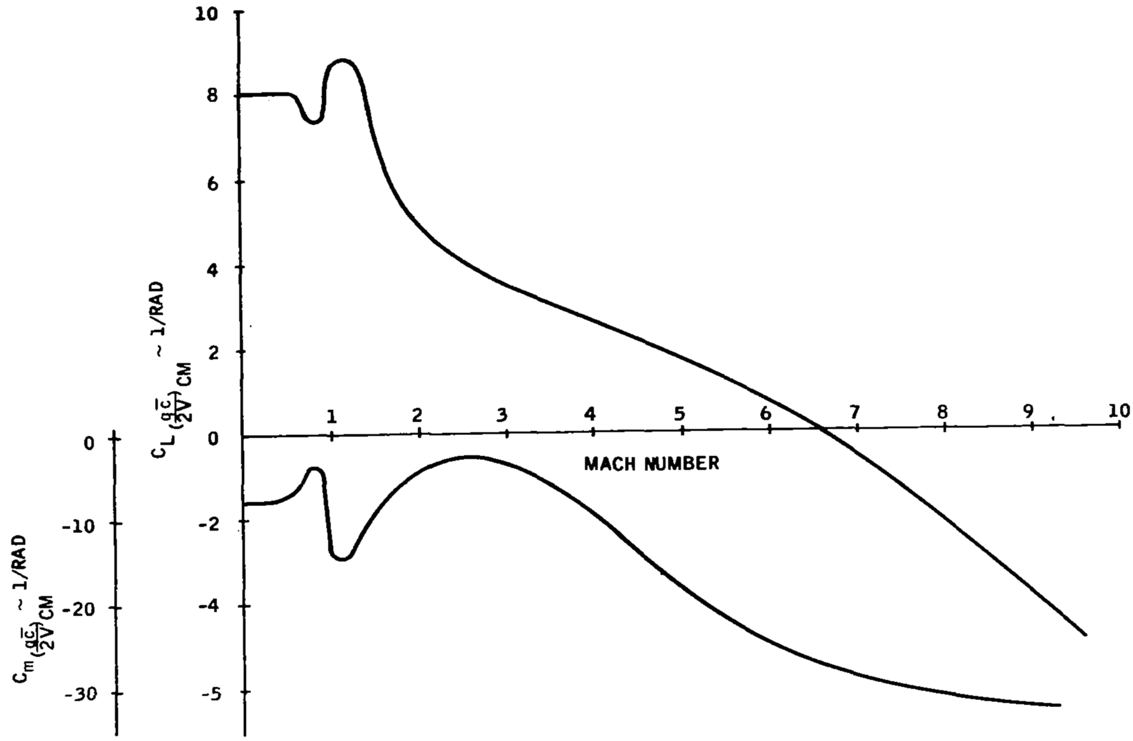


Figure C1. Pitch Rate Derivatives

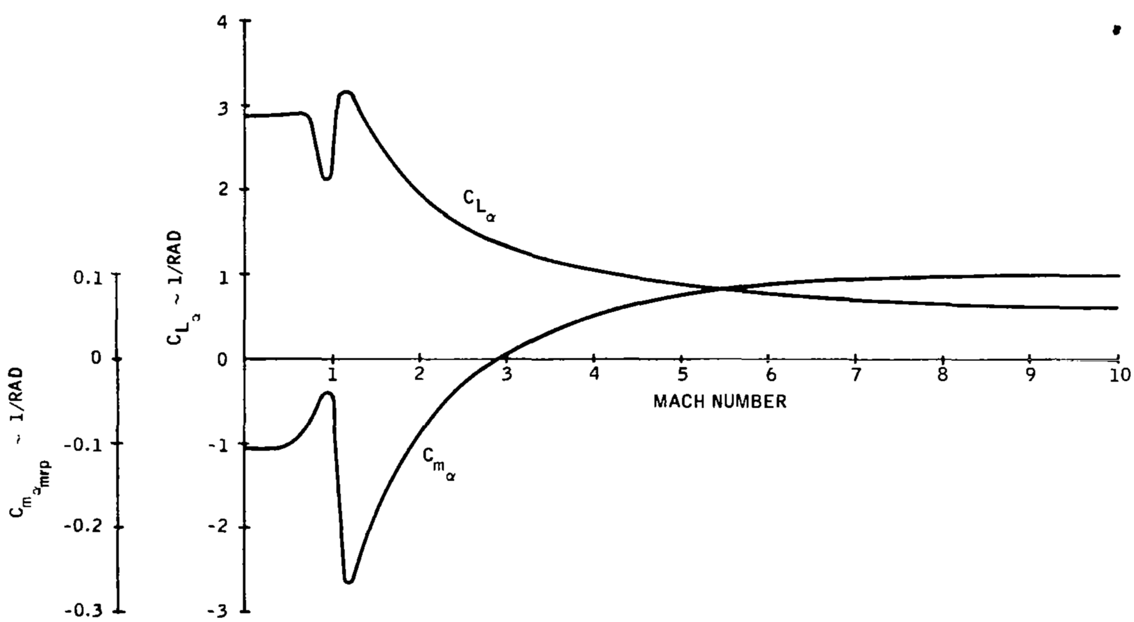


Figure C2. Indicial Angle of Attack Derivatives

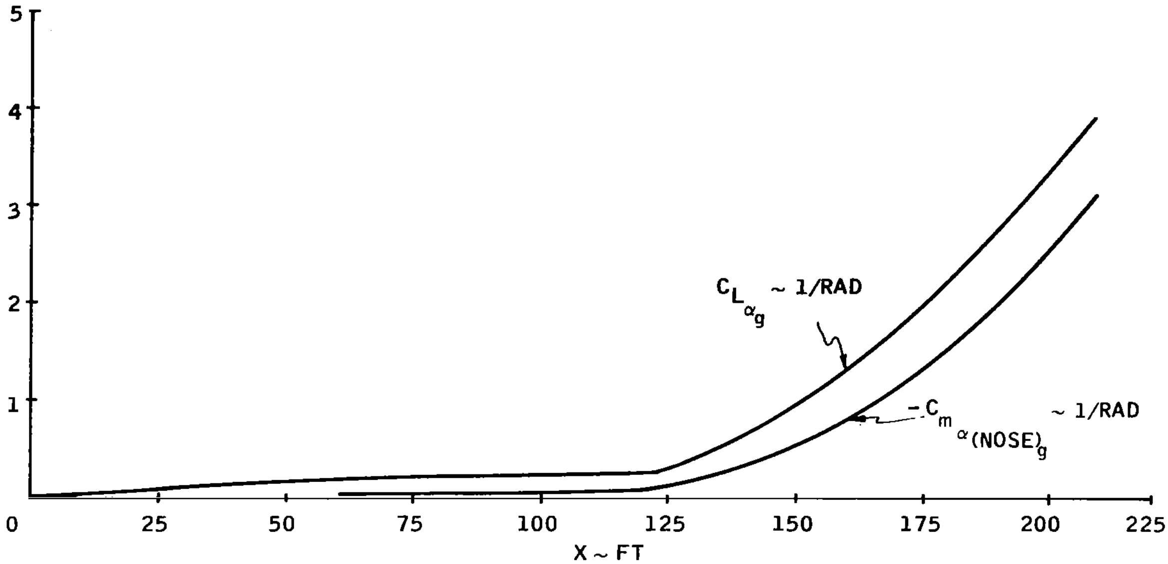


Figure C3. Gust Penetration Derivatives

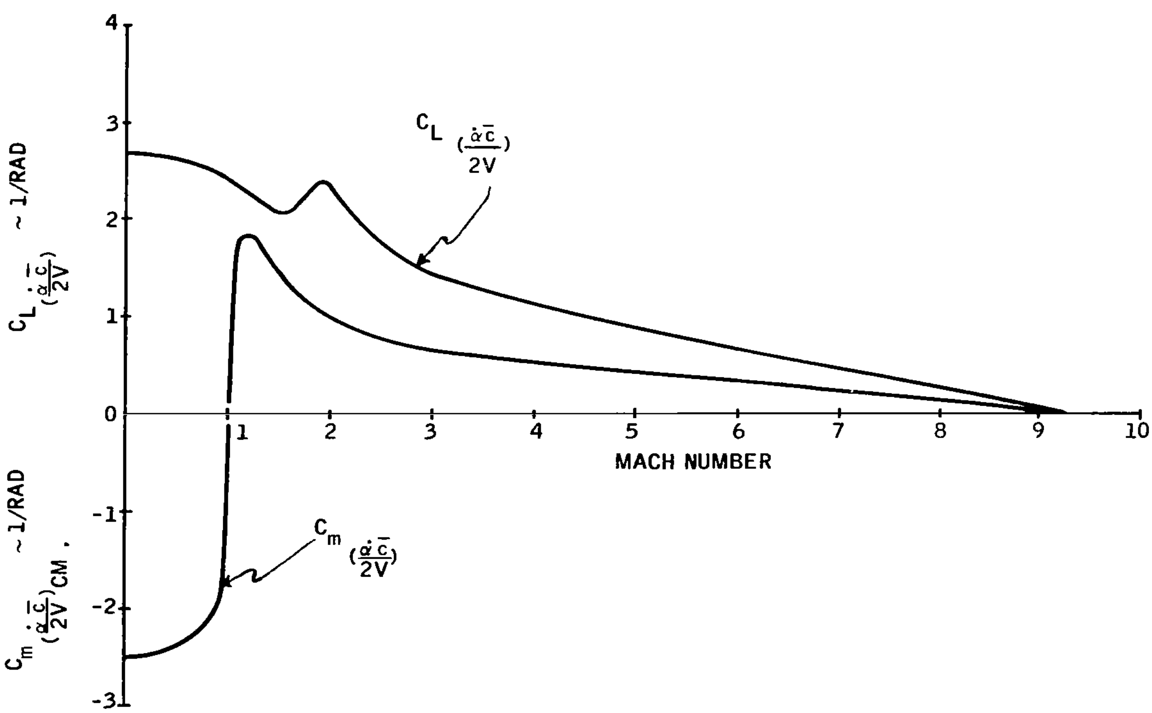


Figure C4. Indicial Angle of Attack Rate Derivatives

The perturbation equation is

$$\bar{q}\,\Delta\alpha = \frac{\bar{q}}{C_{L_\alpha}} \Bigg[\left(C_{L_q} + C_{L_{\dot\alpha}} \right) \Delta q - C_{L_{\dot\alpha}} \Delta\dot\gamma + C_{L_\alpha} \Delta\theta - C_{L_\alpha} \Delta\gamma$$

$$+ C_{L_\alpha} \frac{\mu_1}{V} x_1 + C_{L_\alpha} \frac{\mu_2}{V} x_2 + C_{L_\alpha} \frac{\mu_3}{V} x_3 \Bigg] \qquad \text{(C47)}$$

With the usual substitutions this becomes row 11 of Table C2. Row 12 is obtained by differentiation of row 11.

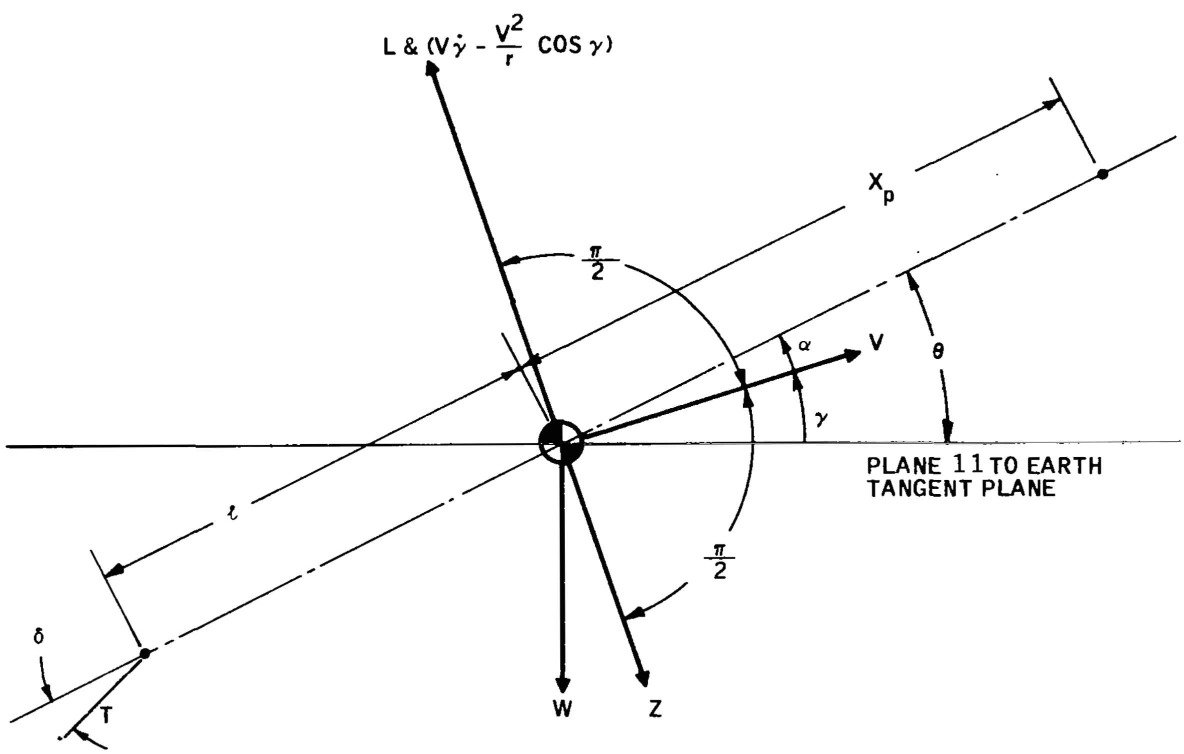


Figure C5. No Wind Flight Geometry

Table C1. State Equations

	Δq	$\Delta\gamma$	x_2	x_3	$\tilde{v}$	x	x_1	$\Delta\delta$	$\Delta\theta$	Δz
$\Delta\dot{q}$	$\dfrac{M.R./I_{yy} + C_{m_q} + C_{m_{\dot\alpha}}(1-a_{21})}{I_{yy}/\bar{q}S\bar{c}}$	$\dfrac{-C_{m_\alpha} - a_{22}C_{m_{\dot\alpha}}}{I_{yy}/\bar{q}S\bar{c}}$	$\dfrac{+C_{m_\alpha}\frac{\mu_{12}}{V} - a_{23}C_{m_{\dot\alpha}}}{I_{yy}/\bar{q}S\bar{c}}$	$\dfrac{+C_{m_\alpha}\frac{\mu_{13}}{V} - a_{24}C_{m_{\dot\alpha}}}{I_{yy}/\bar{q}S\bar{c}}$	0	0	$\dfrac{+C_{m_\alpha}\frac{\mu_{11}}{V} - a_{27}C_{m_{\dot\alpha}}}{I_{yy}/\bar{q}S\bar{c}}$	$\dfrac{-T\ell - \bar{q}S\bar{c}\, a_{28}C_{m_{\dot\alpha}}}{I_{yy}}$	$\dfrac{C_{m_\alpha} - a_{29}C_{m_{\dot\alpha}}}{I_{yy}/\bar{q}S\bar{c}}$	0
$\Delta\dot{\gamma}$	$\dfrac{\bar{q}S\left(C_{L_q} + C_{L_{\dot\alpha}}\right)}{\frac{W}{g}V + \bar{q}SC_{L_{\dot\alpha}}}$	$\dfrac{\left[W\sin\gamma_o\left(1 - \frac{V^2}{gr}\right) - \bar{q}SC_{L_\alpha} - T\right]}{\frac{W}{g}V + \bar{q}SC_{L_{\dot\alpha}}}$	$\dfrac{\bar{q}SC_{L_\alpha}\frac{\mu_2}{V}}{\frac{W}{g}V + \bar{q}SC_{L_{\dot\alpha}}}$	$\dfrac{\bar{q}SC_{L_\alpha}\frac{\mu_3}{V}}{\frac{W}{g}V + \bar{q}SC_{L_{\dot\alpha}}}$	0	0	$\dfrac{\bar{q}SC_{L_\alpha}\frac{\mu_1}{V}}{\frac{W}{g}V + \bar{q}SC_{L_{\dot\alpha}}}$	$\dfrac{T}{\frac{W}{g}V + \bar{q}SC_{L_{\dot\alpha}}}$	$\dfrac{\bar{q}SC_{L_\alpha} + T}{\frac{W}{g}V + \bar{q}SC_{L_{\dot\alpha}}}$	0
$\dot{x}_2$	0	0	$-9.63\frac{V}{L}$	$+5.25\frac{V}{L}$	$+14.88\frac{V}{L}$	0	0	0	0	0
$\dot{x}_3$	0	0	$+17.77\frac{V}{L}$	$+5.03\frac{V}{L}$	$-22.8\frac{V}{L}$	0	0	0	0	0
$\dot{\tilde{v}}$	0	0	0	0	$\dfrac{\dot\sigma_w}{\sigma_w}$	$c_3\sigma_w\dot{h}$	0	0	0	0
$\dot{x}$	0	0	0	0	$-\dfrac{c_5\dot{h}}{\sigma_w}$	$-c_4\dot{h}$	0	0	0	0
$\dot{x}_1$	0	0	0	0	$+2.3\frac{V}{L}$	0	$-2.3\frac{V}{L}$	0	0	0
$\Delta\dot{\delta}$	0	0	0	0	0	0	0	-31.6	0	0
$\Delta\dot{\theta}$	1	0	0	0	0	0	0	0	0	0
$\Delta\dot{z}$	0	-V	0	0	0	0	0	0	0	0

$\times\ [\Delta q,\ \Delta\gamma,\ x_2,\ x_3,\ \tilde{v},\ x,\ x_1,\ \Delta\delta,\ \Delta\theta,\ \Delta z]^T\ +$

	u	$\bar{v}$	η
Δq	0	0	0
$\Delta\gamma$	0	0	0
x_2	0	$+14.88\frac{V}{L}$	0
x_3	0	$-22.8\frac{V}{L}$	0
$\tilde{v}$	0	0	$c_1\sigma_w\sqrt{\dot{h}}$
x	0	0	$c_2\sqrt{\dot{h}}$
x_1	0	$+2.3\frac{V}{L}$	0
$\Delta\delta$	31.6	0	0
$\Delta\theta$	0	0	0
Δz	0	0	0

$\times\ [u,\ \bar{v},\ \eta]^T$

Table C2. Response Equations

	Δq	$\Delta\gamma$	x_2	x_3	$\tilde{v}$	x	x_1	$\Delta\delta$	$\Delta\theta$	Δz	u	$\tilde{v}$
$\Delta\delta$	0	0	0	0	0	0	0	1	0	0	0	0
$\Delta\dot{\delta}$	0	0	0	0	0	0	0	-31.6	0	0	+31.6	0
ΔM_{660}	0	$-h_{39}$	0	0	0	0	$\frac{h_{39}}{V}$	$M'_{1\delta}$	$\frac{\bar{q}\, C_{L_\alpha}}{7.61 \times 10^{-4} W}\; M'_{1\alpha}$	0	0	0
$\Delta\dot{M}_{660}$	$(h_{32}\, a_{21} + h_{39})$	$h_{32}\, a_{22}$	$h_{32}\, a_{23}$	$h_{32}\, a_{24}$	$h_{37}\, a_{75}$	0	$(h_{32}\, a_{27} + h_{37}\, a_{77})$	$(h_{32}\, a_{28} + h_{38}\, a_{88})$	$h_{32}\, a_{29}$	0	$h_{38}\, g_{81}$	$h_{37}\, g_{72}$
ΔM_{1300}	0	$-h_{59}$	0	0	0	0	$\frac{h_{59}}{V}$	$M'_{2\delta}$	$\frac{\bar{q}\, C_{L_\alpha}}{7.61 \times 10^{-4} W}\; M'_{2\alpha}$	0	0	0
$\Delta\dot{M}_{1300}$	$(h_{52}\, a_{21} + h_{59})$	$h_{52}\, a_{22}$	$h_{52}\, a_{23}$	$h_{52}\, a_{24}$	$h_{57}\, a_{75}$	0	$(h_{52}\, a_{27} + h_{57}\, a_{77})$	$(h_{52}\, a_{28} + h_{58}\, a_{88})$	$h_{52}\, a_{29}$	0	$h_{58}\, g_{81}$	$h_{57}\, g_{72}$
ΔM_{1880}	0	$-h_{79}$	0	0	0	0	$\frac{h_{79}}{V}$	$M'_{3\delta}$	$\frac{\bar{q}\, C_{L_\alpha}}{7.61 \times 10^{-4} W}\; M'_{3\alpha}$	0	0	0
$\Delta\dot{M}_{1880}$	$(h_{72}\, a_{21} + h_{79})$	$h_{72}\, a_{22}$	$h_{72}\, a_{23}$	$h_{72}\, a_{24}$	$h_{77}\, a_{75}$	0	$(h_{72}\, a_{27} + h_{77}\, a_{77})$	$(h_{72}\, a_{28} + h_{78}\, a_{88})$	$h_{72}\, a_{29}$	0	$h_{78}\, g_{81}$	$h_{77}\, g_{72}$
Δn_{IT}	$(x_p\, a_{11} + V\, a_{21})$	$(x_p\, a_{12} + V\, a_{22} + \tilde{A})$	$(x_p\, a_{13} + V\, a_{23})$	$(x_p\, a_{14} + V\, a_{24})$	0	0	$(x_p\, a_{17} + V\, a_{27})$	$(x_p\, a_{18} + V\, a_{28})$	$(x_p\, a_{19} + V\, a_{29} + \tilde{B})$	0	0	0
$\Delta\dot{n}_{IT}$	$(h_{91}\, a_{11} + h_{92}\, a_{21} + h_{99})$	$(h_{91}\, a_{12} + h_{92}\, a_{22})$	$(h_{91}\, a_{13} + h_{92}\, a_{23} + h_{93}\, a_{34} + h_{94}\, a_{43})$	$(h_{91}\, a_{14} + h_{92}\, a_{24} + h_{93}\, a_{34} + h_{94}\, a_{44})$	$(h_{93}\, a_{35} + h_{94}\, a_{45} + h_{97}\, a_{75})$	0	$(h_{91}\, a_{17} + h_{92}\, a_{27} + h_{97}\, a_{77})$	$(h_{91}\, a_{18} + h_{92}\, a_{28} + h_{98}\, a_{88})$	$(h_{91}\, a_{19} + h_{92}\, a_{29})$	0	$h_{98}\, g_{81}$	$(h_{93}\, g_{32} + h_{94}\, g_{42} + h_{97}\, g_{72})$
$\bar{q}\Delta\alpha$	$\frac{\bar{q}}{C_{L_\alpha}}\left[C_{L_q} + C_{L_{\dot{\alpha}}}(1-a_{21})\right]$	$\left(-\bar{q} - \bar{q}\frac{C_{L_{\dot{\alpha}}}}{C_{L_\alpha}} a_{22}\right)$	$\left(\bar{q}\frac{\mu_2}{V} - \bar{q}\frac{C_{L_{\dot{\alpha}}}}{C_{L_\alpha}} a_{23}\right)$	$\left(\bar{q}\frac{\mu_3}{V} - \bar{q}\frac{C_{L_{\dot{\alpha}}}}{C_{L_\alpha}} a_{24}\right)$	0	0	$\left(\bar{q}\frac{\mu_1}{V} - \bar{q}\frac{C_{L_{\dot{\alpha}}}}{C_{L_\alpha}}\right)$	$-\bar{q}\frac{C_{L_{\dot{\alpha}}}}{C_{L_\alpha}} a_{28}$	$\left(\bar{q} - \bar{q}\frac{C_{L_{\dot{\alpha}}}}{C_{L_\alpha}} a_{29}\right)$	0	0	0
$\bar{q}\Delta\dot{\alpha}$	$(h_{11,1}\, a_{11} + h_{11,2}\, a_{21} + h_{11,9}\, a_{91})$	$(h_{11,1}\, a_{12} + h_{11,2}\, a_{22})$	$(h_{11,1}\, a_{13} + h_{11,2}\, a_{23} + h_{11,3}\, a_{33} + h_{11,4}\, a_{43})$	$(h_{11,1}\, a_{14} + h_{11,2}\, a_{24} + h_{11,3}\, a_{34} + h_{11,4}\, a_{44})$	$(h_{11,3}\, a_{35} + h_{11,4}\, a_{45} + h_{11,7}\, a_{75})$	0	$(h_{11,1}\, a_{17} + h_{11,2}\, a_{27} + h_{11,7}\, a_{77})$	$(h_{11,1}\, a_{18} + h_{11,2}\, a_{28} + h_{11,8}\, a_{88})$	$(h_{11,1}\, a_{19} + h_{11,2}\, a_{29})$	0	$h_{11,8}\, g_{81}$	$(h_{11,3}\, g_{32} + h_{11,4}\, g_{42} + h_{11,7}\, g_{72})$
$\Delta\dot{z}$	0	$-V$	0	0	0	0	0	0	0	0	0	0
Δz	0	0	0	0	0	0	0	0	0	1	0	0

(Left-hand vector = matrix above (columns Δq … Δz) × $[\Delta q,\ \Delta\gamma,\ x_2,\ x_3,\ \tilde{v},\ x,\ x_1,\ \Delta\delta,\ \Delta\theta,\ \Delta z]^T$ + matrix (columns u, $\tilde{v}$) × $[u,\ \tilde{v}]^T$)

Table C3. Numerical A Matrix

a_{11}	a_{12}	a_{13}	a_{14}	a_{17}	a_{18}
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	-.14416626E 01
-.56482394E 00	.10305180E-01	.43964124E-03	.24156678E-03	-.12007670E-02	-.13742836E 01
-.11715199E 01	.13374152E 00	.90785462E-03	.58144145E-03	-.24787823E-02	-.13908502E 01
-.17843377E 01	.34989974E 00	.13677690E-02	.87599675E-03	-.37344491E-02	-.14158476E 01
-.23933169E 01	.66101005E 00	.18194130E-02	.11594860E-02	-.49435402E-02	-.14393482E 01
-.29617440E 01	.10714235E 01	.22281774E-02	.14270240E-02	-.60861192E-02	-.14708571E 01
-.35436442E 01	.15657354E 01	.25934070E-02	.16544883E-02	-.70599754E-02	-.15072941E 01
-.35453156E 01	.21315404E 01	.28680337E-02	.18367040E-02	-.78437481E-02	-.15493605E 01
-.27224937E 01	.23938060E 01	.26859179E-02	.17200169E-02	-.73508882E-02	-.15948951E 01
-.47699168E 01	.22207161E 01	.20966260E-02	.13424110E-02	-.57586313E-02	-.16654529E 01
-.63299543E 01	.37640169E 01	.30015577E-02	.19210996E-02	-.83069804E-02	-.17726927E 01
-.58243469E 01	.57495831E 01	.44439030E-02	.25880436E-02	-.11208686E-01	-.18342624E 01
-.40925548E 01	.52923353E 01	.33342267E-02	.21339724E-02	-.92317691E-02	-.18623943E 01
-.28470082E 01	.95025176E 01	.25464404E-02	.16298419E-02	-.70445209E-02	-.18920044E 01
-.16344286E 01	.38007920E 01	.19271425E-02	.12335031E-02	-.53276730E-02	-.19224934E 01
-.10070807E 01	.29233132E 01	.13255237E-02	.84844300E-03	-.36629600E-02	-.19535777E 01
-.63699872E 00	.22125519E 01	.89642710E-03	.57379664E-03	-.24762784E-02	-.19855105E 01
-.37072590E 00	.16395870E 01	.59351363E-03	.37990858E-03	-.16390997E-02	-.20188107E 01
-.41219676E 00	.12102012E 01	.39186874E-03	.25083764E-03	-.10820327E-02	-.21085155E 01
-.42974302E 00	.84048243E 00	.24402245E-03	.15620107E-03	-.67372954E-03	-.20901654E 01
-.52437920E 00	.58728453E 00	.15334135E-03	.98155512E-04	-.42334151E-03	-.21272742E 01
-.62041126E 00	.41098435E 00	.96955309E-04	.61998329E-04	-.26738188E-03	-.21729034E 01
-.67399802E 00	.27245326E 00	.58151777E-04	.37223764E-04	-.16053001E-03	-.22239641E 01
-.70360387E 00	.16627051E 00	.32258355E-04	.20649042E-04	-.89048701E-04	-.22520522E 01
-.68597987E 00	.88971998E-01	.15782972E-04	.10102911E-04	-.43568539E-04	-.23112995E 01
-.65269727E 00	.44607461E-01	.72779833E-05	.46587409E-05	-.20090938E-04	-.23115712E 01
-.57443638E 00	.10816700E-01	.16193848E-05	.10365832E-05	-.44710422E-05	-.22091723E 01
-.47982137E 00	-.16142261E-01	-.22965146E-05	-.14709476E-05	.63381533E-05	-.21309448E 01
-.41505677E 00	-.29228484E-01	-.38715354E-05	-.24782437E-05	.10685764E-04	-.21327471E 01
-.37743456E 00	-.36756860E-01	-.45637675E-05	-.29213526E-05	.12596568E-04	-.21583757E 01
-.33601005E 00	-.45622139E-01	-.53296326E-05	-.34115957E-05	.14710568E-04	-.21731895E 01
-.30139198E 00	-.50735955E-01	-.55961359E-05	-.35821889E-05	.15446197E-04	-.21998943E 01
-.26982069E 00	-.53311779E-01	-.55685846E-05	-.35645526E-05	.15370169E-04	-.22516643E 01
-.24910496E 00	-.55675053E-01	-.55204619E-05	-.35337482E-05	.15237357E-04	-.23095303E 01
-.22334286E 00	-.58248622E-01	-.55044538E-05	-.35234011E-05	.15193177E-04	-.24075251E 01

Table C3. (Continued)

a_{19}	a_{21}	a_{22}	a_{23}	a_{24}	a_{27}
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
.44618131E-01	.11803847E 00	-.22424267E 00	-.18700568E-03	-.11868820E-03	.60574447E-03
-.78136320E-01	.11999333E 00	-.13467382E 00	-.19060983E-03	-.12097567E-03	.61741894E-03
-.29511706E 00	.11876994E 00	-.15023542E 00	-.18921972E-03	-.12009340E-03	.61291613E-03
-.60778738E 00	.11616127E 00	-.16196904E 00	-.18554012E-03	-.11775804E-03	.60099726E-03
-.10208710E 01	.11195368E 00	-.17951688E 00	-.17944232E-03	-.11388791E-03	.58124539E-03
-.15192338E 01	.10588424E 00	-.19811344E 00	-.17093971E-03	-.10817416E-03	.55208435E-03
-.20903925E 01	.98710355E-01	-.21534009E 00	-.15959452E-03	-.10129097E-03	.51695485E-03
-.23585137E 01	.85900706E-01	-.21961055E 00	-.13184867E-03	-.83681315E-04	.42708115E-03
-.22018192E 01	.79105597E-01	-.17783453E 00	-.92690478E-04	-.58828513E-04	.30024085E-03
-.37751311E 01	.75000644E-01	-.21766425E 00	-.10400636E-03	-.66010445E-04	.33689500E-03
-.57686296E 01	.65858038E-01	-.25100515E 00	-.10921937E-03	-.69319022E-04	.35378086E-03
-.53055140E 01	.53653807E-01	-.21682940E 00	-.82620658E-04	-.52437430E-04	.26762292E-03
-.45110533E 01	.36545847E-01	-.18109725E 00	-.60040011E-04	-.38106013E-04	.19448021E-03
-.38060027E 01	.26001398E-01	-.15279090E 00	-.43957197E-04	-.27898621E-04	.14238513E-03
-.29266785E 01	.18250930E-01	-.11965541E 00	-.29057440E-04	-.18442088E-04	.94122185E-04
-.22145344E 01	.11785230E-01	-.94407645E-01	-.19094731E-04	-.12118985E-04	.61851210E-04
-.16407495E 01	.74594264E-02	-.74432540E-01	-.12299343E-04	-.78061096E-05	.39839745E-04
-.12109000E 01	.47559322E-02	-.55684119E-01	-.77126102E-05	-.48950162E-05	.24982208E-04
-.84089809E 00	.30920163E-02	-.47656840E-01	-.49207755E-05	-.31231029E-05	.15939262E-04
-.58754965E 00	.20298152E-02	-.39951515E-01	-.32257911E-05	-.20473354E-05	.10448908E-04
-.41114749E 00	.12949389E-02	-.33994115E-01	-.21037292E-05	-.13351889E-05	.68143506E-05
-.27255189E 00	.81030258E-03	-.29575504E-01	-.13843540E-05	-.87861759E-06	.44841672E-05
-.16633052E 00	.50170315E-03	-.25766018E-01	-.91555331E-06	-.58108061E-06	.29656390E-05
-.89009345E-01	.30557704E-03	-.22298332E-01	-.59079717E-06	-.37496536E-06	.19136965E-05
-.44631388E-01	.18994957E-03	-.19706361E-01	-.39694736E-06	-.25174295E-06	.12848109E-05
-.10831642E-01	.11330114E-03	-.17698412E-01	-.27280204E-06	-.17314117E-06	.88365403E-06
.16133245E-01	.64914784E-04	-.15974521E-01	-.17975988E-06	-.11408946E-06	.58227403E-06
.29222937E-01	.32057812E-04	-.14648671E-01	-.12404268E-06	-.78728940E-07	.40180590E-06
.36753266E-01	.88757544E-05	-.13608228E-01	-.91165178E-07	-.57860440E-07	.29530013E-06
.45620200E-01	-.60297392E-05	-.12697530E-01	-.66153330E-07	-.41985996E-07	.21428233E-06
.50734835E-01	-.15971982E-04	-.11922038E-01	-.49181466E-07	-.31214345E-07	.15930746E-06
.53311101E-01	-.23064917E-04	-.11247374E-01	-.37123733E-07	-.23561579E-07	.12025033E-06
.55674845E-01	-.25516326E-04	-.10633780E-01	-.27085937E-07	-.17190821E-07	.87736140E-07
.58248622E-01	-.26952846E-04	-.10112246E-01	-.20366047E-07	-.12925861E-07	.65969226E-07

Table C3. (Continued)

a_{28}	a_{29}	a_{33}	a_{34}	a_{35}	a_{43}
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
.58701755E 00	.61122820E 00	-.37178514E 01	-.20268660E 01	.57447174E 01	.68604589E 01
.29157531E 00	.34241759E 00	-.76598474E 01	-.41759293E 01	.11835777E 02	.14134526E 02
.19401028E 00	.27190682E 00	-.11822032E 02	-.64450332E 01	.18267065E 02	.21814903E 02
.14551290E 00	.25040003E 00	-.16233968E 02	-.88502943E 01	.25084263E 02	.29926139E 02
.11623962E 00	.24740255E 00	-.20990682E 02	-.11443518E 02	.32434200E 02	.38733585E 02
.96541594E-01	.25185601E 00	-.26168651E 02	-.14266398E 02	.40435049E 02	.48288362E 02
.82341471E-01	.25923726E 00	-.31831237E 02	-.17322933E 02	.49183170E 02	.58735547E 02
.71642289E-01	.24617369E 00	-.38013527E 02	-.20723885E 02	.58737412E 02	.70145417E 02
.63605717E-01	.20738430E 00	-.44545044E 02	-.24284681E 02	.68829725E 02	.82197864E 02
.57727773E-01	.24260806E 00	-.51347096E 02	-.27829414E 02	.78876510E 02	.94195939E 02
.53213717E-01	.27226826E 00	-.57596079E 02	-.31399731E 02	.88995810E 02	.10628061E 03
.49346334E-01	.23495990E 00	-.64515102E 02	-.35171785E 02	.99686887E 02	.11904812E 03
.45844566E-01	.19650203E 00	-.72159330E 02	-.39284681E 02	.11134401E 03	.13796929E 03
.42457760E-01	.16577557E 00	-.81563097E 02	-.43920692E 02	.12448379E 03	.14866108E 03
.39286618E-01	.13054525E 00	-.90189696E 02	-.49168837E 02	.13935853E 03	.16642481E 03
.36296872E-01	.10349519E 00	-.10106137E 03	-.55095760E 02	.15615713E 03	.18648603E 03
.33498112E-01	.81987998E-01	-.11321180E 03	-.61719828E 02	.17493163E 03	.20890692E 03
.30940380E-01	.64951666E-01	-.12663740E 03	-.69039083E 02	.19567649E 03	.23368086E 03
.28650487E-01	.52858868E-01	-.14127735E 03	-.77020361E 02	.21829771E 03	.26069558E 03
.26628085E-01	.44275290E-01	-.15710138E 03	-.85647172E 02	.24274856E 03	.28989529E 03
.24842951E-01	.37599411E-01	-.17477824E 03	-.94902467E 02	.26898071E 03	.32122225E 03
.23316668E-01	.32582221E-01	-.19220493E 03	-.10478462E 03	.29698954E 03	.35467098E 03
.21543613E-01	.28283436E-01	-.21140012E 03	-.11524929E 03	.32664940E 03	.39009139E 03
.19664838E-01	.24417841E-01	-.23103089E 03	-.12595142E 03	.35698231E 03	.42631556E 03
.18036118E-01	.21500741E-01	-.25083710E 03	-.13674920E 03	.38758630E 03	.46286348E 03
.16651530E-01	.19224292E-01	-.27082724E 03	-.14764725E 03	.41847449E 03	.49975078E 03
.15455047E-01	.17276523E-01	-.29098533E 03	-.15863686E 03	.44962220E 03	.53694801E 03
.14417996E-01	.15762688E-01	-.31130184E 03	-.16971284E 03	.48101469E 03	.57443757E 03
.13510048E-01	.14563272E-01	-.33176639E 03	-.18086952E 03	.51263591E 03	.61220028E 03
.12705649E-01	.13517373E-01	-.35236838E 03	-.19210414E 03	.54446952E 03	.65021663E 03
.11987343E-01	.12626327E-01	-.37310345E 03	-.20340531E 03	.57650875E 03	.68827853E 03
.11343444E-01	.11852698E-01	-.39393381E 03	-.21476142E 03	.60869523E 03	.72691628E 03
.10762232E-01	.11153584E-01	-.41491878E 03	-.22620183E 03	.64112061E 03	.76563933E 03
.10251732E-01	.10560465E-01	-.43532830E 03	-.23732851E 03	.67265681E 03	.80330050E 03

Table C3. (Continued)

a_{44}	a_{45}	a_{55}	a_{56}	a_{65}	a_{66}
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
.19419307E 01	-.58023896E 01	.91036039E-02	.12555344E 04	-.58113625E-08	-.46549826E-02
.40009380E 01	-.18135464E 02	.91347159E-02	.26524554E 04	-.14541286E-07	-.96140281E-02
.61749556E 01	-.27989858E 02	.12347064E-01	.42888222E 04	-.20673621E-07	-.14824705E-01
.84794248E 01	-.38435564E 02	.16523451E-01	.59839900E 04	-.27271141E-07	-.20316386E-01
.10963980E 02	-.49697565E 02	.19847599E-01	.83539353E 04	-.32551303E-07	-.26069286E-01
.13668568E 02	-.61956930E 02	.21989842E-01	.11939223E 05	-.34457560E-07	-.32047960E-01
.16625762E 02	-.75361309E 02	.24171994E-01	.16326898E 05	-.35750056E-07	-.38233935E-01
.19855456E 02	-.90000873E 02	.26300000E-01	.21550000E 05	-.36900000E-07	-.44500000E-01
.23267038E 02	-.10546490E 03	.23245285E-01	.28101492E 05	-.36461587E-07	-.50593973E-01
.26663229E 02	-.12085917E 03	.34152265E-01	.36529247E 05	-.34411297E-07	-.56112526E-01
.30083933E 02	-.13636455E 03	.37650936E-01	.47124992E 05	-.31351431E-07	-.60842082E-01
.33697919E 02	-.15274604E 03	.20700551E-01	.55941463E 05	-.28498717E-07	-.64894305E-01
.37638466E 02	-.17060776E 03	-.10012253E-01	.64468107E 05	-.29150206E-07	-.68610404E-01
.42080206E 02	-.19074129E 03	-.36381934E-01	.59419078E 05	-.35267868E-07	-.72308361E-01
.47108429E 02	-.21353324E 03	-.41819923E-01	.52120907E 05	-.44155589E-07	-.76049768E-01
.52786985E 02	-.23927301E 03	-.29530865E-01	.46601270E 05	-.54211859E-07	-.79732630E-01
.59133473E 02	-.26804039E 03	-.17902946E-01	.42307724E 05	-.65144389E-07	-.83153736E-01
.66146016E 02	-.29982687E 03	-.17648978E-01	.39733698E 05	-.76755601E-07	-.86212929E-01
.73792841E 02	-.33448843E 03	-.21493652E-01	.35737869E 05	-.88984034E-07	-.89045832E-01
.82058148E 02	-.37195343E 03	-.20998089E-01	.33228514E 05	-.10175118E-06	-.91792023E-01
.90925601E 02	-.41214785E 03	-.17113033E-01	.31115425E 05	-.11471638E-06	-.94384559E-01
.10039364E 03	-.45506462E 03	-.14917164E-01	.29304929E 05	-.12744593E-06	-.96663734E-01
.11041979E 03	-.50051118E 03	-.16378800E-01	.27577923E 05	-.14045649E-06	-.98461586E-01
.12067345E 03	-.54698902E 03	-.19400000E-01	.25550000E 05	-.15550000E-06	-.99600000E-01
.13101876E 03	-.59388224E 03	-.22107769E-01	.22979566E 05	-.17402203E-06	-.99967327E-01
.14146013E 03	-.64121091E 03	-.24615898E-01	.20231455E 05	-.19591246E-06	-.99720500E-01
.15198922E 03	-.68893724E 03	-.27507173E-01	.17793875E 05	-.22068979E-06	-.99071576E-01
.16260107E 03	-.73703863E 03	-.30949843E-01	.15623838E 05	-.24813490E-06	-.98052717E-01
.17329023E 03	-.78549051E 03	-.34800702E-01	.13274708E 05	-.27829155E-06	-.96557804E-01
.18405119E 03	-.83426782E 03	-.40530958E-01	.10542161E 05	-.32412592E-06	-.94520045E-01
.19488165E 03	-.88336018E 03	-.53232105E-01	.77857787E 04	-.42742430E-06	-.91968334E-01
.20576190E 03	-.93267818E 03	-.79451022E-01	.53776117E 04	-.64062162E-06	-.88976780E-01
.21672289E 03	-.98236222E 03	-.13287049E 00	.32179279E 04	-.10660333E-05	-.85857943E-01
.22738332E 03	-.10306838E 04	-.22900000E 00	.10000000E 04	-.18180000E-05	-.83000000E-01

Table C3. (Concluded)

a_{75}	a_{77}	$a_{10,2}$
.00000000E-80	.00000000E-80	.00000000E-80
.88796036E 00	-.88796036E 00	-.80689572E 02
.18294547E 01	-.18294547E 01	-.16624176E 03
.28235383E 01	-.28235383E 01	-.25657370E 03
.38772718E 01	-.38772718E 01	-.35232600E 03
.50133509E 01	-.50133509E 01	-.45556101E 03
.62500412E 01	-.62500412E 01	-.55793853E 03
.76022373E 01	-.76022373E 01	-.69081200E 03
.90790354E 01	-.90790354E 01	-.82500800E 03
.10639003E 02	-.10639003E 02	-.96676160E 03
.12191934E 02	-.12191934E 02	-.11078757E 04
.13756073E 02	-.13756073E 02	-.12500083E 04
.15408591E 02	-.15408591E 02	-.14001720E 04
.17210432E 02	-.17210432E 02	-.15639045E 04
.19241446E 02	-.19241446E 02	-.17484618E 04
.21540633E 02	-.21540633E 02	-.19573880E 04
.24137190E 02	-.24137190E 02	-.21933360E 04
.27039163E 02	-.27039163E 02	-.24570369E 04
.30245693E 02	-.30245693E 02	-.27484130E 04
.33742253E 02	-.33742253E 02	-.30661439E 04
.37521618E 02	-.37521618E 02	-.34095731E 04
.41576319E 02	-.41576319E 02	-.37789220E 04
.45905641E 02	-.45905641E 02	-.41714257E 04
.50490163E 02	-.50490163E 02	-.45880192E 04
.55178717E 02	-.55178717E 02	-.50140660E 04
.59909173E 02	-.59909173E 02	-.54439205E 04
.64683557E 02	-.64683557E 02	-.58777667E 04
.69498055E 02	-.69498055E 02	-.63152580E 04
.74350389E 02	-.74350389E 02	-.67561875E 04
.79238078E 02	-.79238078E 02	-.72003297E 04
.84158596E 02	-.84158596E 02	-.76474550E 04
.89110896E 02	-.89110896E 02	-.80974683E 04
.94085956E 02	-.94085956E 02	-.85495499E 04
.99097943E 02	-.99097943E 02	-.90049870E 04
.10397249E 03	-.10397249E 03	-.94479350E 04

Table C4. Numerical G Matrix

g_{53}	g_{63}
.00000000E-80	.00000000E-80
.10820374E 01	-.15071135E-05
.15278645E 01	-.20748258E-05
.20279125E 01	-.26010943E-05
.24461378E 01	-.30552883E-05
.29857845E 01	-.34462563E-05
.38452125E 01	-.38199523E-05
.48106218E 01	-.41766140E-05
.58700000E 01	-.45100000E-05
.71938670E 01	-.48114902E-05
.88865514E 01	-.50641504E-05
.11004029E 02	-.52646777E-05
.13358246E 02	-.54306652E-05
.14258429E 02	-.55836747E-05
.12769456E 02	-.57382402E-05
.10877721E 02	-.58915939E-05
.95097554E 01	-.60391135E-05
.84814833E 01	-.61764465E-05
.76337293E 01	-.63003208E-05
.69266290E 01	-.64098607E-05
.63369727E 01	-.65047508E-05
.58453254E 01	-.65864219E-05
.54333842E 01	-.66569750E-05
.50610690E 01	-.67141469E-05
.46600000E 01	-.67500000E-05
.41852524E 01	-.67591019E-05
.36932846E 01	-.67480366E-05
.32601122E 01	-.67253700E-05
.28751335E 01	-.66909006E-05
.24612601E 01	-.66374577E-05
.19803648E 01	-.65630183E-05
.14850739E 01	-.64774424E-05
.10330448E 01	-.63894156E-05
.62836345E 00	-.62870614E-05
.25000000E 00	-.61500000E-05

Table C5. Numerical H Matrix

h_{32}	h_{37}	h_{39}	h_{41}	h_{42}	h_{43}
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
.30883092E 07	-.38274432E 05	-.30883092E 07	-.27237687E 07	-.69253071E 06	-.57753138E 03
.13367689E 08	-.80411138E 05	-.13367689E 08	-.11763655E 08	-.28676314E 07	-.25480129E 04
.31597720E 08	-.12315261E 06	-.31597720E 08	-.27844861E 08	-.47470968E 07	-.59789118E 04
.58384238E 08	-.16571084E 06	-.58384238E 08	-.51602251E 08	-.94564389E 07	-.10832619E 05
.94292086E 08	-.20698015E 06	-.94292096E 08	-.83735740E 08	-.16927021E 08	-.16919990E 05
.13897424E 09	-.24469943E 06	-.13897424E 09	-.12425905E 09	-.27532664E 08	-.23686728E 05
.19215642E 09	-.27816022E 06	-.19215642E 09	-.17318859E 09	-.41475059E 08	-.30667111E 05
.22587448E 09	-.27378459E 06	-.22587448E 09	-.20647034E 09	-.47571547E 08	-.29781249E 05
.21739391E 09	-.22486817E 06	-.21739391E 09	-.20019683E 09	-.38660143E 08	-.20150345E 05
.31950204E 09	-.28839159E 06	-.31950204E 09	-.29553918E 09	-.69544171E 08	-.33230245E 05
.42583543E 09	-.34066607E 06	-.42583543E 09	-.39779074E 09	-.10688689E 09	-.46509478E 05
.40320900E 09	-.28797105E 06	-.40320900E 09	-.38157530E 09	-.87427566E 08	-.33313393E 05
.36475253E 09	-.23323198E 06	-.36475253E 09	-.35142234E 09	-.66055682E 08	-.21899746E 05
.33350963E 09	-.19074459E 06	-.33350963E 09	-.32483791E 09	-.50957237E 08	-.14660148E 05
.27570982E 09	-.14085599E 06	-.27570982E 09	-.27067786E 09	-.32990171E 08	-.80114216E 04
.22697758E 09	-.10348509E 06	-.22697758E 09	-.22430259E 09	-.21428418E 08	-.43340758E 04
.18321963E 09	-.74569343E 05	-.18321963E 09	-.18185292E 09	-.13637506E 08	-.22534810E 04
.14364062E 09	-.52263113E 05	-.14364062E 09	-.14295747E 09	-.84294232E 07	-.11078441E 04
.11400214E 09	-.37180949E 05	-.11400214E 09	-.11364964E 09	-.54329818E 07	-.56097894E 03
.92384146E 08	-.27095517E 05	-.92384146E 08	-.92196623E 08	-.36908866E 07	-.29801196E 03
.73959083E 08	-.19576139E 05	-.73959083E 08	-.73863311E 08	-.25141736E 07	-.15558988E 03
.59323924E 08	-.14221498E 05	-.59323924E 08	-.59275850E 08	-.17545350E 07	-.82125309E 02
.47457965E 08	-.10343890E 05	-.47457965E 08	-.47434155E 08	-.12228028E 07	-.43450297E 02
.36573652E 08	-.72942103E 04	-.36573652E 08	-.36562476E 08	-.81553144E 06	-.21607610E 02
.28944206E 08	-.53167944E 04	-.28944206E 08	-.28938708E 08	-.57038496E 06	-.11480643E 02
.23205738E 08	-.39480536E 04	-.23205738E 08	-.23203109E 08	-.41070472E 06	-.63305726E 01
.17651893E 08	-.27951182E 04	-.17651893E 08	-.17650747E 08	-.28198093E 06	-.31731021E 01
.13941119E 08	-.20634594E 04	-.13941119E 08	-.13940672E 08	-.20421886E 06	-.17293356E 01
.11637055E 08	-.16161837E 04	-.11637055E 08	-.11636952E 08	-.15835970E 06	-.10608942E 01
.95256126E 07	-.12455925E 04	-.95256126E 07	-.95256701E 07	-.12095176E 06	-.63015099E 00
.79397324E 07	-.98052033E 03	-.79397324E 07	-.79398592E 07	-.94657788E 05	-.39048768E 00
.66810233E 07	-.78144737E 03	-.66810233E 07	-.66811774E 07	-.75143969E 05	-.24802452E 00
.54077223E 07	-.60052527E 03	-.54077223E 07	-.54078603E 07	-.57504527E 05	-.14647323E 00
.44759426E 07	-.47374824E 03	-.44759426E 07	-.44760632E 07	-.45261832E 05	-.91157256E-01

Table C5. (Continued)

h_{44}	h_{45}	h_{47}	h_{48}	h_{49}	h_{52}
.00000000E-80	.00000000E-80	.00000000E-80	.29333016E 10	.00000000E-80	.00000000E-80
-.36654587E 03	-.33980178E 05	.35956904E 05	.29351145E 10	.18876617E 07	.51471821E 07
-.16171651E 04	-.14710854E 06	.15536200E 06	.29371993E 10	.45773318E 07	.22279481E 08
-.37946777E 04	-.34772610E 06	.36709286E 06	.29394319E 10	.85916357E 07	.55662866E 08
-.68752137E 04	-.64250597E 06	.67759474E 06	.29417973E 10	.14619415E 08	.97307064E 08
-.10738728E 05	-.10376641E 07	.10924709E 07	.29442621E 10	.23328102E 08	.15715348E 09
-.15033421E 05	-.15293815E 07	.15061070E 07	.29467184E 10	.35001497E 08	.23162373E 09
-.19463709E 05	-.21146400E 07	.22139762E 07	.29491240E 10	.49814104E 08	.32026070E 09
-.18901473E 05	-.24857000E 07	.25821667E 07	.29494538E 10	.55604353E 08	.37645746E 09
-.12788960E 05	-.23923732E 07	.24576437E 07	.29471291E 10	.45084083E 08	.36232318E 09
-.21090472E 05	-.35160512E 07	.36236898E 07	.29517457E 10	.77513772E 08	.53250340E 09
-.29518495E 05	-.46866272E 07	.43368796E 07	.29559619E 10	.11594147E 09	.70972571E 09
-.21143244E 05	-.44372282E 07	.45451362E 07	.29531985E 10	.94737945E 08	.67201500E 09
-.13899265E 05	-.40140231E 07	.43849603E 07	.29500635E 10	.71674613E 08	.60792089E 09
-.93044588E 04	-.36702017E 07	.37176885E 07	.29474617E 10	.55287750E 08	.55584938E 09
-.50846649E 04	-.30341272E 07	.30690776E 07	.29441333E 10	.35992607E 08	.49951637E 09
-.27507381E 04	-.24978394E 07	.25118782E 07	.29415402E 10	.23491986E 08	.37829596E 09
-.14302325E 04	-.20162926E 07	.23235920E 07	.29394391E 10	.15021444E 08	.30536605E 09
-.70312315E 03	-.15807341E 07	.15843226E 07	.29377459E 10	.93296975E 07	.23940103E 09
-.35604042E 03	-.12545690E 07	.12563861E 07	.29365678E 10	.60260242E 07	.19000357E 09
-.18914133E 03	-.10166676E 07	.10176329E 07	.29357616E 10	.40903349E 07	.12397358E 09
-.98749316E 02	-.81390379E 06	.81440777E 06	.29351390E 10	.27805221E 07	.16326514E 09
-.52123043E 02	-.65284701E 06	.65311302E 06	.29346848E 10	.19329052E 07	.98873206E 08
-.27576903E 02	-.52226468E 06	.52240543E 06	.29343240E 10	.13422743E 07	.79096608E 08
-.13713853E 02	-.40248516E 06	.40255515E 06	.29340208E 10	.89304962E 06	.60956086E 08
-.72864997E 01	-.31852475E 06	.31856194E 06	.29338236E 10	.62232187E 06	.48240343E 08
-.40178687E 01	-.25537415E 06	.25539465E 06	.29336880E 10	.44611388E 06	.38676230E 08
-.20138949E 01	-.19425528E 06	.19426556E 06	.29335744E 10	.30496333E 06	.29419821E 08
-.10975695E 01	-.15341901E 06	.15342461E 06	.29335026E 10	.21974951E 06	.23235198E 08
-.67332514E 00	-.12806329E 06	.12806672E 06	.29334588E 10	.16947361E 06	.19395092E 08
-.39994233E 00	-.10482732E 06	.10482936E 06	.29334226E 10	.12876126E 06	.15876021E 08
-.24783354E 00	-.87375045E 05	.87376310E 05	.29333968E 10	.10024969E 06	.13232887E 08
-.15741546E 00	-.73523223E 05	.73524026E 05	.29333774E 10	.79188151E 05	.11135039E 08
-.92963186E-01	-.59510819E 05	.59511294E 05	.29333598E 10	.60315483E 05	.90128705E 07
-.57855412E-01	-.49256785E 05	.49257080E 05	.29333475E 10	.47268036E 05	.74599043E 07

Table C5. (Continued)

h_{57}	h_{59}	h_{61}	h_{62}	h_{63}	h_{64}
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
-.63790720E 05	-.51471821E 07	-.45396145E 07	-.11542179E 07	-.96255230E 03	-.61090979E 03
-.13401856E 06	-.22279481E 08	-.19646092E 08	-.34460524E 07	-.42466881E 04	-.26952752E 04
-.20525434E 06	-.52662866E 08	-.16408101E 08	-.79118279E 07	-.99648529E 04	-.63244628E 04
-.27618474E 06	-.97307064E 08	-.86003751E 08	-.15760731E 08	-.18054364E 05	-.11458690E 05
-.34496691E 06	-.15715348E 09	-.13955957E 09	-.28211701E 08	-.28199984E 05	-.17897881E 05
-.40783239E 06	-.23162373E 09	-.20709842E 09	-.45887773E 08	-.39477880E 05	-.25055702E 05
-.46360037E 06	-.32026070E 09	-.23864765E 09	-.69125099E 08	-.51111851E 05	-.35439515E 05
-.45630765E 06	-.37645746E 09	-.34411724E 09	-.79285911E 08	-.49635415E 05	-.31502455E 05
-.37478028E 06	-.36232318E 09	-.33366139E 09	-.64433572E 08	-.33583909E 05	-.21314934E 05
-.48065266E 06	-.53250340E 09	-.49256530E 09	-.11590695E 09	-.55383742E 05	-.35150786E 05
-.56777678E 06	-.70972571E 09	-.66298457E 09	-.17814481E 09	-.77515797E 05	-.49197492E 05
-.47995175E 06	-.67201500E 09	-.63595884E 09	-.14571261E 09	-.55522321E 05	-.35238739E 05
-.38871997E 06	-.60792089E 09	-.58570391E 09	-.11009280E 09	-.36499577E 05	-.23165441E 05
-.31790765E 06	-.55584938E 09	-.54139652E 09	-.84928729E 08	-.24433581E 05	-.15507431E 05
-.23475998E 06	-.45951637E 09	-.45112977E 09	-.54983618E 08	-.13352369E 05	-.84744414E 04
-.17247515E 06	-.37829596E 09	-.37383765E 09	-.35714031E 08	-.72234596E 04	-.45845635E 04
-.12428224E 06	-.30536605E 09	-.30378819E 09	-.22729171E 08	-.37558017E 04	-.23837209E 04
-.87105189E 05	-.23940103E 09	-.23826246E 09	-.14049039E 08	-.18464068E 04	-.11718719E 04
-.61968249E 05	-.19000357E 09	-.18941607E 09	-.90549696E 07	-.93496490E 03	-.59340070E 03
-.45159194E 05	-.15397358E 09	-.15366104E 09	-.61514777E 07	-.49668659E 03	-.31523555E 03
-.32626898E 05	-.12326514E 09	-.12310552E 09	-.41902893E 07	-.25931647E 03	-.16458219E 03
-.23702497E 05	-.98873206E 08	-.98793083E 08	-.29242249E 07	-.13687551E 03	-.86871738E 02
-.17239816E 05	-.79096608E 08	-.79056925E 08	-.20380046E 07	-.72417161E 02	-.45961505E 02
-.12157017E 05	-.60950086E 08	-.60937460E 08	-.13592191E 07	-.36012683E 02	-.24856421E 02
-.88613239E 04	-.48240343E 08	-.48231180E 08	-.95064160E 06	-.19134405E 02	-.12144166E 02
-.65800893E 04	-.38676230E 08	-.38671848E 08	-.68490786E 06	-.10550954E 02	-.66964478E 01
-.46585304E 04	-.29419821E 08	-.29417912E 08	-.46996755E 06	-.52885036E 01	-.33564915E 01
-.34390990E 04	-.23235198E 08	-.23234453E 08	-.34036477E 06	-.28822260E 01	-.18292825E 01
-.26936395E 04	-.19395092E 08	-.19394920E 08	-.26393283E 06	-.17681579E 01	-.11222086E 01
-.20759875E 04	-.15876021E 08	-.15876117E 08	-.20158626E 06	-.10502517E 01	-.66657055E 00
-.16342006E 04	-.13232887E 08	-.13233099E 08	-.15776298E 06	-.65081280E 00	-.41305590E 00
-.13024123E 04	-.11135039E 08	-.11135296E 08	-.12523995E 06	-.41337420E 00	-.26235909E 00
-.10008755E 04	-.90128705E 07	-.90131004E 07	-.95890879E 05	-.24412285E 00	-.15493864E 00
-.78958041E 03	-.74599043E 07	-.74691054E 07	-.75436387E 05	-.15192876E 00	-.96425687E-01

Table C5. (Continued)

h_{65}	h_{67}	h_{68}	h_{69}	h_{72}
.00000000E-80	.00000000E-80	.27250734E 11	.00000000E-80	.00000000E-80
-.56645630E 05	.53761537E 05	.27253755E 11	.31461028E 07	.46416553E 07
-.24518089E 06	.25893667E 06	.27257230E 11	.76288863E 07	.20091318E 08
-.57954391E 06	.61182143E 06	.27260951E 11	.14319393E 08	.47490621E 08
-.10708433E 07	.11293246E 07	.27264893E 11	.24365692E 08	.87750120E 08
-.17294402E 07	.18207849E 07	.27269001E 11	.38880171E 08	.14171876E 09
-.25489692E 07	.26768451E 07	.27273095E 11	.58335828E 08	.20887497E 09
-.35244000E 07	.36899604E 07	.27277105E 11	.83023507E 08	.28880652E 09
-.41428333E 07	.43036112E 07	.27277704E 11	.92673922E 08	.33948396E 09
-.39872886E 07	.40960728E 07	.27273780E 11	.75140138E 08	.32673787E 09
-.58600893E 07	.60394830E 07	.27281474E 11	.12918962E 09	.48060396E 09
-.78103786E 07	.80614660E 07	.27288501E 11	.19323378E 09	.64002051E 09
-.73953804E 07	.75752270E 07	.27283895E 11	.15789657E 09	.69601393E 09
-.66900385E 07	.68082671E 07	.27278604E 11	.11945769E 09	.54821437E 09
-.61170028E 07	.64961475E 07	.27274334E 11	.92146250E 08	.50125703E 09
-.50568787E 07	.51001294E 07	.27268787E 11	.59987678E 08	.41438529E 09
-.41630656E 07	.41864636E 07	.27264465E 11	.39151811E 08	.34114189E 09
-.33604876E 07	.33726533E 07	.27260963E 11	.25035740E 08	.27537474E 09
-.26345568E 07	.26405377E 07	.27258141E 11	.15549496E 08	.21588843E 09
-.20909484E 07	.20939769E 07	.27256178E 11	.10043374E 08	.17134250E 09
-.16944461E 07	.16960549E 07	.27254834E 11	.68172248E 07	.13885117E 09
-.13569063E 07	.13573463E 07	.27253796E 11	.46342036E 07	.11115874E 09
-.10880783E 07	.10885217E 07	.27253039E 11	.32215086E 07	.89162445E 08
-.87044114E 06	.87067571E 06	.27252438E 11	.22371239E 07	.71328191E 08
-.67080861E 06	.67092526E 06	.27251933E 11	.14884160E 07	.59969328E 08
-.53087459E 06	.53093657E 06	.27251604E 11	.10372031E 07	.43502452E 08
-.42566358E 06	.42565776E 06	.27251378E 11	.74352313E 06	.34877671E 08
-.32375880E 06	.32377593E 06	.27251189E 11	.50827222E 06	.26530375E 08
-.25569835E 06	.25570768E 06	.27251069E 11	.36624918E 06	.20953169E 08
-.21343881E 06	.21344454E 06	.27250996E 11	.28245601E 06	.17490217E 08
-.17471219E 06	.17471560E 06	.27250936E 11	.21460210E 06	.14316769E 08
-.14562508E 06	.14562718E 06	.27250893E 11	.16708276E 06	.11933229E 08
-.12253870E 06	.12254004E 06	.27250860E 11	.13198025E 06	.10041419E 08
-.99184699E 05	.99185490E 05	.27250831E 11	.10052580E 06	.81276778E 07
-.82094641E 05	.82095133E 05	.27250810E 11	.78780060E 05	.67272352E 07

Table C5. (Continued)

h_{77}	h_{79}	h_{81}	h_{82}	h_{83}	h_{84}
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
-.57525560E 05	-.46416593E 07	-.41037595E 07	-.10408572E 07	-.86801591E 03	-.52090972E 03
-.12085603E 06	-.20091318E 08	-.17680494E 08	-.31076008E 07	-.38296027E 04	-.24305607E 04
-.18509543E 06	-.47490621E 08	-.41850163E 08	-.71347734E 07	-.89861620E 04	-.57033102E 04
-.24905945E 06	-.87750120E 08	-.77556954E 08	-.14212802E 08	-.16281168E 05	-.10333283E 05
-.31108623E 06	-.14171876E 09	-.12585282E 09	-.25440909E 08	-.25430343E 05	-.16140053E 05
-.36777742E 06	-.20887497E 09	-.18675840E 09	-.41380938E 08	-.35600288E 05	-.22594874E 05
-.41806819E 06	-.28880652E 09	-.26029833E 09	-.62336027E 08	-.46091937E 05	-.29253491E 05
-.41149172E 06	-.33948396E 09	-.31032001E 09	-.71498902E 08	-.44760208E 05	-.28408464E 05
-.33797150E 06	-.32673787E 09	-.30089108E 09	-.58105275E 08	-.30285489E 05	-.19221503E 05
-.43344570E 06	-.48020396E 09	-.44418835E 09	-.10452323E 09	-.49944267E 05	-.31698477E 05
-.51201299E 06	-.64002051E 09	-.59787001E 09	-.16064845E 09	-.69902639E 05	-.44365596E 05
-.43281363E 06	-.60601353E 09	-.57349859E 09	-.13140155E 09	-.50069236E 05	-.31777792E 05
-.35054211E 06	-.54821437E 09	-.52817942E 09	-.99280118E 08	-.32914797E 05	-.20890264E 05
-.28668457E 06	-.50125703E 09	-.48822365E 09	-.76587513E 08	-.22033854E 05	-.13984380E 05
-.21170320E 06	-.41438529E 09	-.41682238E 09	-.49583441E 08	-.12040976E 05	-.76421302E 04
-.15553563E 06	-.34114189E 09	-.33712146E 09	-.32206403E 08	-.65140127E 04	-.41342939E 04
-.11207595E 06	-.27537474E 09	-.27332060E 09	-.20496841E 08	-.33869283E 04	-.21496054E 04
-.78550215E 05	-.21588843E 09	-.21486168E 09	-.12669222E 08	-.16650633E 04	-.10567774E 04
-.55882082E 05	-.17134250E 09	-.17081271E 09	-.81656422E 07	-.84313799E 03	-.53512028E 03
-.40723916E 05	-.13885117E 09	-.13856933E 09	-.55473147E 07	-.44790488E 03	-.28427491E 03
-.29422471E 05	-.11115874E 09	-.11101480E 09	-.37787430E 07	-.23384789E 03	-.14841787E 03
-.21374573E 05	-.89162445E 08	-.89090191E 08	-.26370243E 07	-.12343238E 03	-.78339693E 02
-.15546620E 05	-.71328191E 08	-.71292406E 08	-.18378434E 07	-.65304761E 02	-.41447429E 02
-.10963024E 05	-.54969328E 08	-.54952530E 08	-.12257243E 07	-.32475723E 02	-.20611594E 02
-.79910153E 04	-.43502452E 08	-.43494189E 08	-.85727501E 06	-.17255133E 02	-.10951436E 02
-.59338306E 04	-.34877671E 08	-.34873720E 08	-.61727941E 06	-.95146998E 01	-.60387610E 01
-.42009962E 04	-.26530375E 08	-.26528652E 08	-.42381002E 06	-.47690970E 01	-.30268361E 01
-.31013303E 04	-.20953169E 08	-.20952497E 08	-.30693609E 06	-.25991508E 01	-.16496208E 01
-.24290856E 04	-.17490217E 08	-.17490062E 08	-.23801085E 06	-.15944987E 01	-.10119917E 01
-.18720959E 04	-.14316769E 08	-.14316855E 08	-.18178761E 06	-.94710194E 00	-.60110380E 00
-.14736987E 04	-.11933229E 08	-.11933419E 08	-.14226840E 06	-.58689368E 00	-.37248791E 00
-.11744968E 04	-.10041419E 08	-.10041651E 08	-.11293960E 06	-.37277495E 00	-.23659168E 00
-.90257519E 03	-.81276778E 07	-.81278852E 07	-.86427935E 05	-.22014577E 00	-.13972145E 00
-.71203233E 03	-.67272352E 07	-.67274165E 07	-.68027456E 05	-.13700719E 00	-.86955307E-01

Table C5. (Continued)

h_{85}	h_{87}	h_{88}	h_{89}	h_{91}	h_{92}
.00000000E-80	.00000000E-80	.41283504E 11	.00000000E-80	.00000000E-80	-.32170000E 02
-.51080417E 05	.23892074E 05	.41286229E 11	.28371106E 07	-.88606318E 01	-.33326006E 02
-.22110063E 06	.23359539E 06	.41289362E 11	.68796207E 07	-.19602610E 02	-.35783932E 02
-.52262406E 06	.55173182E 06	.41292718E 11	.12913024E 08	-.31942891E 02	-.39883067E 02
-.96567118E 06	.10184088E 07	.41296273E 11	.21972633E 08	-.45735369E 02	-.45295721E 02
-.15595844E 07	.16419578E 07	.41299977E 11	.35061582E 08	-.59974812E 02	-.51846634E 02
-.22986240E 07	.24139406E 07	.41303669E 11	.52606417E 08	-.77109601E 02	-.59711433E 02
-.31782536E 07	.33275535E 07	.41307285E 11	.74869413E 08	-.73657780E 02	-.68808357E 02
-.37359479E 07	.38809351E 07	.41307825E 11	.83572019E 08	-.41619720E 02	-.77022580E 02
-.35956799E 07	.36937800E 07	.41304286E 11	.67760303E 08	-.12696070E 03	-.77757438E 02
-.52845412E 07	.54463195E 07	.41311225E 11	.11650135E 09	-.19548990E 03	-.75702258E 02
-.70432879E 07	.72697149E 07	.41317562E 11	.17425727E 09	-.18239347E 03	-.50217815E 02
-.66690484E 07	.68312319E 07	.41313409E 11	.14238888E 09	-.11669349E 03	-.50084297E 02
-.60329812E 07	.61395980E 07	.41308637E 11	.10772524E 09	-.80342794E 02	-.55520927E 02
-.55162257E 07	.55875973E 07	.41304786E 11	.83096172E 08	-.35883062E 02	-.61587725E 02
-.45602209E 07	.45992238E 07	.41299784E 11	.54096031E 08	-.15959229E 02	-.61214847E 02
-.37541931E 07	.37752931E 07	.41295886E 11	.35306544E 08	-.78546338E 01	-.60040730E 02
-.30304397E 07	.30414106E 07	.41292729E 11	.22576873E 08	-.18950115E 01	-.56530267E 02
-.23758057E 07	.23811991E 07	.41290184E 11	.14022313E 08	-.10118924E 02	-.49495473E 02
-.18855874E 07	.18883184E 07	.41288413E 11	.90569708E 07	-.15457420E 02	-.47198304E 02
-.15280272E 07	.15294781E 07	.41287201E 11	.61476759E 07	-.24526218E 02	-.44553091E 02
-.12232780E 07	.12240355E 07	.41286266E 11	.41790586E 07	-.33449109E 02	-.40499085E 02
-.98121351E 06	.98161333E 06	.41285583E 11	.29051104E 07	-.39627447E 02	-.37398757E 02
-.78495139E 06	.78516292E 06	.41285041E 11	.20174064E 07	-.44054225E 02	-.34021397E 02
-.60492562E 06	.60503081E 06	.41284585E 11	.13422323E 07	-.45116563E 02	-.30926145E 02
-.47873512E 06	.47879102E 06	.41284289E 11	.93533496E 06	-.44769242E 02	-.27569838E 02
-.38382126E 06	.38385208E 06	.41284085E 11	.67049853E 06	-.40920004E 02	-.25142549E 02
-.29196106E 06	.29197651E 06	.41283914E 11	.45835262E 06	-.35404405E 02	-.22545881E 02
-.23058512E 06	.23059393E 06	.41283806E 11	.33027827E 06	-.31711239E 02	-.20343891E 02
-.19247607E 06	.19248124E 06	.41283740E 11	.25471479E 06	-.29862002E 02	-.18767020E 02
-.15755296E 06	.15755603E 06	.41283686E 11	.19352511E 06	-.27509750E 02	-.17495220E 02
-.13132261E 06	.13132451E 06	.41283647E 11	.15067285E 06	-.25509801E 02	-.16451704E 02
-.11050365E 06	.11050486E 06	.41283618E 11	.11901791E 06	-.23591990E 02	-.15336140E 02
-.89443345E 05	.89444058E 05	.41283591E 11	.90652734E 05	-.22465692E 02	-.15631687E 02
-.74031775E 05	.74032218E 05	.41283573E 11	.71042733E 05	-.20767508E 02	-.16770635E 02

Table C5. (Continued)

h_{93}	h_{94}	h_{97}	h_{98}	h_{99}	$h_{10,1}$
.00000000E-00	.00000000E-00	.00000000E-00	-.45196749E 02	.53695754E-09	.53695754E-09
-.77889916E-03	-.41178291E-03	.97916916E-02	.26326775E 01	.34169544E 02	.35240475E 02
-.10381412E-02	-.48174480E-03	.18957118E-01	.15168875E 01	.36703395E 02	.55374409E 02
-.70428115E-03	-.17044227E-03	.26627133E-01	.35652681E 00	.40853664E 02	.93113660E 02
.18444693E-03	.49576591E-03	.32741371E-01	-.85081943E 00	.46300982E 02	.15049861E 03
.17428844E-02	.15876997E-02	.30745853E-01	-.21587737E 01	.52863179E 02	.22468879E 03
.32560766E-02	.26420598E-02	.40117122E-01	-.35478097E 01	.60696532E 02	.32762302E 03
.45002203E-02	.35139108E-02	.43290251E-01	-.51058381E 01	.69713028E 02	.32406101E 03
.22059199E-02	.20333437E-02	.48686649E-01	-.67956050E 01	.77827081E 02	.18451975E 03
.18849573E-03	.38068257E-03	.44655698E-01	-.95400012E 01	.78014217E 02	.67745514E 03
.16872430E-01	.11416224E-01	.76475772E-02	-.14061009E 02	.74755838E 02	.13065202E 04
.47270262E-01	.30977225E-01	-.67205773E-01	-.16847818E 02	.48994042E 02	.11080097E 04
.40592073E-01	.26597868E-01	-.57974902E-01	-.18197068E 02	.49185972E 02	.52407324E 03
.29045303E-01	.19094602E-01	-.35960999E-01	-.19649452E 02	.54895246E 02	.28167509E 03
.19056404E-01	.12611773E-01	-.16203318E-01	-.21446726E 02	.61146682E 02	.11819362E 03
.11149192E-01	.74437721E-02	-.37494696E-02	-.23358453E 02	.60917251E 02	.75872254E 02
.55487973E-02	.37789719E-02	.46405938E-02	-.25442126E 02	.59864333E 02	.64160131E 02
.21562293E-02	.15441134E-02	.84748350E-02	-.27820027E 02	.56425668E 02	.56706515E 02
.84909738E-03	.65859954E-03	.77870910E-02	-.33588137E 02	.49432026E 02	.53367617E 02
-.92718301E-03	-.51153469E-03	.97755450E-02	-.33445782E 02	.47159838E 02	.53656618E 02
-.18026902E-02	-.10941537E-02	.10238524E-01	-.36782227E 02	.44528459E 02	.57299063E 02
-.19622769E-02	-.12128747E-02	.92205666E-02	-.40428217E 02	.40483715E 02	.61183475E 02
-.20640648E-02	-.12898396E-02	.84619505E-02	-.44647399E 02	.37389295E 02	.64067809E 02
-.20752753E-02	-.13055730E-02	.77395480E-02	-.49531093E 02	.34015554E 02	.64995209E 02
-.18890052E-02	-.11930720E-02	.66326054E-02	-.58574696E 02	.30922478E 02	.61862081E 02
-.16485811E-02	-.10435395E-02	.55845183E-02	-.64028316E 02	.27567494E 02	.56783020E 02
-.14862324E-02	-.94264063E-03	.48782339E-02	-.62057837E 02	.25141072E 02	.48644163E 02
-.13066442E-02	-.83023022E-03	.41502970E-02	-.61453292E 02	.22544974E 02	.39531301E 02
-.11358899E-02	-.72254390E-03	.35366677E-02	-.66648762E 02	.20343316E 02	.33504628E 02
-.10182699E-02	-.64824151E-03	.31250109E-02	-.73855797E 02	.18766650E 02	.30037435E 02
-.94151985E-03	-.59999133E-03	.28410765E-02	-.80458834E 02	.17495013E 02	.26738671E 02
-.86950059E-03	-.55441625E-03	.25907242E-02	-.88187787E 02	.16451585E 02	.24140297E 02
-.80021916E-03	-.51050532E-03	.23607562E-02	-.98249141E 02	.15336071E 02	.21702032E 02
-.73668288E-03	-.47023697E-03	.21581988E-02	-.10924241E 03	.15631665E 02	.21228379E 02
-.69797203E-03	-.44573762E-03	.20186859E-02	-.12426074E 03	.16770635E 02	.21409361E 02

Table C5. (Continued)

$h_{10,2}$	$h_{10,3}$	$h_{10,4}$	$h_{10,5}$	$h_{10,7}$	$h_{10,8}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.14282173E 04
.73818023E 01	.24074651E-02	.22396146E-02	.78447520E-02	-.18242124E-01	-.90578540E 02
.29131543E 01	-.98327821E-02	-.46610116E-02	.31130648E-01	-.81842639E-02	-.31103063E 02
-.51849600E 01	-.31535947E-01	-.19785534E-01	.67088235E-01	.19661395E-01	.26166464E 02
-.22895034E 02	-.62538808E-01	-.45124183E-01	.11251886E 00	.71924839E-01	.86163902E 02
-.54951080E 02	-.99418075E-01	-.82218015E-01	.16184411E 00	.15065839E 00	.15040499E 03
-.10890360E 03	-.14669468E 00	-.13145701E 00	.21869937E 00	.26069247E 00	.26257300E 03
-.14215293E 03	-.13719666E 00	-.14799510E 00	.28565509E 00	.21307950E 00	.26979821E 03
-.83407768E 02	-.42856879E-01	-.70483536E-01	.38786881E 00	-.16825446E 00	.27560213E 03
-.26811571E 03	-.21929388E 00	-.15242417E 00	.42196935E 00	.23268178E 00	.50796529E 03
-.71934960E 03	-.36486730E 00	-.53571486E 00	.44321819E-01	.15051883E 01	.78620129E 03
-.10360815E 04	-.16239994E 00	-.10209180F 01	-.94182754E 00	.29511126E 01	.86426897E 03
-.60672131E 03	.16267978E 00	-.77779724E 00	-.90953304E 00	.19571952E 01	.78988514E 03
-.35169016E 03	.24475600E 00	-.55117431E 00	-.64257104E 00	.11740831E 01	.77038625E 03
-.12697401E 03	.27319241E 00	-.34880808E 00	-.34514780E 00	.49417931E 00	.74408662E 03
-.39329136E 02	.21391054E 00	-.20993995E 00	-.11652370E 00	.13346229E 00	.76689977E 03
-.11710481E 02	.13798719E 00	-.11083512E 00	.74384849E-01	-.96274226E-01	.81738735E 03
.11006550E 01	.78935953E-01	-.42051963E-01	.19246037E 00	-.22829848E 00	.88104488E 03
-.93413353E 01	.42791067E-01	-.17353094E-01	.20420852E 00	-.22581348E 00	.10811896E 04
-.10742368E 02	-.59049817E-02	.31397312E-01	.29854942E 00	-.32018710E 00	.10878430E 04
-.12623905E 02	-.37602019E-01	.62294931E-01	.35353976E 00	-.37424857E 00	.12133060E 04
-.12370330E 02	-.51167161E-01	.73923842E-01	.35542629E 00	-.37468950E 00	.13492072E 04
-.96905399E 01	-.62997888E-01	.85348317E-01	.36240298E 00	-.38225757E 00	.14981158E 04
-.64483227E 01	-.71969329E-01	.94122984E-01	.36633751E 00	-.38694896E 00	.16636620E 04
-.33245052E 01	-.72900400E-01	.93506559E-01	.34423448E 00	-.36407218E 00	.19546301E 04
-.14537411E 01	-.69805897E-01	.88517273E-01	.31533298E 00	-.33369984E 00	.21262848E 04
.23637763E-02	-.68632589E-01	.86053994E-01	.29750517E 00	-.31486331E 00	.20510083E 04
.93166677E 00	-.65498804E-01	.81150513E-01	.27291784E 00	-.28867909E 00	.20170204E 04
.12248824E 01	-.61326448E-01	.75368884E-01	.24911567E 00	-.26329965E 00	.21734396E 04
.13530193E 01	-.58887922E-01	.71928390E-01	.23480570E 00	-.24800156E 00	.23980431E 04
.14771997E 01	-.58175726E-01	.70543551E-01	.22697554E 00	-.23950944E 00	.26020608E 04
.14904019E 01	-.57146455E-01	.68907371E-01	.21933630E 00	-.23125840E 00	.28426557E 04
.14302222E 01	-.55730877E-01	.66897260E-01	.21116403E 00	-.22247897E 00	.31576201E 04
.14170025E 01	-.54243911E-01	.64887553E-01	.20272074E 00	-.21342397E 00	.35037773E 04
.13792675E 01	-.54099625E-01	.64368755E-01	.19980671E 00	-.21020443E 00	.39764657E 04

Table C5. (Continued)

$h_{10,9}$	$h_{11,1}$	$h_{11,2}$	$h_{11,3}$	$h_{11,4}$	$h_{11,7}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
-.20765140E 02	.34715648E 02	-.53414813E 01	-.54999033E-01	-.34906620E-01	.17815159E 00
-.10721372E 02	.71127372E 02	-.28243626E 02	-.11298609E 00	-.71709669E-01	.35598191E 00
-.14175861E 01	.10626391E 03	-.67707914E 02	-.16923124E 00	-.10740717E 00	.54816989E 00
.16455331E 02	.13938716E 03	-.12383202E 03	-.22263798E 00	-.14130320E 00	.72116378E 00
.48399559E 02	.16950212E 03	-.19650801E 03	-.27168247E 00	-.17243061E 00	.88002757E 00
.10210883E 03	.19531417E 03	-.28438276E 03	-.31439325E 00	-.19953816E 00	.10183753E 01
.13613598E 03	.21573042E 03	-.38449828E 03	-.34879210E 00	-.22137032E 00	.11297993E 01
.79199747E 02	.24328790E 03	-.49199636E 03	-.37339559E 00	-.23698559E 00	.12094943E 01
.26341883E 03	.32877360E 03	-.59484236E 03	-.38523421E 00	-.24449929E 00	.12478417E 01
.71963401E 03	.27549530E 03	-.67711683E 03	-.38204024E 00	-.24247215E 00	.12374959E 01
.10384877E 04	.22118018E 03	-.73423549E 03	-.36680656E 00	-.23280368E 00	.11881513E 01
.60735112E 03	.22228621E 03	-.76756203E 03	-.34229505E 00	-.21724679E 00	.11087542E 01
.35152065E 03	.18878975E 03	-.77687731E 03	-.31015668E 00	-.19684931E 00	.10046523E 01
.12636129E 03	.15978862E 03	-.75638588E 03	-.27013393E 00	-.17144779E 00	.87501156E 00
.38716225E 02	.14134806E 03	-.70548259E 03	-.22504128E 00	-.14282852E 00	.72894850E 00
.11180430E 02	.10959720E 03	-.62377788E 03	-.17790738E 00	-.11265985E 00	.57497777E 00
-.15254512E 01	.82861880E 02	-.53798056E 03	-.13662534E 00	-.86712959E-01	.44255362E 00
.90381917E 01	.64406790E 02	-.46012678E 03	-.10444734E 00	-.66290322E-01	.33832340E 00
.10503266E 02	.49942875E 02	-.39067807E 03	-.79481366E-01	-.50444993E-01	.25745419E 00
.12437769E 02	.37972145E 02	-.32988248E 03	-.60345497E-01	-.38299898E-01	.19556973E 00
.12227937E 02	.27929998E 02	-.27483509E 03	-.45367961E-01	-.28794001E-01	.14695485E 00
.95820010E 01	.19816308E 02	-.22645093E 03	-.33852482E-01	-.21485391E-01	.10965418E 00
.63653201E 01	.13792418E 02	-.18520022E 03	-.25169652E-01	-.15974599E-01	.81528953E-01
.32606460E 01	.96469284E 01	-.14999168E 03	-.18651198E-01	-.11837486E-01	.60414529E-01
.14053415E 01	.66199829E 01	-.12070071E 03	-.13822827E-01	-.87730303E-02	.44774581E-01
-.40116843E-01	.42759501E 01	-.97070128E 02	-.10295465E-01	-.65342949E-02	.33348830E-01
-.96070236E 00	.27945397E 01	-.78390470E 02	-.77379933E-02	-.49111263E-02	.25064728E-01
-.12473699E 01	.15199886E 01	-.63727973E 02	-.58799522E-02	-.37318704E-02	.19046205E-01
-.13708353E 01	.44467085E 00	-.52758257E 02	-.45673298E-02	-.28987791E-02	.14794389E-01
-.14914897E 01	-.32741523E 00	-.44071655E 02	-.35921301E-02	-.22798423E-02	.11635545E-01
-.15019601E 01	-.91939742E 00	-.36779130E 02	-.28310395E-02	-.17967956E-02	.91702375E-02
-.14394896E 01	-.13894242E 01	-.30676046E 02	-.22363234E-02	-.14193430E-02	.72438467E-02
-.14251233E 01	-.16656129E 01	-.25545447E 02	-.17688714E-02	-.11221546E-02	.57270959E-02
-.13867844E 01	-.18674648E 01	-.21391000E 02	-.14110894E-02	-.89558594E-03	.45707679E-02

Table C5. (Continued)

$h_{11,8}$	$h_{11,9}$	$h_{12,1}$	$h_{12,2}$	$h_{12,3}$	$h_{12,4}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
-.52205602E 01	.18998785E 01	-.18338853E 02	.15555391E 01	-.18735885E-01	.54098178E-01
-.53037766E 01	.24833552E 02	-.61883225E 02	.13882006E 02	-.78168236E-01	.22968977E 00
-.52564493E 01	.64411389E 02	-.13316889E 03	.47339706E 02	-.18431905E 00	.52864915E 00
-.51666752E 01	.12069213E 03	-.22729000E 03	.11219327E 03	-.34327626E 00	.94844145E 00
-.49944925E 01	.19359115E 03	-.33043054E 03	.21688507E 03	-.56311265E 00	.14867410E 01
-.47603582E 01	.28173277E 03	-.44050281E 03	.36215037E 03	-.85507755E 00	.21117663E 01
-.44519167E 01	.38215194E 03	-.42063446E 03	.54282825E 03	-.12200854E 01	.28072948E 01
-.45210071E 01	.48975214E 03	-.21486342E 03	.68600366E 03	-.17110493E 01	.34923807E 01
-.50818430E 01	.59248145E 03	-.10227966E 04	.83589633E 03	-.21925928E 01	.41428590E 01
-.35088570E 01	.67560067E 03	-.11190562E 04	.11843531E 04	-.24405073E 01	.47408163E 01
-.24078754E 01	.73327335E 03	-.60331204E 03	.14559907E 04	-.26412748E 01	.51372975E 01
-.22601029E 01	.76673164E 03	-.18416947E 03	.13428432E 04	-.29750520E 01	.52329646E 01
-.20995006E 01	.77617183E 03	.21012431E 03	.99071952E 03	-.32978449E 01	.51126016E 01
-.20883038E 01	.75574722E 03	.47491703E 03	.72289220E 03	-.33836038E 01	.48681128E 01
-.17826453E 01	.70498846E 03	.54976385E 03	.49761944E 03	-.32659447E 01	.44695273E 01
-.12103888E 01	.62347484E 03	.54633563E 03	.30129038E 03	-.29602286E 01	.39033533E 01
-.82580728E 00	.53779435E 03	.50306228E 03	.17590252E 03	-.25915403E 01	.33405334E 01
-.58692999E 00	.46000789E 03	.43127128E 03	.10494731E 03	-.22350517E 01	.28445157E 01
-.41619248E 00	.39060250E 03	.36793192E 03	.60594591E 02	-.19077608E 01	.24082294E 01
-.29509784E 00	.32983457E 03	.30925316E 03	.35479758E 02	-.16157119E 01	.20300090E 01
-.20821014E 00	.27480491E 03	.25712341E 03	.20819924E 02	-.13484161E 01	.16895179E 01
-.14406316E 00	.22643235E 03	.21289269E 03	.12096418E 02	-.11121651E 01	.13911593E 01
-.96887402E-01	.18518890E 03	.17539159E 03	.70651446E 01	-.91007158E 00	.11372650E 01
-.65541471E-01	.14998462E 03	.14332118E 03	.42028700E 01	-.73726085E 00	.92082824E 00
-.42752744E-01	.12069646E 03	.11635295E 03	.26738545E 01	-.59334134E 00	.74089027E 00
-.27650061E-01	.97067594E 02	.94680335E 02	.17642388E 01	-.47719308E 00	.59577615E 00
-.18894696E-01	.78388878E 02	.77043006E 02	.12071432E 01	-.38536925E 00	.48109756E 00
-.13527559E-01	.63726928E 02	.63094169E 02	.88911485E 00	-.31328452E 00	.39109856E 00
-.83647192E-02	.52757666E 02	.52589363E 02	.70160166E 00	-.25934409E 00	.32376243E 00
-.53486425E-02	.44071310E 02	.44181590E 02	.57453856E 00	-.21663364E 00	.27094758E 00
-.30061776E-02	.36778953E 02	.37056640E 02	.48512868E 00	-.18077765E 00	.22569040E 00
-.13540725E-02	.30675974E 02	.31051577E 02	.41909764E 00	-.15077125E 00	.18823496E 00
-.56017897E-03	.25545419E 02	.25960984E 02	.36437773E 00	-.12554949E 00	.15675080E 00
.00000000E-80	.21391000E 02	.21808661E 02	.32508830E 00	-.10512679E 00	.13125729E 00

Table C5. (Concluded)

$h_{12,5}$	$h_{12,7}$	$h_{12,8}$	$h_{12,9}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
.14949932E 00	-.20311253E 00	.11412501E 03	-.17159167E 01
.63275738E 00	-.86329785E 00	.60435217E 02	-.15230458E 02
.14627321E 01	-.19859643E 01	.28981368E 01	-.49758614E 02
.26425066E 01	-.35596367E 01	-.55378875E 02	-.11572530E 03
.41694648E 01	-.55577165E 01	-.11432945E 03	-.22165639E 03
.60151530E 01	-.79008042E 01	-.17142334E 03	-.36835139E 03
.81170580E 01	-.10479906E 02	-.22521516E 03	-.55063755E 03
.10377661E 02	-.12979546E 02	-.28040261E 03	-.69491440E 03
.12546320E 02	-.15347674E 02	-.42480608E 03	-.84726099E 03
.14258449E 02	-.17604119E 02	-.41657708E 03	-.12043049E 04
.15446217E 02	-.19083193E 02	-.36867617E 03	-.14758155E 04
.16145598E 02	-.19341852E 02	-.38044169E 03	-.13596889E 04
.16340430E 02	-.18771521E 02	-.32546242E 03	-.10042986E 04
.15911364E 02	-.17795487E 02	-.27331663E 03	-.73354622E 03
.14839226E 02	-.16286166E 02	-.24751884E 03	-.50577772E 03
.13115767E 02	-.14188223E 02	-.20191987E 03	-.30717619E 03
.11308762E 02	-.12123531E 02	-.15920828E 03	-.18006246E 03
.96705574E 01	-.10314011E 02	-.13149222E 03	-.10787618E 03
.82097510E 01	-.87269598E 01	-.10243030E 03	-.62647669E 02
.69313370E 01	-.73538628E 01	-.80236210E 02	-.36916163E 02
.57741210E 01	-.61191813E 01	-.60928771E 02	-.21814242E 02
.47571535E 01	-.50379418E 01	-.44798443E 02	-.12779247E 02
.38902237E 01	-.41181876E 01	-.31989484E 02	-.75321987E 01
.31504234E 01	-.33343035E 01	-.23175392E 02	-.45211398E 01
.25350165E 01	-.26826962E 01	-.16127623E 02	-.28905959E 01
.20385925E 01	-.21572258E 01	-.10188935E 02	-.19124200E 01
.16462341E 01	-.17419778E 01	-.65690396E 01	-.13092330E 01
.13382820E 01	-.14161021E 01	-.37322570E 01	-.96011733E 00
.11078651E 01	-.11722889E 01	-.14082082E 01	-.75198976E 00
.92542478E 00	-.97924535E 00	.32059346E 00	-.61066974E 00
.77226673E 00	-.81718814E 00	.16766883E 01	-.51109080E 00
.64409509E 00	-.68156929E 00	.28233336E 01	-.43766564E 00
.53635832E 00	-.56757104E 00	.35895590E 01	-.37765601E 00
.44912119E 00	-.47526391E 00	.42766735E 01	-.33467616E 00

Table C6. Numerical D Matrix

d_{42}	d_{62}	d_{82}	$d_{10,2}$	$d_{12,2}$	$d_{10,1}$	$d_{12,1}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	-.14282173E 04	.00000000E-80
-.33986178E 05	-.56643630E 05	-.51080417E 05	.78447520E-02	.14949932E 00	.83192611E 02	-.18496970E 03
-.14710854E 06	-.24515089E 06	-.22110063E 06	.31130648E-01	.63275738E 00	.47933647E 02	-.16759934E 03
-.34772610E 06	-.57954351E 06	-.52262406E 06	.67088235E-01	.14627321E 01	.11266247E 02	-.16610380E 03
-.64250597E 06	-.10708433E 07	-.96567118E 06	.11251886E 00	.26425066E 01	-.26885894E 02	-.16356694E 03
-.10376641E 07	-.17294402E 07	-.15595844E 07	.16184411E 00	.41694648E 01	-.68217249E 02	-.15782596E 03
-.15293815E 07	-.25489692E 07	-.22986240E 07	.21869937E 00	.60151530E 01	-.11211079E 03	-.15042732E 03
-.21146400E 07	-.35244000E 07	-.31782536E 07	.28565509E 00	.81170580E 01	-.16134448E 03	-.14068057E 03
-.24857000E 07	-.41428333E 07	-.37359479E 07	.38786881E 00	.10377661E 02	-.21474112E 03	-.14286382E 03
-.23923732E 07	-.39872886E 07	-.35956799E 07	.42196935E 00	.12546320E 02	-.30146404E 03	-.16098624E 03
-.35160512E 07	-.58600853E 07	-.52845412E 07	.44321819E-01	.14258449E 02	-.44432790E 03	-.11087988E 03
-.46862272E 07	-.78103786E 07	-.70432879E 07	-.94182754E 00	.15446217E 02	-.53239105E 03	-.76088864E 02
-.44372282E 07	-.73953804E 07	-.66690484E 07	-.90953304E 00	.16145598E 02	-.57502734E 03	-.71419252E 02
-.40140231E 07	-.66900385E 07	-.60329812E 07	-.64257104E 00	.16340430E 02	-.62092267E 03	-.66344221E 02
-.36702017E 07	-.61170028E 07	-.55162257E 07	-.34514780E 00	.15911364E 02	-.67771655E 03	-.65990400E 02
-.30341272E 07	-.50568787E 07	-.45602209E 07	-.11652370E 00	.14839426E 02	-.73812718E 03	-.56331592E 02
-.24978394E 07	-.41630656E 07	-.37541931E 07	.74384849E-01	.13115767E 02	-.80397119E 03	-.38248287E 02
-.20162926E 07	-.33604876E 07	-.30304397E 07	.19246037E 00	.11308762E 02	-.87911287E 03	-.26095510E 02
-.15807341E 07	-.26345568E 07	-.23758057E 07	.20420852E 00	.96705574E 01	-.10613851E 04	-.18546988E 02
-.12545690E 07	-.20909484E 07	-.18855874E 07	.29854942E 00	.82097510E 01	-.10568867E 04	-.13151682E 02
-.10166676E 07	-.16949461E 07	-.15280272E 07	.35353976E 00	.69313370E 01	-.11623184E 04	-.93250918E 01
-.81390379E 06	-.13565063E 07	-.12232780E 07	.35542629E 00	.57741210E 01	-.12775317E 04	-.65794405E 01
-.65284701E 06	-.10880783E 07	-.98121351E 06	.36240598E 00	.47571535E 01	-.14108578E 04	-.49523957E 01
-.52226468E 06	-.87044114E 06	-.78495139E 06	.36633751E 00	.38902637E 01	-.15651825E 04	-.30616419E 01
-.40248516E 06	-.67080861E 06	-.60492562E 06	.34423448E 00	.31504234E 01	-.18509604E 04	-.28711105E 01
-.31852475E 06	-.53087459E 06	-.47873512E 06	.31533598E 00	.25350165E 01	-.20232948E 04	-.13509867E 01
-.25537415E 06	-.42566358E 06	-.38382126E 06	.29750517E 00	.20385925E 01	-.19610277E 04	-.87374193E 00
-.19425528E 06	-.32375880E 06	-.29196106E 06	.27291784E 00	.16462341E 01	-.19419240E 04	-.59707239E 00
-.15341901E 06	-.25569835E 06	-.23058512E 06	.24911567E 00	.13382820E 01	-.21061009E 04	-.42747085E 00
-.12806329E 06	-.21343881E 06	-.19247607E 06	.23480570E 00	.11078651E 01	-.23338432E 04	-.26432513E 00
-.10482732E 06	-.17471219E 06	-.15755296E 06	.22697554E 00	.92542478E 00	-.25424992E 04	-.16901710E 00
-.87375045E 05	-.14562508E 06	-.13132261E 06	.21933630E 00	.77226674E 00	-.27867341E 04	-.94995213E-01
-.73523223E 05	-.12253870E 06	-.11050365E 06	.21116403E 00	.64409589E 00	-.31046729E 04	-.42788691E-01
-.59510819E 05	-.99184699E 05	-.89443345E 05	.20272074E 00	.53635832E 00	-.34520603E 04	-.17701655E-01
-.49256785E 05	-.62094641E 05	-.74031775E 05	.19980671E 00	.44912119E 00	-.39266394E 04	.00000000E-80

Table C7. Retabulated Reference Trajectory Data

TIME(SEC)	MACH NUMBER	V(FT/SEC)	Q(LB/FT2)	GAMA(RAD)	R(FEET)	THRUST(LB)	WEIGHT(LB)
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.15707963E 01	.20909836E 08	.51999999E 07	.35000000E 07
.50000000E 01	.71263973E-01	.80699572E 02	.73357528E 01	.15676379E 01	.20910033E 08	.52058045E 07	.34319256E 07
.10000000E 02	.14351522E 00	.16624176E 03	.31062154E 02	.15689525E 01	.20910653E 08	.52240028E 07	.33638514E 07
.15000000E 02	.22569208E 00	.25657370E 03	.71778342E 02	.15561124E 01	.20911707E 08	.52541773E 07	.32957771E 07
.20000000E 02	.31340000E 00	.35232600E 03	.12059300E 03	.14978241E 01	.20913224E 08	.52960620E 07	.32277027E 07
.25000000E 02	.40738400E 00	.45556101E 03	.20422135E 03	.14217918E 01	.20915227E 08	.53485860E 07	.31596284E 07
.30000000E 02	.51233025E 00	.56793853E 03	.29415151E 03	.13450025E 01	.20917734E 08	.54100148E 07	.30915541E 07
.35000000E 02	.62810000E 00	.69081200E 03	.39516800E 03	.12718040E 01	.20920769E 08	.54783240E 07	.30234798E 07
.40000000E 02	.75950000E 00	.82500800E 03	.50528700E 03	.12034743E 01	.20924343E 08	.55509171E 07	.29554055E 07
.45000000E 02	.90331193E 00	.96676160E 03	.60995063E 03	.11345602E 01	.20928467E 08	.56251042E 07	.28873312E 07
.50000000E 02	.10546586E 01	.11078757E 04	.69034707E 03	.10650814E 01	.20933087E 08	.56975362E 07	.28192569E 07
.55000000E 02	.12179218E 01	.12500083E 04	.74559326E 03	.99596691E 00	.20938136E 08	.57652369E 07	.27511826E 07
.60000000E 02	.14007800E 01	.14001720E 04	.77749300E 03	.92757268E 00	.20943564E 08	.58263723E 07	.26831083E 07
.65000000E 02	.16086496E 01	.15639045E 04	.78517085E 03	.86066282E 00	.20949331E 08	.58797317E 07	.26150341E 07
.70000000E 02	.18407917E 01	.17484618E 04	.76390097E 03	.79607360E 00	.20955420E 08	.59244267E 07	.25469596E 07
.75000000E 02	.20878000E 01	.19573880E 04	.71091200E 03	.73459163E 00	.20961825E 08	.59602436E 07	.24788854E 07
.80000000E 02	.23281775E 01	.21933360E 04	.64692608E 03	.67676374E 00	.20968538E 08	.59874456E 07	.24108111E 07
.85000000E 02	.25749649E 01	.24570369E 04	.53981550E 03	.62291820E 00	.20975556E 08	.60071321E 07	.23427367E 07
.90000000E 02	.28429080E 01	.27484130E 04	.46124000E 03	.57314867E 00	.20982868E 08	.60211780E 07	.22746625E 07
.95000000E 02	.31353786E 01	.30661439E 04	.39137036E 03	.52736866E 00	.20990455E 08	.60309425E 07	.22065882E 07
.10000000E 03	.34581419E 01	.34095731E 04	.33032523E 03	.48539838E 00	.20998290E 08	.60389036E 07	.21385135E 07
.10500000E 03	.37984000E 01	.37780220E 04	.27512000E 03	.44696137E 00	.21006351E 08	.60429349E 07	.20704396E 07
.11000000E 03	.41340986E 01	.41714257E 04	.22663366E 03	.41181889E 00	.21014612E 08	.60555291E 07	.20023613E 07
.11500000E 03	.44885733E 01	.45880192E 04	.18531610E 03	.37968002E 00	.21023042E 08	.59448291E 07	.19345307E 07
.12000000E 03	.48395000E 01	.50140660E 04	.15006600E 03	.35025267E 00	.21031599E 08	.57475769E 07	.18665113E 07
.12500000E 03	.51836889E 01	.54439205E 04	.12074742E 03	.32317312E 00	.21040227E 08	.55103832E 07	.18052963E 07
.13000000E 03	.55289737E 01	.58777667E 04	.97099517E 02	.29819422E 00	.21048870E 08	.53073874E 07	.17424007E 07
.13500000E 03	.58748000E 01	.63152580E 04	.78410000E 02	.27504644E 00	.21057478E 08	.51145021E 07	.16857015E 07
.14000000E 03	.62377461E 01	.67561875E 04	.63741717E 02	.25357055E 00	.21066008E 08	.49330885E 07	.16291264E 07
.14500000E 03	.66621198E 01	.72003297E 04	.52766682E 02	.23358041E 00	.21074410E 08	.47612036E 07	.15745382E 07
.15000000E 03	.71359000E 01	.76474550E 04	.44077000E 02	.21493730E 00	.21082661E 08	.45966115E 07	.15218495E 07
.15500000E 03	.76382649E 01	.80974683E 04	.36782120E 02	.19752322E 00	.21090673E 08	.44383696E 07	.14709586E 07
.16000000E 03	.81656911E 01	.85495499E 04	.30677388E 02	.18127864E 00	.21098765E 08	.42867136E 07	.14219571E 07
.16500000E 03	.87173000E 01	.90049870E 04	.25546000E 02	.16599826E 00	.21106118E 08	.41404768E 07	.13744078E 07
.17000000E 03	.92784089E 01	.94479350E 04	.21391000E 02	.15214035E 00	.21113189E 08	.40043459E 07	.13299904E 07

Table C7. (Continued)

TIME(SEC)	DW/DT	IYY(SLUG-FT2)	I_{xx}	I_{zz}	I_{xz}	XCM(FEET)	Z_{cm}
.00000000E-80	-.13614800E 05	.37133000E 09	.30492000E 08	.36551000E 09	.47500000E 08	.91050000E 02	.77400000E 01
.50000000E 01	-.13614853E 05	.36340000E 09	.30363000E 08	.35771000E 09	.46102941E 08	.92250000E 02	.79000000E 01
.10000000E 02	-.13614882E 05	.35555000E 09	.30227000E 08	.34999000E 09	.44705882E 08	.93460000E 02	.80600000E 01
.15000000E 02	-.13614847E 05	.34785000E 09	.30087000E 08	.34244000E 09	.43308824E 08	.94680000E 02	.82200000E 01
.20000000E 02	-.13614879E 05	.34022000E 09	.29940000E 08	.33495000E 09	.41911765E 08	.95910000E 02	.84000000E 01
.25000000E 02	-.13614898E 05	.33254000E 09	.29787000E 08	.32743000E 09	.40514706E 08	.97170000E 02	.85800000E 01
.30000000E 02	-.13614848E 05	.32501000E 09	.29628000E 08	.32005000E 09	.39117647E 08	.98430000E 02	.87700000E 01
.35000000E 02	-.13614866E 05	.31741000E 09	.29461000E 08	.31262000E 09	.37720588E 08	.99710000E 02	.89700000E 01
.40000000E 02	-.13614862E 05	.30980000E 09	.29286000E 08	.30518000E 09	.36323529E 08	.10102000E 03	.91700000E 01
.45000000E 02	-.13614864E 05	.30217000E 09	.29103000E 08	.29774000E 09	.34926471E 08	.10235000E 03	.93900000E 01
.50000000E 02	-.13614847E 05	.29447000E 09	.28912000E 08	.29023000E 09	.33529412E 08	.10371000E 03	.96200000E 01
.55000000E 02	-.13614877E 05	.28672000E 09	.28710000E 08	.28268000E 09	.32132353E 08	.10515000E 03	.98600000E 01
.60000000E 02	-.13614839E 05	.27889000E 09	.28499000E 08	.27508000E 09	.30735294E 08	.10657000E 03	.10110000E 02
.65000000E 02	-.13614864E 05	.27096000E 09	.28276000E 08	.26735000E 09	.29338235E 08	.10798000E 03	.10370000E 02
.70000000E 02	-.13614885E 05	.26282000E 09	.28042000E 08	.25955000E 09	.27941176E 08	.10947000E 03	.10650000E 02
.75000000E 02	-.13614837E 05	.25475000E 09	.27795000E 08	.25163000E 09	.26544118E 08	.11102000E 03	.10950000E 02
.80000000E 02	-.13614880E 05	.24642000E 09	.27533000E 08	.24356000E 09	.25147059E 08	.11261000E 03	.11260000E 02
.85000000E 02	-.13614862E 05	.23791000E 09	.27256000E 08	.23532000E 09	.23750000E 08	.11425000E 03	.11580000E 02
.90000000E 02	-.13614825E 05	.22322000E 09	.26936000E 08	.22693000E 09	.22352941E 08	.11596000E 03	.11930000E 02
.95000000E 02	-.13614915E 05	.22031000E 09	.26652000E 08	.21833000E 09	.20955882E 08	.11773000E 03	.12300000E 02
.10000000E 03	-.13614814E 05	.21117000E 09	.26320000E 08	.20952000E 09	.19558824E 08	.11967000E 03	.12700000E 02
.10500000E 03	-.13615914E 05	.20173000E 09	.25967000E 08	.20044000E 09	.18161765E 08	.12150000E 03	.13120000E 02
.11000000E 03	-.13612296E 05	.19200000E 09	.25589000E 08	.19108000E 09	.16764706E 08	.12351000E 03	.13560000E 02
.11500000E 03	-.13452780E 05	.18064226E 09	.25192415E 08	.18160964E 09	.15367647E 08	.12558373E 03	.14031839E 02
.12000000E 03	-.12919420E 05	.16431352E 09	.24779173E 08	.17211873E 09	.13970588E 08	.12770308E 03	.14525458E 02
.12500000E 03	-.12392889E 05	.15287771E 09	.24348751E 08	.16257236E 09	.12573529E 08	.12987543E 03	.15036091E 02
.13000000E 03	-.11963160E 05	.14873507E 09	.23901617E 08	.15295547E 09	.11176471E 08	.13209437E 03	.15563566E 02
.13500000E 03	-.11521024E 05	.14319531E 09	.23439302E 08	.14328875E 09	.97794118E 07	.13434102E 03	.16112358E 02
.14000000E 03	-.11112909E 05	.13271639E 09	.22958454E 08	.13359002E 09	.83823529E 07	.13662400E 03	.16685039E 02
.14500000E 03	-.10724635E 05	.12135563E 09	.22449808E 08	.12386975E 09	.69852941E 07	.13898768E 03	.17281279E 02
.15000000E 03	-.10358926E 05	.11118505E 09	.21924469E 08	.11411899E 09	.55882353E 07	.14143457E 03	.17899577E 02
.15500000E 03	-.99846827E 04	.10105767E 09	.21419331E 08	.10430699E 09	.41911765E 07	.14391083E 03	.18537247E 02
.16000000E 03	-.96637393E 04	.90611830E 08	.20925013E 08	.94514347E 08	.27941176E 07	.14640497E 03	.19194521E 02
.16500000E 03	-.90315253E 04	.80741080E 08	.20370435E 08	.84956142E 08	.13970588E 07	.14896325E 03	.19875376E 02
.17000000E 03	-.95587525E 04	.70614292E 08	.19709667E 08	.75380542E 08	.00000000E-80	.15154471E 03	.20577800E 02

Table C7. (Concluded)

TIME(SEC)	θ_o	ϕ_o	$\dot{\gamma}_o$
.00000000E-80	.156155E 01	-.925025E-02	-.829977E-03
.50000000E 01	.155813E 01	-.951153E-02	-.245741E-03
.10000000E 02	.156058E 01	-.837053E-02	.252946E-03
.15000000E 02	.153979E 01	-.163191E-01	-.676157E-02
.20000000E 02	.146649E 01	-.313296E-01	-.146632E-01
.25000000E 02	.138831E 01	-.334858E-01	-.155121E-01
.30000000E 02	.132879E 01	-.162107E-01	-.150493E-01
.35000000E 02	.126778E 01	-.402818E-02	-.140857E-01
.40000000E 02	.119785E 01	-.562295E-02	-.135885E-01
.45000000E 02	.112018E 01	-.143753E-01	-.139067E-01
.50000000E 02	.104276E 01	-.223243E-01	-.138491E-01
.55000000E 02	.975836E 00	-.201309E-01	-.137819E-01
.60000000E 02	.918401E 00	-.917139E-02	-.135550E-01
.65000000E 02	.861390E 00	.727108E-03	-.131788E-01
.70000000E 02	.799559E 00	.348499E-02	-.126311E-01
.75000000E 02	.736354E 00	.176200E-02	-.119439E-01
.80000000E 02	.674571E 00	-.219303E-02	-.111758E-01
.85000000E 02	.615547E 00	-.737141E-02	-.103611E-01
.90000000E 02	.559856E 00	-.132927E-01	-.954982E-02
.95000000E 02	.506750E 00	-.206182E-01	-.876794E-02
.10000000E 03	.453905E 00	-.314932E-01	-.803059E-02
.10500000E 03	.397841E 00	-.491201E-01	-.735039E-02
.11000000E 03	.345105E 00	-.667141E-01	-.671767E-02
.11500000E 03	.309578E 00	-.701023E-01	-.614686E-02
.12000000E 03	.290189E 00	-.600641E-01	-.563896E-02
.12500000E 03	.266438E 00	-.567349E-01	-.519871E-02
.13000000E 03	.229375E 00	-.688188E-01	-.480318E-02
.13500000E 03	.186608E 00	-.884386E-01	-.445871E-02
.14000000E 03	.147316E 00	-.106254E 00	-.413977E-02
.14500000E 03	.120881E 00	-.112699E 00	-.385986E-02
.15000000E 03	.106916E 00	-.108022E 00	-.360281E-02
.15500000E 03	.835837E-01	-.113940E 00	-.336217E-02
.16000000E 03	.436393E-01	-.137639E 00	-.315020E-02
.16500000E 03	.236275E-02	-.163636E 00	-.289464E-02
.17000000E 03	-.236143E-01	-.175755E 00	-.279137E-02

Table C8. Pitch Damper (c1) Covariance Results

MEAN RESPONSES (1)

$\tilde{t}$	DELTA	DDELTA	NSUBIT	DNSUBIT	QALF	QDALF	DZ	Z
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.137E-05	.102E-03	.108E-02	.236E-02	.457E-02	.349E-02	-.915E-03	-.877E-03
3	-.102E-02	-.758E-03	.105E-01	-.699E-02	.361E 00	.979E-01	-.531E-01	-.112E 00
4	-.324E-02	-.655E-03	.603E-02	-.144E-01	.116E 01	.231E 00	.884E-01	-.246E 00
5	-.604E-02	.824E-04	-.217E-01	-.195E-01	.228E 01	.473E 00	.127E 01	.240E 01
6	-.872E-02	.111E-02	-.802E-01	-.207E-01	.347E 01	.885E 00	.483E 01	.162E 02
7	-.107E-01	.217E-02	-.147E 00	-.679E-02	.455E 01	.155E 01	.124E 02	.569E 02
8	-.126E-01	.274E-02	-.302E 00	.124E-01	.527E 01	.242E 01	.256E 02	.148E 03
9	-.140E-01	.361E-02	-.662E 00	.819E-01	.577E 01	.363E 01	.468E 02	.324E 03
10	-.108E-01	.533E-02	-.391E 00	.477E-01	.843E 01	.572E 01	.759E 02	.627E 03
11	-.131E-01	.298E-02	.747E-01	-.929E-01	.993E 01	.556E 01	.109E 03	.109E 04
12	-.154E-01	.324E-02	-.484E 00	-.425E 00	.829E 01	.638E 01	.148E 03	.172E 04
13	-.154E-01	.499E-02	-.132E 01	-.615E 00	.759E 01	.913E 01	.200E 03	.259E 04
14	-.123E-01	.534E-02	-.174E 01	-.207E 00	.644E 01	.561E 01	.265E 03	.374E 04
15	-.631E-02	.383E-02	-.180E 01	.280E 00	.353E 01	-.217E 01	.343E 03	.526E 04
16	-.743E-03	.197E-02	-.142E 01	.331E 00	.788E 00	-.754E 01	.430E 03	.718E 04
17	.168E-02	.387E-03	-.868E 00	.134E 00	-.721E 00	-.796E 01	.523E 03	.956E 04
18	.104E-02	-.163E-03	-.349E 00	.817E-02	-.551E 00	-.549E 01	.620E 03	.124E 05
19	-.772E-03	.687E-04	.334E-01	.342E-02	.688E 00	-.226E 01	.721E 03	.158E 05
20	-.183E-02	.596E-03	.259E 00	.215E-01	.196E 01	.155E 00	.827E 03	.196E 05
21	-.226E-02	.884E-03	.404E 00	.752E-01	.297E 01	.162E 01	.939E 03	.240E 05
22	-.214E-02	.986E-03	.466E 00	.104E 00	.347E 01	.195E 01	.106E 04	.290E 05
23	-.167E-02	.945E-03	.474E 00	.899E-01	.342E 01	.145E 01	.118E 04	.346E 05
24	-.110E-02	.761E-03	.450E 00	.545E-01	.305E 01	.803E 00	.132E 04	.409E 05
25	-.611E-03	.524E-03	.407E 00	.233E-01	.258E 01	.362E 00	.145E 04	.478E 05
26	-.311E-03	.296E-03	.362E 00	-.775E-02	.210E 01	.398E-01	.159E 04	.554E 05
27	-.890E-04	.189E-03	.332E 00	.385E-03	.173E 01	.356E-01	.172E 04	.636E 05
28	.115E-03	.115E-03	.302E 00	.923E-03	.144E 01	.335E-01	.186E 04	.726E 05
29	.234E-03	.920E-05	.280E 00	.487E-02	.121E 01	.166E-01	.200E 04	.822E 05
30	.308E-03	-.433E-04	.267E 00	.768E-02	.104E 01	.165E-01	.213E 04	.926E 05
31	.396E-03	-.572E-04	.255E 00	-.379E-02	.899E 00	.155E-01	.227E 04	.104E 06
32	.455E-03	-.977E-04	.244E 00	.217E-02	.775E 00	.114E-01	.241E 04	.115E 06
33	.487E-03	-.126E-03	.231E 00	.181E-02	.667E 00	.139E-01	.254E 04	.128E 06
34	.513E-03	-.137E-03	.236E 00	.170E-02	.571E 00	.741E-02	.268E 04	.141E 06
35	.532E-03	-.147E-03	.254E 00	.157E-02	.491E 00	.656E-02	.281E 04	.154E 06

Table C8. (Continued)

MEAN RESPONSES (1)

$\tilde{t}$	IB1	DIB1	IB2	DIB2	IB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.876E 04	-.226E 05	-.136E 05	-.110E 06	-.115E 05	-.153E 06
3	-.919E 05	.633E 05	.567E 06	.858E 06	.105E 07	.134E 07
4	-.299E 06	.776E 05	.180E 07	.126E 07	.333E 07	.201E 07
5	-.653E 06	.367E 05	.319E 07	.129E 07	.607E 07	.208E 07
6	-.110E 07	-.622E 05	.434E 07	.964E 06	.853E 07	.167E 07
7	-.158E 07	-.237E 06	.494E 07	.340E 06	.101E 08	.852E 06
8	-.193E 07	-.410E 06	.570E 07	.511E 05	.118E 08	.597E 06
9	-.188E 07	-.672E 06	.680E 07	-.700E 06	.136E 08	-.313E 06
10	-.250E 07	-.122E 07	.351E 07	-.350E 07	.890E 07	-.425E 07
11	-.400E 07	-.974E 06	.260E 07	-.940E 06	.927E 07	-.347E 06
12	-.403E 07	-.127E 07	.421E 07	-.115E 07	.120E 08	-.301E 06
13	-.318E 07	-.201E 07	.558E 07	-.362E 07	.132E 08	-.344E 07
14	-.220E 07	-.155E 07	.505E 07	-.376E 07	.111E 08	-.427E 07
15	-.102E 07	-.338E 06	.277E 07	-.194E 07	.584E 07	-.276E 07
16	-.177E 06	.667E 06	.232E 06	-.137E 06	.602E 06	-.104E 07
17	.173E 06	.112E 07	-.900E 06	.123E 07	-.170E 07	.640E 06
18	.125E 06	.863E 06	-.525E 06	.133E 07	-.102E 07	.112E 07
19	-.139E 06	.327E 06	.314E 06	.660E 06	.692E 06	.682E 06
20	-.408E 06	-.566E 05	.614E 06	-.126E 06	.152E 07	-.139E 06
21	-.629E 06	-.257E 06	.548E 06	-.572E 06	.169E 07	-.625E 06
22	-.738E 06	-.300E 06	.287E 06	-.744E 06	.139E 07	-.852E 06
23	-.744E 06	-.240E 06	-.602E 05	-.717E 06	.827E 06	-.890E 06
24	-.681E 06	-.150E 06	-.359E 06	-.557E 06	.256E 06	-.731E 06
25	-.574E 06	-.821E 05	-.524E 06	-.378E 06	-.150E 06	-.522E 06
26	-.475E 06	-.280E 05	-.571E 06	-.190E 06	-.350E 06	-.279E 06
27	-.404E 06	-.220E 05	-.611E 06	-.151E 06	-.594E 06	-.222E 06
28	-.335E 06	-.194E 05	-.640E 06	-.138E 06	-.638E 06	-.203E 06
29	-.287E 06	-.116E 05	-.644E 06	-.748E 05	-.704E 06	-.110E 06
30	-.258E 06	-.730E 04	-.648E 06	-.479E 05	-.747E 06	-.690E 05
31	-.231E 06	-.866E 04	-.665E 06	-.573E 05	-.809E 06	-.840E 05
32	-.210E 06	-.581E 04	-.672E 06	-.372E 05	-.846E 06	-.540E 05
33	-.191E 06	-.333E 04	-.662E 06	-.196E 05	-.855E 06	-.283E 05
34	-.169E 06	-.277E 04	-.644E 06	-.162E 05	-.852E 06	-.231E 05
35	-.152E 06	-.220E 04	-.630E 06	-.121E 05	-.850E 06	-.173E 05

Table C8. (Continued)

RESPONSE COVARIANCES (1)

$\tilde{t}$	DELTA	DELTA*DELTA	DDELTA	DZDOT	DELO	$\Delta\gamma$	$\Delta\theta$	ΔZ
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.214E-08	.111E-06	.873E-05	.764E-03	.313E-08	.113E-06	.757E-07	.112E-02
3	.589E-04	-.274E-05	.217E-04	.241E-01	.104E-04	.889E-06	.662E-04	.128E 01
4	.894E-04	-.188E-04	.100E-03	.793E 01	.156E-04	.122E-03	.736E-03	.138E 02
5	.108E-03	-.287E-04	.247E-03	.165E 03	.188E-04	.853E-03	.223E-02	.115E 04
6	.121E-03	-.374E-04	.498E-03	.521E 03	.211E-04	.254E-02	.470E-02	.129E 05
7	.128E-03	-.493E-04	.100E-02	.169E 04	.222E-04	.529E-02	.815E-02	.730E 05
8	.145E-03	-.662E-04	.198E-02	.433E 04	.253E-04	.915E-02	.126E-01	.284E 06
9	.159E-03	-.877E-04	.306E-02	.959E 04	.277E-04	.142E-01	.182E-01	.879E 06
10	.841E-04	-.812E-04	.271E-02	.186E 05	.144E-04	.200E-01	.236E-01	.231E 07
11	.119E-03	-.135E-03	.721E-02	.313E 05	.208E-04	.256E-01	.289E-01	.528E 07
12	.191E-03	-.285E-03	.170E-01	.488E 05	.336E-04	.314E-01	.354E-01	.108E 08
13	.201E-03	-.300E-03	.163E-01	.739E 05	.350E-04	.378E-01	.422E-01	.203E 08
14	.168E-03	-.245E-03	.121E-01	.109E 06	.291E-04	.447E-01	.483E-01	.361E 08
15	.121E-03	-.168E-03	.777E-02	.157E 06	.208E-04	.514E-01	.534E-01	.610E 08
16	.692E-04	-.874E-04	.353E-02	.220E 06	.119E-04	.577E-01	.580E-01	.993E 08
17	.395E-04	-.405E-04	.138E-02	.303E 06	.678E-05	.633E-01	.624E-01	.156E 09
18	.233E-04	-.189E-04	.494E-03	.410E 06	.399E-05	.682E-01	.664E-01	.239E 09
19	.130E-04	-.917E-05	.172E-03	.545E 06	.224E-05	.725E-01	.699E-01	.357E 09
20	.718E-05	-.468E-05	.556E-04	.712E 06	.123E-05	.761E-01	.728E-01	.522E 09
21	.400E-05	-.240E-05	.188E-04	.915E 06	.684E-06	.791E-01	.751E-01	.748E 09
22	.221E-05	-.128E-05	.671E-05	.116E 07	.378E-06	.815E-01	.769E-01	.105E 10
23	.111E-05	-.680E-06	.232E-05	.145E 07	.189E-06	.834E-01	.783E-01	.145E 10
24	.478E-06	-.327E-06	.741E-06	.178E 07	.811E-07	.850E-01	.792E-01	.197E 10
25	.162E-06	-.131E-06	.216E-06	.216E 07	.273E-07	.862E-01	.799E-01	.265E 10
26	.482E-07	-.428E-07	.572E-07	.257E 07	.807E-08	.872E-01	.802E-01	.350E 10
27	.430E-08	-.874E-08	.187E-07	.303E 07	.668E-09	.879E-01	.804E-01	.455E 10
28	.786E-08	.761E-08	.818E-08	.352E 07	.148E-08	.884E-01	.804E-01	.585E 10
29	.337E-07	.147E-08	.220E-08	.404E 07	.599E-08	.888E-01	.802E-01	.743E 10
30	.607E-07	-.812E-08	.337E-08	.460E 07	.106E-07	.890E-01	.799E-01	.933E 10
31	.103E-06	-.144E-07	.408E-08	.520E 07	.181E-07	.891E-01	.796E-01	.116E 11
32	.139E-06	-.291E-07	.744E-08	.583E 07	.243E-07	.891E-01	.792E-01	.143E 11
33	.162E-06	-.412E-07	.112E-07	.650E 07	.282E-07	.891E-01	.788E-01	.174E 11
34	.182E-06	-.480E-07	.129E-07	.720E 07	.317E-07	.889E-01	.783E-01	.210E 11
35	.198E-06	-.542E-07	.149E-07	.791E 07	.344E-07	.887E-01	.778E-01	.251E 11

Table C8. (Continued)

RESPONSE COVARIANCES (1)

$\tilde{t}$	NIT	NIT*DNIT	DNIT	QALF	QALF*DQALF	DQALF
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.648E-03	.146E-02	.331E-02	.116E-01	.490E-02	.529E-02
3	.298E-02	.338E-02	.577E-02	.577E 01	.289E-01	.194E 00
4	.210E-01	.394E-02	.734E-02	.978E 01	.311E 00	.146E 01
5	.254E-01	.159E-02	.276E-01	.135E 02	.904E 00	.633E 01
6	.481E-01	.291E-02	.900E-01	.172E 02	.163E 01	.222E 02
7	.132E 00	.657E-02	.279E 00	.214E 02	.241E 01	.723E 02
8	.250E 00	.111E-01	.636E 00	.243E 02	.301E 01	.192E 03
9	.328E 00	.179E-01	.104E 01	.267E 02	.363E 01	.422E 03
10	.736E 00	-.133E-01	.229E 01	.508E 02	.602E 01	.876E 03
11	.187E 01	-.152E 00	.720E 01	.641E 02	-.432E 01	.186E 04
12	.183E 01	-.598E 00	.357E 02	.474E 02	-.603E 01	.361E 04
13	.157E 01	-.426E 00	.378E 02	.409E 02	.316E 01	.586E 04
14	.158E 01	-.363E 00	.217E 02	.368E 02	.114E 02	.660E 04
15	.117E 01	-.254E 00	.720E 01	.260E 02	.963E 01	.470E 04
16	.704E 00	-.841E-01	.221E 01	.188E 02	.608E 00	.276E 04
17	.434E 00	-.105E-01	.978E 00	.142E 02	-.410E 01	.159E 04
18	.299E 00	-.519E-03	.651E 00	.110E 02	-.317E 01	.940E 03
19	.242E 00	-.317E-02	.445E 00	.898E 01	-.150E 01	.556E 03
20	.214E 00	-.160E-02	.494E 00	.774E 01	-.556E 00	.330E 03
21	.207E 00	-.141E-02	.533E 00	.678E 01	-.172E 00	.197E 03
22	.191E 00	-.196E-02	.448E 00	.574E 01	-.647E-01	.116E 03
23	.178E 00	-.246E-02	.396E 00	.468E 01	-.314E-01	.681E 02
24	.161E 00	-.236E-02	.349E 00	.374E 01	-.793E-02	.395E 02
25	.146E 00	-.227E-02	.262E 00	.292E 01	.692E-02	.220E 02
26	.127E 00	-.118E-02	.177E 00	.221E 01	.853E-02	.115E 02
27	.113E 00	-.100E-02	.123E 00	.165E 01	.837E-02	.582E 01
28	.962E-01	-.103E-02	.808E-01	.122E 01	.824E-02	.296E 01
29	.836E-01	-.333E-03	.524E-01	.912E 00	.606E-02	.152E 01
30	.751E-01	-.122E-03	.342E-01	.694E 00	.434E-02	.765E 00
31	.672E-01	-.467E-03	.208E-01	.533E 00	.351E-02	.348E 00
32	.608E-01	-.203E-03	.110E-01	.404E 00	.263E-02	.138E 00
33	.536E-01	.442E-05	.502E-02	.304E 00	.186E-02	.470E-01
34	.571E-01	.159E-04	.177E-02	.226E 00	.133E-02	.125E-01
35	.682E-01	.107E-03	.302E-03	.168E 00	.952E-03	.155E-02

Table C8. (Concluded)

RESPONSE COVARIANCES (1)

$\tilde{t}$	IB1	IB1*DIB1	DIB1	IB2	IB2*DIB2	DIB2	IB3	IB3*DIB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.581E 11	.139E 12	.334E 12	.184E 12	.130E 13	.937E 13	.166E 12	.175E 13	.187E 14
3	.181E 12	-.929E 11	.236E 12	.225E 14	.788E 13	.190E 14	.695E 14	.211E 14	.434E 14
4	.455E 12	-.104E 12	.933E 12	.315E 14	.329E 13	.723E 14	.191E 15	.100E 14	.166E 15
5	.889E 12	-.137E 12	.248E 13	.342E 14	-.719E 12	.179E 15	.116E 15	.144E 13	.409E 15
6	.151E 13	-.212E 12	.567E 13	.345E 14	-.578E 13	.366E 15	.123E 15	-.882E 13	.834E 15
7	.240E 13	-.382E 12	.134E 14	.319E 14	-.158E 14	.749E 15	.122E 15	-.295E 14	.170E 16
8	.323E 13	-.906E 12	.305E 14	.352E 14	-.312E 14	.159E 16	.136E 15	-.587E 14	.338E 16
9	.306E 13	-.147E 13	.525E 14	.432E 14	-.506E 14	.233E 16	.157E 15	-.971E 14	.524E 16
10	.461E 13	-.440E 12	.571E 14	.124E 14	-.495E 14	.209E 16	.617E 14	-.107E 15	.464E 16
11	.109E 14	-.325E 13	.169E 15	.126E 14	-.110E 15	.564E 16	.718E 14	-.218E 15	.125E 17
12	.124E 14	-.907E 13	.433E 15	.339E 14	-.261E 15	.134E 17	.145E 15	-.511E 15	.295E 17
13	.862E 13	-.104E 14	.512E 15	.492E 14	-.280E 15	.131E 17	.181E 15	-.545E 15	.286E 17
14	.545E 13	-.903E 13	.446E 15	.468E 14	-.223E 15	.987E 16	.163E 15	-.435E 15	.212E 17
15	.289E 13	-.577E 13	.297E 15	.366E 14	-.143E 15	.636E 16	.124E 15	-.284E 15	.136E 17
16	.141E 13	-.241E 13	.144E 15	.206E 14	-.667E 14	.291E 16	.706E 14	-.136E 15	.621E 16
17	.852E 12	-.966E 12	.703E 14	.106E 14	-.273E 14	.118E 16	.385E 14	-.564E 14	.246E 16
18	.562E 12	-.368E 12	.343E 14	.550E 13	-.107E 14	.445E 15	.215E 14	-.226E 14	.897E 15
19	.405E 12	-.120E 12	.164E 14	.252E 13	-.411E 13	.166E 15	.110E 14	-.913E 13	.319E 15
20	.336E 12	-.267E 11	.826E 13	.961E 12	-.159E 13	.612E 14	.523E 13	-.388E 13	.109E 15
21	.304E 12	.174E 10	.440E 13	.279E 12	-.587E 12	.249E 14	.231E 13	-.162E 13	.398E 14
22	.260E 12	.950E 10	.236E 13	.524E 11	-.204E 12	.110E 14	.953E 12	-.763E 12	.157E 14
23	.222E 12	.116E 11	.130E 13	.565E 10	-.393E 11	.536E 13	.279E 12	-.294E 12	.633E 13
24	.187E 12	.108E 11	.718E 12	.547E 11	.361E 11	.242E 13	.269E 11	-.798E 11	.261E 13
25	.144E 12	.825E 10	.362E 12	.122E 12	.583E 11	.111E 13	.108E 11	.203E 11	.107E 13
26	.113E 12	.497E 10	.183E 12	.165E 12	.457E 11	.534E 12	.626E 11	.412E 11	.474E 12
27	.905E 11	.396E 10	.915E 11	.207E 12	.463E 11	.265E 12	.141E 12	.569E 11	.231E 12
28	.663E 11	.331E 10	.415E 11	.242E 12	.498E 11	.125E 12	.241E 12	.740E 11	.117E 12
29	.511E 11	.175E 10	.201E 11	.257E 12	.293E 11	.605E 11	.307E 12	.474E 11	.561E 11
30	.427E 11	.109E 10	.103E 11	.269E 12	.197E 11	.315E 11	.358E 12	.334E 11	.301E 11
31	.352E 11	.113E 10	.452E 10	.291E 12	.251E 11	.161E 11	.431E 12	.454E 11	.184E 11
32	.295E 11	.716E 09	.179E 10	.303E 12	.170E 11	.686E 10	.481E 12	.317E 11	.837E 10
33	.248E 11	.394E 09	.625E 09	.299E 12	.936E 10	.251E 10	.499E 12	.177E 11	.318E 10
34	.197E 11	.286E 09	.161E 09	.287E 12	.764E 10	.840E 09	.532E 12	.148E 11	.125E 10
35	.162E 11	.200E 09	.218E 08	.277E 12	.556E 10	.208E 09	.534E 12	.110E 11	.379E 09

Table C9. Attitude (c7) Covariance Results

MEAN RESPONSES (7)

$\tilde{t}$	DELTA	DDELTA	NSUBIT	DNSUBIT	QALF	QDALF	D7	Z
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.191E-05	.123E-03	.117E-02	.243E-02	.469E-02	.335E-02	-.962E-03	-.866E-03
3	-.134E-02	-.112E-02	.175E-01	-.218E-02	.390E 00	.113E 00	-.553E-01	-.109E 00
4	-.500E-02	-.164E-02	.591E-01	.775E-03	.140E 01	.288E 00	-.226E 00	-.741E 00
5	-.113E-01	-.146E-02	.137E 00	.975E-02	.318E 01	.597E 00	-.621E 00	-.273E 01
6	-.202E-01	-.301E-03	.255E 00	.234E-01	.567E 01	.108E 01	-.135E 01	-.747E 01
7	-.307E-01	.210E-02	.419E 00	.467E-01	.872E 01	.177E 01	-.249E 01	-.168E 02
8	-.418E-01	.525E-02	.618E 00	.721E-01	.120E 02	.266E 01	-.415E 01	-.331E 02
9	-.489E-01	.111E-01	.821E 00	.145E 00	.160E 02	.396E 01	-.635E 01	-.590E 02
10	-.490E-01	.166E-01	.950E 00	.811E-01	.216E 02	.563E 01	-.939E 01	-.978E 02
11	-.645E-01	.758E-02	.120E 01	.561E-01	.227E 02	.549E 01	-.136E 02	-.155E 03
12	-.862E-01	.938E-02	.602E 00	-.180E 00	.222E 02	.672E 01	-.159E 02	-.230E 03
13	-.957E-01	.252E-01	.453E 00	-.464E 00	.267E 02	.101E 02	-.143E 02	-.307E 03
14	-.904E-01	.340E-01	.774E 00	-.249E 00	.298E 02	.622E 01	-.120E 02	-.372E 03
15	-.688E-01	.359E-01	.106E 01	-.105E-01	.263E 02	-.257E 01	-.108E 02	-.428E 03
16	-.387E-01	.297E-01	.818E 00	-.130E 00	.181E 02	-.872E 01	-.112E 02	-.483E 03
17	-.151E-01	.173E-01	.379E 00	-.292E 00	.844E 01	-.934E 01	-.120E 02	-.541E 03
18	-.292E-02	.692E-02	-.469E-02	-.256E 00	.195E 01	-.647E 01	-.123E 02	-.602E 03
19	.496E-03	.138E-02	-.149E 00	-.102E 00	-.399E 00	-.274E 01	-.122E 02	-.664E 03
20	.359E-03	-.175E-03	-.116E 00	.484E-02	-.344E 00	-.127E-01	-.120E 02	-.724E 03
21	-.541E-03	-.122E-03	-.202E-02	.910E-01	.651E 00	.160E 01	-.120E 02	-.784E 03
22	-.108E-02	.261E-03	.108E 00	.125E 00	.156E 01	.197E 01	-.124E 02	-.845E 03
23	-.106E-02	.519E-03	.169E 00	.104E 00	.193E 01	.145E 01	-.131E 02	-.908E 03
24	-.739E-03	.514E-03	.182E 00	.609E-01	.181E 01	.790E 00	-.140E 02	-.976E 03
25	-.395E-03	.367E-03	.156E 00	.254E-01	.149E 01	.336E 00	-.150E 02	-.105E 04
26	-.183E-03	.193E-03	.119E 00	-.839E-02	.110E 01	.139E-01	-.158E 02	-.113E 04
27	-.460E-04	.107E-03	.918E-01	-.361E-03	.814E 00	.133E-01	-.164E 02	-.121E 04
28	.548E-04	.526E-04	.685E-01	.924E-03	.608E 00	.140E-01	-.169E 02	-.129E 04
29	.969E-04	-.252E-05	.522E-01	.385E-02	.459E 00	.112E-02	-.173E 02	-.137E 04
30	.113E-03	-.237E-04	.421E-01	.656E-02	.355E 00	.468E-02	-.177E 02	-.146E 04
31	.131E-03	-.274E-04	.345E-01	-.344E-02	.277E 00	.594E-02	-.180E 02	-.155E 04
32	.136E-03	-.379E-04	.284E-01	.202E-02	.218E 00	.372E-02	-.182E 02	-.164E 04
33	.132E-03	-.422E-04	.236E-01	.119E-02	.171E 00	.805E-02	-.184E 02	-.173E 04
34	.127E-03	-.413E-04	.166E-01	.118E-02	.135E 00	.288E-02	-.186E 02	-.183E 04
35	.121E-03	-.399E-04	.993E-02	.818E-03	.107E 00	.304E-02	-.188E 02	-.192E 04

Table C9. (Continued)

MEAN RESPONSES (7)

$\tilde{t}$	IB1	DIB1	IB2	DIB2	IB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.872E 04	-.245E 05	-.132E 05	-.127E 06	-.109E 05	-.179E 06
3	-.667E 05	.103E 06	.836E 06	.125E 07	.146E 07	.193E 07
4	-.200E 06	.202E 06	.320E 07	.256E 07	.553E 07	.396E 07
5	-.458E 06	.285E 06	.727E 07	.391E 07	.126E 08	.610E 07
6	-.861E 06	.317E 06	.129E 08	.504E 07	.223E 08	.791E 07
7	-.142E 07	.241E 06	.193E 08	.543E 07	.337E 08	.864E 07
8	-.211E 07	.723E 05	.261E 08	.528E 07	.456E 08	.862E 07
9	-.276E 07	-.531E 06	.300E 08	.162E 07	.530E 08	.334E 07
10	-.324E 07	-.120E 07	.293E 08	-.335E 07	.523E 08	-.399E 07
11	-.470E 07	.113E 06	.378E 08	.855E 07	.682E 08	.139E 08
12	-.494E 07	-.154E 05	.528E 08	.116E 08	.932E 08	.192E 08
13	-.509E 07	-.215E 07	.592E 08	-.112E 07	.104E 09	.889E 06
14	-.540E 07	-.233E 07	.550E 08	-.880E 07	.974E 08	-.116E 08
15	-.497E 07	-.142E 07	.404E 08	-.132E 08	.728E 08	-.200E 08
16	-.333E 07	-.430E 06	.218E 08	-.136E 08	.401E 08	-.218E 08
17	-.159E 07	.502E 06	.806E 07	-.819E 07	.153E 08	-.141E 08
18	-.365E 06	.644E 06	.146E 07	-.321E 07	.286E 07	-.609E 07
19	.848E 05	.317E 06	-.210E 06	-.557E 06	-.451E 06	-.131E 07
20	.673E 05	.361E 04	-.142E 06	.544E 05	-.318E 06	.837E 05
21	-.133E 06	-.206E 06	.161E 06	-.139E 06	.431E 06	.247E 05
22	-.321E 06	-.268E 06	.228E 06	-.404E 06	.776E 06	-.331E 06
23	-.407E 06	-.220E 06	.680E 05	-.512E 06	.619E 06	-.567E 06
24	-.396E 06	-.134E 06	-.137E 06	-.430E 06	.267E 06	-.543E 06
25	-.327E 06	-.674E 05	-.265E 06	-.288E 06	-.298E 05	-.392E 06
26	-.247E 06	-.158E 05	-.282E 06	-.124E 06	-.158E 06	-.185E 06
27	-.190E 06	-.104E 05	-.285E 06	-.830E 05	-.232E 06	-.125E 06
28	-.142E 06	-.751E 04	-.276E 06	-.611E 05	-.278E 06	-.915E 05
29	-.110E 06	-.330E 04	-.251E 06	-.237E 05	-.278E 06	-.359E 05
30	-.888E 05	-.112E 04	-.228E 06	-.103E 05	-.266E 06	-.147E 05
31	-.722E 05	-.197E 04	-.213E 06	-.111E 05	-.262E 06	-.162E 05
32	-.597E 05	-.815E 03	-.195E 06	-.343E 04	-.248E 06	-.454E 04
33	-.496E 05	.460E 02	-.176E 06	.186E 04	-.226E 06	.312E 04
34	-.404E 05	-.356E 01	-.157E 06	.233E 04	-.209E 06	.393E 04
35	-.337E 05	.179E 02	-.142E 06	.263E 04	-.192E 06	.432E 04

Table C9. (Continued)

RESPONSE COVARIANCES (7)

$\tilde{t}$	DELTA	DELTA*DELTA	DDELTA	DZDOT	DELO	ΔY	Δθ	ΔZ
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.343E-08	.175E-06	.128E-04	.967E-03	.243E-07	.155E-06	.766E-08	.120E=02
3	.107E-03	.674E-05	.295E-04	.117E [illegible]	.384E-06	.431E-05	.143E-04	.157E 01
4	.231E-03	-.229E-04	.117E-03	.264E 00	.381E-06	.406E-05	.355E-04	.112E 02
5	.377E-03	-.630E-04	.278E-03	.679E 00	.595E-06	.553E-05	.6[illegible]E-04	.426E 02
6	.529E-03	-.111E-03	.551E-03	.159E 01	.951E-06	.772E-05	.866E-04	.131E 03
7	.663E-03	-.166E-03	.109E-02	.331E 01	.159E-05	.103E-04	.109E-03	.345E 03
8	.780E-03	-.220E-03	.212E-02	.647E 01	.278E-05	.137E-04	.129E-03	.816E 03
9	.763E-03	-.284E-03	.333E-02	.119E 02	.418E-05	.176E-04	.130E-03	.178E 04
10	.600E-03	-.279E-03	.278E-02	.213E 02	.285E-05	.230E-04	.107E-03	.369E 04
11	.917E-03	-.227E-03	.702E-02	.383E 02	.566E-05	.314E-04	.142E-03	.726E 04
12	.162E-02	-.405E-03	.168E-01	.471E 02	.138E-04	.303E-04	.243E-03	.133E 05
13	.185E-02	-.821E-03	.173E-01	.337E 02	.175E-04	.173E-04	.304E-03	.207E 05
14	.146E-02	-.875E-03	.136E-01	.204E 02	.163E-04	.840E-05	.256E-03	.281E 05
15	.791E-03	-.595E-03	.915E-02	.151E 02	.116E-04	.495E-05	.149E-03	.348E 05
16	.306E-03	-.268E-03	.425E-02	.150E 02	.561E-05	.394E-05	.595E-04	.417E 05
17	.115E-03	-.100E-03	.169E-02	.174E 02	.227E-05	.363E-05	.220E-04	.494E 05
18	.454E-04	-.386E-04	.617E-03	.207E 02	.877E-06	.345E-05	.264E-05	.580E 05
19	.174E-04	-.150E-04	.213E-03	.240E 02	.312E-06	.319E-05	.339E-05	.677E 05
20	.625E-05	-.554E-05	.686E-04	.265E 02	.111E-06	.283E-05	.125E-05	.786E 05
21	.209E-05	-.186E-05	.225E-04	.282E 02	.370E-07	.243E-05	.423E-06	.907E 05
22	.713E-06	-.623E-06	.759E-05	.291E 02	.122E-07	.205E-05	.143E-06	.104E 06
23	.228E-06	-.209E-06	.242E-05	.293E 02	.391E-08	.169E-05	.468E-07	.118E 06
24	.638E-07	-.633E-07	.666E-06	.292E 02	.115E-08	.139E-05	.137E-07	.134E 06
25	.134E-07	-.155E-07	.145E-06	.288E 02	.285E-09	.115E-05	.310E-08	.151E 06
26	.249E-08	-.304E-08	.262E-07	.283E 02	.559E-10	.958E-06	.599E-09	.168E 06
27	.137E-09	-.336E-09	.196E-08	.277E 02	.106E-10	.8[illegible]5E-06	.536E-10	.187E 06
28	.161E-09	.125E-09	.105E-08	.272E 02	.445E-11	.684E-06	.126E-10	.207E 06
29	.423E-09	-.794E-10	.256E-08	.267E 02	.391E-11	.587E-06	.622E-10	.228E 06
30	.478E-09	-.174E-09	.279E-08	.263E 02	.399E-11	.508E-06	.782E-10	.251E 06
31	.518E-09	-.186E-09	.255E-08	.259E 02	.362E-11	.444E-06	.657E-10	.274E 06
32	.435E-09	-.184E-09	.168E-08	.256E 02	.240E-11	.391E-06	.759E-10	.299E 06
33	.310E-09	-.140E-09	.870E-09	.253E 02	.127E-11	.347E-06	.560E-10	.324E 06
34	.221E-09	-.919E-10	.353E-09	.250E 02	.550E-12	.309E-06	.400E-10	.351E 06
35	.173E-09	-.627E-10	.853E-10	.248E 02	.142E-12	.278E-06	.309E-10	.379E 06

Table C9. (Continued)

RESPONSE COVARIANCES (7)

$\tilde{\tau}$	NIT	NIT*DNIT	DNIT	QALF	QALF*DQALF	DQALF
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.838E-03	.169E-02	.343E-02	.124E-01	.441E-02	.479E-02
3	.360E-02	-.152E-02	.161E-02	.731E 01	.198E 00	.197E 00
4	.146E-01	-.163E-02	.644E-02	.161E 02	.542E 00	.146E 01
5	.346E-01	-.101E-02	.266E-01	.268E 02	.126E 01	.633E 01
6	.662E-01	.774E-03	.871E-01	.385E 02	.226E 01	.221E 02
7	.126E 00	.634E-02	.272E 00	.504E 02	.353E 01	.721E 02
8	.214E 00	.180E-01	.616E 00	.620E 02	.508E 01	.192E 03
9	.281E 00	.447E-01	.997E 00	.806E 02	.753E 01	.421E 03
10	.409E 00	.986E-02	.223E 01	.117E 03	.883E 01	.874E 03
11	.835E 00	-.314E-01	.694E 01	.119E 03	.135E 00	.186E 04
12	.850E 00	-.416E 00	.352E 02	.115E 03	.203E 01	.366E 04
13	.578E 00	-.212E 00	.377E 02	.148E 03	.285E 01	.585E 04
14	.436E 00	.305E-01	.219E 02	.158E 03	-.280E 02	.659E 04
15	.327E 00	.700E-01	.747E 01	.114E 03	-.447E 02	.470E 04
16	.218E 00	.562E-02	.240E 01	.656E 02	-.315E 02	.276E 04
17	.156E 00	-.165E-01	.110E 01	.345E 02	-.162E 02	.159E 04
18	.107E 00	-.171E-01	.713E 00	.190E 02	-.816E 01	.939E 03
19	.671E-01	-.147E-01	.481E 00	.107E 02	-.472E 01	.556E 03
20	.406E-01	-.116E-01	.506E 00	.560E 01	-.279E 01	.330E 03
21	.257E-01	-.870E-02	.539E 00	.283E 01	-.152E 01	.197E 03
22	.153E-01	-.516E-02	.451E 00	.143E 01	-.772E 00	.116E 03
23	.964E-02	-.359E-02	.397E 00	.731E 00	-.409E 00	.681E 02
24	.613E-02	-.269E-02	.349E 00	.373E 00	-.226E 00	.395E 02
25	.359E-02	-.176E-02	.262E 00	.185E 00	-.123E 00	.229E 02
26	.205E-02	-.109E-02	.178E 00	.885E-01	-.634E-01	.115E 02
27	.121E-02	-.661E-03	.123E 00	.417E-01	-.315E-01	.582E 01
28	.680E-03	-.391E-03	.808E-01	.196E-01	-.156E-01	.296E 01
29	.399E-03	-.225E-03	.524E-01	.934E-02	-.787E-02	.152E 01
30	.252E-03	-.135E-03	.342E-01	.460E-02	-.389E-02	.765E 00
31	.162E-03	-.897E-04	.208E-01	.228E-02	-.188E-02	.349E 00
32	.106E-03	-.506E-04	.110E-01	.110E-02	-.889E-03	.138E 00
33	.690E-04	-.274E-04	.502E-02	.518E-03	-.383E-03	.469E-01
34	.557E-04	-.116E-04	.177E-02	.249E-03	-.131E-03	.125E-01
35	.540E-04	-.306E-05	.302E-03	.136E-03	-.247E-04	.154E-02

Table C9. (Concluded)

RESPONSE COVARIANCES (7)

$\tilde{t}$	IB1	IB1*DIB1	DIB1	IB2	IB2*DIB2	DIB2	IB3	IB3*DIB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.588E 11	.154E 12	.405E 12	.193E 12	.157E 13	.130E 14	.179E 12	.216E 13	.265E 14
3	.602E 11	-.924E 11	.382E 12	.480E 14	.221E 14	.320E 14	.137E 15	.570E 14	.736E 14
4	.172E 12	-.164E 12	.117E 13	.103E 15	.255E 14	.925E 14	.295E 15	.667E 14	.212E 15
5	.385E 12	-.279E 12	.280E 13	.164E 15	.253E 14	.205E 15	.476E 15	.691E 14	.469E 15
6	.729E 12	-.454E 12	.613E 13	.226E 15	.200E 14	.401E 15	.660E 15	.599E 14	.913E 15
7	.130E 13	-.783E 12	.141E 14	.276E 15	.462E 13	.800E 15	.617E 15	.285E 14	.181E 16
8	.216E 13	-.142E 13	.320E 14	.315E 15	-.189E 14	.159E 16	.946E 15	-.166E 14	.357E 16
9	.289E 13	-.178E 13	.553E 14	.297E 15	-.703E 14	.251E 16	.907E 15	-.135E 15	.562E 16
10	.333E 13	-.110E 13	.578E 14	.221E 15	-.881E 14	.210E 16	.692E 15	-.190E 15	.467E 16
11	.707E 13	-.519E 13	.169E 15	.322E 15	-.552E 14	.555E 16	.103E 16	-.425E 14	.122E 17
12	.959E 13	-.121E 14	.438E 15	.614E 15	-.145E 15	.134E 17	.189E 16	-.143E 15	.294E 17
13	.872E 13	-.122E 14	.527E 15	.726E 15	-.347E 15	.139E 17	.221E 16	-.655E 15	.301E 17
14	.719E 13	-.101E 14	.464E 15	.558E 15	-.371E 15	.110E 17	.172E 16	-.803E 15	.236E 17
15	.498E 13	-.645E 13	.311E 15	.284E 15	-.256E 15	.731E 16	.901E 15	-.590E 15	.158E 17
16	.260E 13	-.273E 13	.151E 15	.102E 15	-.118E 15	.341E 16	.335E 15	-.279E 15	.733E 16
17	.141E 13	-.112E 13	.732E 14	.342E 14	-.439E 14	.139E 16	.119E 15	-.104E 15	.294E 16
18	.785E 12	-.434E 12	.354E 14	.119E 14	-.162E 14	.531E 15	.442E 14	-.387E 14	.109E 16
19	.417E 12	-.178E 12	.168E 14	.388E 13	-.579E 13	.195E 15	.157E 14	-.143E 14	.386E 15
20	.217E 12	-.818E 11	.830E 13	.111E 13	-.195E 13	.704E 14	.511E 13	-.500E 13	.130E 15
21	.116E 12	-.415E 11	.442E 13	.251E 12	-.609E 12	.277E 14	.145E 13	-.159E 13	.462E 14
22	.600E 11	-.207E 11	.237E 13	.506E 11	-.195E 12	.118E 14	.403E 12	-.504E 12	.176E 14
23	.327E 11	-.104E 11	.130E 13	.642E 10	-.601E 11	.526E 13	.889E 11	-.156E 12	.681E 13
24	.178E 11	-.571E 10	.717E 12	.359E 10	-.164E 11	.244E 13	.113E 11	-.410E 11	.267E 13
25	.890E 10	-.295E 10	.361E 12	.617E 10	-.397E 10	.110E 13	.745E 09	-.744E 10	.104E 13
26	.446E 10	-.161E 10	.182E 12	.589E 10	-.200E 10	.522E 12	.196E 10	-.137E 10	.450E 12
27	.228E 10	-.835E 09	.912E 11	.510E 10	-.103E 10	.254E 12	.340E 10	-.138E 09	.208E 12
28	.107E 10	-.387E 09	.413E 11	.404E 10	-.536E 09	.115E 12	.409E 10	.337E 08	.944E 11
29	.532E 09	-.201E 09	.200E 11	.280E 10	-.580E 09	.573E 11	.342E 10	-.452E 09	.493E 11
30	.288E 09	-.110E 09	.102E 11	.191E 10	-.440E 09	.304E 11	.259E 10	-.469E 09	.277E 11
31	.155E 09	-.536E 08	.449E 10	.135E 10	-.261E 09	.142E 11	.204E 10	-.307E 09	.143E 11
32	.828E 08	-.281E 08	.178E 10	.894E 09	-.190E 09	.610E 10	.144E 10	-.263E 09	.674E 10
33	.434E 08	-.139E 08	.620E 09	.548E 09	-.120E 09	.232E 10	.925E 09	-.182E 09	.279E 10
34	.223E 08	-.497E 07	.157E 09	.338E 09	-.529E 08	.677E 09	.597E 09	-.853E 08	.908E 09
35	.134E 08	-.114E 07	.194E 08	.237E 09	-.168E 08	.103E 09	.434E 09	-.296E 08	.156E 09

Table C10. Scheduled Attitude (c2) Covariance Results

MEAN RESPONSES (2)

$\tilde{t}$	DELTA	DDELTA	NSUBIT	DNSUBIT	QALF	QDALF	DZ	Z
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.191E-05	.123E-03	.117E-02	.243E-02	.469E-02	.335E-02	-.352E-03	-.866E-03
3	-.134E-02	-.112E-02	.175E-01	-.218E-02	.390E 00	.113E 00	-.353E-01	-.109E 00
4	-.500E-02	-.164E-02	.591E-01	.775E-03	.140E 01	.238E 00	-.226E 00	-.741E 00
5	-.113E-01	-.146E-02	.137E 00	.975E-02	.318E 01	.537E 00	-.621E 00	-.273E 01
6	-.202E-01	-.301E-03	.255E 00	.234E-01	.567E 01	.109E 01	-.135E 01	-.747E 01
7	-.307E-01	.210E-02	.419E 00	.467E-01	.372E 01	.177E 01	-.249E 01	-.168E 02
8	-.376E-01	.773E-02	.528E 00	.244E-01	.111E 02	.241E 01	-.338E 01	-.330E 02
9	-.385E-01	.130E-01	.412E 00	.553E-01	.131E 02	.349E 01	-.431E 01	-.546E 02
10	-.289E-01	.183E-01	.273E 00	-.633E-01	.148E 02	.434E 01	-.225E 01	-.722E 02
11	-.141E-01	.227E-01	-.935E-02	-.458E 00	.391E 01	.335E 01	.290E 01	-.728E 02
12	-.112E-01	.249E-02	-.118E 01	-.439E 00	.600E 01	.649E 01	.172E 02	-.278E 02
13	-.113E-01	.373E-02	-.185E 01	-.606E 00	.552E 01	.918E 01	.413E 02	.113E 03
14	-.850E-02	.403E-02	-.217E 01	-.206E 00	.444E 01	.555E 01	.755E 02	.400E 03
15	-.274E-02	.257E-02	-.215E 01	.284E 00	.168E 01	-.212E 01	.118E 03	.379E 03
16	.233E-02	.763E-03	-.172E 01	.338E 00	-.947E 00	-.736E 01	.165E 03	.158E 04
17	.428E-02	-.713E-03	-.113E 01	.139E 00	-.236E 01	-.739E 01	.213E 03	.253E 04
18	.322E-02	-.112E-02	-.594E 00	.138E-01	-.209E 01	-.532E 01	.259E 03	.371E 04
19	.980E-03	-.743E-03	-.203E 00	.109E-01	-.781E 00	-.230E 01	.305E 03	.512E 04
20	-.174E-01	-.374E-02	.210E 01	.817E 00	.152E 02	.424E 01	.345E 03	.675E 04
21	-.228E-01	.972E-02	.406E 01	.173E 00	.261E 02	.235E 01	.354E 03	.851E 04
22	-.174E-01	.101E-01	.408E 01	-.742E-01	.246E 02	.130E 01	.347E 03	.103E 05
23	-.111E-01	.749E-02	.354E 01	-.113E 00	.199E 02	.118E 01	.337E 03	.120E 05
24	-.622E-02	.479E-02	.289E 01	-.116E 00	.152E 02	.539E 00	.327E 03	.136E 05
25	-.302E-02	.280E-02	.233E 01	-.107E 00	.113E 02	.136E 00	.319E 03	.153E 05
26	-.139E-02	.138E-02	.184E 01	-.900E-01	.834E 01	-.113E 00	.312E 03	.168E 05
27	-.349E-03	.759E-03	.149E 01	-.575E-01	.616E 01	-.741E-01	.306E 03	.134E 05
28	.414E-03	.359E-03	.119E 01	-.416E-01	.460E 01	-.452E-01	.302E 03	.199E 05
29	.731E-03	-.330E-04	.967E 00	-.206E-01	.347E 01	-.423E-01	.298E 03	.214E 05
30	.855E-03	-.185E-03	.810E 00	-.921E-02	.267E 01	-.271E-01	.295E 03	.229E 05
31	.987E-03	-.214E-03	.683E 00	-.182E-01	.209E 01	-.172E-01	.292E 03	.243E 05
32	.102E-02	-.287E-03	.584E 00	-.705E-02	.164E 01	-.136E-01	.290E 03	.258E 05
33	.990E-03	-.318E-03	.496E 00	-.347E-02	.129E 01	-.491E-02	.288E 03	.272E 05
34	.953E-03	-.310E-03	.462E 00	-.247E-02	.101E 01	-.677E-02	.286E 03	.287E 05
35	.907E-03	-.301E-03	.456E 00	-.167E-02	.805E 00	-.426E-02	.285E 03	.301E 05

Table C10. (Continued)

MEAN RESPONSES (2)

$\tilde{t}$	IB1	DIB1	IB2	DIB2	IB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.872E 04	-.245E 05	-.132E 05	-.127E 06	-.109E 05	-.179E 06
3	-.667E 05	.103E 06	.836E 06	.125E 07	.146E 07	.193E 07
4	-.200E 06	.202E 06	.320E 07	.256E 07	.553E 07	.396E 07
5	-.458E 06	.285E 06	.727E 07	.391E 07	.126E 08	.610E 07
6	-.861E 06	.317E 06	.129E 08	.504E 07	.223E 08	.791E 07
7	-.142E 07	.241E 06	.193E 08	.543E 07	.337E 08	.864E 07
8	-.216E 07	-.170E 06	.230E 08	.223E 07	.407E 08	.390E 07
9	-.256E 07	-.811E 06	.230E 08	-.239E 07	.411E 08	-.292E 07
10	-.292E 07	-.167E 07	.156E 08	-.961E 07	.293E 08	-.138E 08
11	-.395E 07	-.205E 07	.342E 07	-.165E 08	.106E 08	-.246E 08
12	-.294E 07	-.137E 07	.305E 07	-.168E 07	.869E 07	-.105E 07
13	-.233E 07	-.204E 07	.408E 07	-.365E 07	.963E 07	-.347E 07
14	-.151E 07	-.155E 07	.349E 07	-.363E 07	.764E 07	-.407E 07
15	-.468E 06	-.337E 06	.116E 07	-.180E 07	.250E 07	-.254E 07
16	.260E 06	.697E 06	-.121E 07	.115E 06	-.233E 07	-.655E 06
17	.556E 06	.116E 07	-.210E 07	.152E 07	-.416E 07	.107E 07
18	.464E 06	.899E 06	-.151E 07	.161E 07	-.306E 07	.153E 07
19	.167E 06	.364E 06	-.415E 06	.924E 06	-.893E 06	.107E 07
20	-.265E 07	-.415E 06	.793E 07	.566E 07	.164E 08	.986E 07
21	-.514E 07	-.864E 06	.753E 07	-.348E 07	.188E 08	-.466E 07
22	-.500E 07	-.713E 06	.400E 07	-.467E 07	.128E 08	-.690E 07
23	-.419E 07	-.517E 06	.838E 06	-.381E 07	.660E 07	-.555E 07
24	-.332E 07	-.312E 06	-.113E 07	-.259E 07	.227E 07	-.388E 07
25	-.249E 07	-.176E 06	-.201E 07	-.164E 07	-.219E 06	-.248E 07
26	-.187E 07	-.620E 05	-.214E 07	-.786E 06	-.120E 07	-.122E 07
27	-.144E 07	-.415E 05	-.215E 07	-.532E 06	-.176E 07	-.826E 06
28	-.107E 07	-.324E 05	-.208E 07	-.396E 06	-.210E 07	-.612E 06
29	-.827E 06	-.863E 04	-.190E 07	-.146E 06	-.210E 07	-.230E 06
30	-.669E 06	.201E 03	-.172E 07	-.516E 05	-.200E 07	-.843E 05
31	-.544E 06	-.353E 04	-.160E 07	-.635E 05	-.197E 07	-.101E 06
32	-.449E 06	.139E 04	-.147E 07	-.113E 05	-.187E 07	-.202E 05
33	-.372E 06	.461E 04	-.132E 07	.227E 05	-.172E 07	.319E 05
34	-.303E 06	.398E 04	-.118E 07	.236E 05	-.157E 07	.342E 05
35	-.253E 06	.387E 04	-.106E 07	.273E 05	-.144E 07	.432E 05

Table C10. (Continued)

RESPONSE COVARIANCES (2)

$\tilde{t}$	DELTA	DELTA*DELTA	DDELTA	DZDOT	DELQ	Δγ	Δθ	Δz
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.343E-08	.175E-06	.128E-04	.967E-03	.243E-07	.155E-06	.768E-08	.120E-02
3	.107E-03	.674E-05	.295E-04	.117E 00	.384E-06	.431E-05	.143E-04	.157E 01
4	.231E-03	-.229E-04	.117E-03	.264E 00	.381E-06	.466E-05	.355E-04	.112E 02
5	.377E-03	-.630E-04	.278E-03	.679E 00	.595E-06	.553E-05	.609E-04	.426E 02
6	.529E-03	-.111E-03	.551E-03	.159E 01	.951E-06	.772E-05	.863E-04	.131E 03
7	.663E-03	-.166E-03	.109E-02	.331E 01	.159E-05	.103E-04	.109E-03	.345E 03
8	.630E-03	-.233E-03	.211E-02	.585E 01	.331E-05	.123E-04	.164E-03	.812E 03
9	.474E-03	-.243E-03	.321E-02	.484E 01	.539E-05	.716E-05	.254E-03	.153E 04
10	.213E-03	-.185E-03	.278E-02	.209E 01	.419E-05	.225E-05	.377E-03	.203E 04
11	.763E-04	-.172E-03	.734E-02	.150E 02	.123E-04	.123E-04	.724E-03	.157E 04
12	.122E-03	-.263E-03	.169E-01	.104E 03	.217E-04	.667E-04	.131E-02	.375E 03
13	.150E-03	-.281E-03	.163E-01	.399E 03	.263E-04	.265E-03	.195E-02	.452E 04
14	.134E-03	-.230E-03	.121E-01	.109E 04	.232E-04	.446E-03	.241E-02	.370E 05
15	.936E-04	-.159E-03	.776E-02	.230E 04	.162E-04	.755E-03	.244E-02	.151E 06
16	.474E-04	-.794E-04	.353E-02	.403E 04	.812E-05	.106E-02	.224E-02	.435E 06
17	.221E-04	-.335E-04	.138E-02	.626E 04	.377E-05	.131E-02	.207E-02	.102E 07
18	.101E-04	-.133E-04	.492E-03	.905E 04	.172E-05	.151E-02	.203E-02	.207E 07
19	.421E-05	-.517E-05	.170E-03	.125E 05	.717E-06	.166E-02	.198E-02	.380E 07
20	.436E-04	.671E-05	.573E-04	.160E 05	.211E-04	.171E-02	.889E-03	.646E 07
21	.668E-04	-.304E-04	.325E-04	.170E 05	.581E-05	.147E-02	.136E-03	.101E 08
22	.354E-04	-.218E-04	.201E-04	.164E 05	.668E-06	.115E-02	.191E-04	.147E 08
23	.130E-04	-.917E-05	.870E-05	.155E 05	.106E-06	.896E-03	.328E-05	.199E 08
24	.386E-05	-.303E-05	.299E-05	.147E 05	.166E-07	.763E-03	.867E-06	.257E 08
25	.878E-06	-.819E-06	.892E-06	.141E 05	.627E-08	.563E-03	.212E-06	.322E 08
26	.184E-06	-.182E-06	.203E-06	.136E 05	.153E-08	.460E-03	.456E-07	.392E 08
27	.116E-07	-.251E-07	.552E-07	.132E 05	.660E-09	.383E-03	.461E-08	.467E 08
28	.163E-07	.139E-07	.129E-07	.129E 05	.359E-09	.323E-03	.132E-08	.549E 08
29	.510E-07	-.249E-08	.268E-08	.126E 05	.586E-10	.277E-03	.764E-08	.635E 08
30	.696E-07	-.152E-07	.604E-08	.124E 05	.122E-10	.239E-03	.115E-07	.727E 08
31	.928E-07	-.202E-07	.690E-08	.122E 05	.142E-10	.209E-03	.154E-07	.825E 08
32	.995E-07	-.280E-07	.951E-08	.120E 05	.302E-11	.184E-03	.171E-07	.928E 08
33	.934E-07	-.300E-07	.105E-07	.119E 05	.196E-11	.163E-03	.164E-07	.104E 09
34	.864E-07	-.281E-07	.944E-08	.118E 05	.142E-11	.146E-03	.152E-07	.115E 09
35	.782E-07	-.260E-07	.870E-08	.117E 05	.148E-11	.131E-03	.138E-07	.127E 09

Table C10. (Continued)

RESPONSE COVARIANCES (2)

$\tilde{t}$	NIT	NIT*DNIT	DNIT	QALF	QALF*DQALF	DQALF
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.838E-03	.169E-02	.343E-02	.124E-01	.441E-02	.479E-02
3	.360E-02	-.152E-02	.161E-02	.731E 01	.198E 00	.197E 00
4	.146E-01	-.163E-02	.644E-02	.161E 02	.542E 00	.146E 01
5	.346E-01	-.101E-02	.266E-01	.268E 02	.126E 01	.633E 01
6	.662E-01	.774E-03	.871E-01	.385E 02	.226E 01	.221E 02
7	.126E 00	.634E-02	.272E 00	.504E 02	.353E 01	.721E 02
8	.180E 00	.889E-02	.620E 00	.533E 02	.369E 01	.191E 03
9	.160E 00	.263E-01	.101E 01	.542E 02	.475E 01	.421E 03
10	.310E 00	-.548E-02	.227E 01	.589E 02	.366E 01	.875E 03
11	.782E 00	-.115E 00	.723E 01	.362E 02	-.599E 01	.186E 04
12	.136E 01	-.655E 00	.357E 02	.271E 02	-.400E 01	.361E 04
13	.155E 01	-.529E 00	.378E 02	.279E 02	.677E 01	.586E 04
14	.156E 01	-.479E 00	.217E 02	.268E 02	.179E 02	.660E 04
15	.108E 01	-.315E 00	.720E 01	.182E 02	.150E 02	.470E 04
16	.570E 00	-.102E 00	.221E 01	.116E 02	.307E 01	.276E 04
17	.275E 00	-.123E-01	.979E 00	.708E 01	-.321E 01	.159E 04
18	.139E 00	.180E-02	.651E 00	.432E 01	-.287E 01	.940E 03
19	.805E-01	.146E-02	.445E 00	.276E 01	-.146E 01	.556E 03
20	.586E 00	.216E 00	.578E 00	.331E 02	.534E 01	.331E 03
21	.213E 01	.258E-01	.533E 00	.877E 02	.738E 00	.197E 03
22	.204E 01	-.120E 00	.456E 00	.704E 02	-.217E 01	.116E 03
23	.146E 01	-.105E 00	.404E 00	.421E 02	-.154E 01	.681E 02
24	.933E 00	-.667E-01	.354E 00	.230E 02	-.833E 00	.395E 02
25	.596E 00	-.392E-01	.264E 00	.124E 02	-.395E 00	.220E 02
26	.375E 00	-.190E-01	.178E 00	.666E 01	-.188E 00	.115E 02
27	.246E 00	-.106E-01	.123E 00	.362E 01	-.882E-01	.582E 01
28	.159E 00	-.625E-02	.810E-01	.201E 01	-.427E-01	.296E 01
29	.106E 00	-.292E-02	.524E-01	.115E 01	-.220E-01	.152E 01
30	.746E-01	-.158E-02	.342E-01	.681E 00	-.118E-01	.765E 00
31	.533E-01	-.124E-02	.208E-01	.416E 00	-.646E-02	.348E 00
32	.391E-01	-.648E-03	.110E-01	.256E 00	-.362E-02	.138E 00
33	.283E-01	-.281E-03	.502E-02	.158E 00	-.203E-02	.470E-01
34	.251E-01	-.202E-03	.177E-02	.978E-01	-.112E-02	.125E-01
35	.252E-01	-.137E-03	.303E-03	.616E-01	-.643E-03	.155E-02

Table C10. (Concluded)

RESPONSE COVARIANCES (2)

$\tilde{t}$	IB1	IB1*DIB1	DIB1	IB2	IB2*DIB2	DIB2	IB3	IB3*DIB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.588E 11	.154E 12	.405E 12	.193E 12	.157E 13	.130E 14	.179E 12	.216E 13	.265E 14
3	.602E 11	-.924E 11	.382E 12	.480E 14	.221E 14	.320E 14	.137E 15	.570E 14	.736E 14
4	.172E 12	-.164E 12	.117E 13	.103E 15	.255E 14	.925E 14	.295E 15	.667E 14	.212E 15
5	.385E 12	-.279E 12	.280E 13	.164E 15	.253E 14	.205E 15	.476E 15	.691E 14	.469E 15
6	.729E 12	-.454E 12	.613E 13	.226E 15	.200E 14	.401E 15	.560E 15	.599E 14	.913E 15
7	.130E 13	-.783E 12	.141E 14	.276E 15	.462E 13	.830E 15	.617E 15	.295E 14	.181E 16
8	.224E 13	-.118E 13	.315E 14	.247E 15	-.473E 14	.156E 16	.752E 15	-.959E 14	.351E 16
9	.264E 13	-.148E 13	.538E 14	.176E 15	-.879E 14	.241E 16	.550E 15	-.190E 15	.540E 16
10	.308E 13	-.588E 12	.574E 14	.659E 14	-.869E 14	.210E 16	.224E 15	-.203E 15	.468E 16
11	.647E 13	-.241E 13	.169E 15	.115E 14	-.120E 15	.571E 16	.520E 14	-.266E 15	.126E 17
12	.785E 13	-.881E 13	.433E 15	.287E 14	-.261E 15	.134E 17	.103E 15	-.512E 15	.295E 17
13	.644E 13	-.103E 14	.512E 15	.426E 14	-.280E 15	.131E 17	.144E 15	-.542E 15	.286E 17
14	.430E 13	-.887E 13	.446E 15	.412E 14	-.222E 15	.937E 16	.136E 15	-.431E 15	.212E 17
15	.221E 13	-.561E 13	.297E 15	.313E 14	-.144E 15	.636E 16	.102E 15	-.283E 15	.136E 17
16	.955E 12	-.236E 13	.144E 15	.158E 14	-.665E 14	.291E 16	.510E 14	-.135E 15	.621E 16
17	.465E 12	-.966E 12	.703E 14	.690E 13	-.268E 14	.118E 16	.239E 14	-.546E 14	.246E 16
18	.242E 12	-.386E 12	.343E 14	.285E 13	-.101E 14	.445E 15	.101E 14	-.206E 14	.897E 15
19	.134E 12	-.145E 12	.164E 14	.988E 12	-.351E 13	.166E 15	.381E 13	-.759E 13	.319E 15
20	.101E 13	.313E 11	.822E 13	.912E 13	.512E 13	.669E 14	.306E 14	.198E 14	.124E 15
21	.339E 13	.349E 12	.445E 13	.741E 13	-.370E 13	.272E 14	.459E 14	-.125E 14	.447E 14
22	.290E 13	.224E 12	.239E 13	.190E 13	-.228E 13	.138E 14	.132E 14	-.107E 14	.224E 14
23	.186E 13	.121E 12	.131E 13	.813E 11	-.382E 12	.664E 13	.465E 13	-.405E 13	.101E 14
24	.110E 13	.556E 11	.721E 12	.128E 12	.253E 12	.302E 13	.518E 12	-.885E 12	.408E 13
25	.597E 12	.254E 11	.362E 12	.390E 12	.291E 12	.132E 13	.526E 10	.422E 11	.158E 13
26	.335E 12	.757E 10	.182E 12	.438E 12	.152E 12	.576E 12	.137E 12	.133E 12	.584E 12
27	.198E 12	.410E 10	.914E 11	.443E 12	.104E 12	.279E 12	.295E 12	.134E 12	.269E 12
28	.110E 12	.261E 10	.413E 11	.414E 12	.757E 11	.129E 12	.420E 12	.119E 12	.129E 12
29	.652E 11	.342E 09	.200E 11	.343E 12	.249E 11	.592E 11	.419E 12	.443E 11	.542E 11
30	.427E 11	-.166E 09	.102E 11	.282E 12	.754E 10	.306E 11	.382E 12	.150E 11	.283E 11
31	.282E 11	.614E 08	.449E 10	.245E 12	.908E 10	.146E 11	.369E 12	.180E 11	.152E 11
32	.192E 11	-.124E 09	.178E 10	.206E 12	.118E 10	.611E 10	.332E 12	.307E 10	.677E 10
33	.132E 11	-.193E 09	.622E 09	.166E 12	-.307E 10	.237E 10	.280E 12	-.551E 10	.290E 10
34	.875E 10	-.134E 09	.159E 09	.132E 12	-.277E 10	.732E 09	.234E 12	-.593E 10	.102E 10
35	.607E 10	-.107E 09	.212E 08	.107E 12	-.287E 10	.179E 09	.197E 12	-.566E 10	.318E 09

Table C11. Scheduled Attitude (c3) Covariance Results

MEAN RESPONSES (3)

$\tilde{t}$	DELTA	DDELTA	NSUBIT	DNSUBIT	QALF	QDALF	DZ	Z
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.191E-05	.123E-03	.117E-02	.243E-02	.469E-02	.335E-02	-.962E-03	-.866E-03
3	-.134E-02	-.112E-02	.175E-01	-.218E-02	.390E 00	.113E 00	-.553E-01	-.109E 00
4	-.500E-02	-.164E-02	.591E-01	.775E-03	.140E 01	.288E 00	-.226E 00	-.741E 00
5	-.113E-01	-.146E-02	.137E 00	.975E-02	.318E 01	.597E 00	-.621E 00	-.273E 01
6	-.202E-01	-.301E-03	.255E 00	.234E-01	.567E 01	.108E 01	-.135E 01	-.747E 01
7	-.307E-01	.210E-02	.419E 00	.467E-01	.872E 01	.177E 01	-.249E 01	-.168E 02
8	-.379E-01	.708E-02	.523E 00	.333E-01	.112E 02	.246E 01	-.393E 01	-.330E 02
9	-.403E-01	.121E-01	.474E 00	.800E-01	.135E 02	.362E 01	-.440E 01	-.544E 02
10	-.341E-01	.167E-01	.423E 00	-.977E-02	.165E 02	.515E 01	-.319E 01	-.742E 02
11	-.322E-01	.662E-02	.294E 00	-.204E 00	.141E 02	.506E 01	-.176E 00	-.841E 02
12	-.407E-01	.524E-02	-.464E 00	-.330E 00	.124E 02	.658E 01	.892E 01	-.656E 02
13	-.466E-01	.105E-01	-.896E 00	-.502E 00	.144E 02	.973E 01	.252E 02	.161E 02
14	-.475E-01	.144E-01	-.798E 00	-.133E 00	.164E 02	.629E 01	.472E 02	.195E 03
15	-.410E-01	.161E-01	-.321E 00	.285E 00	.159E 02	-.171E 01	.719E 02	.491E 03
16	-.301E-01	.155E-01	.255E 00	.255E 00	.140E 02	-.729E 01	.953E 02	.910E 03
17	-.208E-01	.122E-01	.783E 00	.109E-01	.114E 02	-.795E 01	.114E 03	.144E 04
18	-.148E-01	.874E-02	.112E 01	-.108E 00	.974E 01	-.554E 01	.128E 03	.204E 04
19	-.125E-01	.433E-02	.131E 01	.147E-01	.949E 01	-.182E 01	.138E 03	.271E 04
20	-.130E-01	.543E-02	.179E 01	.328E-01	.123E 02	.622E 00	.143E 03	.342E 04
21	-.108E-01	.576E-02	.195E 01	.411E-03	.126E 02	.167E 01	.141E 03	.413E 04
22	-.795E-02	.457E-02	.179E 01	.201E-01	.113E 02	.186E 01	.136E 03	.482E 04
23	-.517E-02	.344E-02	.157E 01	.839E-02	.939E 01	.131E 01	.132E 03	.549E 04
24	-.300E-02	.228E-02	.130E 01	-.123E-01	.734E 01	.682E 00	.127E 03	.614E 04
25	-.148E-02	.137E-02	.105E 01	-.294E-01	.556E 01	.262E 00	.123E 03	.676E 04
26	-.679E-03	.683E-03	.829E 00	-.421E-01	.409E 01	-.387E-01	.120E 03	.737E 04
27	-.171E-03	.376E-03	.668E 00	-.240E-01	.302E 01	-.228E-01	.117E 03	.796E 04
28	.203E-03	.179E-03	.531E 00	-.166E-01	.225E 01	-.109E-01	.115E 03	.854E 04
29	.359E-03	-.151E-04	.430E 00	-.623E-02	.170E 01	-.168E-01	.113E 03	.911E 04
30	.420E-03	-.901E-04	.359E 00	.440E-04	.131E 01	-.842E-02	.111E 03	.967E 04
31	.484E-03	-.104E-03	.302E 00	-.954E-02	.103E 01	-.362E-02	.110E 03	.102E 05
32	.502E-03	-.141E-03	.258E 00	-.173E-02	.805E 00	-.342E-02	.109E 03	.108E 05
33	.486E-03	-.156E-03	.219E 00	-.732E-03	.633E 00	.270E-02	.108E 03	.113E 05
34	.468E-03	-.152E-03	.201E 00	-.331E-03	.498E 00	-.111E-02	.107E 03	.119E 05
35	.446E-03	-.148E-03	.194E 00	-.209E-03	.395E 00	.272E-04	.107E 03	.124E 05

Table C11. (Continued)

MEAN RESPONSES (3)

$\tilde{t}$	IB1	DIB1	IB2	DIB2	IB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.872E 04	-.245E 05	-.132E 05	-.127E 06	-.109E 05	-.179E 06
3	-.667E 05	.103E 06	.836E 06	.125E 07	.146E 07	.193E 07
4	-.200E 06	.202E 06	.320E 07	.256E 07	.553E 07	.396E 07
5	-.458E 06	.285E 06	.727E 07	.391E 07	.126E 08	.610E 07
6	-.861E 06	.317E 06	.129E 08	.504E 07	.223E 08	.791E 07
7	-.142E 07	.241E 06	.193E 08	.543E 07	.337E 08	.864E 07
8	-.214E 07	-.123E 06	.232E 08	.283E 07	.410E 08	.482E 07
9	-.258E 07	-.727E 06	.242E 08	-.123E 07	.432E 08	-.111E 07
10	-.296E 07	-.147E 07	.192E 08	-.702E 07	.354E 08	-.973E 07
11	-.397E 07	-.479E 06	.162E 08	.138E 07	.317E 08	.285E 07
12	-.375E 07	-.855E 06	.225E 08	.347E 07	.418E 08	.681E 07
13	-.346E 07	-.196E 07	.272E 08	-.806E 06	.492E 08	.115E 07
14	-.329E 07	-.172E 07	.281E 08	-.308E 07	.505E 08	-.280E 07
15	-.299E 07	-.717E 06	.240E 08	-.389E 07	.434E 08	-.554E 07
16	-.246E 07	.121E 06	.172E 08	-.437E 07	.315E 08	-.735E 07
17	-.208E 07	.640E 06	.112E 08	-.314E 07	.211E 08	-.598E 07
18	-.185E 07	.489E 06	.741E 07	-.222E 07	.145E 08	-.428E 07
19	-.174E 07	.135E 06	.597E 07	-.176E 06	.120E 08	-.456E 06
20	-.234E 07	-.336E 06	.528E 07	-.164E 07	.116E 08	-.229E 07
21	-.252E 07	-.486E 06	.346E 07	-.259E 07	.884E 07	-.366E 07
22	-.230E 07	-.448E 06	.179E 07	-.230E 07	.582E 07	-.322E 07
23	-.198E 07	-.341E 06	.359E 06	-.191E 07	.306E 07	-.272E 07
24	-.160E 07	-.207E 06	-.547E 06	-.132E 07	.109E 07	-.192E 07
25	-.122E 07	-.112E 06	-.986E 06	-.845E 06	-.108E 06	-.125E 07
26	-.918E 06	-.349E 05	-.105E 07	-.397E 06	-.586E 06	-.612E 06
27	-.706E 06	-.232E 05	-.106E 07	-.268E 06	-.862E 06	-.414E 06
28	-.527E 06	-.178E 05	-.102E 07	-.199E 06	-.103E 07	-.307E 06
29	-.406E 06	-.550E 04	-.930E 06	-.741E 05	-.103E 07	-.116E 06
30	-.328E 06	-.576E 03	-.844E 06	-.273E 05	-.983E 06	-.435E 05
31	-.267E 06	-.262E 04	-.788E 06	-.327E 05	-.966E 06	-.510E 05
32	-.220E 06	.946E 02	-.722E 06	-.670E 04	-.916E 06	-.110E 05
33	-.183E 06	.193E 04	-.649E 06	.105E 05	-.842E 06	.150E 05
34	-.149E 06	.164E 04	-.579E 06	.111E 05	-.770E 06	.164E 05
35	-.124E 06	.161E 04	-.522E 06	.128E 05	-.707E 06	.191E 05

Table C11. (Continued)

RESPONSE COVARIANCES (3)

$\tilde{t}$	DELTA	DELTA*DELTA	DDELTA	DZDOT	DELQ	$\Delta\gamma$	$\Delta\theta$	Δz
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.343E-08	.175E-06	.128E-04	.967E-03	.243E-07	.155E-06	.768E-08	.120E-02
3	.107E-03	.674E-05	.295E-04	.117E 00	.384E-06	.431E-05	.143E-04	.157E 01
4	.231E-03	-.229E-04	.117E-03	.264E 00	.381E-06	.406E-05	.355E-04	.112E 02
5	.377E-03	-.630E-04	.278E-03	.679E 00	.595E-06	.553E-05	.600E-04	.426E 02
6	.529E-03	-.111E-03	.551E-03	.159E 01	.951E-06	.772E-05	.860E-04	.131E 03
7	.663E-03	-.166E-03	.109E-02	.331E 01	.159E-05	.103E-04	.109E-03	.345E 03
8	.639E-03	-.224E-03	.210E-02	.568E 01	.324E-05	.120E-04	.165E-03	.809E 03
9	.520E-03	-.243E-03	.321E-02	.507E 01	.509E-05	.750E-05	.237E-03	.152E 04
10	.294E-03	-.200E-03	.276E-02	.270E 01	.366E-05	.291E-05	.311E-03	.212E 04
11	.245E-03	-.157E-03	.713E-02	.788E 01	.908E-05	.645E-05	.532E-03	.206E 04
12	.401E-03	-.296E-03	.168E-01	.420E 02	.190E-04	.270E-04	.874E-03	.102E 04
13	.466E-03	-.374E-03	.164E-01	.162E 03	.231E-04	.830E-04	.122E-02	.735E 03
14	.402E-03	-.350E-03	.122E-01	.437E 03	.211E-04	.179E-03	.132E-02	.993E 04
15	.264E-03	-.249E-03	.792E-02	.860E 03	.155E-04	.283E-03	.110E-02	.485E 05
16	.146E-03	-.132E-03	.361E-02	.134E 04	.839E-05	.352E-03	.758E-03	.145E 06
17	.867E-04	-.649E-04	.142E-02	.180E 04	.407E-05	.376E-03	.492E-03	.330E 06
18	.523E-04	-.342E-04	.514E-03	.221E 04	.200E-05	.367E-03	.319E-03	.632E 06
19	.331E-04	-.149E-04	.177E-03	.255E 04	.164E-05	.340E-03	.200E-03	.107E 07
20	.283E-04	-.140E-04	.630E-04	.274E 04	.158E-05	.292E-03	.590E-04	.167E 07
21	.155E-04	-.965E-05	.251E-04	.268E 04	.375E-06	.232E-03	.118E-04	.240E 07
22	.649E-05	-.433E-05	.969E-05	.254E 04	.733E-07	.179E-03	.238E-05	.326E 07
23	.221E-05	-.164E-05	.345E-05	.240E 04	.131E-07	.138E-03	.502E-06	.421E 07
24	.646E-06	-.522E-06	.103E-05	.228E 04	.358E-08	.109E-03	.145E-06	.526E 07
25	.145E-06	-.138E-06	.259E-06	.218E 04	.120E-08	.869E-04	.349E-07	.640E 07
26	.299E-07	-.301E-07	.530E-07	.210E 04	.280E-09	.711E-04	.740E-08	.762E 07
27	.187E-08	-.406E-08	.998E-08	.204E 04	.108E-09	.591E-04	.742E-09	.892E 07
28	.260E-08	.221E-08	.284E-08	.199E 04	.580E-10	.500E-04	.209E-09	.103E 08
29	.808E-08	-.438E-09	.258E-08	.195E 04	.122E-10	.428E-04	.121E-08	.118E 08
30	.110E-07	-.244E-08	.328E-08	.191E 04	.526E-11	.370E-04	.181E-08	.133E 08
31	.146E-07	-.323E-08	.321E-08	.189E 04	.526E-11	.323E-04	.241E-08	.150E 08
32	.155E-07	-.442E-08	.287E-08	.186E 04	.250E-11	.285E-04	.267E-08	.167E 08
33	.145E-07	-.470E-08	.233E-08	.184E 04	.137E-11	.252E-04	.255E-08	.185E 08
34	.134E-07	-.436E-08	.174E-08	.182E 04	.679E-12	.225E-04	.236E-08	.204E 08
35	.121E-07	-.402E-08	.140E-08	.180E 04	.345E-12	.202E-04	.214E-08	.223E 08

Table C11. (Continued)

RESPONSE COVARIANCES (3)

$\tilde{t}$	NIT	NIT*DNIT	DNIT	QALF	QALF*DQALF	DQALF
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.838E-03	.169E-02	.343E-02	.124E-01	.441E-02	.479E-02
3	.360E-02	-.152E-02	.161E-02	.731E 01	.198E 00	.197E 00
4	.146E-01	-.163E-02	.644E-02	.161E 02	.542E 00	.146E 01
5	.346E-01	-.101E-02	.266E-01	.268E 02	.126E 01	.633E 01
6	.662E-01	.774E-03	.871E-01	.385E 02	.226E 01	.221E 02
7	.126E 00	.634E-02	.272E 00	.504E 02	.353E 01	.721E 02
8	.178E 00	.106E-01	.619E 00	.535E 02	.395E 01	.191E 03
9	.171E 00	.288E-01	.101E 01	.582E 02	.539E 01	.421E 03
10	.310E 00	-.603E-02	.226E 01	.710E 02	.512E 01	.875E 03
11	.725E 00	-.119E 00	.713E 01	.546E 02	-.328E 01	.186E 04
12	.100E 01	-.610E 00	.356E 02	.467E 02	-.231E 01	.361E 04
13	.912E 00	-.447E 00	.378E 02	.520E 02	.416E 01	.586E 04
14	.687E 00	-.278E 00	.217E 02	.534E 02	-.212E 01	.659E 04
15	.303E 00	-.945E-01	.720E 01	.410E 02	-.138E 02	.470E 04
16	.161E 00	.363E-02	.221E 01	.321E 02	-.169E 02	.276E 04
17	.189E 00	.101E-01	.976E 00	.266E 02	-.123E 02	.159E 04
18	.242E 00	-.372E-02	.651E 00	.224E 02	-.729E 01	.939E 03
19	.268E 00	.657E-02	.445E 00	.192E 02	-.385E 01	.556E 03
20	.454E 00	-.610E-02	.494E 00	.251E 02	-.285E 01	.330E 03
21	.482E 00	-.381E-01	.537E 00	.210E 02	-.245E 01	.197E 03
22	.352E 00	-.324E-01	.452E 00	.130E 02	-.143E 01	.116E 03
23	.236E 00	-.225E-01	.399E 00	.725E 01	-.743E 00	.681E 02
24	.148E 00	-.135E-01	.350E 00	.385E 01	-.368E 00	.395E 02
25	.938E-01	-.783E-02	.262E 00	.204E 01	-.179E 00	.220E 02
26	.586E-01	-.390E-02	.178E 00	.108E 01	-.853E-01	.115E 02
27	.384E-01	-.217E-02	.123E 00	.582E 00	-.399E-01	.582E 01
28	.247E-01	-.125E-02	.808E-01	.321E 00	-.190E-01	.296E 01
29	.164E-01	-.605E-03	.524E-01	.181E 00	-.945E-02	.152E 01
30	.116E-01	-.332E-03	.342E-01	.107E 00	-.475E-02	.765E 00
31	.826E-02	-.248E-03	.208E-01	.653E-01	-.239E-02	.348E 00
32	.606E-02	-.131E-03	.110E-01	.399E-01	-.121E-02	.138E 00
33	.438E-02	-.595E-04	.502E-02	.245E-01	-.584E-03	.469E-01
34	.389E-02	-.365E-04	.177E-02	.151E-01	-.259E-03	.125E-01
35	.390E-02	-.216E-04	.302E-03	.953E-02	-.112E-03	.154E-02

Table C11. (Concluded)

RESPONSE COVARIANCES (3)

~t	IB1	IB1*DIB1	DIB1	IB2	IB2*DIB2	DIB2	IB3	IB3*DIB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.588E 11	.154E 12	.405E 12	.193E 12	.157E 13	.130E 14	.179E 12	.216E 13	.265E 14
3	.602E 11	-.924E 11	.382E 12	.480E 14	.221E 14	.320E 14	.137E 15	.570E 14	.736E 14
4	.172E 12	-.164E 12	.117E 13	.103E 15	.255E 14	.925E 14	.295E 15	.667E 14	.212E 15
5	.385E 12	-.279E 12	.280E 13	.164E 15	.253E 14	.205E 15	.476E 15	.691E 14	.469E 15
6	.729E 12	-.454E 12	.613E 13	.226E 15	.200E 14	.401E 15	.660E 15	.599E 14	.913E 15
7	.130E 13	-.783E 12	.141E 14	.276E 15	.462E 13	.800E 15	.817E 15	.285E 14	.181E 16
8	.220E 13	-.123E 13	.315E 14	.252E 15	-.413E 14	.156E 16	.765E 15	-.787E 14	.351E 16
9	.265E 13	-.155E 13	.539E 14	.196E 15	-.821E 14	.241E 16	.607E 15	-.173E 15	.541E 16
10	.310E 13	-.754E 12	.573E 14	.982E 14	-.859E 14	.209E 16	.322E 15	-.195E 15	.464E 16
11	.633E 13	-.384E 13	.169E 15	.655E 14	-.108E 15	.559E 16	.237E 15	-.205E 15	.123E 17
12	.838E 13	-.965E 13	.433E 15	.125E 15	-.250E 15	.133E 17	.418E 15	-.461E 15	.293E 17
13	.693E 13	-.109E 14	.514E 15	.164E 15	-.293E 15	.132E 17	.518E 15	-.559E 15	.286E 17
14	.477E 13	-.940E 13	.449E 15	.147E 15	-.246E 15	.998E 16	.457E 15	-.489E 15	.214E 17
15	.270E 13	-.615E 13	.299E 15	.956E 14	-.160E 15	.647E 16	.300E 15	-.331E 15	.139E 17
16	.148E 13	-.269E 13	.145E 15	.497E 14	-.748E 14	.297E 16	.161E 15	-.160E 15	.633E 16
17	.110E 13	-.111E 13	.707E 14	.259E 14	-.310E 14	.120E 16	.899E 14	-.681E 14	.251E 16
18	.904E 12	-.413E 12	.345E 14	.134E 14	-.131E 14	.456E 15	.505E 14	-.301E 14	.921E 15
19	.684E 12	-.170E 12	.164E 14	.759E 13	-.398E 13	.169E 15	.305E 14	-.865E 13	.327E 15
20	.916E 12	-.842E 10	.823E 13	.481E 13	-.270E 13	.641E 14	.229E 14	-.740E 13	.115E 15
21	.834E 12	.219E 11	.441E 13	.164E 13	-.160E 13	.271E 14	.105E 14	-.549E 13	.448E 14
22	.539E 12	.116E 11	.237E 13	.350E 12	-.554E 12	.120E 14	.351E 13	-.232E 13	.182E 14
23	.322E 12	.666E 10	.130E 13	.164E 11	-.108E 12	.548E 13	.786E 12	-.776E 12	.736E 13
24	.183E 12	.238E 10	.718E 12	.227E 11	.245E 11	.252E 13	.892E 11	-.171E 12	.289E 13
25	.981E 11	.944E 09	.361E 12	.645E 11	.404E 11	.113E 13	.143E 10	.586E 08	.112E 13
26	.545E 11	-.311E 09	.182E 12	.712E 11	.211E 11	.530E 12	.223E 11	.189E 11	.470E 12
27	.318E 11	-.874E 08	.913E 11	.711E 11	.148E 11	.257E 12	.474E 11	.201E 11	.217E 12
28	.176E 11	.853E 08	.413E 11	.660E 11	.111E 11	.117E 12	.669E 11	.181E 11	.996E 11
29	.103E 11	-.103E 09	.200E 11	.543E 11	.335E 10	.576E 11	.663E 11	.640E 10	.501E 11
30	.672E 10	-.108E 09	.102E 11	.444E 11	.826E 09	.304E 11	.602E 11	.195E 10	.278E 11
31	.441E 10	-.301E 08	.449E 10	.385E 11	.120E 10	.143E 11	.579E 11	.254E 10	.144E 11
32	.299E 10	-.393E 08	.178E 10	.322E 11	.451E 08	.610E 10	.518E 11	.282E 09	.675E 10
33	.205E 10	-.394E 08	.620E 09	.258E 11	-.554E 09	.233E 10	.435E 11	-.970E 09	.281E 10
34	.136E 10	-.238E 08	.158E 09	.205E 11	-.459E 09	.685E 09	.362E 11	-.858E 09	.925E 09
35	.939E 09	-.170E 08	.197E 08	.166E 11	-.450E 09	.115E 09	.304E 11	-.885E 09	.181E 09

Table C12. Minimum Drift (c4) Covariance Results

MEAN RESPONSES (4)

$\tilde{t}$	DELTA	DDELTA	NSUBIT	DNSUBIT	QALF	QDALF	DZ	Z
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.176E-05	.123E-03	.117E-02	.243E-02	.469E-02	.334E-02	-.962E-03	-.866E-03
3	-.133E-02	-.111E-02	.173E-01	.223E-02	.389E 00	.113E 00	-.545E-01	-.108E 00
4	-.497E-02	-.162E-02	.582E-01	.573E-03	.140E 01	.287E 00	-.217E 00	-.722E 00
5	-.112E-01	-.141E-02	.134E 00	.916E-02	.316E 01	.594E 00	-.581E 00	-.261E 01
6	-.199E-01	-.232E-03	.247E 00	.220E-01	.562E 01	.107E 01	-.122E 01	-.697E 01
7	-.301E-01	.219E-02	.403E 00	.441E-01	.859E 01	.175E 01	-.217E 01	-.153E 02
8	-.407E-01	.529E-02	.584E 00	.679E-01	.117E 02	.264E 01	-.344E 01	-.291E 02
9	-.474E-01	.110E-01	.755E 00	.139E 00	.156E 02	.393E 01	-.491E 01	-.498E 02
10	-.466E-01	.165E-01	.870E 00	.688E-01	.208E 02	.557E 01	-.682E 01	-.788E 02
11	-.601E-01	.771E-02	.108E 01	.285E-01	.215E 02	.543E 01	-.946E 01	-.119E 03
12	-.805E-01	.769E-02	.466E 00	-.183E 00	.210E 02	.676E 01	-.962E 01	-.169E 03
13	-.918E-01	.223E-01	.337E 00	-.431E 00	.257E 02	.102E 02	-.559E 01	-.208E 03
14	-.893E-01	.319E-01	.729E 00	-.206E 00	.294E 02	.637E 01	-.716E 00	-.224E 03
15	-.698E-01	.353E-01	.111E 01	.209E-01	.267E 02	-.244E 01	.266E 01	-.218E 03
16	-.407E-01	.300E-01	.945E 00	-.112E 00	.191E 02	-.861E 01	.415E 01	-.201E 03
17	-.175E-01	.180E-01	.559E 00	-.282E 00	.973E 01	-.924E 01	.487E 01	-.178E 03
18	-.522E-02	.773E-02	.215E 00	-.250E 00	.345E 01	-.639E 01	.559E 01	-.152E 03
19	-.161E-02	.223E-02	.946E-01	-.101E 00	.125E 01	-.267E 01	.632E 01	-.122E 03
20	-.142E-02	.676E-03	.141E 00	.354E-03	.134E 01	.373E-01	.663E 01	-.894E 02
21	-.190E-02	.624E-03	.254E 00	.813E-01	.222E 01	.162E 01	.618E 01	-.570E 02
22	-.202E-02	.838E-03	.337E 00	.112E 00	.289E 01	.196E 01	.494E 01	-.289E 02
23	-.162E-02	.931E-03	.361E 00	.904E-01	.295E 01	.143E 01	.323E 01	-.822E 01
24	-.101E-02	.763E-03	.331E 00	.484E-01	.254E 01	.764E 00	.142E 01	.345E 01
25	-.493E-03	.490E-03	.264E 00	.154E-01	.197E 01	.313E 00	-.149E 00	.653E 01
26	-.203E-03	.236E-03	.191E 00	-.148E-01	.139E 01	-.351E-02	-.125E 01	.288E 01
27	-.324E-04	.118E-03	.139E 00	-.446E-02	.985E 00	.138E-02	-.185E 01	-.501E 01
28	.786E-04	.475E-04	.971E-01	-.148E-02	.703E 00	.662E-02	-.204E 01	-.149E 02
29	.116E-03	-.125E-04	.692E-01	.269E-02	.511E 00	-.292E-02	-.190E 01	-.249E 02
30	.125E-03	-.313E-04	.527E-01	.607E-02	.385E 00	.290E-02	-.153E 01	-.336E 02
31	.139E-03	-.315E-04	.421E-01	-.356E-02	.298E 00	.562E-02	-.103E 01	-.400E 02
32	.142E-03	-.395E-04	.354E-01	.212E-02	.236E 00	.425E-02	-.465E 00	-.438E 02
33	.140E-03	-.426E-04	.312E-01	.139E-02	.190E 00	.981E-02	.878E-01	-.448E 02
34	.139E-03	-.416E-04	.264E-01	.141E-02	.155E 00	.396E-02	.582E 00	-.431E 02
35	.140E-03	-.412E-04	.234E-01	.106E-02	.129E 00	.406E-02	.979E 00	-.391E 02

Table C12. (Continued)

MEAN RESPONSES (4)

$\tilde{t}$	IB1	DIB1	IB2	DIB2	IB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.873E 04	-.245E 05	-.133E 05	-.128E 06	-.111E 05	-.180E 06
3	-.671E 05	.102E 06	.831E 06	.124E 07	.145E 07	.192E 07
4	-.202E 06	.199E 06	.318E 07	.253E 07	.550E 07	.392E 07
5	-.462E 06	.279E 06	.719E 07	.385E 07	.124E 08	.601E 07
6	-.867E 06	.306E 06	.127E 08	.491E 07	.220E 08	.771E 07
7	-.143E 07	.221E 06	.189E 08	.521E 07	.330E 08	.830E 07
8	-.210E 07	.467E 05	.253E 08	.498E 07	.443E 08	.815E 07
9	-.273E 07	-.547E 06	.290E 08	.137E 07	.512E 08	.296E 07
10	-.320E 07	-.124E 07	.277E 08	-.381E 07	.496E 08	-.472E 07
11	-.461E 07	-.109E 03	.349E 08	.734E 07	.632E 08	.121E 08
12	-.478E 07	-.449E 05	.490E 08	.115E 08	.867E 08	.191E 08
13	-.494E 07	-.203E 07	.567E 08	.323E 06	.997E 08	.313E 07
14	-.533E 07	-.224E 07	.543E 08	-.742E 07	.962E 08	-.942E 07
15	-.504E 07	-.139E 07	.418E 08	-.124E 08	.739E 08	-.188E 08
16	-.350E 07	-.441E 06	.230E 08	-.134E 08	.422E 08	-.215E 08
17	-.183E 07	.472E 06	.930E 07	-.822E 07	.176E 08	-.142E 08
18	-.657E 06	.604E 06	.260E 07	-.336E 07	.511E 07	-.629E 07
19	-.231E 06	.274E 06	.756E 06	-.783E 06	.153E 07	-.163E 07
20	-.255E 06	-.406E 05	.582E 06	-.243E 06	.128E 07	-.351E 06
21	-.445E 06	-.243E 06	.604E 06	-.439E 06	.155E 07	-.424E 06
22	-.591E 06	-.293E 06	.446E 06	-.655E 06	.147E 07	-.713E 06
23	-.624E 06	-.237E 06	.104E 06	-.713E 06	.947E 06	-.878E 06
24	-.557E 06	-.143E 06	-.211E 06	-.563E 06	.347E 06	-.751E 06
25	-.434E 06	-.704E 05	-.375E 06	-.359E 06	-.773E 05	-.505E 06
26	-.315E 06	-.150E 05	-.382E 06	-.149E 06	-.237E 06	-.227E 06
27	-.232E 06	-.888E 04	-.365E 06	-.910E 05	-.312E 06	-.140E 06
28	-.166E 06	-.604E 04	-.332E 06	-.602E 05	-.341E 06	-.918E 05
29	-.123E 06	-.201E 04	-.287E 06	-.184E 05	-.320E 06	-.289E 05
30	-.966E 05	-.352E 03	-.258E 06	-.611E 04	-.292E 06	-.883E 04
31	-.775E 05	-.175E 04	-.228E 06	-.956E 04	-.279E 06	-.139E 05
32	-.642E 05	-.968E 03	-.208E 06	-.396E 04	-.263E 06	-.522E 04
33	-.544E 05	-.363E 03	-.198E 06	-.342E 03	-.245E 06	-.538E 01
34	-.458E 05	-.560E 03	-.175E 06	-.109E 04	-.232E 06	-.102E 04
35	-.400E 05	-.599E 03	-.166E 06	-.147E 04	-.223E 06	-.166E 04

Table C12. (Continued)

RESPONSE COVARIANCES (4)

$\tilde{t}$	DELTA	DELTA*DELTA	DDELTA	DZDOT	DELQ	$\Delta\gamma$	$\Delta\theta$	ΔZ
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.380E-08	.190E-06	.130E-04	.962E-03	.229E-07	.154E-06	.872E-08	.120E-02
3	.106E-03	.630E-05	.289E-04	.106E 00	.404E-06	.391E-05	.153E-04	.152E 01
4	.230E-03	-.232E-04	.114E-03	.207E 00	.410E-06	.319E-05	.383E-04	.989E 01
5	.374E-03	-.633E-04	.270E-03	.492E 00	.645E-06	.401E-05	.661E-04	.344E 02
6	.523E-03	-.111E-03	.533E-03	.107E 01	.102E-05	.522E-05	.973E-04	.974E 02
7	.650E-03	-.165E-03	.105E-02	.208E 01	.169E-05	.651E-05	.128E-03	.238E 03
8	.755E-03	-.216E-03	.204E-02	.379E 01	.293E-05	.800E-05	.157E-03	.520E 03
9	.728E-03	-.275E-03	.320E-02	.626E 01	.432E-05	.926E-05	.167E-03	.104E 04
10	.552E-03	-.266E-03	.267E-02	.103E 02	.292E-05	.111E-04	.151E-03	.198E 04
11	.806E-03	-.218E-03	.675E-02	.184E 02	.604E-05	.150E-04	.204E-03	.357E 04
12	.142E-02	-.361E-03	.161E-01	.196E 02	.143E-04	.126E-04	.332E-03	.598E 04
13	.170E-02	-.736E-03	.166E-01	.872E 01	.180E-04	.446E-05	.402E-03	.802E 04
14	.140E-02	-.821E-03	.131E-01	.462E 01	.168E-04	.190E-05	.338E-03	.839E 04
15	.773E-03	-.576E-03	.878E-02	.726E 01	.120E-04	.238E-05	.197E-03	.720E 04
16	.299E-03	-.262E-03	.408E-02	.101E 02	.576E-05	.264E-05	.861E-04	.546E 04
17	.110E-03	-.973E-04	.162E-02	.117E 02	.232E-05	.245E-05	.365E-04	.387E 04
18	.422E-04	-.366E-04	.589E-03	.121E 02	.891E-06	.202E-05	.177E-04	.276E 04
19	.156E-04	-.138E-04	.202E-03	.113E 02	.314E-06	.150E-05	.992E-05	.220E 04
20	.545E-05	-.494E-05	.645E-04	.930E 01	.112E-06	.993E-06	.650E-05	.207E 04
21	.179E-05	-.163E-05	.208E-04	.695E 01	.393E-07	.600E-06	.493E-05	.218E 04
22	.601E-06	-.536E-06	.696E-05	.497E 01	.161E-07	.350E-06	.406E-05	.232E 04
23	.188E-06	-.177E-06	.218E-05	.383E 01	.924E-08	.221E-06	.330E-05	.233E 04
24	.503E-07	-.517E-07	.580E-06	.359E 01	.789E-08	.171E-06	.251E-05	.213E 04
25	.101E-07	-.119E-07	.119E-06	.388E 01	.779E-08	.155E-06	.177E-05	.177E 04
26	.218E-08	-.229E-08	.194E-07	.423E 01	.741E-08	.143E-06	.120E-05	.135E 04
27	.481E-09	-.375E-09	.108E-08	.432E 01	.641E-08	.125E-06	.851E-06	.947E 03
28	.370E-09	-.306E-10	.175E-08	.402E 01	.507E-08	.101E-06	.694E-06	.644E 03
29	.496E-09	-.132E-09	.324E-08	.342E 01	.367E-08	.750E-07	.667E-06	.460E 03
30	.567E-09	-.189E-09	.324E-08	.265E 01	.252E-08	.513E-07	.692E-06	.381E 03
31	.694E-09	-.210E-09	.281E-08	.191E 01	.176E-08	.327E-07	.706E-06	.368E 03
32	.678E-09	-.245E-09	.183E-08	.131E 01	.136E-08	.280E-07	.675E-06	.380E 03
33	.548E-09	-.223E-09	.955E-09	.918E 00	.123E-08	.126E-07	.594E-06	.384E 03
34	.412E-09	-.171E-09	.407E-09	.722E 00	.124E-08	.892E-08	.480E-06	.364E 03
35	.289E-09	-.123E-09	.125E-09	.664E 00	.127E-08	.745E-08	.359E-06	.318E 03

Table C12. (Continued)

RESPONSE COVARIANCES (4)

$\tilde{t}$	NIT	NIT*DNIT	DNIT	QALF	QALF*DQALF	DQALF
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.832E-03	.169E-02	.342E-02	.123E-01	.438E-02	.478E-02
3	.347E-02	-.146E-02	.158E-02	.730E 01	.198E 00	.197E 00
4	.148E-01	-.161E-02	.646E-02	.161E 02	.539E 00	.146E 01
5	.349E-01	-.105E-02	.266E-01	.268E 02	.126E 01	.633E 01
6	.661E-01	.628E-03	.871E-01	.383E 02	.224E 01	.221E 02
7	.124E 00	.589E-02	.272E 00	.498E 02	.347E 01	.721E 02
8	.208E 00	.168E-01	.614E 00	.605E 02	.495E 01	.192E 03
9	.262E 00	.422E-01	.991E 00	.774E 02	.725E 01	.421E 03
10	.390E 00	.577E-02	.222E 01	.110E 03	.824E 01	.874E 03
11	.803E 00	-.471E-01	.686E 01	.109E 03	-.494E 00	.186E 04
12	.838E 00	-.435E 00	.349E 02	.104E 03	.162E 01	.360E 04
13	.570E 00	-.225E 00	.374E 02	.137E 03	.327E 01	.585E 04
14	.417E 00	.235E-01	.217E 02	.151E 03	-.267E 02	.659E 04
15	.309E 00	.729E-01	.731E 01	.111E 03	-.444E 02	.470E 04
16	.206E 00	.807E-02	.231E 01	.643E 02	-.316E 02	.276E 04
17	.144E 00	-.151E-01	.105E 01	.332E 02	-.162E 02	.159E 04
18	.957E-01	-.155E-01	.693E 00	.177E 02	-.814E 01	.939E 03
19	.583E-01	-.127E-01	.470E 00	.959E 01	-.459E 01	.556E 03
20	.355E-01	-.965E-02	.502E 00	.489E 01	-.261E 01	.330E 03
21	.232E-01	-.702E-02	.537E 00	.244E 01	-.137E 01	.197E 03
22	.143E-01	-.411E-02	.450E 00	.123E 01	-.684E 00	.116E 03
23	.904E-02	-.290E-02	.397E 00	.628E 00	-.362E 00	.681E 02
24	.552E-02	-.219E-02	.349E 00	.316E 00	-.201E 00	.395E 02
25	.305E-02	-.142E-02	.262E 00	.153E 00	-.109E 00	.220E 02
26	.166E-02	-.869E-03	.178E 00	.719E-01	-.562E-01	.115E 02
27	.973E-03	-.521E-03	.123E 00	.341E-01	-.279E-01	.582E 01
28	.600E-03	-.305E-03	.808E-01	.168E-01	-.137E-01	.296E 01
29	.420E-03	-.174E-03	.524E-01	.881E-02	-.691E-02	.152E 01
30	.323E-03	-.105E-03	.342E-01	.491E-02	-.341E-02	.765E 00
31	.243E-03	-.708E-04	.208E-01	.277E-02	-.165E-02	.348E 00
32	.176E-03	-.392E-04	.110E-01	.149E-02	-.772E-03	.138E 00
33	.117E-03	-.196E-04	.502E-02	.748E-03	-.324E-03	.469E-01
34	.876E-04	-.653E-05	.177E-02	.357E-03	-.104E-03	.125E-01
35	.702E-04	-.825E-06	.302E-03	.171E-03	-.176E-04	.154E-02

Table C12. (Concluded)

RESPONSE COVARIANCES (4)

$\tilde{t}$	IB1	IB1*DIB1	DIB1	IB2	IB2*DIB2	DIB2	IB3	IB3*DIB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.590E 11	.155E 12	.408E 12	.196E 12	.159E 13	.131E 14	.183E 12	.220E 13	.268E 14
3	.606E 11	-.916E 11	.374E 12	.479E 14	.218E 14	.314E 14	.137E 15	.562E 14	.721E 14
4	.174E 12	-.163E 12	.114E 13	.102E 15	.251E 14	.901E 14	.293E 15	.658E 14	.206E 15
5	.391E 12	-.276E 12	.273E 13	.163E 15	.248E 14	.199E 15	.473E 15	.677E 14	.454E 15
6	.740E 12	-.446E 12	.599E 13	.223E 15	.192E 14	.388E 15	.653E 15	.577E 14	.882E 15
7	.132E 13	-.762E 12	.138E 14	.270E 15	.335E 13	.771E 15	.800E 15	.248E 14	.174E 16
8	.217E 13	-.138E 13	.313E 14	.304E 15	-.203E 14	.153E 16	.914E 15	-.212E 14	.344E 16
9	.287E 13	-.173E 13	.543E 14	.282E 15	-.701E 14	.242E 16	.863E 15	-.136E 15	.541E 16
10	.332E 13	-.102E 13	.568E 14	.201E 15	-.873E 14	.202E 16	.633E 15	-.190E 15	.447E 16
11	.700E 13	-.493E 13	.167E 15	.278E 15	-.648E 14	.534E 16	.897E 15	-.723E 14	.118E 17
12	.938E 13	-.118E 14	.432E 15	.533E 15	-.148E 15	.129E 17	.165E 16	-.158E 15	.283E 17
13	.848E 13	-.121E 14	.521E 15	.665E 15	-.322E 15	.134E 17	.202E 16	-.594E 15	.289E 17
14	.701E 13	-.100E 14	.459E 15	.534E 15	-.351E 15	.105E 17	.164E 16	-.751E 15	.227E 17
15	.490E 13	-.641E 13	.308E 15	.277E 15	-.248E 15	.705E 16	.881E 15	-.569E 15	.152E 17
16	.256E 13	-.272E 13	.150E 15	.996E 14	-.115E 15	.328E 16	.328E 15	-.272E 15	.704E 16
17	.136E 13	-.112E 13	.725E 14	.329E 14	-.427E 14	.134E 16	.114E 15	-.101E 15	.282E 16
18	.736E 12	-.438E 12	.352E 14	.111E 14	-.156E 14	.511E 15	.412E 14	-.372E 14	.105E 16
19	.377E 12	-.180E 12	.167E 14	.350E 13	-.548E 13	.187E 15	.141E 14	-.134E 14	.368E 15
20	.191E 12	-.818E 11	.827E 13	.976E 12	-.181E 13	.675E 14	.446E 13	-.458E 13	.123E 15
21	.101E 12	-.403E 11	.441E 13	.216E 12	-.564E 12	.266E 14	.124E 13	-.143E 13	.436E 14
22	.522E 11	-.195E 11	.237E 13	.427E 11	-.180E 12	.113E 14	.337E 12	-.451E 12	.166E 14
23	.285E 11	-.965E 10	.130E 13	.593E 10	-.551E 11	.509E 13	.713E 11	-.138E 12	.643E 13
24	.154E 11	-.524E 10	.717E 12	.449E 10	-.146E 11	.238E 13	.893E 10	-.346E 11	.254E 13
25	.750E 10	-.271E 10	.361E 12	.660E 10	-.356E 10	.108E 13	.202E 10	-.569E 10	.998E 12
26	.369E 10	-.146E 10	.182E 12	.580E 10	-.188E 10	.517E 12	.308E 10	-.106E 10	.439E 12
27	.188E 10	-.748E 09	.912E 11	.469E 10	-.997E 09	.253E 12	.375E 10	-.219E 09	.206E 12
28	.923E 09	-.338E 09	.413E 11	.363E 10	-.483E 09	.116E 12	.390E 10	-.368E 08	.956E 11
29	.500E 09	-.171E 09	.200E 11	.267E 10	-.450E 09	.578E 11	.335E 10	-.335E 09	.505E 11
30	.307E 09	-.923E 08	.102E 11	.207E 10	-.321E 09	.307E 11	.285E 10	-.319E 09	.285E 11
31	.189E 09	-.443E 08	.449E 10	.171E 10	-.172E 09	.144E 11	.261E 10	-.174E 09	.148E 11
32	.115E 09	-.238E 08	.178E 10	.131E 10	-.150E 09	.620E 10	.215E 10	-.204E 09	.697E 10
33	.656E 08	-.123E 08	.621E 09	.900E 09	-.118E 09	.237E 10	.155E 10	-.190E 09	.289E 10
34	.344E 08	-.472E 07	.158E 09	.581E 09	-.679E 08	.696E 09	.105E 10	-.121E 09	.951E 09
35	.185E 08	-.154E 07	.196E 08	.368E 09	-.396E 08	.115E 09	.691E 09	-.786E 08	.182E 09

Table C13. Normal Acceleration (c5) Covariance Results

MEAN RESPONSES (5)

$\tilde{t}$	DELTA	DDELTA	NSUBIT	DNSUBIT	QALF	QDALF	DZ	Z
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.191E-05	.123E-03	.117E-02	.243E-02	.469E-02	.335E-02	-.962E-03	-.866E-03
3	-.134E-02	-.112E-02	.175E-01	-.218E-02	.390E 00	.113E 00	-.553E-01	-.109E 00
4	-.500E-02	-.164E-02	.591E-01	.775E-03	.140E 01	.288E 00	-.226E 00	-.741E 00
5	-.113E-01	-.146E-02	.137E 00	.975E-02	.318E 01	.597E 00	-.621E 00	-.273E 01
6	-.202E-01	-.301E-03	.255E 00	.234E-01	.567E 01	.108E 01	-.135E 01	-.747E 01
7	-.307E-01	.210E-02	.419E 00	.467E-01	.872E 01	.177E 01	-.249E 01	-.168E 02
8	-.364E-01	.813E-02	.497E 00	.120E-01	.109E 02	.235E 01	-.392E 01	-.330E 02
9	-.369E-01	.125E-01	.334E 00	.536E-01	.126E 02	.348E 01	-.376E 01	-.533E 02
10	-.473E-01	.173E-01	.191E 00	-.595E-01	.141E 02	.489E 01	-.853E 00	-.661E 02
11	-.155E-01	.147E-01	-.125E 00	-.335E 00	.983E 01	.446E 01	.552E 01	-.571E 02
12	-.485E-01	-.489E-03	-.816E 00	-.276E 00	.963E 01	.688E 01	.196E 02	.222E 01
13	-.361E-01	.7[illegible]6E-02	-.117E 01	-.498E 00	.118E 02	.969E 01	.406E 02	.149E 03
14	-.346E-01	.136E-01	-.121E 01	-.216E 00	.126E 02	.583E 01	.683E 02	.417E 03
15	-.455E-01	.147E-01	-.102E 01	.166E 00	.103E 02	-.236E 01	.101E 03	.839E 03
16	-.137E-01	.111E-01	-.714E 00	.189E 00	.656E 01	-.787E 01	.137E 03	.143E 04
17	-.208E-02	.617E-02	-.402E 00	.586E-02	.285E 01	-.833E 01	.172E 03	.220E 04
18	-.112E-02	.250E-02	-.176E 00	-.767E-01	.759E 00	-.578E 01	.207E 03	.315E 04
19	-.371E-03	.753E-03	-.424E-01	-.450E-01	.286E 00	-.248E 01	.242E 03	.427E 04
20	-.930E-02	-.176E-02	.111E 01	.391E 00	.810E 01	.199E 01	.274E 03	.556E 04
21	-.140E-01	.375E-02	.231E 01	.278E 00	.153E 02	.294E 01	.292E 03	.698E 04
22	-.135E-01	.596E-02	.290E 01	.148E 00	.182E 02	.261E 01	.297E 03	.846E 04
23	-.999E-02	.599E-02	.298E 01	.154E-01	.172E 02	.160E 01	.292E 03	.994E 04
24	-.552E-02	.424E-02	.255E 01	-.931E-01	.135E 02	.564E 00	.284E 03	.114E 05
25	-.268E-02	.249E-02	.205E 01	-.904E-01	.101E 02	.179E 00	.276E 03	.128E 05
26	-.123E-02	.123E-02	.162E 01	-.797E-01	.742E 01	-.973E-01	.270E 03	.141E 05
27	-.310E-03	.676E-03	.131E 01	-.503E-01	.548E 01	-.630E-01	.265E 03	.155E 05
28	.368E-03	.320E-03	.105E 01	-.362E-01	.409E 01	-.385E-01	.261E 03	.168E 05
29	.651E-03	-.291E-04	.851E 00	-.175E-01	.309E 01	-.368E-01	.258E 03	.181E 05
30	.761E-03	-.164E-03	.713E 00	-.721E-02	.238E 01	-.230E-01	.255E 03	.194E 05
31	.878E-03	-.190E-03	.601E 00	-.163E-01	.186E 01	-.143E-01	.253E 03	.207E 05
32	.909E-03	-.256E-03	.514E 00	-.590E-02	.146E 01	-.114E-01	.251E 03	.219E 05
33	.881E-03	-.283E-03	.436E 00	-.288E-02	.115E 01	-.326E-02	.249E 03	.232E 05
34	.848E-03	-.276E-03	.405E 00	-.201E-02	.902E 00	-.555E-02	.248E 03	.244E 05
35	.807E-03	-.268E-03	.400E 00	-.135E-02	.716E 00	-.333E-02	.246E 03	.256E 05

Table C13. (Continued)

MEAN RESPONSES (5)

$\tilde{t}$	IB1	DIB1	IB2	DIB2	IB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.872E 04	-.245E 05	-.132E 05	-.127E 06	-.109E 05	-.179E 06
3	-.967E 05	.103E 06	.836E 06	.125E 07	.146E 07	.193E 07
4	-.200E 06	.202E 06	.320E 07	.256E 07	.553E 07	.396E 07
5	-.458E 06	.285E 06	.727E 07	.391E 07	.126E 08	.610E 07
6	-.861E 06	.317E 06	.129E 08	.504E 07	.223E 08	.791E 07
7	-.142E 07	.241E 06	.193E 08	.543E 07	.337E 08	.864E 07
8	-.216E 07	-.216E 06	.222E 08	.161E 07	.392E 08	.294E 07
9	-.251E 07	-.810E 06	.219E 08	-.241E 07	.392E 08	-.295E 07
10	-.285E 07	-.163E 07	.145E 08	-.913E 07	.275E 08	-.130E 08
11	-.371E 07	-.151E 07	.481E 07	-.965E 07	.125E 08	-.140E 08
12	-.330E 07	-.835E 06	.146E 08	.498E 07	.283E 08	.926E 07
13	-.313E 07	-.191E 07	.204E 08	-.516E 06	.375E 08	.156E 07
14	-.280E 07	-.180E 07	.198E 08	-.527E 07	.362E 08	-.645E 07
15	-.207E 07	-.740E 06	.146E 08	-.620E 07	.266E 08	-.931E 07
16	-.116E 07	.292E 06	.779E 07	-.450E 07	.143E 08	-.777E 07
17	-.467E 06	.930E 06	.281E 07	-.179E 07	.522E 07	-.408E 07
18	-.108E 06	.770E 06	.612E 06	-.248E 06	.114E 07	-.137E 07
19	-.449E 05	.318E 06	.188E 06	.754E 05	.365E 06	-.271E 06
20	-.142E 07	-.164E 06	.421E 07	.294E 07	.871E 07	.506E 07
21	-.294E 07	-.569E 06	.497E 07	-.636E 06	.119E 08	-.339E 06
22	-.361E 07	-.626E 06	.354E 07	-.240E 07	.103E 08	-.317E 07
23	-.358E 07	-.520E 06	.111E 07	-.298E 07	.628E 07	-.427E 07
24	-.295E 07	-.289E 06	-.100E 07	-.231E 07	.201E 07	-.345E 07
25	-.221E 07	-.163E 06	-.179E 07	-.146E 07	-.195E 06	-.221E 07
26	-.167E 07	-.561E 05	-.190E 07	-.702E 06	-.106E 07	-.109E 07
27	-.128E 07	-.376E 05	-.192E 07	-.475E 06	-.156E 07	-.737E 06
28	-.956E 06	-.292E 05	-.185E 07	-.353E 06	-.187E 07	-.546E 06
29	-.736E 06	-.795E 04	-.169E 07	-.130E 06	-.187E 07	-.206E 06
30	-.595E 06	.328E 02	-.153E 07	-.464E 05	-.178E 07	-.755E 05
31	-.484E 06	-.333E 04	-.143E 07	-.568E 05	-.175E 07	-.898E 05
32	-.399E 06	.111E 04	-.131E 07	-.103E 05	-.166E 07	-.182E 05
33	-.331E 06	.403E 04	-.118E 07	.201E 05	-.153E 07	.283E 05
34	-.270E 06	.348E 04	-.105E 07	.209E 05	-.140E 07	.304E 05
35	-.225E 06	.338E 04	-.946E 06	.241E 05	-.128E 07	.356E 05

Table C13. (Continued)

RESPONSE COVARIANCES (5)

$\tilde{t}$	DELTA	DELTA*DELTA	DDELTA	DZDOT	DELQ	$\Delta\gamma$	$\Delta\theta$	ΔZ
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.343E-08	.175E-06	.128E-04	.967E-03	.243E-07	.155E-06	.768E-08	.120E-02
3	.107E-03	.674E-05	.295E-04	.117E 00	.384E-06	.431E-05	.143E-04	.157E 01
4	.231E-03	-.229E-04	.117E-03	.264E 00	.381E-06	.406E-05	.355E-04	.112E 02
5	.377E-03	-.630E-04	.278E-03	.679E 00	.595E-06	.553E-05	.600E-04	.426E 02
6	.529E-03	-.111E-03	.551E-03	.159E 01	.951E-06	.772E-05	.860E-04	.131E 03
7	.663E-03	-.166E-03	.109E-02	.331E 01	.159E-05	.103E-04	.109E-03	.345E 03
8	.597E-03	-.227E-03	.179E-02	.565E 01	.445E-05	.119E-04	.174E-03	.811E 03
9	.442E-03	-.238E-03	.362E-02	.360E 01	.891E-05	.532E-05	.280E-03	.148E 04
10	.212E-03	-.120E-03	.183E-02	.120E 01	.117E-04	.129E-05	.418E-03	.180E 04
11	.423E-03	-.451E-03	.318E-01	.169E 02	.378E-04	.138E-04	.789E-03	.117E 04
12	.344E-03	-.131E-02	.831E-01	.105E 03	.641E-04	.674E-04	.124E-02	.317E 03
13	.289E-03	-.498E-03	.267E-01	.355E 03	.650E-04	.182E-03	.165E-02	.576E 04
14	.217E-03	-.269E-03	.111E-01	.862E 03	.561E-04	.354E-03	.185E-02	.369E 05
15	.119E-03	-.187E-03	.800E-02	.167E 04	.339E-04	.549E-03	.173E-02	.132E 06
16	.505E-04	-.986E-04	.441E-02	.277E 04	.165E-04	.725E-03	.149E-02	.352E 06
17	.212E-04	-.507E-04	.249E-02	.416E 04	.822E-05	.869E-03	.134E-02	.777E 06
18	.945E-05	-.269E-04	.140E-02	.592E 04	.416E-05	.984E-03	.128E-02	.152E 07
19	.360E-05	-.124E-04	.661E-03	.811E 04	.217E-05	.108E-02	.126E-02	.270E 07
20	.149E-04	-.238E-05	.213E-03	.105E 05	.572E-05	.112E-02	.776E-03	.451E 07
21	.261E-04	-.907E-05	.671E-04	.119E 05	.452E-05	.103E-02	.289E-03	.704E 07
22	.413E-04	-.104E-04	.201E-04	.124E 05	.226E-05	.869E-03	.648E-04	.103E 08
23	.106E-04	-.667E-05	.679E-05	.120E 05	.745E-06	.694E-03	.512E-05	.141E 08
24	.301E-05	-.237E-05	.247E-05	.114E 05	.137E-07	.545E-03	.680E-06	.185E 08
25	.684E-06	-.639E-06	.725E-06	.109E 05	.493E-08	.437E-03	.165E-06	.233E 08
26	.143E-06	-.142E-06	.164E-06	.105E 05	.120E-08	.357E-03	.355E-07	.285E 08
27	.904E-08	-.195E-07	.432E-07	.102E 05	.514E-09	.297E-03	.359E-08	.342E 08
28	.127E-07	.108E-07	.102E-07	.997E 04	.279E-09	.251E-03	.102E-08	.404E 08
29	.396E-07	-.164E-08	.265E-08	.977E 04	.463E-10	.215E-03	.594E-08	.469E 08
30	.541E-07	-.118E-07	.531E-08	.960E 04	.104E-10	.186E-03	.895E-08	.539E 08
31	.720E-07	-.157E-07	.592E-08	.946E 04	.119E-10	.162E-03	.119E-07	.613E 08
32	.772E-07	-.218E-07	.775E-08	.934E 04	.288E-11	.143E-03	.133E-07	.691E 08
33	.725E-07	-.233E-07	.832E-08	.924E 04	.181E-11	.127E-03	.127E-07	.774E 08
34	.671E-07	-.218E-07	.740E-08	.915E 04	.122E-11	.113E-03	.118E-07	.860E 08
35	.907E-07	-.202E-07	.677E-08	.905E 04	.118E-11	.102E-03	.107E-07	.951E 08

Table C13. (Continued)

RESPONSE COVARIANCES (5)

$\tilde{t}$	NIT	NIT*DNIT	DNIT	QALF	QALF*DQALF	DQALF
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.838E-03	.169E-02	.343E-02	.124E-01	.441E-02	.479E-02
3	.360E-02	-.152E-02	.161E-02	.731E 01	.198E 00	.197E 00
4	.146E-01	-.163E-02	.644E-02	.161E 02	.542E 00	.146E 01
5	.346E-01	-.101E-02	.266E-01	.268E 02	.126E 01	.633E 01
6	.662E-01	.774E-03	.871E-01	.385E 02	.226E 01	.221E 02
7	.126E 00	.634E-02	.272E 00	.504E 02	.353E 01	.721E 02
8	.171E 00	.683E-02	.613E 00	.509E 02	.340E 01	.190E 03
9	.134E 00	.265E-01	.956E 00	.498E 02	.451E 01	.418E 03
10	.343E 00	-.409E-01	.233E 01	.509E 02	.264E 01	.870E 03
11	.124E 01	-.921E 00	.222E 02	.250E 02	-.803E 01	.187E 04
12	.184E 01	-.273E 01	.956E 02	.256E 02	-.584E 01	.364E 04
13	.122E 01	-.100E 01	.590E 02	.331E 02	.298E 01	.588E 04
14	.827E 00	-.405E 00	.285E 02	.333E 02	.223E 01	.661E 04
15	.357E 00	-.135E 00	.972E 01	.215E 02	-.422E 01	.470E 04
16	.142E 00	-.214E-01	.303E 01	.121E 02	-.806E 01	.276E 04
17	.588E-01	.477E-02	.155E 01	.655E 01	-.724E 01	.160E 04
18	.269E-01	-.563E-05	.121E 01	.368E 01	-.443E 01	.940E 03
19	.156E-01	-.382E-02	.941E 00	.207E 01	-.237E 01	.556E 03
20	.173E 00	.534E-01	.669E 00	.113E 02	-.295E 00	.330E 03
21	.108E 00	.470E-01	.586E 00	.311E 02	.324E 00	.197E 03
22	.104E 01	-.524E-02	.459E 00	.382E 02	-.141E 00	.116E 03
23	.104E 01	-.441E-01	.399E 00	.313E 02	-.562E 00	.681E 02
24	.725E 00	-.527E-01	.353E 00	.180E 02	-.720E 00	.395E 02
25	.463E 00	-.310E-01	.264E 00	.966E 01	-.343E 00	.220E 02
26	.291E 00	-.150E-01	.178E 00	.518E 01	-.162E 00	.115E 02
27	.191E 00	-.840E-02	.123E 00	.282E 01	-.759E-01	.582E 01
28	.123E 00	-.493E-02	.810E-01	.157E 01	-.366E-01	.296E 01
29	.822E-01	-.231E-02	.524E-01	.891E 00	-.187E-01	.152E 01
30	.579E-01	-.125E-02	.342E-01	.529E 00	-.995E-02	.765E 00
31	.414E-01	-.973E-03	.208E-01	.323E 00	-.537E-02	.348E 00
32	.304E-01	-.510E-03	.110E-01	.199E 00	-.297E-02	.138E 00
33	.220E-01	-.222E-03	.502E-02	.123E 00	-.164E-02	.470E-01
34	.195E-01	-.158E-03	.177E-02	.759E-01	-.889E-03	.125E-01
35	.196E-01	-.106E-03	.303E-03	.478E-01	-.502E-03	.155E-02

Table C13. (Concluded)

RESPONSE COVARIANCES (5)

$\tilde{t}$	IB1	IB1*DIB1	DIB1	IB2	IB2*DIB2	DIB2	IB3	IB3*DIB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.288E 11	.164E 12	.405E 12	.193E 12	.157E 13	.130E 14	.179E 12	.216E 13	.265E 14
3	.602E 11	-.924E 11	.382E 12	.480E 14	.221E 14	.320E 14	.137E 15	.570E 14	.736E 14
4	.172E 12	-.164E 12	.117E 13	.103E 15	.255E 14	.925E 14	.295E 15	.667E 14	.212E 15
5	.385E 12	-.279E 12	.280E 13	.164E 15	.253E 14	.205E 15	.476E 15	.691E 14	.469E 15
6	.129E 12	-.454E 12	.613E 13	.226E 15	.200E 14	.401E 15	.660E 15	.599E 14	.913E 15
7	.130E 13	-.783E 12	.141E 14	.276E 15	.462E 13	.800E 15	.817E 15	.285E 14	.181E 16
8	.433E 13	-.110E 13	.319E 14	.235E 15	-.476E 14	.137E 16	.713E 15	-.981E 14	.303E 16
9	.277E 13	-.165E 13	.677E 14	.170E 15	-.929E 14	.287E 16	.520E 15	-.200E 15	.632E 16
10	.373E 13	.374E 12	.653E 14	.882E 14	-.507E 14	.166E 16	.255E 15	-.129E 15	.343E 16
11	.968E 13	.163E 13	.424E 15	.185E 15	-.199E 15	.244E 17	.395E 15	-.536E 15	.550E 17
12	.127E 14	-.708E 13	.108E 16	.253E 15	-.832E 15	.633E 17	.565E 15	-.197E 16	.143E 18
13	.926E 13	-.799E 13	.684E 15	.160E 15	-.350E 15	.220E 17	.399E 15	-.759E 15	.477E 17
14	.590E 13	-.747E 13	.496E 15	.106E 15	-.199E 15	.998E 16	.280E 15	-.408E 15	.207E 17
15	.475E 13	-.618E 13	.328E 15	.523E 14	-.153E 15	.695E 16	.146E 15	-.310E 15	.146E 17
16	.111E 13	-.290E 13	.163E 15	.213E 14	-.793E 14	.372E 16	.607E 14	-.164E 15	.792E 16
17	.523E 12	-.132E 13	.845E 14	.874E 13	-.402E 14	.207E 16	.251E 14	-.847E 14	.443E 16
18	.457E 12	-.602E 12	.441E 14	.382E 13	-.208E 14	.114E 16	.110E 14	-.447E 14	.247E 16
19	.126E 12	-.282E 12	.213E 14	.139E 13	-.926E 13	.538E 15	.405E 13	-.203E 14	.116E 16
20	.371E 12	-.945E 11	.978E 13	.331E 13	-.125E 13	.183E 15	.134E 14	-.382E 12	.385E 15
21	.414E 13	.666E 11	.487E 13	.346E 13	-.132E 13	.604E 14	.191E 14	-.284E 13	.120E 15
22	.150E 13	.120E 12	.247E 13	.153E 13	-.119E 13	.184E 14	.126E 14	-.446E 13	.326E 14
23	.135E 13	.104E 12	.131E 13	.141E 12	-.397E 12	.633E 13	.422E 13	-.294E 13	.927E 13
24	.856E 12	.412E 11	.720E 12	.101E 12	.192E 12	.289E 13	.404E 12	-.695E 12	.376E 13
25	.265E 12	.188E 11	.362E 12	.304E 12	.225E 12	.127E 13	.425E 10	.311E 11	.146E 13
26	.261E 12	.544E 10	.182E 12	.341E 12	.117E 12	.564E 12	.107E 12	.103E 12	.553E 12
27	.154E 12	.297E 10	.913E 11	.344E 12	.805E 11	.273E 12	.229E 12	.104E 12	.255E 12
28	.857E 11	.194E 10	.413E 11	.322E 12	.586E 11	.126E 12	.326E 12	.925E 11	.121E 12
29	.207E 11	.223E 09	.200E 11	.266E 12	.192E 11	.588E 11	.326E 12	.342E 11	.531E 11
30	.331E 11	-.150E 09	.102E 11	.219E 12	.576E 10	.306E 11	.297E 12	.115E 11	.282E 11
31	.219E 11	.375E 08	.449E 10	.190E 12	.699E 10	.145E 11	.287E 12	.139E 11	.150E 11
32	.149E 11	-.101E 09	.178E 10	.160E 12	.882E 09	.611E 10	.258E 12	.233E 10	.677E 10
33	.102E 11	-.152E 09	.622E 09	.129E 12	-.240E 10	.236E 10	.217E 12	-.430E 10	.287E 10
34	.679E 10	-.105E 09	.159E 09	.103E 12	-.216E 10	.720E 09	.182E 12	-.407E 10	.996E 09
35	.471E 10	-.829E 08	.208E 08	.834E 11	-.223E 10	.162E 09	.153E 12	-.439E 10	.282E 09

Table C14. $\bar{q}a$ (c6) Covariance Results

MEAN RESPONSES (6)

$\tilde{t}$	DELTA	DDELTA	NSUBIT	DNSUBIT	QALF	QDALF	DZ	Z
1	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00
2	-.191E-05	.123E-03	.117E-02	.243E-02	.469E-02	.335E-02	-.962E-03	-.866E-03
3	-.134E-02	-.112E-02	.175E-01	-.218E-02	.390E 00	.113E 00	-.553E-01	-.109E 00
4	-.500E-02	-.164E-02	.591E-01	.775E-03	.140E 01	.288E 00	-.226E 00	-.741E 00
5	-.113E-01	-.146E-02	.137E 00	.975E-02	.318E 01	.597E 00	-.621E 00	-.273E 01
6	-.202E-01	-.301E-03	.255E 00	.234E-01	.567E 01	.108E 01	-.135E 01	-.747E 01
7	-.307E-01	.210E-02	.419E 00	.467E-01	.872E 01	.177E 01	-.249E 01	-.168E 02
8	-.345E-01	.890E-02	.454E 00	-.952E-02	.105E 02	.225E 01	-.384E 01	-.330E 02
9	-.320E-01	.132E-01	.146E 00	.124E-01	.112E 02	.327E 01	-.281E 01	-.512E 02
10	-.190E-01	.182E-01	-.846E-01	-.116E 00	.114E 02	.455E 01	.235E 01	-.543E 02
11	.215E-02	.162E-01	-.597E 00	-.480E 00	.521E 01	.410E 01	.126E 02	-.206E 02
12	.194E-02	-.352E-02	-.154E 01	-.383E 00	.305E 01	.679E 01	.332E 02	.886E 02
13	-.585E-03	.834E-03	-.211E 01	-.607E 00	.292E 01	.911E 01	.633E 02	.324E 03
14	-.169E-02	.161E-02	-.239E 01	-.194E 00	.243E 01	.561E 01	.104E 03	.737E 03
15	-.827E-03	.384E-03	-.223E 01	.330E 00	.101E 01	-.198E 01	.154E 03	.138E 04
16	.111E-02	-.134E-02	-.164E 01	.420E 00	-.424E 00	-.720E 01	.207E 03	.228E 04
17	.202E-02	-.175E-02	-.966E 00	.211E 00	-.118E 01	-.764E 01	.262E 03	.345E 04
18	.144E-02	-.117E-02	-.430E 00	.465E-01	-.995E 00	-.534E 01	.315E 03	.489E 04
19	.215E-03	-.377E-03	-.113E 00	.335E-02	-.209E 00	-.231E 01	.369E 03	.660E 04
20	-.170E-01	-.373E-02	.206E 01	.767E 00	.148E 02	.393E 01	.417E 03	.857E 04
21	-.240E-01	.820E-02	.415E 01	.322E 00	.268E 02	.354E 01	.437E 03	.107E 05
22	-.205E-01	.107E-01	.465E 01	.205E-01	.283E 02	.241E 01	.437E 03	.129E 05
23	-.137E-01	.896E-02	.433E 01	-.114E 00	.243E 02	.131E 01	.427E 03	.151E 05
24	-.762E-02	.588E-02	.358E 01	-.161E 00	.186E 02	.464E 00	.414E 03	.172E 05
25	-.369E-02	.342E-02	.288E 01	-.141E 00	.139E 02	.110E 00	.404E 03	.192E 05
26	-.169E-02	.168E-02	.228E 01	-.111E 00	.102E 02	-.146E 00	.396E 03	.212E 05
27	-.426E-03	.925E-03	.184E 01	-.721E-01	.752E 01	-.964E-01	.389E 03	.232E 05
28	.505E-03	.438E-03	.147E 01	-.525E-01	.561E 01	-.615E-01	.383E 03	.251E 05
29	.893E-03	-.408E-04	.120E 01	-.268E-01	.424E 01	-.534E-01	.379E 03	.270E 05
30	.104E-02	-.226E-03	.101E 01	-.132E-01	.327E 01	-.352E-01	.375E 03	.289E 05
31	.121E-02	-.261E-03	.849E 00	-.220E-01	.255E 01	-.231E-01	.372E 03	.308E 05
32	.125E-02	-.351E-03	.726E 00	-.937E-02	.200E 01	-.180E-01	.369E 03	.326E 05
33	.121E-02	-.389E-03	.617E 00	-.466E-02	.157E 01	-.822E-02	.366E 03	.345E 05
34	.116E-02	-.378E-03	.576E 00	-.341E-02	.124E 01	-.924E-02	.364E 03	.363E 05
35	.111E-02	-.368E-03	.570E 00	-.230E-02	.983E 00	-.613E-02	.362E 03	.381E 05

Table C14. (Continued)

MEAN RESPONSES (6)

$\tilde{t}$	IB1	DIB1	IB2	DIB2	IB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.872E 04	-.245E 05	-.132E 05	-.127E 06	-.109E 05	-.179E 06
3	-.667E 05	.103E 06	.836E 06	.125E 07	.146E 07	.193E 07
4	-.200E 06	.202E 06	.320E 07	.256E 07	.553E 07	.396E 07
5	-.458E 06	.285E 06	.727E 07	.391E 07	.126E 08	.610E 07
6	-.861E 06	.317E 06	.129E 08	.504E 07	.223E 08	.791E 07
7	-.142E 07	.241E 06	.193E 08	.543E 07	.337E 08	.864E 07
8	-.218E 07	-.294E 06	.208E 08	.536E 06	.370E 08	.126E 07
9	-.241E 07	-.917E 06	.186E 08	-.406E 07	.338E 08	-.554E 07
10	-.273E 07	-.184E 07	.892E 07	-.119E 08	.181E 08	-.173E 08
11	-.336E 07	-.199E 07	-.712E 07	-.152E 08	-.756E 07	-.227E 08
12	-.249E 07	-.136E 07	-.553E 07	-.197E 06	-.601E 07	.137E 07
13	-.203E 07	-.204E 07	-.297E 07	-.387E 07	-.237E 07	-.383E 07
14	-.124E 07	-.150E 07	-.877E 06	-.329E 07	.102E 06	-.356E 07
15	-.355E 06	-.251E 06	-.686E 04	-.523E 06	.432E 06	-.536E 06
16	.188E 06	.798E 06	-.474E 06	.203E 07	-.102E 07	.237E 07
17	.355E 06	.120E 07	-.834E 06	.281E 07	-.182E 07	.314E 07
18	.262E 06	.899E 06	-.584E 06	.202E 07	-.129E 07	.222E 07
19	.574E 05	.356E 06	-.567E 05	.813E 06	-.165E 06	.899E 06
20	-.258E 07	-.331E 06	.777E 07	.571E 07	.160E 08	.983E 07
21	-.521E 07	-.878E 06	.830E 07	-.217E 07	.202E 08	-.248E 07
22	-.568E 07	-.824E 06	.501E 07	-.462E 07	.153E 08	-.658E 07
23	-.509E 07	-.617E 06	.121E 07	-.446E 07	.833E 07	-.659E 07
24	-.406E 07	-.357E 06	-.138E 07	-.314E 07	.278E 07	-.473E 07
25	-.304E 07	-.204E 06	-.246E 07	-.198E 07	-.268E 06	-.301E 07
26	-.229E 07	-.738E 05	-.261E 07	-.956E 06	-.146E 07	-.148E 07
27	-.176E 07	-.495E 05	-.263E 07	-.646E 06	-.215E 07	-.100E 07
28	-.131E 07	-.388E 05	-.255E 07	-.482E 06	-.256E 07	-.746E 06
29	-.101E 07	-.999E 04	-.232E 07	-.177E 06	-.256E 07	-.280E 06
30	-.817E 06	.539E 03	-.210E 07	-.622E 05	-.245E 07	-.102E 06
31	-.664E 06	-.393E 04	-.196E 07	-.769E 05	-.240E 07	-.122E 06
32	-.548E 06	.195E 04	-.180E 07	-.134E 05	-.228E 07	-.242E 05
33	-.455E 06	.578E 04	-.161E 07	.280E 05	-.210E 07	.393E 05
34	-.370E 06	.500E 04	-.144E 07	.290E 05	-.191E 07	.419E 05
35	-.309E 06	.486E 04	-.130E 07	.336E 05	-.176E 07	.493E 05

Table C14. (Continued)

RESPONSE COVARIANCES (6)

$\tilde{t}$	DELTA	DELTA*DELTA	DDELTA	DZDOT	DELQ	$\Delta\gamma$	$\Delta\theta$	Δz
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.343E-08	.175E-06	.128E-04	.967E-03	.243E-07	.155E-06	.768E-08	.120E-02
3	.107E-03	.674E-05	.295E-04	.117E 00	.384E-06	.431E-05	.143E-04	.157E 01
4	.231E-03	-.229E-04	.117E-03	.264E 00	.381E-06	.406E-05	.355E-04	.112E 02
5	.377E-03	-.630E-04	.278E-03	.679E 00	.595E-06	.553E-05	.600E-04	.426E 02
6	.529E-03	-.111E-03	.551E-03	.159E 01	.951E-06	.772E-05	.860E-04	.131E 03
7	.663E-03	-.166E-03	.109E-02	.331E 01	.159E-05	.103E-04	.109E-03	.345E 03
8	.539E-03	-.240E-03	.253E-02	.539E 01	.456E-05	.114E-04	.192E-03	.809E 03
9	.344E-03	-.257E-03	.624E-02	.190E 01	.919E-05	.281E-05	.354E-03	.138E 04
10	.109E-03	-.226E-03	.883E-02	.589E 01	.890E-05	.634E-05	.595E-03	.125E 04
11	.459E-04	-.490E-03	.333E-01	.621E 02	.230E-04	.508E-04	.115E-02	.266E 03
12	.102E-03	-.124E-02	.821E-01	.291E 03	.411E-04	.187E-03	.188E-02	.270E 04
13	.133E-03	-.153E-02	.100E 00	.863E 03	.557E-04	.442E-03	.268E-02	.265E 05
14	.129E-03	-.133E-02	.859E-01	.200E 04	.540E-04	.822E-03	.321E-02	.117E 06
15	.101E-03	-.864E-03	.549E-01	.383E 04	.403E-04	.126E-02	.322E-02	.363E 06
16	.521E-04	-.392E-03	.241E-01	.633E 04	.210E-04	.166E-02	.299E-02	.900E 06
17	.240E-04	-.163E-03	.994E-02	.953E 04	.102E-04	.199E-02	.283E-02	.191E 07
18	.107E-04	-.660E-04	.397E-02	.136E 05	.496E-05	.226E-02	.279E-02	.365E 07
19	.411E-05	-.258E-04	.154E-02	.186E 05	.224E-05	.247E-02	.281E-02	.643E 07
20	.420E-04	.169E-05	.408E-03	.239E 05	.187E-04	.255E-02	.153E-02	.106E 08
21	.760E-04	-.288E-04	.109E-03	.263E 05	.103E-04	.227E-02	.399E-03	.164E 08
22	.509E-04	-.282E-04	.353E-04	.263E 05	.269E-05	.185E-02	.672E-04	.236E 08
23	.212E-04	-.143E-04	.122E-04	.252E 05	.508E-06	.145E-02	.698E-05	.321E 08
24	.622E-05	-.488E-05	.443E-05	.239E 05	.265E-07	.114E-02	.140E-05	.415E 08
25	.142E-05	-.132E-05	.136E-05	.229E 05	.999E-08	.913E-03	.342E-06	.520E 08
26	.298E-06	-.295E-06	.314E-06	.220E 05	.245E-08	.746E-03	.737E-07	.633E 08
27	.188E-07	-.405E-07	.885E-07	.214E 05	.107E-08	.620E-03	.747E-08	.755E 08
28	.264E-07	.226E-07	.203E-07	.208E 05	.580E-09	.524E-03	.213E-08	.887E 08
29	.826E-07	-.400E-08	.275E-08	.204E 05	.928E-10	.448E-03	.124E-07	.103E 09
30	.113E-06	-.245E-07	.807E-08	.201E 05	.173E-10	.388E-03	.187E-07	.118E 09
31	.150E-06	-.327E-07	.962E-08	.198E 05	.208E-10	.339E-03	.249E-07	.133E 09
32	.161E-06	-.454E-07	.144E-07	.195E 05	.340E-11	.298E-03	.277E-07	.150E 09
33	.151E-06	-.487E-07	.165E-07	.193E 05	.240E-11	.265E-03	.266E-07	.168E 09
34	.140E-06	-.455E-07	.151E-07	.191E 05	.196E-11	.236E-03	.247E-07	.186E 09
35	.127E-06	-.422E-07	.141E-07	.189E 05	.232E-11	.212E-03	.224E-07	.205E 09

Table C14. (Continued)

RESPONSE COVARIANCES (6)

$\tilde{t}$	NIT	NIT*DNIT	DNIT	QALF	QALF*DQALF	DQALF
1	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00
2	.838E-03	.169E-02	.343E-02	.124E-01	.441E-02	.479E-02
3	.360E-02	-.152E-02	.161E-02	.731E 01	.198E 00	.197E 00
4	.146E-01	-.163E-02	.644E-02	.161E 02	.542E 00	.146E 01
5	.346E-01	-.101E-02	.266E-01	.268E 02	.126E 01	.633E 01
6	.662E-01	.774E-03	.871E-01	.385E 02	.226E 01	.221E 02
7	.126E 00	.634E-02	.272E 00	.504E 02	.353E 01	.721E 02
8	.158E 00	.935E-02	.612E 00	.473E 02	.290E 01	.188E 03
9	.122E 00	.419E-01	.886E 00	.399E 02	.377E 01	.407E 03
10	.351E 00	.315E-01	.276E 01	.347E 02	.264E 01	.834E 03
11	.106E 01	.461E-01	.183E 02	.131E 02	-.470E 01	.176E 04
12	.184E 01	-.112E 00	.881E 02	.945E 01	-.291E 01	.343E 04
13	.194E 01	.107E 00	.105E 03	.960E 01	.926E 01	.563E 04
14	.177E 01	-.564E-01	.773E 02	.103E 02	.223E 02	.640E 04
15	.106E 01	-.174E 00	.383E 02	.735E 01	.172E 02	.461E 04
16	.505E 00	-.868E-01	.151E 02	.491E 01	.370E 01	.273E 04
17	.234E 00	-.134E-01	.579E 01	.312E 01	-.281E 01	.159E 04
18	.118E 00	.117E-02	.223E 01	.193E 01	-.259E 01	.939E 03
19	.696E-01	.260E-03	.123E 01	.125E 01	-.121E 01	.556E 03
20	.570E 00	.208E 00	.494E 00	.310E 02	.505E 01	.331E 03
21	.227E 01	.117E 00	.400E 00	.943E 02	.369E 01	.197E 03
22	.275E 01	-.822E-01	.388E 00	.967E 02	-.494E 00	.116E 03
23	.228E 01	-.134E 00	.404E 00	.666E 02	-.146E 01	.681E 02
24	.151E 01	-.105E 00	.356E 00	.371E 02	-.115E 01	.395E 02
25	.966E 00	-.621E-01	.266E 00	.200E 02	-.547E 00	.228E 02
26	.608E 00	-.301E-01	.179E 00	.108E 02	-.262E 00	.115E 02
27	.399E 00	-.169E-01	.124E 00	.586E 01	-.125E 00	.582E 01
28	.257E 00	-.996E-02	.811E-01	.326E 01	-.609E-01	.296E 01
29	.172E 00	-.465E-02	.525E-01	.186E 01	-.318E-01	.152E 01
30	.121E 00	-.251E-02	.342E-01	.110E 01	-.173E-01	.765E 00
31	.864E-01	-.198E-02	.208E-01	.675E 00	-.960E-02	.348E 00
32	.634E-01	-.104E-02	.110E-01	.415E 00	-.547E-02	.138E 00
33	.459E-01	-.449E-03	.502E-02	.256E 00	-.312E-02	.470E-01
34	.407E-01	-.326E-03	.177E-02	.159E 00	-.177E-02	.125E-01
35	.409E-01	-.222E-03	.303E-03	.999E-01	-.104E-02	.155E-02

Table C14. (Concluded)

RESPONSE COVARIANCES (6)

$\tilde{t}$	IB1	IB1*DIB1	DIB1	IB2	IB2*DIB2	DIB2	IB3	IB3*DIB3	DIB3
1	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00
2	.588E 11	.154E 12	.405E 12	.193E 12	.157E 13	.130E 14	.179E 12	.216E 13	.265E 14
3	.602E 11	-.924E 11	.382E 12	.480E 14	.221E 14	.320E 14	.137E 15	.570E 14	.736E 14
4	.172E 12	-.164E 12	.117E 13	.103E 15	.255E 14	.925E 14	.295E 15	.667E 14	.212E 15
5	.385E 12	-.279E 12	.280E 13	.164E 15	.253E 14	.205E 15	.476E 15	.691E 14	.469E 15
6	.729E 12	-.454E 12	.613E 13	.226E 15	.200E 14	.401E 15	.660E 15	.599E 14	.913E 15
7	.130E 13	-.783E 12	.141E 14	.276E 15	.462E 13	.800E 15	.817E 15	.285E 14	.181E 16
8	.236E 13	-.148E 13	.451E 14	.209E 15	-.712E 14	.202E 16	.638E 15	-.152E 15	.443E 16
9	.267E 13	-.306E 13	.116E 15	.132E 15	-.143E 15	.521E 16	.403E 15	-.302E 15	.113E 17
10	.331E 13	-.328E 13	.175E 15	.437E 14	-.169E 15	.760E 16	.126E 15	-.365E 15	.163E 17
11	.737E 13	-.116E 14	.647E 15	.723E 14	-.461E 15	.288E 17	.122E 15	-.958E 15	.621E 17
12	.102E 14	-.318E 14	.163E 16	.130E 15	-.121E 16	.713E 17	.238E 15	-.248E 16	.153E 18
13	.899E 13	-.397E 14	.200E 16	.137E 15	-.150E 16	.870E 17	.269E 15	-.307E 16	.187E 18
14	.621E 13	-.342E 14	.174E 16	.114E 15	-.129E 16	.745E 17	.238E 15	-.265E 16	.160E 18
15	.325E 13	-.215E 14	.111E 16	.787E 14	-.820E 15	.474E 17	.174E 15	-.169E 16	.102E 18
16	.133E 13	-.929E 13	.500E 15	.374E 14	-.364E 15	.209E 17	.852E 14	-.756E 15	.449E 17
17	.570E 12	-.386E 13	.225E 15	.163E 14	-.151E 15	.874E 16	.379E 14	-.313E 15	.187E 17
18	.253E 12	-.157E 13	.101E 15	.684E 13	-.607E 14	.358E 16	.163E 14	-.126E 15	.756E 16
19	.117E 12	-.610E 12	.444E 14	.249E 13	-.235E 14	.143E 16	.602E 13	-.490E 14	.298E 16
20	.957E 12	-.132E 12	.169E 14	.927E 13	-.205E 12	.413E 15	.379E 14	.877E 13	.838E 15
21	.354E 13	.341E 12	.700E 13	.936E 13	-.394E 13	.114E 15	.542E 14	-.102E 14	.218E 15
22	.390E 13	.342E 12	.298E 13	.312E 13	-.314E 13	.308E 14	.288E 14	-.133E 14	.544E 14
23	.292E 13	.218E 12	.133E 13	.173E 12	-.651E 12	.764E 13	.786E 13	-.629E 13	.123E 14
24	.177E 13	.954E 11	.723E 12	.206E 12	.421E 12	.338E 13	.833E 12	-.141E 13	.495E 13
25	.964E 12	.436E 11	.363E 12	.630E 12	.476E 12	.146E 13	.809E 10	.733E 11	.193E 13
26	.543E 12	.134E 11	.183E 12	.708E 12	.248E 12	.611E 12	.221E 12	.217E 12	.667E 12
27	.321E 12	.716E 10	.914E 11	.717E 12	.170E 12	.295E 12	.477E 12	.218E 12	.308E 12
28	.178E 12	.445E 10	.414E 11	.671E 12	.123E 12	.138E 12	.680E 12	.194E 12	.150E 12
29	.106E 12	.656E 09	.200E 11	.555E 12	.407E 11	.604E 11	.679E 12	.721E 11	.571E 11
30	.691E 11	-.217E 09	.102E 11	.457E 12	.124E 11	.307E 11	.619E 12	.246E 11	.287E 11
31	.456E 11	.124E 09	.449E 10	.397E 12	.148E 11	.148E 11	.598E 12	.294E 11	.158E 11
32	.311E 11	-.188E 09	.178E 10	.334E 12	.200E 10	.612E 10	.538E 12	.509E 10	.679E 10
33	.214E 11	-.307E 09	.624E 09	.269E 12	-.494E 10	.241E 10	.454E 12	-.886E 10	.296E 10
34	.142E 11	-.216E 09	.160E 09	.215E 12	-.448E 10	.768E 09	.379E 12	-.846E 10	.109E 10
35	.984E 10	-.173E 09	.224E 08	.174E 12	-.466E 10	.227E 09	.319E 12	-.917E 10	.419E 09

Table C15. Quadratic (Q13) Covariance Results

MEAN RESPONSES

$\tilde{t}$	DELTA	DDELTA	NSUBIT	DNSUBIT	QALF	QDALF	DZ	Z
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.955E-03	.125E-02	.168E 00	-.781E-01	.146E 00	-.481E-01	-.738E 00	-.541E 00
3	-.237E-03	.343E-03	-.421E 00	-.924E-01	.628E-01	.639E-02	-.709E 01	-.182E 02
4	-.856E-05	.137E-03	-.318E 00	-.387E-01	-.491E-01	.186E 00	-.157E 02	-.740E 02
5	.103E-03	.537E-04	-.104E 01	-.115E-01	-.816E-02	.488E 00	-.258E 02	-.177E 03
6	.168E-03	.552E-04	-.121E 01	.466E-02	.158E 00	.961E 00	-.372E 02	-.333E 03
7	.215E-03	.717E-04	-.135E 01	.234E-01	.379E 00	.168E 01	-.492E 02	-.549E 03
8	.267E-03	.502E-04	-.149E 01	.470E-01	.544E 00	.260E 01	-.608E 02	-.824E 03
9	.641E-03	.344E-03	-.175E 01	.982E-01	.371E 00	.374E 01	-.707E 02	-.115E 04
10	.109E-02	.834E-04	-.132E 01	.734E-01	.107E 01	.547E 01	-.775E 02	-.152E 04
11	.101E-02	-.249E-03	-.174E 01	-.647E-01	.233E 01	.582E 01	-.815E 02	-.192E 04
12	.804E-03	-.404E-04	-.199E 01	-.411E 00	.229E 01	.672E 01	-.822E 02	-.233E 04
13	.478E-03	-.105E-02	-.231E 01	-.585E 00	.173E 01	.923E 01	-.769E 02	-.274E 04
14	-.334E-05	-.202E-02	-.274E 01	-.145E 00	.109E 01	.587E 01	-.640E 02	-.309E 04
15	-.280E-03	-.167E-02	-.243E 01	.374E 00	.275E 00	-.174E 01	-.464E 02	-.337E 04
16	-.309E-03	-.408E-03	-.165E 01	.411E 00	-.531E-01	-.718E 01	-.299E 02	-.356E 04
17	-.343E-04	.665E-03	-.850E 00	.152E 00	-.119E 00	-.786E 01	-.185E 02	-.368E 04
18	.248E-03	.734E-03	-.326E 00	-.155E-01	-.130E 00	-.558E 01	-.132E 02	-.376E 04
19	.275E-03	.486E-03	-.136E 00	-.345E-01	-.234E 00	-.244E 01	-.121E 02	-.382E 04
20	.291E-03	.293E-03	-.955E-01	-.209E-01	-.236E 00	-.106E 00	-.124E 02	-.388E 04
21	.321E-03	.614E-04	-.121E 00	.429E-01	-.170E 00	.137E 01	-.121E 02	-.394E 04
22	.313E-03	-.129E-03	-.163E 00	.940E-01	-.128E 00	.178E 01	-.983E 01	-.400E 04
23	.244E-03	-.181E-03	-.196E 00	.982E-01	-.129E 00	.135E 01	-.539E 01	-.404E 04
24	.160E-03	-.142E-03	-.200E 00	.715E-01	-.146E 00	.759E 00	.917E 00	-.405E 04
25	.730E-04	-.961E-04	-.195E 00	.430E-01	-.139E 00	.343E 00	.836E 01	-.403E 04
26	.291E-04	-.346E-04	-.174E 00	.547E-02	-.140E 00	.332E-01	.163E 02	-.396E 04
27	-.118E-04	-.227E-04	-.145E 00	.115E-01	-.928E-01	.337E-01	.243E 02	-.386E 04
28	-.481E-04	-.302E-05	-.112E 00	.117E-01	-.274E-01	.366E-01	.322E 02	-.372E 04
29	-.659E-04	.155E-04	-.758E-01	.131E-01	.539E-01	.276E-01	.397E 02	-.354E 04
30	-.665E-04	.253E-04	-.330E-01	.164E-01	.149E 00	.356E-01	.464E 02	-.333E 04
31	-.560E-04	.256E-04	.199E-01	.948E-02	.263E 00	.449E-01	.517E 02	-.308E 04
32	-.580E-04	.967E-05	.946E-01	.227E-01	.418E 00	.604E-01	.548E 02	-.281E 04
33	-.110E-03	-.229E-04	.222E 00	.421E-01	.674E 00	.104E 00	.537E 02	-.254E 04
34	-.248E-03	-.107E-03	.518E 00	.102E 00	.115E 01	.180E 00	.440E 02	-.229E 04
35	-.579E-03	-.803E-04	.132E 01	.246E 00	.212E 01	.358E 00	.151E 02	-.213E 04

Table C15. Continued

MEAN RESPONSES

$\tilde{t}$	IB1	DIB1	IB2	DIB2	IB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.611E 05	-.942E 05	.777E 06	-.839E 06	.121E 07	-.126E 07
3	-.888E 04	-.280E 05	.153E 06	-.239E 06	.263E 06	-.369E 06
4	.174E 05	-.681E 05	.351E 05	-.219E 06	.361E 05	-.259E 06
5	-.341E 05	-.145E 06	-.129E 06	-.310E 06	-.171E 06	-.316E 06
6	-.168E 06	-.258E 06	-.399E 06	-.513E 06	-.449E 06	-.510E 06
7	-.342E 06	-.417E 06	-.722E 06	-.793E 06	-.765E 06	-.785E 06
8	-.504E 06	-.618E 06	-.103E 07	-.112E 07	-.107E 07	-.108E 07
9	-.511E 06	-.832E 06	-.130E 07	-.177E 07	-.152E 07	-.188E 07
10	-.736E 06	-.100E 07	-.200E 07	-.195E 07	-.238E 07	-.197E 07
11	-.151E 07	-.121E 07	-.322E 07	-.205E 07	-.344E 07	-.188E 07
12	-.175E 07	-.164E 07	-.318E 07	-.287E 07	-.357E 07	-.270E 07
13	-.135E 07	-.194E 07	-.259E 07	-.260E 07	-.259E 07	-.186E 07
14	-.659E 06	-.130E 07	-.110E 07	-.743E 06	-.987E 06	.391E 06
15	.137E 02	-.156E 06	.197E 06	.969E 06	.327E 06	.181E 07
16	.228E 06	.741E 06	.600E 06	.158E 07	.704E 06	.169E 07
17	.184E 06	.110E 07	.332E 06	.136E 07	.317E 06	.881E 06
18	.902E 05	.821E 06	-.219E 05	.798E 06	-.154E 06	.292E 06
19	.678E 05	.308E 06	-.814E 05	.110E 06	-.219E 06	-.201E 06
20	.386E 05	-.110E 05	-.111E 06	-.287E 06	-.281E 06	-.461E 06
21	.858E 04	-.180E 06	-.213E 06	-.408E 06	-.362E 06	-.452E 06
22	-.174E 04	-.218E 06	-.225E 06	-.340E 06	-.368E 06	-.289E 06
23	.723E 04	-.164E 06	-.161E 06	-.199E 06	-.274E 06	-.121E 06
24	.211E 05	-.900E 05	-.730E 05	-.838E 05	-.155E 06	-.259E 05
25	.269E 05	-.387E 05	-.677E 04	-.119E 05	-.447E 05	.280E 05
26	.308E 05	-.518E 04	.307E 05	.987E 04	.123E 05	.217E 05
27	.233E 05	-.409E 04	.472E 05	.122E 05	.488E 05	.244E 05
28	.107E 05	-.457E 04	.519E 05	.497E 04	.722E 05	.138E 05
29	-.563E 04	-.623E 04	.373E 05	-.671E 04	.685E 05	-.438E 04
30	-.268E 05	-.748E 04	.245E 04	-.173E 05	.374E 05	-.184E 05
31	-.517E 05	-.101E 05	-.436E 05	-.225E 05	-.124E 05	-.249E 05
32	-.852E 05	-.121E 05	-.101E 06	-.148E 05	-.604E 05	-.929E 04
33	-.138E 06	-.160E 05	-.151E 06	.128E 05	-.778E 05	.411E 05
34	-.224E 06	-.214E 05	-.198E 06	.928E 05	-.474E 05	.180E 06
35	-.397E 06	-.524E 05	-.253E 06	.923E 05	.783E 05	.217E 06

Table C15. Continued

RESPONSE COVARIANCES

$\tilde{t}$	DELTA	DELTA*DELTA	DDELTA	DZDOT	DELQ	$\Delta\gamma$	$\Delta\theta$	ΔZ
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.267E-05	-.198E-05	.732E-05	.174E 01	.559E-04	.278E-03	.679E-03	.995E 00
3	.762E-05	.121E-05	.344E-04	.132E 03	.388E-04	.489E-02	.765E-03	.102E 04
4	.284E-04	-.193E-06	.871E-04	.261E 03	.633E-05	.402E-02	.804E-04	.107E 05
5	.545E-04	-.124E-04	.982E-04	.296E 03	.112E-05	.241E-02	.217E-04	.350E 05
6	.573E-04	-.218E-04	.697E-04	.302E 03	.209E-05	.147E-02	.582E-05	.745E 05
7	.404E-04	-.181E-04	.478E-04	.286E 03	.534E-05	.895E-03	.689E-04	.128E 06
8	.288E-04	-.113E-04	.474E-04	.251E 03	.101E-04	.530E-03	.255E-03	.193E 06
9	.341E-04	-.102E-04	.647E-04	.221E 03	.160E-04	.326E-03	.555E-03	.265E 06
10	.161E-04	-.124E-04	.688E-04	.248E 03	.900E-05	.267E-03	.881E-03	.337E 06
11	.655E-05	-.546E-05	.178E-03	.396E 03	.155E-04	.324E-03	.134E-02	.412E 06
12	.680E-05	-.825E-05	.490E-03	.750E 03	.326E-04	.482E-03	.203E-02	.499E 06
13	.832E-05	-.115E-04	.642E-03	.148E 04	.477E-04	.759E-03	.287E-02	.628E 06
14	.852E-05	-.117E-04	.611E-03	.282E 04	.529E-04	.116E-02	.343E-02	.856E 06
15	.782E-05	-.918E-05	.440E-03	.490E 04	.510E-04	.161E-02	.343E-02	.129E 07
16	.663E-05	-.595E-05	.234E-03	.765E 04	.349E-04	.201E-02	.316E-02	.209E 07
17	.604E-05	-.382E-05	.125E-03	.111E 05	.203E-04	.232E-02	.295E-02	.348E 07
18	.593E-05	-.273E-05	.634E-04	.153E 05	.113E-04	.254E-02	.281E-02	.571E 07
19	.584E-05	-.218E-05	.232E-04	.203E 05	.541E-05	.270E-02	.265E-02	.911E 07
20	.615E-05	-.200E-05	.135E-04	.260E 05	.264E-05	.278E-02	.242E-02	.141E 08
21	.636E-05	-.199E-05	.717E-05	.323E 05	.156E-05	.279E-02	.211E-02	.210E 08
22	.646E-05	-.202E-05	.407E-05	.388E 05	.148E-05	.273E-02	.172E-02	.303E 08
23	.609E-05	-.208E-05	.258E-05	.452E 05	.219E-05	.261E-02	.125E-02	.425E 08
24	.529E-05	-.193E-05	.173E-05	.507E 05	.359E-05	.242E-02	.748E-03	.578E 08
25	.391E-05	-.171E-05	.127E-05	.543E 05	.610E-05	.217E-02	.275E-03	.764E 08
26	.245E-05	-.121E-05	.858E-06	.550E 05	.721E-05	.186E-02	.171E-04	.982E 08
27	.110E-05	-.785E-06	.690E-06	.526E 05	.853E-05	.153E-02	.115E-03	.122E 09
28	.520E-07	-.155E-06	.494E-06	.471E 05	.870E-05	.118E-02	.647E-03	.148E 09
29	.349E-06	.165E-06	.108E-06	.391E 05	.469E-05	.858E-03	.149E-02	.175E 09
30	.129E-05	-.656E-07	.183E-07	.300E 05	.966E-06	.580E-03	.217E-02	.200E 09
31	.204E-05	-.494E-06	.121E-06	.215E 05	.558E-07	.369E-03	.242E-02	.223E 09
32	.188E-05	-.772E-06	.319E-06	.144E 05	.139E-06	.220E-03	.248E-02	.243E 09
33	.845E-06	-.640E-06	.486E-06	.861E 04	.582E-05	.118E-03	.303E-02	.260E 09
34	.728E-08	-.580E-07	.601E-06	.354E 04	.976E-04	.438E-04	.664E-02	.273E 09
35	.890E-06	.120E-06	.163E-07	.651E 01	.828E-03	.731E-07	.287E-01	.278E 09

Table C15. Continued

RESPONSE COVARIANCES

$\tilde{t}$	NIT	NIT*DNIT	DNIT	QALF	QALF*DQALF	DQALF
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.879E-01	-.284E-01	.958E-02	.110E 00	-.581E-02	.520E-02
3	.124E 01	.340E 00	.954E-01	.157E 01	-.135E 00	.296E 00
4	.309E 01	-.390E-01	.765E-02	.192E 01	.197E 00	.184E 01
5	.241E 01	-.144E 00	.309E-01	.447E 01	.203E 00	.711E 01
6	.161E 01	-.102E 00	.854E-01	.626E 01	.267E 00	.232E 02
7	.115E 01	-.659E-01	.237E 00	.668E 01	.607E 00	.739E 02
8	.946E 00	-.509E-01	.529E 00	.691E 01	.117E 01	.195E 03
9	.849E 00	-.640E-01	.939E 00	.879E 01	.198E 01	.428E 03
10	.880E 00	-.651E-01	.133E 01	.173E 02	.178E 01	.882E 03
11	.119E 01	-.276E 00	.452E 01	.205E 02	-.500E 01	.187E 04
12	.160E 01	-.904E 00	.247E 02	.176E 02	-.595E 01	.363E 04
13	.178E 01	-.807E 00	.249E 02	.172E 02	.525E 01	.590E 04
14	.166E 01	-.775E 00	.123E 02	.167E 02	.185E 02	.665E 04
15	.942E 00	-.470E 00	.249E 01	.123E 02	.135E 02	.474E 04
16	.409E 00	-.135E 00	.294E 00	.885E 01	.287E 00	.278E 04
17	.189E 00	-.190E-01	.364E 00	.624E 01	-.470E 01	.169E 04
18	.114E 00	.462E-03	.585E 00	.487E 01	-.354E 01	.943E 03
19	.101E 00	.184E-02	.469E 00	.473E 01	-.189E 01	.557E 03
20	.128E 00	.547E-02	.615E 00	.587E 01	-.859E 00	.339E 03
21	.197E 00	.797E-02	.658E 00	.799E 01	-.305E 00	.197E 03
22	.291E 00	.119E-01	.541E 00	.107E 02	.132E 00	.116E 03
23	.433E 00	.175E-01	.473E 00	.138E 02	.528E 00	.681E 02
24	.617E 00	.240E-01	.408E 00	.172E 02	.854E 00	.396E 02
25	.884E 00	.309E-01	.305E 00	.209E 02	.115E 01	.221E 02
26	.116E 01	.325E-01	.235E 00	.234E 02	.107E 01	.116E 02
27	.143E 01	.256E-01	.139E 00	.235E 02	.939E 00	.586E 01
28	.158E 01	.105E-01	.839E-01	.222E 02	.719E 00	.298E 01
29	.162E 01	-.176E-02	.571E-01	.189E 02	.307E 00	.152E 01
30	.147E 01	-.176E-01	.373E-01	.140E 02	-.868E-02	.765E 00
31	.116E 01	-.196E-01	.228E-01	.913E 01	-.982E-01	.349E 00
32	.877E 00	.118E-03	.118E-01	.569E 01	-.480E-01	.138E 00
33	.749E 00	.405E-01	.758E-02	.419E 01	.975E-01	.494E-01
34	.133E 01	.190E 00	.290E-01	.503E 01	.489E 00	.600E-01
35	.557E 01	.907E 00	.148E 00	.129E 02	.204E 01	.325E 00

Table C15. Concluded

RESPONSE COVARIANCES

$\tilde{t}$	IB1	IB1*DIB1	DIB1	IB2	IB2*DIB2	DIB2	IB3	IB3*DIB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.167E 11	.510E 11	.138E 12	.975E 12	-.916E 12	.573E 13	.306E 13	-.219E 13	.121E 14
3	.380E 12	-.298E 11	.135E 12	.381E 13	.248E 13	.244E 14	.966E 13	.590E 13	.580E 14
4	.615E 11	.162E 11	.318E 12	.132E 14	.495E 13	.581E 14	.371E 14	.125E 14	.141E 15
5	.122E 12	-.358E 11	.237E 12	.224E 14	.147E 13	.560E 14	.668E 14	.471E 13	.142E 15
6	.391E 12	-.673E 11	.632E 12	.200E 14	-.410E 13	.281E 14	.644E 14	-.880E 13	.788E 14
7	.904E 12	-.627E 11	.300E 13	.119E 14	-.523E 13	.101E 14	.409E 14	-.114E 14	.344E 14
8	.157E 13	-.908E 11	.948E 13	.848E 13	-.390E 13	.479E 13	.274E 14	-.710E 13	.161E 14
9	.188E 13	-.138E 12	.191E 14	.122E 14	-.303E 13	.608E 13	.357E 14	-.425E 13	.114E 14
10	.255E 13	.238E 12	.260E 14	.573E 13	-.307E 13	.128E 14	.137E 14	-.967E 13	.917E 13
11	.585E 13	.539E 11	.819E 14	.712E 13	.191E 13	.348E 14	.367E 13	.471E 12	.654E 13
12	.859E 13	-.634E 12	.219E 15	.100E 14	.420E 13	.890E 14	.304E 13	.359E 13	.165E 14
13	.736E 13	-.133E 13	.237E 15	.783E 13	.317E 13	.114E 15	.301E 13	.165E 13	.250E 14
14	.513E 13	-.174E 13	.266E 15	.605E 13	.892E 12	.102E 15	.467E 13	-.106E 13	.254E 14
15	.283E 13	-.143E 13	.179E 15	.444E 13	-.181E 13	.644E 14	.613E 13	-.422E 13	.287E 14
16	.133E 13	-.785E 12	.834E 14	.300E 13	-.247E 13	.334E 14	.606E 13	-.458E 13	.266E 14
17	.676E 12	-.414E 12	.451E 14	.212E 13	-.189E 13	.193E 14	.562E 13	-.328E 13	.202E 14
18	.375E 12	-.195E 12	.232E 14	.172E 13	-.103E 13	.109E 14	.551E 13	-.176E 13	.112E 14
19	.246E 12	-.759E 11	.116E 14	.137E 13	-.291E 12	.525E 13	.518E 13	-.550E 12	.299E 13
20	.238E 12	-.215E 11	.604E 13	.113E 13	-.634E 11	.278E 13	.503E 13	-.150E 12	.752E 12
21	.310E 12	.440E 10	.334E 13	.837E 12	-.251E 11	.168E 13	.459E 13	-.930E 11	.292E 12
22	.407E 12	.227E 11	.183E 13	.589E 12	-.440E 11	.102E 13	.410E 13	-.158E 12	.213E 12
23	.543E 12	.442E 11	.132E 13	.294E 12	-.786E 11	.652E 12	.318E 13	-.363E 12	.212E 12
24	.711E 12	.619E 11	.574E 12	.646E 11	-.448E 11	.424E 12	.203E 13	-.396E 12	.205E 12
25	.861E 12	.833E 11	.296E 12	.304E 11	.519E 11	.320E 12	.848E 12	-.413E 12	.286E 12
26	.102E 13	.833E 11	.153E 12	.336E 12	.203E 12	.232E 12	.104E 12	-.148E 12	.275E 12
27	.112E 13	.922E 11	.810E 11	.105E 13	.461E 12	.260E 12	.140E 12	.232E 12	.432E 12
28	.108E 13	.931E 11	.414E 11	.248E 13	.802E 12	.350E 12	.169E 13	.107E 13	.696E 12
29	.101E 13	.584E 11	.196E 11	.438E 13	.881E 12	.192E 12	.484E 13	.137E 13	.396E 12
30	.864E 12	.239E 11	.899E 10	.553E 13	.572E 12	.673E 11	.740E 13	.100E 13	.142E 12
31	.618E 12	.103E 10	.367E 10	.539E 13	.152E 12	.820E 10	.811E 13	.302E 12	.144E 11
32	.412E 12	-.118E 11	.179E 10	.416E 13	-.282E 12	.208E 11	.658E 13	-.526E 12	.435E 11
33	.278E 12	-.150E 11	.132E 10	.233E 13	-.527E 12	.120E 12	.347E 13	-.995E 12	.285E 12
34	.236E 12	-.111E 11	.672E 09	.741E 12	-.492E 12	.326E 12	.666E 12	-.745E 12	.833E 12
35	.456E 12	.561E 11	.693E 10	.209E 12	-.694E 11	.230E 11	.744E 10	.305E 11	.125E 12

Table C16. Quadratic (Q15) Covariance Results

MEAN RESPONSES

$\tilde{t}$	DELTA	DDELTA	NSUBIT	DNSUBIT	QALF	QDALF	DZ	Z
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.947E-03	.124E-02	.167E 00	-.776E-01	.145E 00	-.476E-01	-.733E 00	-.537E 00
3	-.233E-03	.343E-03	-.418E 00	-.919E-01	.640E-01	.677E-02	-.704E 01	-.181E 02
4	-.638E-05	.146E-03	-.813E 00	-.387E-01	-.440E-01	.186E 00	-.155E 02	-.734E 02
5	.107E-03	.627E-04	-.104E 01	-.117E-01	.320E-03	.488E 00	-.255E 02	-.175E 03
6	.178E-03	.507E-04	-.120E 01	.440E-02	.169E 00	.960E 00	-.368E 02	-.330E 03
7	.225E-03	.638E-04	-.134E 01	.202E-01	.393E 00	.168E 01	-.485E 02	-.543E 03
8	.275E-03	.462E-04	-.149E 01	.468E-01	.558E 00	.260E 01	-.598E 02	-.814E 03
9	.658E-03	.340E-03	-.174E 01	.977E-01	.377E 00	.374E 01	-.693E 02	-.114E 04
10	.110E-02	.869E-04	-.181E 01	.734E-01	.110E 01	.547E 01	-.756E 02	-.158E 04
11	.102E-02	-.254E-03	-.173E 01	-.650E-01	.237E 01	.582E 01	-.792E 02	-.189E 04
12	.813E-03	-.436E-04	-.198E 01	-.412E 00	.223E 01	.672E 01	-.793E 02	-.229E 04
13	.488E-03	-.105E-02	-.250E 01	-.586E 00	.175E 01	.923E 01	-.733E 02	-.267E 04
14	.603E-05	-.203E-02	-.273E 01	-.145E 00	.110E 01	.587E 01	-.597E 02	-.301E 04
15	-.272E-03	-.167E-02	-.242E 01	.374E 00	.284E 00	-.174E 01	-.413E 02	-.326E 04
16	-.302E-03	-.409E-03	-.165E 01	.411E 00	-.490E-01	-.718E 01	-.238E 02	-.343E 04
17	-.288E-04	.664E-03	-.849E 00	.152E 00	-.118E 00	-.786E 01	-.114E 02	-.351E 04
18	.252E-03	.733E-03	-.325E 00	-.156E-01	-.130E 00	-.558E 01	-.496E 01	-.355E 04
19	.279E-03	.485E-03	-.135E 00	-.345E-01	-.235E 00	-.244E 01	-.255E 01	-.357E 04
20	.295E-03	.292E-03	-.953E-01	-.209E-01	-.236E 00	-.106E 00	-.141E 01	-.358E 04
21	.324E-03	.590E-04	-.120E 00	.430E-01	-.170E 00	.137E 01	.470E 00	-.358E 04
22	.314E-03	-.131E-03	-.162E 00	.941E-01	-.124E 00	.178E 01	.433E 01	-.357E 04
23	.242E-03	-.183E-03	-.195E 00	.985E-01	-.122E 00	.135E 01	.105E 02	-.354E 04
24	.154E-03	-.144E-03	-.197E 00	.719E-01	-.133E 00	.761E 00	.186E 02	-.346E 04
25	.624E-04	-.958E-04	-.191E 00	.436E-01	-.118E 00	.345E 00	.278E 02	-.335E 04
26	.147E-04	-.331E-04	-.167E 00	.631E-02	-.108E 00	.368E-01	.376E 02	-.319E 04
27	-.291E-04	-.186E-04	-.135E 00	.125E-01	-.494E-01	.383E-01	.473E 02	-.297E 04
28	-.632E-04	.477E-05	-.977E-01	.128E-01	.302E-01	.421E-01	.568E 02	-.271E 04
29	-.744E-04	.231E-04	-.555E-01	.144E-01	.127E 00	.336E-01	.656E 02	-.241E 04
30	-.677E-04	.311E-04	-.592E-02	.180E-01	.238E 00	.421E-01	.734E 02	-.206E 04
31	-.502E-04	.280E-04	.556E-01	.118E-01	.369E 00	.532E-01	.794E 02	-.168E 04
32	-.567E-04	-.127E-04	.145E 00	.289E-01	.554E 00	.734E-01	.827E 02	-.127E 04
33	-.278E-03	-.172E-03	.314E 00	.712E-01	.886E 00	.141E 00	.807E 02	-.860E 03
34	-.877E-03	-.434E-03	.789E 00	.205E 00	.167E 01	.303E 00	.665E 02	-.484E 03
35	-.216E-02	-.121E-03	.230E 01	.507E 00	.356E 01	.708E 00	.193E 02	-.245E 03

Table C16. (Continued)

MEAN RESPONSES

$\tilde{t}$	IB1	DIB1	IB2	DIB2	IB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.605E 05	-.937E 05	.771E 06	-.834E 06	.120E 07	-.126E 07
3	-.102E 05	-.283E 05	.148E 06	-.241E 06	.256E 06	-.362E 06
4	.138E 05	-.690E 05	.275E 05	-.217E 06	.281E 05	-.272E 06
5	-.405E 05	-.145E 06	-.143E 06	-.309E 06	-.186E 06	-.329E 06
6	-.177E 06	-.257E 06	-.421E 06	-.501E 06	-.474E 06	-.507E 06
7	-.353E 06	-.416E 06	-.748E 06	-.788E 06	-.793E 06	-.778E 06
8	-.516E 06	-.617E 06	-.105E 07	-.112E 07	-.110E 07	-.108E 07
9	-.520E 06	-.831E 06	-.133E 07	-.177E 07	-.155E 07	-.188E 07
10	-.750E 06	-.100E 07	-.203E 07	-.196E 07	-.241E 07	-.199E 07
11	-.153E 07	-.121E 07	-.327E 07	-.205E 07	-.349E 07	-.187E 07
12	-.177E 07	-.163E 07	-.353E 07	-.287E 07	-.361E 07	-.270E 07
13	-.137E 07	-.194E 07	-.262E 07	-.260E 07	-.262E 07	-.186E 07
14	-.670E 06	-.130E 07	-.112E 07	-.741E 06	-.101E 07	.392E 06
15	-.638E 04	-.156E 06	.181E 06	.971E 06	.308E 06	.181E 07
16	.225E 06	.741E 06	.589E 06	.158E 07	.692E 06	.169E 07
17	.182E 06	.110E 07	.325E 06	.136E 07	.308E 06	.881E 06
18	.894E 05	.821E 06	-.296E 05	.797E 06	-.160E 06	.291E 06
19	.674E 05	.308E 06	-.851E 05	.110E 06	-.224E 06	-.200E 06
20	.382E 05	-.110E 05	-.145E 06	-.286E 06	-.287E 06	-.460E 06
21	.801E 04	-.180E 06	-.216E 06	-.407E 06	-.366E 06	-.451E 06
22	-.270E 04	-.218E 06	-.227E 06	-.339E 06	-.370E 06	-.287E 06
23	.562E 04	-.164E 06	-.162E 06	-.198E 06	-.274E 06	-.118E 06
24	.185E 05	-.902E 05	-.779E 05	-.820E 05	-.151E 06	-.227E 05
25	.228E 05	-.391E 05	-.612E 04	-.105E 05	-.385E 05	.307E 05
26	.247E 05	-.578E 04	.307E 05	.109E 05	.199E 05	.241E 05
27	.146E 05	-.507E 04	.449E 05	.113E 05	.559E 05	.243E 05
28	-.862E 03	-.611E 04	.433E 05	.906E 02	.724E 05	.768E 04
29	-.207E 05	-.800E 04	.181E 05	-.133E 05	.556E 05	-.130E 05
30	-.461E 05	-.942E 04	-.289E 05	-.244E 05	.975E 04	-.278E 05
31	-.753E 05	-.123E 05	-.900E 05	-.290E 05	-.546E 05	-.330E 05
32	-.115E 06	-.129E 05	-.151E 06	-.588E 03	-.106E 06	.152E 05
33	-.169E 06	-.566E 04	-.838E 05	.171E 06	.716E 05	.290E 06
34	-.276E 06	-.253E 03	.160E 06	.492E 06	.608E 06	.812E 06
35	-.557E 06	-.790E 05	.603E 06	.413E 06	.169E 07	.779E 06

Table C16. (Continued)

RESPONSE COVARIANCES

$\tilde{t}$	DELTA	DELTA*DELTA	DDELTA	DZDOT	DELQ	$\Delta\gamma$	$\Delta\theta$	ΔZ
1	.000E-80	.000E-80	.000E-80	.000E-80	.000F-80	.000F-80	.000E-80	.000E-80
2	.267E-05	-.198E-05	.733E-05	.174E 01	.558E-04	.278E-03	.679E-03	.995E 00
3	.767E-05	.127E-05	.350E-04	.132E 03	.388E-04	.489F-02	.764E-03	.102E 04
4	.299E-04	.529E-06	.959E-04	.260E 03	.653E-05	.401F-02	.814E-04	.107E 05
5	.651E-04	-.112E-04	.132E-03	.296E 03	.130E-05	.241F-02	.276E-04	.350E 05
6	.845E-04	-.259E-04	.117E-03	.304E 03	.129E-05	.148F-02	.599E-05	.745E 05
7	.740E-04	-.284E-04	.879E-04	.293E 03	.377E-05	.916F-03	.309E-04	.128E 06
8	.620E-04	-.213E-04	.776E-04	.259E 03	.820E-05	.546F-03	.150E-03	.194E 06
9	.844E-04	-.204E-04	.964E-04	.209E 03	.131E-04	.310E-03	.345E-03	.266E 06
10	.447E-04	-.315E-04	.928E-04	.176E 03	.797E-05	.190F-03	.550E-03	.339E 06
11	.163E-04	-.122E-04	.189E-03	.202E 03	.150E-04	.165F-03	.920E-03	.407E 06
12	.114E-04	-.101E-04	.486E-03	.355E 03	.321E-04	.228F-03	.152E-02	.472E 06
13	.132E-04	-.126E-04	.647E-03	.769E 03	.472E-04	.394F-03	.224E-02	.546E 06
14	.143E-04	-.133E-04	.615E-03	.163E 04	.526E-04	.671F-03	.269E-02	.660E 06
15	.145E-04	-.107E-04	.442E-03	.304F 04	.509E-04	.997F-03	.262E-02	.883E 06
16	.144E-04	-.784E-05	.236E-03	.488E 04	.350E-04	.128F-02	.227E-02	.132E 07
17	.147E-04	-.613E-05	.126E-03	.708E 04	.204E-04	.148E-02	.197E-02	.212E 07
18	.158E-04	-.510E-05	.645E-04	.961E 04	.115E-04	.160F-02	.172E-02	.342E 07
19	.170E-04	-.522E-05	.293E-04	.124E 05	.580E-05	.165E-02	.144E-02	.543E 07
20	.185E-04	-.550E-05	.146E-04	.152E 05	.358E-05	.163E-02	.110E-02	.832E 07
21	.192E-04	-.583E-05	.839E-05	.178F 05	.307E-05	.153E-02	.715E-03	.123E 08
22	.193E-04	-.604E-05	.537E-05	.196E 05	.390E-05	.138E-02	.342E-03	.174E 08
23	.177E-04	-.620E-05	.405E-05	.203F 05	.630E-05	.117F-02	.675E-04	.236E 08
24	.148E-04	-.562E-05	.317E-05	.192E 05	.998E-05	.917F-03	.570E-04	.309E 08
25	.104E-04	-.478E-05	.272E-05	.161F 05	.158E-04	.641F-03	.608E-03	.386E 08
26	.591E-05	-.316E-05	.195E-05	.110E 05	.167E-04	.373E-03	.202E-02	.461E 08
27	.219E-05	-.179E-05	.159E-05	.534E 04	.168E-04	.155E-03	.426E-02	.523E 08
28	.107E-07	-.985E-07	.103E-05	.106E 04	.131E-04	.267E-04	.721E-02	.561E 08
29	.139E-05	.391E-06	.139E-06	.583E 03	.300E-05	.128F-04	.981E-02	.565E 08
30	.385E-05	-.433E-06	.637E-07	.572F 04	.879E-06	.111F-03	.103E-01	.530E 08
31	.526E-05	-.149E-05	.427E-06	.159E 05	.120E-04	.273F-03	.815E-02	.459E 08
32	.496E-05	-.122E-05	.302E-06	.281E 05	.371E-04	.429F-03	.448E-02	.365E 08
33	.963E-05	-.155E-05	.251E-06	.370E 05	.225E-03	.507F-03	.403E-03	.263E 08
34	.102E-04	-.142E-05	.204E-06	.317E 05	.120E-02	.391E-03	.984E-02	.175E 08
35	.256E-04	.143E-05	.797E-07	.539E 04	.675E-02	.605F-04	.135E 00	.122E 08

Table C16. (Continued)

RESPONSE COVARIANCES

$\tilde{t}$	NIT	NIT*DNIT	DNIT	QALF	QALF*DQALF	DQALF
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.879E-01	-.284E-01	.958E-02	.110E 00	-.580E-02	.520F-02
3	.124E 01	.340E 00	.954E-01	.157E 01	-.135E 00	.296E 00
4	.309E 01	-.387E-01	.773E-02	.196E 01	.207E 00	.185E 01
5	.242E 01	-.143E 00	.305E-01	.493E 01	.760E 00	.721E 01
6	.162E 01	-.102E 00	.772E-01	.787F 01	.363E 00	.234E 02
7	.115E 01	-.672E-01	.229E 00	.925E 01	.698E 00	.740F 02
8	.916E 00	-.503E-01	.520E 00	.974E 01	.138E 01	.195F 03
9	.770E 00	-.599E-01	.935E 00	.137E 02	.290E 01	.428F 03
10	.799E 00	-.591E-01	.193E 01	.238E 02	.232E 01	.882F 03
11	.115E 01	-.268E 00	.461E 01	.228E 02	-.496E 01	.187F 04
12	.158E 01	-.897E 00	.246E 02	.183E 02	-.583F 01	.363F 04
13	.174E 01	-.805E 00	.249E 02	.178E 02	.515E 01	.590F 04
14	.159E 01	-.764E 00	.123E 02	.172E 02	.173E 02	.664E 04
15	.865E 00	-.455E 00	.249E 01	.131E 02	.113E 02	.474F 04
16	.357E 00	-.124E 00	.283E 00	.104E 02	-.171E 01	.278E 04
17	.175E 00	-.135E-01	.364E 00	.880E 01	-.582E 01	.160F 04
18	.152E 00	.706E-02	.587E 00	.898E 01	-.403E 01	.942F 03
19	.205E 00	.928E-02	.470E 00	.113E 02	-.218E 01	.557F 03
20	.332E 00	.177E-01	.607E 00	.161E 02	-.777E 00	.330F 03
21	.558E 00	.243E-01	.651E 00	.229E 02	.146E 00	.197F 03
22	.837E 00	.350E-01	.542E 00	.308E 02	.102E 01	.116E 03
23	.124E 01	.488E-01	.472E 00	.394E 02	.187E 01	.682F 02
24	.173E 01	.620E-01	.409E 00	.482E 02	.252E 01	.396F 02
25	.241E 01	.725E-01	.306E 00	.569E 02	.304E 01	.222E 02
26	.304E 01	.645E-01	.206E 00	.608E 02	.252E 01	.116F 02
27	.352E 01	.336E-01	.139E 00	.574E 02	.191E 01	.588E 01
28	.362E 01	-.131E-01	.888E-01	.500E 02	.114E 01	.298E 01
29	.333E 01	-.494E-01	.579E-01	.378E 02	.699E-01	.152E 01
30	.254E 01	-.853E-01	.400E-01	.232E 02	-.585E 00	.780E 00
31	.145E 01	-.831E-01	.272E-01	.107E 02	-.649E 00	.387F 00
32	.522E 00	-.738E-01	.224E-01	.295E 01	-.423E 00	.198E 00
33	.323E-02	-.140E-02	.456E-01	.223E-01	.298E-01	.257E 00
34	.204E 01	.653E 00	.211E 00	.896E 01	.253E 01	.728F 00
35	.271E 02	.629E 01	.146E 01	.626E 02	.131E 02	.273F 01

Table C16. (Concluded)

RESPONSE COVARIANCES

$\tilde{t}$	IB1	IB1*DIB1	DIB1	IB2	IB2*DIB2	DIB2	IB3	IB3*DIB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.167E 11	.510E 11	.188E 12	.975E 12	-.916E 12	.573E 13	.306E 13	-.218E 13	.121E 14
3	.380E 12	-.297E 11	.189E 12	.385E 13	.252E 13	.248E 14	.974E 13	.600E 13	.590E 14
4	.615E 11	.192E 11	.366E 12	.141E 14	.568E 13	.645E 14	.393E 14	.143E 14	.156E 15
5	.108E 12	-.351E 11	.344E 12	.279E 14	.406E 13	.790E 14	.814E 14	.113E 14	.197E 15
6	.338E 12	-.987E 11	.564E 12	.321E 14	-.233E 13	.561E 14	.992E 14	-.364E 13	.150E 15
7	.842E 12	-.137E 12	.262E 13	.244E 14	-.657E 13	.270E 14	.804E 14	-.134E 14	.830E 14
8	.153E 13	-.204E 12	.887E 13	.196E 14	-.578E 13	.125E 14	.646E 14	-.989E 13	.455E 14
9	.185E 13	-.279E 12	.182E 14	.306E 14	-.380E 13	.116E 14	.941E 14	-.206E 13	.399E 14
10	.262E 13	.231E 12	.254E 14	.135E 14	-.101E 14	.144E 14	.428E 14	-.266E 14	.218E 14
11	.592E 13	.142E 11	.815E 14	.722E 13	-.603E 12	.330E 14	.970E 13	-.543E 13	.964E 13
12	.857E 13	-.689E 12	.218E 15	.954E 13	.280E 13	.860E 14	.520E 13	.132E 13	.161E 14
13	.734E 13	-.138E 13	.287E 15	.877E 13	.236E 13	.111E 15	.746E 13	.798E 12	.240E 14
14	.512E 13	-.178E 13	.266E 15	.828E 13	.810E 12	.995E 14	.116E 14	-.102E 13	.251E 14
15	.283E 13	-.148E 13	.179E 15	.718E 13	-.123E 13	.633E 14	.144E 14	-.299E 13	.291E 14
16	.136E 13	-.826E 12	.883E 14	.572E 13	-.200E 13	.329E 14	.148E 14	-.361E 13	.270E 14
17	.754E 12	-.439E 12	.450E 14	.467E 13	-.162E 13	.190E 14	.146E 14	-.267E 13	.205E 14
18	.517E 12	-.202E 12	.232E 14	.423E 13	-.798E 12	.107E 14	.151E 14	-.104E 13	.114E 14
19	.470E 12	-.712E 11	.116E 14	.382E 13	-.233E 12	.512E 13	.153E 14	-.294E 12	.302E 13
20	.587E 12	.264E 10	.603E 13	.337E 13	-.109E 12	.269E 13	.153E 14	-.136E 12	.741E 12
21	.853E 12	.465E 11	.333E 13	.254E 13	-.149E 12	.163E 13	.140E 14	-.343E 12	.270E 12
22	.116E 13	.841E 11	.183E 13	.177E 13	-.215E 12	.100E 13	.124E 14	-.634E 12	.212E 12
23	.154E 13	.137E 12	.103E 13	.848E 12	-.292E 12	.708E 12	.931E 13	-.124E 13	.315E 12
24	.199E 13	.180E 12	.584E 12	.153E 12	-.154E 12	.540E 12	.566E 13	-.129E 13	.408E 12
25	.235E 13	.229E 12	.310E 12	.842E 11	.172E 12	.575E 12	.212E 13	-.121E 13	.763E 12
26	.268E 13	.216E 12	.163E 12	.102E 13	.631E 12	.495E 12	.148E 12	-.326E 12	.791E 12
27	.279E 13	.220E 12	.907E 11	.302E 13	.132E 13	.633E 12	.622E 12	.855E 12	.121E 13
28	.251E 13	.198E 12	.490E 11	.660E 13	.227E 13	.810E 12	.513E 13	.295E 13	.171E 13
29	.212E 13	.965E 11	.206E 11	.106E 14	.194E 13	.370E 12	.127E 14	.321E 13	.820E 12
30	.155E 13	.914E 10	.839E 10	.120E 14	.945E 12	.827E 11	.173E 14	.183E 13	.200E 12
31	.846E 12	-.361E 11	.520E 10	.995E 13	-.119E 12	.537E 10	.165E 14	-.554E 11	.325E 10
32	.332E 12	-.243E 11	.322E 10	.643E 13	.379E 11	.175E 10	.120E 14	.266E 12	.711E 10
33	.738E 11	-.164E 11	.417E 10	.700E 13	.540E 12	.429E 11	.162E 14	.166E 13	.172E 12
34	.123E 12	.464E 11	.179E 11	.283E 13	.237E 12	.254E 11	.103E 14	.128E 13	.172E 12
35	.148E 13	.225E 12	.340E 11	.239E 13	.149E 13	.930E 12	.165E 14	.740E 13	.331E 13

Table C17. Attitude (C7) Covariance Results (Δt=0.02)

MEAN RESPONSES

$\tilde{t}$	DELTA	DDELTA	NSUBIT	DNSUBIT	QALF	QDALF	DZ	Z
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.268E-04	.584E-05	.695E-03	.264E-02	.806E-02	.398E-02	-.639E-03	-.516E-03
3	-.139E-02	-.211E-03	.180E-01	-.173E-02	.403E 00	.964E-01	-.578E-01	-.112E 00
4	-.510E-02	.248E-03	.603E-01	-.528E-03	.143E 01	.234E 00	-.233E 00	-.772E 00
5	-.115E-01	.146E-02	.140E 00	.236E-02	.322E 01	.478E 00	-.634E 00	-.283E 01
6	-.205E-01	.354E-02	.258E 00	.813E-02	.574E 01	.856E 00	-.136E 01	-.767E 01
7	-.310E-01	.638E-02	.424E 00	.171E-01	.880E 01	.144E 01	-.253E 01	-.172E 02
8	-.421E-01	.966E-02	.624E 00	.344E-01	.121E 02	.218E 01	-.420E 01	-.338E 02
9	-.491E-01	.133E-01	.827E 00	.801E-01	.161E 02	.362E 01	-.643E 01	-.601E 02
10	-.489E-01	.158E-01	.948E 00	.122E 00	.217E 02	.518E 01	-.954E 01	-.997E 02
11	-.647E-01	.146E-01	.120E 01	-.115E 00	.227E 02	.561E 01	-.139E 02	-.158E 03
12	-.867E-01	.192E-01	.601E 00	-.676E 00	.222E 02	.741E 01	-.161E 02	-.235E 03
13	-.955E-01	.273E-01	.461E 00	-.807E 00	.268E 02	.105E 02	-.145E 02	-.312E 03
14	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
15	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
16	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
17	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
18	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
19	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
20	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
21	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
22	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
23	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
24	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
25	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
26	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
27	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
28	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
29	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
30	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
31	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
32	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
33	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
34	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
35	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80

Table C17. Continued

MEAN RESPONSES

$\tilde{t}$	IB_1	DIB_1	IB2	DIB2	IB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.349E 04	-.162E 05	.131E 05	-.255E 05	.260E 05	-.218E 05
3	-.675E 05	.224E 05	.871E 06	.482E 06	.152E 07	.767E 06
4	-.203E 06	.377E 05	.327E 07	.971E 06	.565E 07	.155E 07
5	-.463E 06	.417E 05	.739E 07	.148E 07	.128E 08	.239E 07
6	-.869E 06	.162E 05	.130E 08	.187E 07	.226E 08	.306E 07
7	-.143E 07	-.541E 05	.195E 08	.197E 07	.340E 08	.330E 07
8	-.213E 07	-.165E 06	.262E 08	.182E 07	.459E 08	.322E 07
9	-.279E 07	-.491E 06	.301E 08	.183E 06	.531E 08	.929E 06
10	-.326E 07	-.830E 06	.291E 08	-.198E 07	.521E 08	-.220E 07
11	-.474E 07	-.922E 05	.379E 08	.326E 07	.684E 08	.546E 07
12	-.497E 07	-.217E 06	.531E 08	.441E 07	.937E 08	.758E 07
13	-.517E 07	-.151E 07	.590E 08	-.161E 07	.104E 09	-.782E 06
14	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
15	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
16	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
17	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
18	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
19	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
20	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
21	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
22	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
23	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
24	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
25	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
26	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
27	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
28	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
29	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
30	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
31	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
32	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
33	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
34	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
35	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80

Table C17. Continued

RESPONSE COVARIANCES

$\tilde{t}$	DELTA	DELTA*DELTA	DDELTA	DZDOT	DELQ	$\Delta\gamma$	$\Delta\theta$	ΔZ
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.458E-06	-.287E-06	.195E-06	.298E-03	.108E-07	.461E-07	.308E-07	.307E-03
3	.108E-03	-.161E-04	.561E-05	.125E 00	.421E-06	.453E-05	.139E-04	.132E 01
4	.232E-03	-.501E-04	.224E-04	.280E 00	.344E-06	.426E-05	.354E-04	.109E 02
5	.379E-03	-.916E-04	.484E-04	.700E 00	.524E-06	.565E-05	.601E-04	.431E 02
6	.532E-03	-.137E-03	.873E-04	.161E 01	.817E-06	.777E-05	.862E-04	.133E 03
7	.666E-03	-.180E-03	.149E-03	.337E 01	.134E-05	.165E-04	.110E-03	.351E 03
8	.781E-03	-.217E-03	.247E-03	.657E 01	.229E-05	.138E-04	.129E-03	.832E 03
9	.760E-03	-.233E-03	.342E-03	.121E 02	.332E-05	.178E-04	.130E-03	.182E 04
10	.592E-03	-.203E-03	.252E-03	.219E 02	.232E-05	.235E-04	.106E-03	.376E 04
11	.920E-03	-.217E-03	.499E-03	.396E 02	.460E-05	.323E-04	.142E-03	.744E 04
12	.163E-02	-.362E-03	.135E-02	.483E 02	.111E-04	.310E-04	.245E-03	.136E 05
13	.183E-02	-.567E-03	.177E-02	.346E 02	.139E-04	.176E-04	.303E-03	.213E 05
14	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
15	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
16	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
17	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
18	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
19	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
20	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
21	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
22	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
23	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
24	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
25	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
26	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
27	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
28	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
29	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
30	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
31	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
32	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
33	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
34	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
35	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80

Table C17. Continued

RESPONSE COVARIANCES

$\tilde{t}$	NIT	NIT*DNIT	DNIT	QALF	QALF*DQALF	DQALF
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.258E-03	.103E-02	.411E-02	.377E-01	.582E-02	.313E-02
3	.391E-02	-.158E-02	.144E-02	.739E 01	.199E 00	.157E 00
4	.147E-01	-.140E-02	.490E-02	.162E 02	.606E 00	.977E 00
5	.349E-01	-.125E-02	.187E-01	.271E 02	.155E 01	.358E 01
6	.667E-01	-.546E-04	.591E-01	.389E 02	.305E 01	.108E 02
7	.125E 00	.296E-02	.182E 00	.508E 02	.541E 01	.315E 02
8	.213E 00	.860E-02	.416E 00	.626E 02	.826E 01	.786E 02
9	.280E 00	.201E-01	.617E 00	.813E 02	.147E 02	.173E 03
10	.400E 00	.272E-01	.112E 01	.118E 03	.236E 02	.346E 03
11	.704E 00	-.599E-02	.392E 01	.119E 03	.254E 02	.629E 03
12	.748E 00	-.854E-01	.178E 02	.116E 03	.328E 02	.107E 04
13	.516E 00	-.755E-01	.206E 02	.149E 03	.455E 02	.165E 04
14	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
15	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
16	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
17	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
18	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
19	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
20	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
21	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
22	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
23	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
24	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
25	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
26	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
27	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
28	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
29	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
30	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
31	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
32	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
33	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
34	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
35	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80

Table C17. Concluded)

RESPONSE COVARIANCES

$\tilde{t}$	IB1	IB1*DIB1	DIB1	IB2	IB2*DIB2	DIB2	IB3	IB3*DIB3	DIB3
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.772E 10	.361E 11	.169E 12	.111E 12	-.280E 12	.717E 12	.432E 12	-.576E 12	.788E 12
3	.613E 11	-.332E 11	.586E 11	.484E 14	.928E 13	.419E 13	.138E 15	.239E 14	.962E 13
4	.173E 12	-.448E 11	.191E 12	.103E 15	.108E 14	.987E 13	.296E 15	.281E 14	.225E 14
5	.384E 12	-.571E 11	.544E 12	.165E 15	.115E 14	.219E 14	.479E 15	.311E 14	.472E 14
6	.726E 12	-.578E 11	.144E 13	.226E 15	.104E 14	.413E 14	.663E 15	.292E 14	.913E 14
7	.129E 13	-.477E 11	.385E 13	.277E 15	.677E 13	.823E 14	.820E 15	.219E 14	.177E 15
8	.213E 13	-.441E 11	.928E 13	.314E 15	.243E 13	.159E 15	.945E 15	.143E 14	.334E 15
9	.283E 13	.125E 12	.161E 14	.293E 15	-.130E 14	.238E 15	.899E 15	-.226E 14	.490E 15
10	.330E 13	.430E 12	.183E 14	.215E 15	-.231E 14	.179E 15	.679E 15	-.507E 14	.345E 15
11	.702E 13	-.394E 12	.536E 14	.318E 15	.167E 14	.466E 15	.103E 16	.622E 14	.871E 15
12	.925E 13	-.101E 13	.136E 15	.609E 15	.344E 14	.129E 16	.190E 16	.132E 15	.245E 16
13	.841E 13	-.151E 12	.167E 15	.703E 15	-.525E 14	.161E 16	.216E 16	-.881E 14	.307E 16
14	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
15	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
16	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
17	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
18	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
19	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
20	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
21	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
22	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
23	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
24	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
25	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
26	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
27	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
28	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
29	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
30	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
31	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
32	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
33	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
34	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
35	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80

APPENDIX D

LATERAL EQUATIONS AND DATA FOR COVARIANCE ANALYSES OF THE LAUNCH PHASE OF MSFC VEHICLE B

This appendix presents the equations and data used to generate the covariance analyses in Section III. The nomenclature, representation, and derivations are presented below. A sketch of the vehicle is presented in Figure 1.

NOMENCLATURE

A = Matrix [Equation (D1) and Table D1]

A′ [x] = Slender body space derivative [Equation (D18)] ft

$C_{\ell_p} = \dfrac{\partial C_\ell}{\partial\left(\frac{pb}{2V}\right)}$ Figure D4 1/rad

$C_{\ell_r} = \dfrac{\partial C_\ell}{\partial\left(\frac{rb}{2V}\right)}$ Figure D5 1/rad

$C_{\ell_{\beta_{cm}}} = C_{\ell_{\beta_{mrp}}} - C_{y_\beta}\left(\dfrac{z_{cm} - z_{mrp}}{b}\right)$ 1/rad

$C_{\ell_{\beta_{mrp}}}$ Figure D6 1/rad

$C_{\ell_{\delta_a}}$ Figure D7 1/rad

$C_{n_p} = \dfrac{\partial C_n}{\partial\left(\frac{pb}{2V}\right)}$ Figure D8 1/rad

$C_{n_r} = \dfrac{\partial C_n}{\partial\left(\frac{rb}{2V}\right)}$ Figure D9 1/rad

$C_{n_{\beta_{cm}}} = C_{n_{\beta_{mrp}}} + C_{y_\beta}\left(\frac{x_{cm} - x_{mrp}}{b}\right)$		1/rad
$C_{n_{\beta_{cm}}}$	Figure D10	1/rad
$C_{n_{\delta a}}$	Figure D11	1/rad
C_{y_β}	Figure D12	1/rad
D =	Matrix [Equation (D2) and Table D2]	
G =	Matrix [Equation (D1) and Table D1]	
H =	Matrix [Equation (D2) and Table D2]	
I =	$I_{xx}I_{zz} - I_{xz}^2$	$slug^2 ft^4$
I_{xx}	Table C7	$slug\ ft^2$
I_{xz} =	$47.5 \cdot 10^6 (1-t/170)$	$slug\ ft^2$
I_{yy}	Table C7	$slug\ ft^2$
I_{zz}	Table C7	$slug\ ft^2$
L	Rolling moment	ft lb
L_p = 1750	Scale length of rolling turbulence	ft
L_s = 228.5	(Gust penetration length)	ft

$\frac{L_{\delta_p}}{T}$ = Rolling moment due to roll command (Table D10) ft/rad

$\frac{L_{\delta_r}}{T}$ = Rolling moment due to yaw command (Table D10) ft/rad

M Mach No. (Table C7)

M.R. $= \frac{(\ell+15)^2}{32.17} \frac{d}{dt} W - \frac{d}{dt} I_{zz}$ (inertial rate and jet damping) slug ft^2/sec

$M'_{1\beta} = -8.96 \times 10^6 \times 57.3$ (M_{660} due to β @ $\bar{q}_{max}$) in. lb/rad

$M'_{2\beta} = -19.5 \times 10^6 \times 57.3$ (M_{880} due to β @ $\bar{q}_{max}$) in. lb/rad

$M'_{1\delta} = -1.62 \times 10^6 \times 57.3$ (M_{660} due to δ_z @ $\bar{q}_{max}$) in. lb/rad

$M'_{2\delta} = -22.8 \times 10^6 \times 57.3$ (M_{1880} due to δ_z @ $\bar{q}_{max}$) lb/rad

N = Yawing moment ft lb

$N_\beta = \frac{\partial N}{\partial \beta}$ ft lb/rad

$\frac{N_{\delta_p}}{T}$ = Yawing moment due to roll command (Table D10) ft/rad

$\frac{N_{\delta_r}}{T}$ = Yawing moment due to yaw command (Table D10) ft/rad

S = 10,250 (reference area) ft^2

T = Thrust (Table C7) lb

V = Speed (Table C7) ft/sec

W = Weight (Table C7)		lb
$\dot{W}$ Table 11 (Table C7)		lb/sec
$\frac{Y_{\delta_p}}{T}$ = Side force due to roll command (Table D10)		1/rad
$\frac{Y_{\delta_r}}{T}$ = Side force due to yaw command (Table D10)		1/rad
a_{ij}	Element of A matrix	
a_y	Lateral acceleration at pilot's station	ft/sec^2

$$a_{11} = \frac{1}{I}\left\{\frac{\bar{q}Sb^2}{2V}\left[I_{zz}C_{\ell_p} + I_{xz}C_{n_p}\right] + I_{xz}\left(I_{zz}+I_{xx}-I_{yy}\right)q_o\right\}$$

$$a_{12} = \frac{1}{I}\left\{\frac{\bar{q}Sb^2}{2V}\left[I_{zz}C_{\ell_r} + I_{xz}C_{n_r}\right] + \left[I_{zz}\left(I_{yy}-I_{zz}\right) - I_{xz}^2\right] q_o + I_{xz}(M.R.)\right\}$$

$$a_{13} = \frac{1}{I}\left\{\frac{\bar{q}Sb}{V}\left[I_{zz}C_{\ell_\beta} + I_{xz}C_{n_\beta}\right]\right\}$$

$$a_{17} = \frac{1}{I}\left\{\frac{\bar{q}Sb}{V}\left[I_{zz}C_{\ell_\beta}\mu_{21} + I_{xz}C_{n_\beta}\mu_{11}\right]\right\}$$

$$a_{18} = \frac{1}{I}\left\{\frac{\bar{q}Sb}{V}\left[I_{zz}C_{\ell_\beta}\mu_{22} + I_{xz}C_{n_\beta}\mu_{12}\right]\right\}$$

$$a_{19} = \frac{1}{I}\left\{\frac{\bar{q}Sb}{V}\left[I_{zz}C_{\ell_\beta}\mu_{23} + I_{xz}C_{n_\beta}\mu_{13}\right]\right\}$$

$$a_{1,10} = \frac{1}{I}\left\{\frac{\bar{q}Sb^2}{2V}\left[I_{zz}C_{\ell_p} + I_{xz}C_{n_p}\right]\right\}$$

$$a_{1,14} = \frac{1}{I}\left\{I_{zz}\left(\frac{L_{\delta_p}}{T}\right)T + I_{xz}\left(\frac{N_{\delta_p}}{T}\right)T\right\}$$

$$a_{1,15} = \frac{1}{I}\left\{I_{zz}\left(\frac{L_{\delta_r}}{T}\right)T + I_{xz}\left(\frac{N_{\delta_r}}{T}\right)T\right\}$$

$$a_{1,16} = \frac{\bar{q}Sb}{I}\left\{I_{zz}C_{\ell_{\delta a}} + I_{xz}C_{n_{\delta a}}\right\}$$

$$a_{21} = \frac{1}{I}\left\{\frac{\bar{q}Sb^2}{2V}\left[I_{xx}C_{n_p} + I_{xz}C_{\ell_p}\right] + \left[I_{xx}\left(I_{xx}-I_{yy}\right) + I_{xz}^{\;2}\right]q_o\right\}$$

$$a_{22} = \frac{1}{I}\left\{\frac{\bar{q}Sb^2}{2V}\left[I_{xx}C_{n_r} + I_{xz}C_{\ell_r}\right] + I_{xz}\left[I_{yy}-I_{xx}-I_{zz}\right]q_o + I_{xx}\,(\text{M.R.})\right\}$$

$$a_{23} = \frac{1}{I}\left\{\frac{\bar{q}Sb}{V}\left[I_{xx}C_{n_\beta} + I_{xz}C_{\ell_\beta}\right]\right\}$$

$$a_{27} = \frac{1}{I}\left\{\frac{\bar{q}Sb}{V}\left[I_{xx}C_{n_\beta}\mu_{11} + I_{xz}C_{\ell_\beta}\mu_{21}\right]\right\}$$

$$a_{28} = \frac{1}{I}\left\{\frac{\bar{q}Sb}{V}\left[I_{xx}C_{n_\beta}\mu_{12} + I_{xz}C_{\ell_\beta}\mu_{22}\right]\right\}$$

$$a_{29} = \frac{1}{I}\left\{\frac{\bar{q}Sb}{V}\left[I_{xx}C_{n_\beta}\mu_{1} + I_{xz}C_{\ell_\beta}\mu_{23}\right]\right\}$$

$$a_{3,15} = \frac{g}{W}\left(\frac{Y_{\delta_r}}{T}\right)T$$

$$a_{3,16} = \frac{g}{W}\,\bar{q}SC_{y_{\delta a}}$$

$$a_{41} = 1.0$$

$$a_{45} = -q_o$$

$$a_{52} = 1.0$$

$$a_{54} = q_o$$

$$a_{63} = 1.0$$

$$a_{64} = -w_o$$

$$a_{65} = u_o$$

$$a_{77} = -a_{7,11}$$

$$a_{7,11} = +2.3\,\frac{V}{L}$$

$$a_{88} = -9.63\,\frac{V}{L_s}$$

$$a_{89} = -5.25\,\frac{V}{L_s}$$

$$a_{8,11} = +14.88\,\frac{V}{L_s}$$

$$a_{98} = +17.77\,\frac{V}{L_s}$$

$$a_{2,10} = \frac{1}{I}\left\{\frac{\bar{q}Sb^2}{2V}\left[I_{xx}C_{n_p} + I_{xz}C_{\ell_p}\right]\right\}$$

$$a_{2,14} = \frac{1}{I}\left\{I_{xx}\left(\frac{N_{\delta_p}}{T}\right)T + I_{xz}\left(\frac{L_{\delta_p}}{T}\right)T\right\}$$

$$a_{2,15} = \frac{1}{I}\left\{I_{xx}\left(\frac{N_{\delta_r}}{T}\right)T + I_{xz}\left(\frac{L_{\delta_r}}{T}\right)T\right\}$$

$$a_{2,16} = \frac{\bar{q}Sb}{I}\left\{I_{xx}C_{n_{\delta a}} + I_{xz}C_{\ell_{\delta a}}\right\}$$

$$a_{31} = w_o$$

$$a_{32} = -u_o$$

$$a_{33} = \frac{g}{W}\frac{\bar{q}S}{V}C_{y_\beta}$$

$$a_{34} = g(c\theta_o)$$

$$a_{35} = g(s\theta_o)$$

$$a_{37} = \frac{g}{W}\frac{\bar{q}S}{V}C_{y_\beta}\mu_{31}$$

$$a_{38} = \frac{g}{W}\frac{\bar{q}S}{V}C_{y_\beta}\mu_{32}$$

$$a_{39} = \frac{g}{W}\frac{\bar{q}S}{V}C_{y_\beta}\mu_{32}$$

$$a_{3,14} = \frac{g}{W}\left(\frac{Y_{\delta_p}}{T}\right)T$$

$a_{99} = +5.03 \frac{V}{L_s}$

$a_{9,11} = -22.8 \frac{V}{L_s}$

$a_{10,10} = -a_{10,13}$

$a_{10,13} = +2.3 \frac{V}{r.c.}$

$a_{11,11} = \frac{\dot{\sigma}}{\sigma}$

$a_{11,12} = c_3 \sigma \dot{h}$

$a_{12,11} = -c_5 \frac{\dot{h}}{\sigma}$

$a_{12,12} = -c_4 \dot{h}$

$a_{13,13} = -\frac{\pi}{4} \frac{V}{b}$

$a_{14,14} = -g_{14,1}$

$a_{15,15} = -g_{15,2}$

$a_{16,16} = -g_{16,3}$

b = 160 (wing span) ft

b Body (subscript)

c Cosine

cm Center of mass (subscript)

$c_1 \sigma_v \sqrt{\dot{h}}$	Coefficient in random side wind (Figure A7 and Table A2)	$ft/sec^{3/2}$
$c_2 \sqrt{\dot{h}}$	Coefficient in random side wind (Figure A8 and Table A2)	$1/ft\ sec^{1/2}$
$c_3 \sigma_v \dot{h}$	Coefficient in random side wind (Figure A9 and Table A2)	ft^2/sec^2
$c_4 \dot{h}$	Coefficient in random side wind (Figure A10 and Table A2)	1/sec
$c_5 \dot{h}/\sigma_v$	Coefficient in random side wind (Figure A11 and Table A2)	$1/ft^2$
d_{ij}	Element of D matrix	

$d_{21} = g_{14,1}$

$d_{42} = g_{15,2}$

$d_{63} = g_{16,3}$

$d_{82} = h_{7,15} g_{15,2}$

$d_{84} = h_{77} g_{74}$

$d_{10,2} = h_{9,15} g_{15,2}$

$d_{10,4} = h_{97} g_{74}$

$d_{12,1} = h_{11,14} g_{14,1}$

$d_{12,2} = h_{11,15} g_{15,2}$

$d_{12,3} = h_{11,16} g_{16,3}$

$d_{12,4} = h_{11,7} g_{74} + h_{11,8} g_{84} + h_{11,9} g_{94}$

$d_{14,4} = h_{13,7}g_{74} + h_{13,8}g_{84} + h_{13,9}g_{94}$

e Earth (subscript)

f Force vector [Equation (D2) and Table D2]

$\tilde{f}$ Force vector [Equation (D1) and Table D1)

f_1 Step response of x_1 [Equation (D13)]

f_2 Step response of x_2 [Equation (D14)]

f_3 Step response of x_3 [Equation (D15)]

$g = 32.17$ Gravity ft/sec^2

g_{ij} Element of G matrix

$g_{74} = a_{7,11}$

$g_{84} = a_{8,11}$

$g_{94} = a_{9,11}$

$g_{11,5} = c_1 \sigma \sqrt{\dot{h}}$

$g_{12,5} = c_2 \sqrt{\dot{h}}$

$$g_{13,6} = \sigma_p \sqrt{0.8 \frac{V}{L_p}} \frac{\pi}{4b} \left(\frac{\pi}{4} \frac{L_p}{b} \right)^{1/6}$$

$g_{14,1} = 31.6$

$g_{15,2} = 31.6$

$g_{16,3} = 10.0$

h	Altitude	ft
h_{ij}	Element of H matrix	

$h_{1,14} = 1.0$

$h_{2,14} = -g_{14,1}$

$h_{3,15} = 1.0$

$h_{4,15} = -g_{15,2}$

$h_{5,16} = 1.0$

$h_{6,16} = -g_{16,3}$

$$h_{73} = -\frac{\bar{q}\, C_{y_\beta}}{VW 4.19\times10^{-4}}\, M'_{1\beta}$$

$h_{77} = h_{73}$

$h_{7,15} = \left(Y_{\delta_r}/T\right) M'_{1\delta}$

$h_{83} = h_{73}a_{33}$

$h_{84} = h_{73}a_{34}$

$h_{85} = h_{73}a_{35}$

$h_{87} = h_{73}a_{37} + h_{77}a_{77}$

$h_{88} = h_{73}a_{38}$

$$h_{89} = h_{73}a_{39}$$

$$h_{8,11} = h_{77}a_{7,11}$$

$$h_{8,14} = h_{73}a_{3,14}$$

$$h_{8,15} = h_{73}a_{3,15} + h_{7,15}a_{15,15}$$

$$h_{8,16} = h_{73}a_{3,16}$$

$$h_{93} = - \frac{\bar{q}\, C_{y_\beta}}{VW4.19x10^{-4}} M'_{2\beta}$$

$$h_{97} = h_{93}$$

$$h_{9,15} = \left(Y_{\delta_r} / T \right) M'_{2\delta}$$

$$h_{10,3} = h_{93}a_{33}$$

$$h_{10,4} = h_{93}a_{34}$$

$$h_{10,5} = h_{93}a_{35}$$

$$h_{10,7} = h_{93}a_{37} + h_{97}a_{77}$$

$$h_{10,8} = h_{93}a_{38}$$

$$h_{10,9} = h_{93}a_{39}$$

$$h_{10,11} = h_{97}a_{7,11}$$

$$h_{10,14} = h_{93}a_{3,14}$$

$$h_{10,15} = h_{93}a_{3,15} + h_{9,15}a_{15,15}$$

$$h_{10,16} = h_{93}a_{3,16}$$

$$h_{11,1} = + x_p a_{21} - z_p a_{11}$$

$$h_{11,2} = + x_p a_{22} - z_p a_{12}$$

$$h_{11,3} = a_{33} + x_p a_{23} - z_p a_{13}$$

$$h_{11,7} = a_{37} + x_p a_{27} - z_p a_{17}$$

$$h_{11,8} = a_{38} + x_p a_{28} - z_p a_{18}$$

$$h_{11,9} = a_{39} + x_p a_{29} - z_p a_{19}$$

$$h_{11,10} = +x_p a_{2,10} - z_p a_{1,10}$$

$$h_{11,14} = a_{3,14} + x_p a_{2,14} - z_p a_{1,14}$$

$$h_{11,15} = a_{3,15} + x_p a_{2,15} - z_p a_{1,15}$$

$$h_{11,16} = a_{3,16} + x_p a_{2,16} - z_p a_{1,16}$$

$$h_{12,1} = h_{11,1}a_{11} + h_{11,2}a_{21}$$

$$h_{12,2} = h_{11,1}a_{12} + h_{11,2}a_{22}$$

$$h_{12,3} = h_{11,1}a_{13} + h_{11,2}a_{23} + h_{11,3}a_{33}$$

$$h_{12,4} = h_{11,3}a_{34}$$

$$h_{12,5} = h_{11,3}a_{35}$$

$$h_{12,7} = h_{11,1}a_{17} + h_{11,2}a_{27} + h_{11,3}a_{37} + h_{11,7}a_{77}$$

$$h_{12,8} = h_{11,1}a_{18} + h_{11,2}a_{28} + h_{11,3}a_{38} + h_{11,8}a_{88} + h_{11,9}a_{98}$$

$$h_{12,9} = h_{11,1}a_{19} + h_{11,2}a_{29} + h_{11,3}a_{39} + h_{11,8}a_{89} + h_{11,9}a_{99}$$

$$h_{12,10} = h_{11,1}a_{1,10} + h_{11,2}a_{2,10} + h_{11,10}a_{10,10}$$

$$h_{12,11} = h_{11,7}a_{7,11} + h_{11,8}a_{8,11} + h_{11,9}a_{9,11}$$

$$h_{12,13} = h_{11,10}a_{10,13}$$

$$h_{12,14} = h_{11,1}a_{1,14} + h_{11,2}a_{2,14} + h_{11,3}a_{3,14} + h_{11,14}a_{14,14}$$

$$h_{12,15} = h_{11,1}a_{1,15} + h_{11,2}a_{2,15} + h_{11,3}a_{3,15} + h_{11,15}a_{15,15}$$

$$h_{12,16} = h_{11,1}a_{1,16} + h_{11,2}a_{2,16} + h_{11,3}a_{3,16} + h_{11,16}a_{16,16}$$

$$h_{13,3} = \frac{\bar{q}}{V}$$

$$h_{13,7} = \frac{\bar{q}}{V}\mu_{31}$$

$$h_{13,8} = \frac{\bar{q}}{V}\mu_{32}$$

$$h_{13,9} = \frac{\bar{q}}{V}\mu_{33}$$

$$h_{14,3} = h_{13,3}a_{33}$$

$$h_{14,4} = h_{13,3}a_{34}$$

$$h_{14,5} = h_{13,3}a_{35}$$

$$h_{14,7} = h_{13,3}a_{37} + h_{13,7}a_{77}$$

$$h_{14,8} = h_{13,3}a_{38} + h_{13,8}a_{88} + h_{13,9}a_{98}$$

$$h_{14,9} = h_{13,3}a_{39} + h_{13,8}a_{89} + h_{13,9}a_{99}$$

$$h_{14,11} = h_{13,7}a_{7,11} + h_{13,8}a_{8,11} + h_{13,9}a_{9,11}$$

$$h_{14,14} = h_{13,3}a_{3,14}$$

$$h_{14,15} = h_{13,3}a_{3,15}$$

$$h_{14,16} = h_{13,3}a_{3,16}$$

$$h_{15,4} = 1.0$$

$$h_{16,1} = a_{41}$$

$$h_{16,5} = a_{45}$$

$$h_{17,6} = 1.0$$

$$h_{18,3} = a_{63}$$

$$h_{18,4} = a_{64}$$

$$h_{18,5} = a_{65}$$

$\hat{i} = \hat{i}_b, \hat{j} = \hat{j}_b, \hat{k} = \hat{k}_b$ Unit vectors along aircraft x, y, and z axes

$\hat{i}_e, \hat{j}_e, \hat{k}_e$ Unit vectors in the flat earth

$\ell = x_\delta - x_{cm}$		ft
mrp	Moment reference point (subscript)	
o	Implies value on reference trajectory (subscript)*	
p	Body axis roll rate	rad/sec
p	Pilot (subscript)	
p_g	Rolling wind velocity. An element of the state.	rad/sec
q	Body axis pitch rate	rad/sec
q_o	Body axis reference pitch rate (Table C7) (use $\dot{\gamma}_o$)	rad/sec
$\bar{q}$	Dynamic pressure (Table C7)	lb/ft^2
r	Body axis yaw rate	rad/sec
r	Response vector [Equation (D2) and Table D2]	
r.c. = 133.5	Root chord	ft
s	Laplace operator	1/sec
s	Side (subscript)	
s	Sine	
t	Time from launch	sec
u	Velocity along aircraft x axis	ft/sec
$u_o = V \cos \alpha_o$		ft/sec
u_1, u_2, u_3	Control inputs [Equation (D1) and Table D1]	
v	Velocity along aircraft y axis	ft/sec

$v_v = \bar{v} + \tilde{v}$	Side wind velocity	ft/sec
$\bar{v}$	Mean side wind (Figure A5 and Table A2). An element of Υ	ft/sec
$\tilde{v}$	Random side wind. A component of the state x	ft/sec
$w_o = V \sin \alpha_o$		ft/sec
x	Distance forward of cm measured on x-axis (aircraft coordinates)	ft
x	Distance aft of nose measured on x-axis (shop coordinates)	ft
x	State vector [Equation (D1) and Table D1]	
x	A side wind state	1/ft
x_{cm}, x_{mrp} = 155.8	Center of mass (shop coordinates, Table C7) (shop coordinates)	ft
$x_p = x_{cm} - 59.7$	(Pilot's position in aircraft coordinates)	ft
x_δ = 194.0	Gimbal position in shop coordinates	ft
x_1, x_2, x_3	Lumped parameters side wind distribution states	ft/sec
x_4	Lumped parameter rolling gust distribution state	rad/sec
y	Coordinate axis in aircraft	
y	State component along y_e	
y_{cm}	In shop coordinates; taken to be zero (Table C7)	ft
y_e	Coordinate axis in earth	ft
y_{δ_i} = -16.0	In aircraft coordinates (i = 1, 6, Figure B9)	ft
y_{δ_i} = -8.0	In aircraft coordinates (i = 2, 7, 11, Figure B9)	ft

y_{δ_i} = 0.0 In aircraft coordinates (i = 3, 8, 12, Figure B9) ft

y_{δ_i} = +8.0 In aircraft coordinates (i = 4, 9, 13, Figure B9) ft

y_{δ_i} = +16.0 In aircraft coordinates (i = 5, 10, Figure B9) ft

z_{cm} = Center of mass (shop coordinates Table C7) ft

z_{mrp} = 20.0 (shop coordinates)

$z_p = z_{cm} - 32.5$ (Pilot's position in aircraft coordinates) ft

$z_{\delta_i} = +12.0 - z_{cm}$ In aircraft coordinates (i = 1-5, Figure B9) ft

$z_{\delta_i} = +4.0 - z_{cm}$ In aircraft coordinates (i = 6-10, Figure B9) ft

$z_{\delta_i} = -4.0 - z_{cm}$ In aircraft coordinates (i = 11-13, Figure B9) ft

Δ Perturbation symbol (suppressed after derivations)

α_o Angle of attack (Tables C7 and Figure B6) rad

β Side slip angle rad

δ_a Aileron deflection state component rad

δ_p Gimbal roll command state component rad

δ_r Gimbal yaw command state component rad

δ_y Gimbal deflection about aircraft y-axis rad

δ_z	Gimbal deflection about aircraft z-axis	rad
η_1	Unity white noise for side wind disturbance	$1/sec^{1/2}$
η_2	Unity white noise for rolling gust wind disturbance (η_1 is independent of η_2)	$1/sec^{1/2}$
θ	Pitch angle	rad
θ_o	Body axis reference pitch angle (Table C7)	rad
μ_{1j}	Obtained from the solution of Equations (D19) through (D21)	
μ_{2j}	Obtained from the solution of Equations (D19) through (D21)	
μ_{3j}	Obtained from the solution of Equations (D19) through (D21)	
σ_p	Standard deviation of rolling gust (Table C7)	ft/sec
$\sigma_v = \sigma_p$	Standard deviation of random side wind	ft/sec
$\dot{\sigma}_v/\sigma_v$	Coefficient in random side wind (Figure A6 and Table A2)	1/sec
ϕ	Roll angle	rad
ϕ	Roll angle state component	rad
ψ	Yaw angle	rad
ψ	Yaw angle state component	rad

REPRESENTATIONS

The generic forms for the perturbation state transition and response are given by:

$$\dot{x} = Ax + G\tilde{f} \tag{D1}$$

$$r = Hx + Df \tag{D2}$$

They are presented explicitly in Tables D1 and D2. These tables and the nomenclature provide for generating all data.

The coefficients a_{77}, $a_{7,11}$, $a_{8,11}$, a_{88}, a_{99}, $a_{9,11}$, g_{74}, g_{84}, g_{94}, and $\bar{v}$ are tabulated in Table A2. The remainder of the coefficients of matrices A, G, H, and D are presented in Tables D3 through D6.

DERIVATIONS

Euler Angles

A pitch (θ), roll (ϕ), yaw (ψ) system relative to a flat earth is used. This system is nonsingular at liftoff as would be a heading, elevation, roll system.

Body axis base vectors (i, j, k) are given relative to flat earth base vectors (i_e, j_e, k_e) by

$$\begin{Bmatrix} \hat{i} \\ \hat{j} \\ \hat{k} \end{Bmatrix} = \begin{bmatrix} (c\theta c\psi + s\theta s\phi s\psi) & (c\phi s\psi) & (-s\theta c\psi + c\theta s\phi s\psi) \\ (-c\theta s\psi + s\theta s\phi c\psi) & (c\phi c\psi) & (s\theta s\psi + c\theta s\phi c\psi) \\ (s\theta c\phi) & (-s\phi) & (c\theta c\phi) \end{bmatrix} \begin{Bmatrix} \hat{i}_e \\ \hat{j}_e \\ \hat{k}_e \end{Bmatrix} \tag{D3}$$

Rotation rates p, q, and r in body axes relative to $\dot{\theta}$, $\dot{\phi}$, $\dot{\psi}$, and the inverse are given by Equations (D4) and (D5).

$$\begin{Bmatrix} p \\ q \\ r \end{Bmatrix} = \begin{bmatrix} c\psi & (c\phi)(S\psi) & 0 \\ -s\psi & (c\phi)(c\psi) & 0 \\ 0 & -s\phi & 1 \end{bmatrix} \begin{Bmatrix} \dot{\phi} \\ \dot{\theta} \\ \dot{\psi} \end{Bmatrix} \tag{D4}$$

$$\begin{Bmatrix} \dot{\phi} \\ \dot{\theta} \\ \dot{\psi} \end{Bmatrix} = \begin{bmatrix} c\psi & -s\psi \\ (s\psi/c\phi) & (c\psi/c\phi) \\ (\tan\phi)(s\psi) & (\tan\phi)(c\psi) \end{bmatrix} \begin{matrix} 0 \\ 0 \\ 1 \end{matrix} \begin{Bmatrix} p \\ q \\ r \end{Bmatrix} \tag{D5}$$

The perturbation equations for $\dot{\phi}$ and $\dot{\psi}$ are

$$\Delta\dot{\phi} = \Delta p - q_o \Delta\psi \tag{D6}$$

$$\Delta\dot{\psi} = \Delta r + q_o \Delta\phi \tag{D7}$$

which correspond to rows 4 and 5 of Table D1.

By use of Equation (D3), the cross-course velocity is

$$\dot{y} = (c\phi)(s\psi)u + (c\phi)(c\psi)v - (s\phi)w$$

Its perturbation equation is

$$\Delta\dot{y} = u_o \Delta\psi + \Delta v - w_o \Delta\phi \tag{D8}$$

This corresponds to row 6 of Table D1.

In deriving (D6), (D7), and (D8), the variables u and w are not perturbed; $s\phi_o = s\psi_o = 0$.

Winds

Laterally, the shuttle is forced by side winds v_w and by rolling gusts p_g.

The side wind v_w is made up of a mean $\bar{v}_w$ and ramdom $\tilde{v}$. The model is discussed in Appendix A.

The mean wind $\bar{v}$ appears as a disturbance function in Tables D1 and D2. Numerical values are shown in Figure A5 and column 2 of Table A2.

The random wind $\tilde{v}$ is generated by the differential equations of rows 7 and 8 of Table D1. Coefficients are plotted in Figures A6-A11 and columns 4-9 of Table A2.

There does not appear to be a rolling gust model specifically derived for vertically rising vehicles, The rolling gust model specified for horizontal flight (pp. 48-53 of ref. 13 will be adapted. This model is

$$p_g = \sigma_p \sqrt{\frac{1}{L_p V}} \frac{\sqrt{0.8 \left(\frac{\pi}{4} \frac{L_p}{b}\right)^{1/3}}}{1 + \frac{4b}{\pi V} s} \eta_2 \quad \text{(D9)}$$

Values for the scale length L_p and gust intensity σ_p have to be chosen. These are taken as

$$L_p = 1750 \text{ feet}$$

$$\sigma_p = \sigma_v$$

These choices are motivated, reference 13; σ_v is plotted in Figure A2 and tabulated in Table A2.

A state representation for Equation (D9) is given by

$$\dot{p}_g = -\frac{\pi}{4} \frac{V}{b} p_g + \sigma_p \sqrt{0.8 \frac{V}{L_p}} \frac{\pi}{4b} \left(\frac{\pi}{4} \frac{L_p}{b}\right)^{1/6} \eta_2 \quad \text{(D10)}$$

This corresponds to row 13 of Table D1.

Distributing the Wind Gust Loads

The side force due to winds on the vehicle is the integrated sum of the local body and fin pressure developed by side gusts (v_w). Analogous statements prevail for the yawing and rolling moments due to side gusts and for the rolling moment developed by the rolling wind (p_g).

These are all distributed forces for which it is desirable (mandatory in the present context) to find a lumped parameter representation. Lumped parameter approximations for the side gusts are discussed first. Then the rolling gust approximation is presented.

The side force and yawing moment coefficients due to side gusts are taken to be

$$C_{y_{sg}} = \frac{C_{y_\beta}}{V} \{\mu_{31} x_1 + \mu_{32} x_2 + \mu_{33} x_3\} \quad \text{(D11)}$$

$$C_{n_{sg}} = \frac{C_{n_\beta}}{V} \{\mu_{11} x_1 + \mu_{12} x_2 + \mu_{13} x_3\} \quad \text{(D12)}$$

where x_1, x_2, and x_3 are system states driven by the wind v_w. For constant winds $x_1 = x_2 = x_3 = v_w$. Rows 7, 8, and 9 of Table D1 show this and how the x_is are driven by the wind v_w. The μ_{ij}s are constants to be determined.

The step responses of x_1, x_2, and x_3 (called f_1, f_2, and f_3) for a sharp-edged side gust v_w are

$$f_1[x] = 1 - e^{\frac{-2.3}{L_s} x} \tag{D13}$$

$$f_2[x] = 1 - e^{\frac{-2.3}{L_s} x} \left\{ \cos \frac{2\pi}{L_s} x - 1.165 \sin \frac{2\pi}{L_s} x \right\} \tag{D14}$$

$$f_3[x] = 1 - e^{\frac{-2.3}{L_s} x} \left\{ \cos \frac{2\pi}{L_s} x + 1.167 \sin \frac{2\pi}{L_s} x \right\} \tag{D15}$$

$$L_s = 228.5$$

The most gross result of slender body theory (refs. 22 or 23) give the step responses for gust penetration as

$$C_{y_\beta}[x] = \frac{-2}{S} \int_0^x A'[\tilde{x}]\, d\tilde{x} \tag{D16}$$

$$C_{n_{\beta_{ref}}}[x] = \frac{2}{Sb} \int_0^x (\tilde{x} - x_{ref})\, A'[\tilde{x}]\, d\tilde{x} \tag{D17}$$

$$0 \le x \le L_s$$

$$A[x] = \frac{\pi}{4} (d[x])^2$$

where d[x] is the "slender body maximum" projected side dimension.

If the theory was correct, Equations (D16) and (D17) would yield the same results as the wind tunnel (Figures D10 and D11). The slender body depth is plotted in Figure D1 (from Figure 1), the slender body area in Figure D2. The slender body area is assumed to vary linearly between $0 < x < 120$ and $190 < x < 228.5$. It is assumed constant for $120 < x < 190$. With

$$A'[x] = \begin{cases} \frac{4260}{120} & \text{for} \quad 0 < x < 120 \\ 0 & \text{for} \quad 120 < x < 190 \\ \frac{2900}{38.5} & \text{for} \quad 190 < x < 228.5 \end{cases} \tag{D18}$$

both C_{y_β} and C_{n_β} Figure D3 computed from Equations (D16) and (D17) agree with Figure D10 and D12 for M = 1.5 (maximum $\bar{q}$). The amount of finagling is not large; the vertical fins are less effective than the theory estimates.

The μ_{ij}s are to be determined to provide a least-squared fit of $C_{y_\beta}[x]$ and $C_{y_{\beta_{cm}}}[x]$ from the solution

$$B\tilde{\mu}_{ij} = c_{ij} \quad \text{for} \quad i = 1, 3 \tag{D19}$$

$$\mu_{ij} = k_i \tilde{\mu}_{ij} \quad \text{for} \quad i = 1, 3 \tag{D20}$$

$$k_i = \frac{1}{\sum_j \tilde{\mu}_{ij}} \quad \text{for} \quad i = 1, 3 \tag{D21}$$

$$B = \begin{vmatrix} \int_0^{L_s} f_1^2\, dx & \int_0^{L_s} f_1 f_2\, dx & \int_0^{L_s} f_1 f_3\, dx \\ \int_0^{L_s} f_1 f_2\, dx & \int_0^{L_s} f_2^2\, dx & \int_0^{L_s} f_2 f_3\, dx \\ \int_0^{L_s} f_1 f_3\, dx & \int_0^{L_s} f_2 f_3\, dx & \int_0^{L_s} f_3^2\, dx \end{vmatrix}$$

$$c_{ij} = \begin{vmatrix} \int_o^{L_s} f_1 g_i \, dx \\ \int_o^{L_s} f_2 g_i \, dx \\ \int_o^{L_s} f_3 g_i \, dx \end{vmatrix}$$

$$g_1 = c_{n_{\beta_{cm}}} [x]$$

$$g_3 = c_{y_\beta} [x]$$

$$x_{cm} = .107.68 \ (@ \ \bar{q}_{max})$$

The least-squared fit for the $\tilde{\mu}$s is obtained by Equation (D19). These are adjusted by Equation (D20) to enforce the correct steady state. The μs provide the correct steady-state side force and yawing for all flight conditions. Good accuracy should be obtained dynamically in the critical maximum dynamic pressure flight range. For the purpose intended, the representation should be reasonably good over the whole flight regime. To do better would require aerodynamic estimates appropriate to each flight regime, an increase in the number of basis functions (f_i), and calculation of time-varying μs; straightforward in principle but not warranted at this time.

For a constant side gust v_w, the rolling moment coefficient is

$$C_\ell = C_{\ell_\beta} \frac{v_w}{V} \qquad \text{(D22)}$$

For a sharp-edged side gust it is assumed that

$$C_{\ell_\beta}[x] = \begin{cases} 0 & \text{for } 0 < x < 95.0 \\ \left\{\frac{(x-95.0)}{r.c.}\right\}^2 (-0.055) & \text{for } 95 < x < 228.5 \end{cases} \quad \text{(D23)}$$

where

$r.c. = 133.5$

C_{ℓ_β} is generated primarily by the wing which starts at x = 95 and extends to x = 228.5. The quadratic variation for $95 < x < 228.5$ is motivated by the results of slender-body theory. C_{ℓ_β} at M = 1.5 is -0.055 (Figure D6).

The μ_{2j}s are obtained by use of Equations (D19) through (D21) (with a notational adjustment) and (D22).

Treatment of the rolling gusts is analogous to, but simpler than, those for the side gusts.

The rolling gust (p_g) drives x_4 through the equation shown in row 10 of Table D1. Time to 90 percent is taken as the time to traverse the wing root chord. x_4 "distributes" p_g over the wing chord. Steady-state values of x_4 and p_g are the same. x_4 drives the equations of motion in the same way as the geometric roll rate (p).

Thrust Vectoring

There are a number of alternatives available in selecting the manner in which roll and yaw torques are obtained from gimbaling of the rocket engines. The one selected here has merit for this particular vehicle.

The gimbaling scheme selected:

- Yields pure roll torques (no yawing moments) about the velocity vector due to roll commands
- Yields pure yaw torques (no roll torques) about the velocity vector due to yaw commands

For roll commands, the sidewise motion of most of the engines is twice the vertical motion (to conserve pitch power).

For yaw commands, the maximum yawing moment used from thrust vectoring is less than that available, in order to obtain yawing moments without rolling moments. This is not a loss. The resulting $|N_{\delta r}/N_\beta| \gg 1$ (yawing moment due yaw vectoring divided yawing moment due to sideslip is much greater than one, as it must be). This open-loop compensation should give better control than can be attained with closed-loop control alone. Most importantly, it will permit a comparison between the results to be attained from these equations and those obtained from those of Appendix B.

There may be concern that the scheme selected will generate large payload losses. This is not the case. For maximum propulsive efficiency, the thrust vector should be aligned along the velocity vector. If it is not, there is a thrust loss (TL)

$$(TL) = T(1-\cos\delta) \cong T\frac{\delta^2}{2}$$

The fuel for control (FC)

$$(FC) = \int_0^{170} \frac{T\delta^2}{2I_{sp}}\,dt$$

where

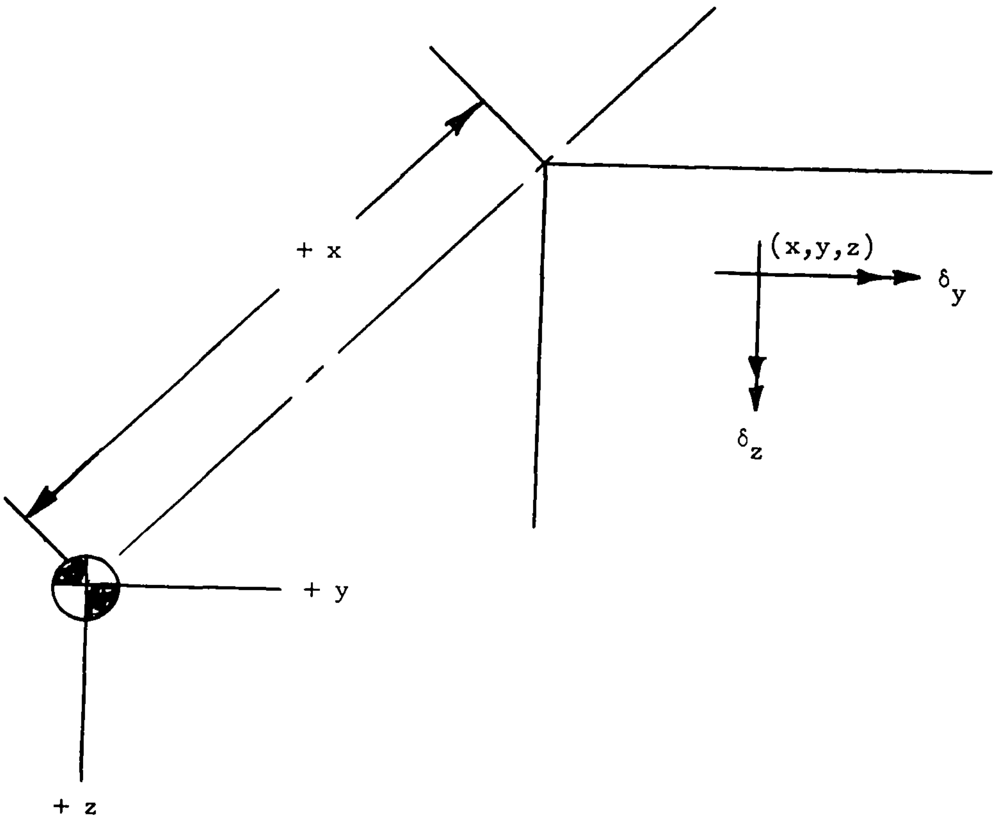
I_{sp} is the specific impulse (taken equal to 450 lb thrust/fuel/sec). The analog results of Section III show that the gimbal angles approaching 0.1 radian are obtained over less than 20 seconds of flight. That is,

$$(FC) \leq \frac{(6\cdot 10^6)(0.1)^2 20}{2(450)} = 1330 \text{ lb}$$

This is booster fuel. Using the 1/6 rule of thumb, this implies a loss in payload of less than 225 lb for control.

Derivation of the equations is now presented. Forces and moments for a single engine are determined first. Coupling of the engines is then presented.

An engine with thrust T_i is mounted at (x, y, z) in aircraft coordinates. The nominal thrust is in the positive x direction (directed along the unit vector, $\hat{i}_1$). Engine gimbals are provided along the y and z axes; positive rotations about the gimbal axes are δ_y and δ_z (radians). The ordering of gimbal rotations is δ_y and δ_z.



Unit vectors i_1, j_1, and k_1 are aligned along the body axes, x, y, and z. Unit vectors i_2, j_2, and k_2 are oriented with respect to the rocket nozzle after the rotation δ_y. Unit vectors i_3, j_3, and k_3 are oriented with respect to the rocket nozzle after rotations δ_y and δ_z.

$$\begin{Bmatrix} i_2 \\ j_2 \\ k_2 \end{Bmatrix} = \begin{bmatrix} c\delta_y & 0 & -s\delta_y \\ 0 & 1 & 0 \\ s\delta_y & 0 & c\delta_y \end{bmatrix} \begin{Bmatrix} i_1 \\ j_1 \\ k_1 \end{Bmatrix}$$

$$\begin{Bmatrix} i_3 \\ j_3 \\ k_3 \end{Bmatrix} = \begin{bmatrix} c\delta_z & s\delta_z & 0 \\ -s\delta_z & c\delta_z & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{Bmatrix} i_2 \\ j_2 \\ k_2 \end{Bmatrix}$$

$$\begin{Bmatrix} i_3 \\ j_3 \\ k_3 \end{Bmatrix} = \begin{bmatrix} (c\delta_y)(c\delta_z) & s\delta_z & (-s\delta_y)(c\delta_z) \\ (c\delta_y)(-s\delta_z) & c\delta_z & (s\delta_y)(s\delta_z) \\ s\delta_y & 0 & c\delta_y \end{bmatrix} \begin{Bmatrix} i_1 \\ j_1 \\ k_1 \end{Bmatrix}$$

Hence, the force F along the body axes is

$$F = T_i \left[(c\delta_y)(c\delta_z)\,\hat{i}_1 + (s\delta_z)\,\hat{j}_1 - (s\delta_y)(c\delta_z)\,\hat{k}_1\right]$$

The moment is

$$\frac{M}{T_i} = \begin{bmatrix} \hat{i}_1 & \hat{j}_1 & \hat{k}_1 \\ x & y & z \\ (c\delta_y)(c\delta_z) & (s\delta_z) & -(s\delta_y)(c\delta_z) \end{bmatrix}$$

$$= \hat{i}_1\left[-y(s\delta_y)(c\delta_z) - z(s\delta_z)\right] + \hat{j}_1\left[z(c\delta_y)(c\delta_z) + x(s\delta_y)(c\delta_z)\right]$$

$$+ \hat{k}_1\left[x(s\delta_z) - y(c\delta_y)(c\delta_z)\right]$$

The perturbation and moment equations are (for $s\delta_{z_o} = 0$; $c\delta_{z_o} = 1$)

$$\Delta F \cong T_i\,\hat{i}_1\left[-s\delta_{y_o}(\Delta\delta_y)\right] \qquad \text{Thrust}$$

$$+ T_i\hat{j}_1\left[\Delta\delta_z\right] \qquad \text{Side force}$$

$$+ T_i\hat{k}_1\left[-(c\delta_{y_o})(\Delta\delta_{y_o})\right] \qquad \text{Heave}$$

$$\Delta M \cong T_i\,\hat{i}_1\left[-y(c\delta_{y_o})(\Delta\delta_y) - z(\Delta\delta_z)\right] \qquad \text{Rolling moment}$$

$$+ T_i\hat{j}_1\left[-z(s\delta_{y_o})(\Delta\delta_y) + x(c\delta_{y_o})(\Delta\delta_y)\right] \qquad \text{Pitching moment}$$

$$+ T_i\hat{k}_1\left[x(\Delta\delta_z) + y(s\delta_{y_o})(\Delta\delta_y)\right] \qquad \text{Yawing moment}$$

These are approximated to

$$\Delta Y = T_i \, \Delta\delta_z \qquad \text{Side force} \qquad (D24)$$

$$\Delta L = T_i \, [-y(\Delta\delta_y) - z(\Delta\delta_z)] \qquad \text{Rolling moment} \qquad (D25)$$

$$\Delta N = T_i \, [x(\Delta\delta_z)] \qquad \text{Yawing moment} \qquad (D26)$$

The gimbals are to be driven to obtain:

- Yawing moment without rolling moment about the velocity vector due to yaw control
- Rolling moment without yawing moment about the velocity vector due to roll control
- The maximum yawing moment per gimbal deflection due to yaw commands
- The maximum rolling moment per gimbal deflection due to roll commands

The first two of the above are obtained by enforcing

$$L_{\delta_r} = -(\tan \alpha) \, N_{\delta_r} \qquad (D27)$$

$$N_{\delta_p} = (\tan \alpha) \, L_{\delta_p} \qquad (D28)$$

where δ_r and δ_p are the yaw and roll commands.

Obtaining the latter two objectives is illustrated by example.

Figure 1 shows the vehicle; Figure B3 the engine numbering system. The x-axis is taken midway between the bottom two rows of engines. The engines are taken as being 8 feet on centers. Table C7 presents the positions of the center of mass in "manufacturing shop" coordinates. At 10 sec x_{cm} - 93.46 ft, y_{cm} = 0 (by assumption), and z_{cm} = 8.08 feet. The x gimbal positions are all taken as 194 feet. For the 10-sec flight condition the gimbal positions in flight coordinates are presented in Table D7. Engine numbers are identified in Figure B3. Figure B7 and Table C7 show the angle of attack is -0.6 degree so that tan α = -0.0105.

Roll commands are considered first. From Equations (D25) and (D26) the perturbation rolling and yawing moments for roll commands are

$$L_{\delta_p} = \sum_{i=1}^{13} T_i \left\{ -y_i \frac{\partial \delta_{y_i}}{\partial \delta_p} - z_i \frac{\partial \delta_{z_i}}{\partial \delta_p} \right\} \tag{D29}$$

$$N_{\delta_p} = \sum_{i=1}^{13} T_i \, x_i \frac{\partial \delta_{z_i}}{\partial \delta_p} \tag{D30}$$

It is assumed

$$T_i = T_j \text{ for all i and j} \tag{D31}$$

$$\frac{\partial \delta_{y_i}}{\partial \delta_p} = \begin{cases} +\frac{1}{2} & \text{for} \quad i = 1, 2, 6, 7, 11 \\ 0 & \text{for} \quad i = 3, 8, 12 \\ -\frac{1}{2} & \text{for} \quad i = 4, 5, 9, 10, 13 \end{cases} \tag{D32}$$

$$\left[\frac{\partial \delta_{z_i}}{\partial \delta_p} \right] \leq 1 \tag{D33}$$

Hence, $\frac{\partial \delta_{z_i}}{\partial \delta_p}$ have to be determined to minimize L_{δ_p} subject to

$$N_{\delta_p} = -0.0105 \, L_{\delta_p} \tag{D34}$$

Some fussing yields the solution of Table D9.

Yaw commands are derived similarly,

$$L_{\delta_r} = \sum_{i=1}^{13} T_i(-z_i) \frac{\partial \delta_{z_i}}{\partial \delta_r} \tag{D35}$$

$$N_{\delta_r} = \sum_{i=1}^{13} T_i x_i \frac{\partial \delta_{z_i}}{\partial \delta_r} \quad \text{(D36)}$$

where it is now assumed

$$T_i = T_j \text{ for all i and j} \quad \text{(D37)}$$

$$\left| \frac{\partial \delta_{z_i}}{\partial \delta_r} \right| \leq 1 \quad \text{(D38)}$$

Hence, $\frac{\partial \delta_{z_i}}{\partial \delta_r}$ have to be determined to minimize N_{δ_r} subject to

$$L_{\delta_r} = +0.0105 \, N_{\delta_r} \quad \text{(D39)}$$

A little more fussing yields the solution of Table D9.

$$L_{\delta_p}/T, \; N_{\delta_p}/T, \; L_{\delta_r}/T, \text{ and } N_{\delta_r}/T$$

from Tables D8 and D9 were interpolated and are presented at 5-second intervals in Table D 10. These quantities are used in coefficients $a_{1, 14}$, $a_{1, 15}$, $a_{2, 14}$, and $a_{2, 15}$.

Side forces are also required. Equation (D24) shows they result from gimbal deflections δ_z. For yaw control

$$\frac{Y_{\delta_r}}{T} = \frac{1}{T} \sum_i T_i \frac{\partial \delta_{z_i}}{\partial \delta_r} \quad \text{(D40)}$$

$$\frac{Y_{\delta_r}}{T} = \begin{cases} \frac{1}{13} \sum_i \frac{\partial \delta_{z_i}}{\partial \delta_r} & \text{for } t < 117 \\ \frac{1}{10} \sum_i \frac{\partial \delta_{z_i}}{\partial \delta_r} & \text{for } 117 < t < 148 \\ \frac{1}{8} \sum_i \frac{\partial \delta_{z_i}}{\partial \delta_r} & \text{for } 148 < t < 170 \end{cases} \quad \text{(D41)}$$

At 10 seconds, Table D9 yields

$$\frac{Y_{\delta_r}}{T} = \frac{1}{13} (10 + 3 \cdot 0.294) = 0.834 \qquad \text{(D42)}$$

$\frac{Y_{\delta_p}}{T}$ is obtained in a similar manner from Table D8. Y_{δ_r}/T and Y_{δ_p}/T are tabulated for use in Table D10. The latter is so small it will be neglected in the analyses; it is presented here for completeness.

Table D10 contains all the data needed for perturbation control synthesis. For flight purposes, the open-loop gains of Tables D8 and D9 would have to be implemented.

Body Dynamics

The equations of motion are

$$\dot{p} = \frac{1}{I} \{I_{zz} [L - (I_{zz}-I_{yy})qr + I_{xz} pq] + I_{xz} [N - (I_{yy}-I_{xx})pq - I_{xz}qr]\} \qquad \text{(D43)}$$

$$\dot{r} = \frac{1}{I} \{I_{xx} [N - (I_{yy}-I_{xx})pq - I_{xz}qr] + I_{xz} [L - (I_{zz}-I_{yy})qr + I_{xz}pq]\} \qquad \text{(D44)}$$

$$\dot{v} = \frac{g}{W} Y + g(s\theta)(s\psi) + g(c\theta)(c\psi) - ur + wp \qquad \text{(D45)}$$

The gravity contribution in Equation (D45) is obtained from Equation (D3).

The corresponding perturbation equations of motion are:

$$\Delta\dot{p} = \frac{1}{I} \{I_{zz} [\Delta L + (I_{yy}-I_{zz}) q_o \Delta r + I_{xz} q_o \Delta p] + I_{xz} [\Delta N + (I_{xx}-I_{yy}) q_o \Delta p - I_{xz} q_o \Delta r]\} \qquad \text{(D46)}$$

$$\Delta\dot{r} = \frac{1}{I} \{I_{xx} [\Delta N + (I_{xx} - I_{yy}) q_o \Delta p - I_{xz} q_o \Delta r] + I_{xz} [\Delta L + (I_{yy}-I_{zz}) q_o \Delta r + I_{xz} q_o \Delta p]\} \qquad \text{(D47)}$$

$$\Delta\dot{v} = \frac{g}{W} \Delta Y + g(s\theta_o) \Delta\psi + g(c\theta_o) \Delta\phi - u_o \Delta r + w_o \Delta p \qquad \text{(D48)}$$

The perturbation rolling moment ΔL is taken as made up from two contributions from aerodynamics and thrust vectoring forces:

$$\Delta L = \Delta L_1 + \Delta L_2 \tag{D49}$$

where

$$\Delta L_1 = \bar{q}Sb \left\{ \frac{b}{2V} C_{\ell_p} \Delta p + \frac{b}{2V} C_{\ell_r} \Delta r + C_{\ell_\beta} \Delta \beta + C_{\ell_{\delta a}} \delta a + \frac{b}{2V} C_{\ell_p} x_4 + \frac{C_{\ell_\beta}}{V} \left[\mu_{21}x_1 + \mu_{22}x_2 + \mu_{23}x_3\right] \right\} \tag{D50}$$

$$\Delta L_2 = T \left(\frac{L_{\delta_p}}{T} \right) \Delta \delta_p + T \left(\frac{L_{\delta_r}}{T} \right) \Delta \delta_r \tag{D51}$$

The first four terms of Equation (D50) are the usual aerodynamic force terms; the last four are associated with gust penetration which was discussed previously under Distributing the Wind Loads.

The thrust vectoring terms appear in Equation (D51). Their derivation was discussed under Thrust Vectoring.

Equations (D36), (D49), and (D51) correspond to row 1 of Table D1.

The perturbation rolling moment ΔN is made up of three contributions:

$$\Delta N = \Delta N_1 + \Delta N_2 + \Delta N_3 \tag{D52}$$

where

$$\Delta N_1 = \bar{q}Sb \left\{ \frac{b}{2V} C_{n_p} \Delta p + \frac{b}{2V} C_{n_r} \Delta_r + C_{n_\beta} \Delta \beta + C_{n_{\delta a}} \delta a + \frac{b}{2V} C_{n_p} x_4 + \frac{C_{n_\beta}}{V} \left[\mu_{11}x_1 + \mu_{22}x_2 + \mu_{13}x_3\right] \right\} \tag{D53}$$

$$\Delta N_2 = T \left(\frac{N_{\delta_p}}{T} \right) \Delta \delta_p + T \left(\frac{N_{\delta_r}}{T} \right) \Delta \delta_r \tag{D54}$$

$$\Delta N_3 = \left\{ \frac{(\ell + 15)^2}{32.17} \frac{d}{dt} W - \frac{d}{dt} I_{zz} \right\} \Delta r \triangleq (M.R.)\Delta r \tag{D55}$$

Equations (D53) and (D54) are in direct correspondence with (D50) and (D51). Equation (D55) is the mass rate damping term (from Equation 7.8-2 of ref. D5).

Equations (D47), (D52), (D53), (D54), and (D55) correspond to row 2 of Table D1.

The perturbation side force ΔY is taken as made up of two contributions:

$$\Delta Y = \Delta Y_1 + \Delta Y_2 \qquad \text{(D56)}$$

where

$$\Delta Y_1 = \bar{q} S \left\{ C_{y_\beta} \Delta\beta + C_{y_{\delta a}} \delta a + \frac{C_{y_\beta}}{V} \left[\mu_{31} x_1 + \mu_{32} x_2 + \mu_{33} x_3\right] \right\} \qquad \text{(D57)}$$

$$\Delta Y_2 = T \left(\frac{Y_{\delta_p}}{T} \right) \Delta \delta_p + T \left(\frac{Y_{\delta_r}}{T} \right) \Delta \delta_r \qquad \text{(D58)}$$

Equations (D48), (D56), (D57), and (D58) correspond to row 3 of Table D1.

Actuator Dynamics

Appendix B uses second-order actuator dynamics for both the gimbals:

$$\ddot{\delta} = -2(0.396)(31.6)\dot{\delta} - (31.6)^2 \delta \qquad \text{(D59)}$$

and for the aileron

$$\ddot{\delta}_a = -2(0.5)(10)\dot{\delta}_a - (10)^2 \delta_a \qquad \text{(D60)}$$

First-order approximations to each of these are used here

$$\dot{\delta}_r = -31.6\, \delta_r + 31.6\, \mu_1 \qquad \text{(D61)}$$

$$\dot{\delta}_p = -31.6\, \delta_p + 31.6\, u_2 \qquad \text{(D62)}$$

$$\dot{\delta}_a = -10.0\, \delta_a + 10.0\, u_3 \qquad \text{(D63)}$$

These correspond to rows 14 through 16 of Table D1.

Bending Moments

The bending moments at stations 660 and 1800 are given by (page 15 of ref. 25) as

$$M_{660} = M_1 = M'_{1\delta}\delta + M'_{1\beta}\beta \tag{D64}$$

$$M_{1800} = M_2 = M'_{2\delta}\delta + M'_{2\beta}\beta \tag{D65}$$

where the numerical values for the maximum dynamic pressure condition are listed in Appendix B. The same assumption used in Appendix B is used to estimate M'_βs for all flight conditions. The assumption on the M'_δ s used here is comparable to that in Appendix B; it differs slightly due to the differences in thrust vectoring.

For the M'_βs Appendix B assumes

$$M'_\beta[t] = \frac{\frac{\bar{q}S}{W} C_{y_\beta}[t]}{\left(\frac{\bar{q}S}{W} C_{y_\beta}[t=64]\right)} M'_\beta$$

$$= \frac{\bar{q}}{W} \frac{C_{y_\beta}}{\left[\frac{7.86 \times 10^2}{2.63 \times 10^6}(-1.4)\right]} M'_\beta$$

$$= -\frac{\bar{q}}{W} \frac{C_{y_\beta}}{4.19 \times 10^{-4}} M'_\beta \tag{D66}$$

It is the gimbaling about the z-axis gimbals that yields the side-bending moments. For the gimbaling selected here the rockets are not all fully slewed in yaw. They are deficient by the amount Y_{δ_r} (column 6 of Table D10). Hence, consistency with Appendix B requires

$$M'_\delta = \left(Y_{\delta_r}/T\right) M'_\delta$$

For gust penetration the winds are assumed filtered by x_1. Thus,

$$M_1 = \left(Y_{\delta_r}/T\right) M'_{1\delta}\delta_r - \frac{\tilde{q}\, C_{y_\beta}}{VW4.19 \times 10^{-4}} M'_{1\beta}(v+x_1) \quad (D67)$$

Similarly for M_2. These equations correspond to rows 7 and 9 of Table D2.

$\bar{q}\beta$

The term $\bar{q}\beta$ is used as an indicator of aerodynamic loading. It is most commonly employed in preliminary design where gust penetration is neglected. Since gust penetration is included here, an equivalent $\bar{q}\beta$ is defined to be

$$\bar{q}\beta = \frac{\bar{q}}{V} \{v + \mu_{31}x_1 + \mu_{32}x_2 + \mu_{33}x_3\} \quad (D68)$$

This is row 13 of Table D2.

Pilot's Lateral Acceleration

The lateral acceleration felt by the pilot is [from Equation (D45)] approximately

$$\begin{aligned} a_y &= \dot{v} + ur - wp - g(s\theta)(s\psi) - g(c\theta)(s\psi) + x_p\dot{r} - z_p\dot{p} \\ &= \frac{g}{W} Y + x_p\dot{r} - z_p\dot{p} \end{aligned} \quad (D69)$$

Its perturbation [using Equations (D56) through (D58)] is

$$\begin{aligned} \Delta a_y = \frac{g}{W}\frac{\bar{q}}{S} &\left\{ \frac{C_{y_\beta}}{V} [v + \mu_{31}x_1 + \mu_{32}x_2 + \mu_{33}x_3] + C_{y_{\delta a}}\delta a \right\} \\ &+ \frac{g}{W} T \left(\frac{Y_{\delta_p}}{T}\right) \Delta\delta_p + \frac{g}{W} T \left(\frac{Y_{\delta_r}}{T}\right) \Delta\delta_r + x_p \Delta\dot{r} - z_p \Delta\dot{p} \end{aligned} \quad (D70)$$

When rows 2 and 1 of Table D1 are used to obtain $\Delta\dot{r}$ and $\Delta\dot{p}$, the result is that listed in Table D2.

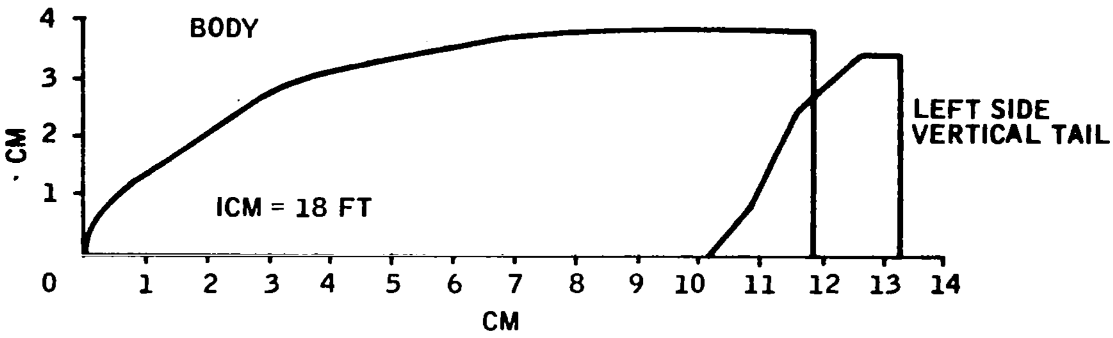


Figure D1. Slender Body Depth

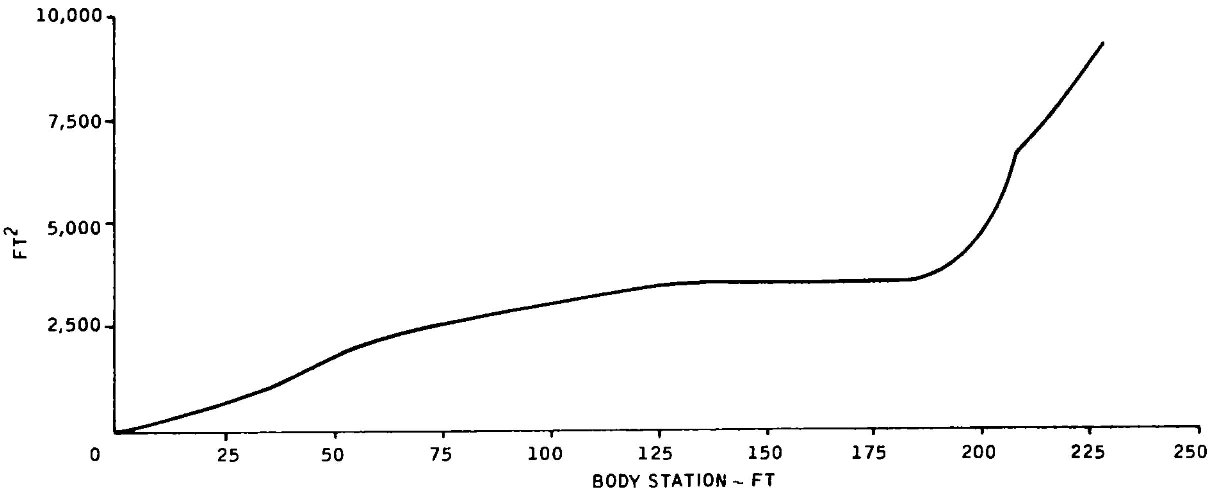


Figure D2. Slender Body Area

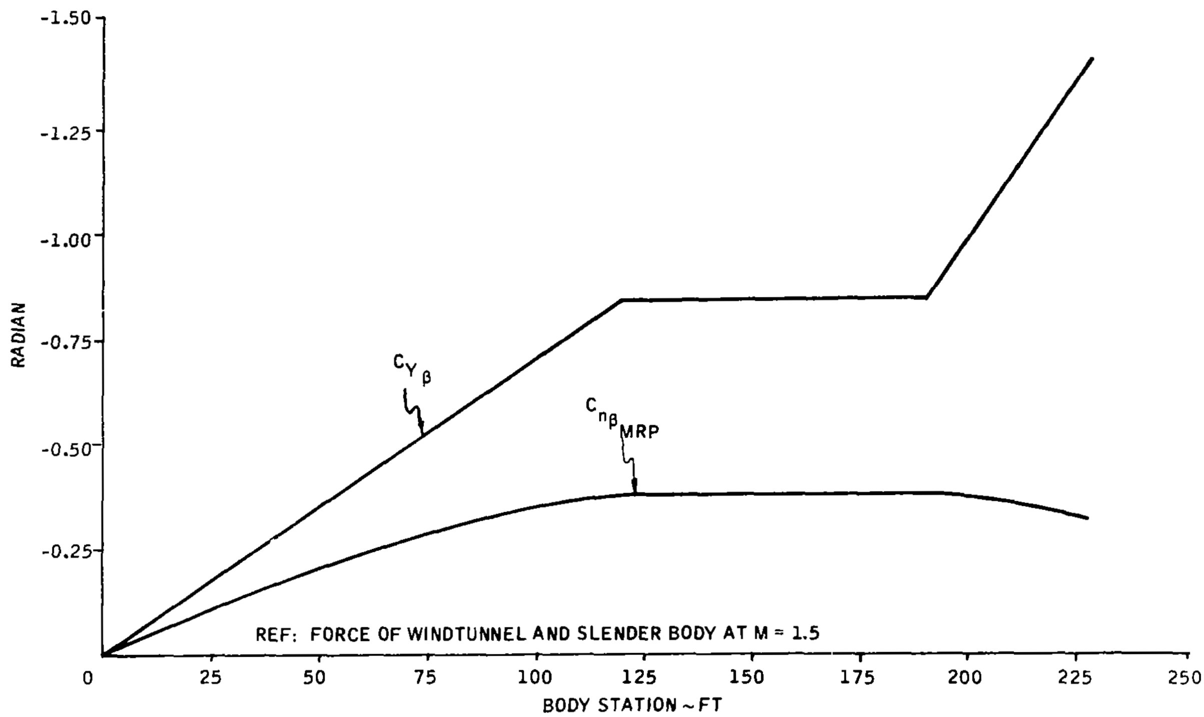


Figure D3. Gust Penetration

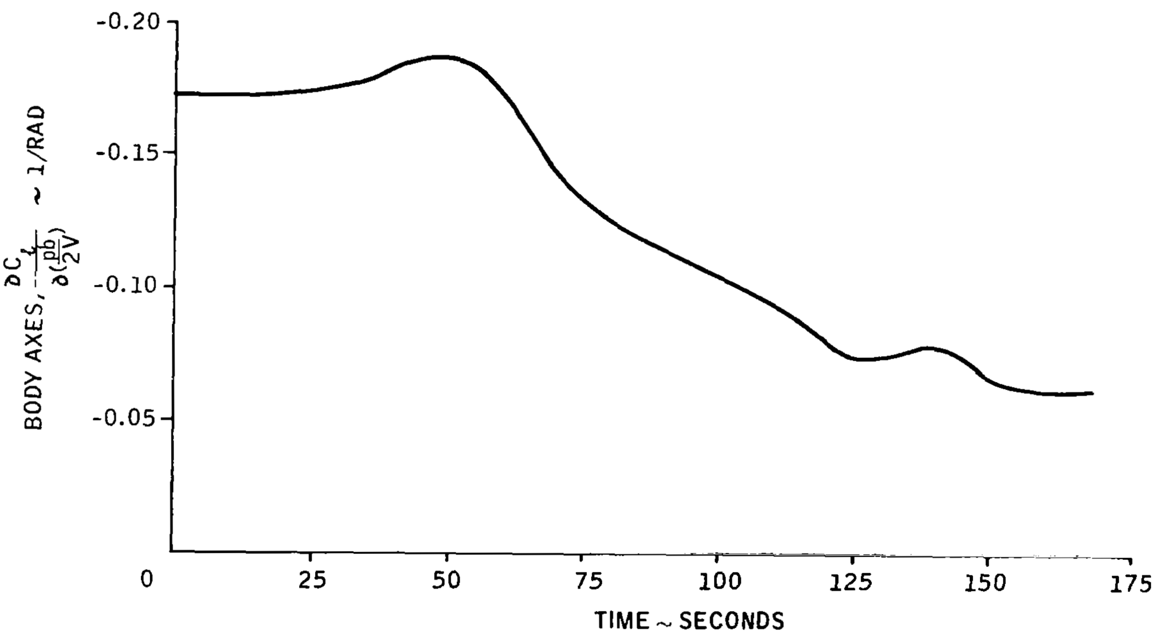


Figure D4. C_{ℓ_p}

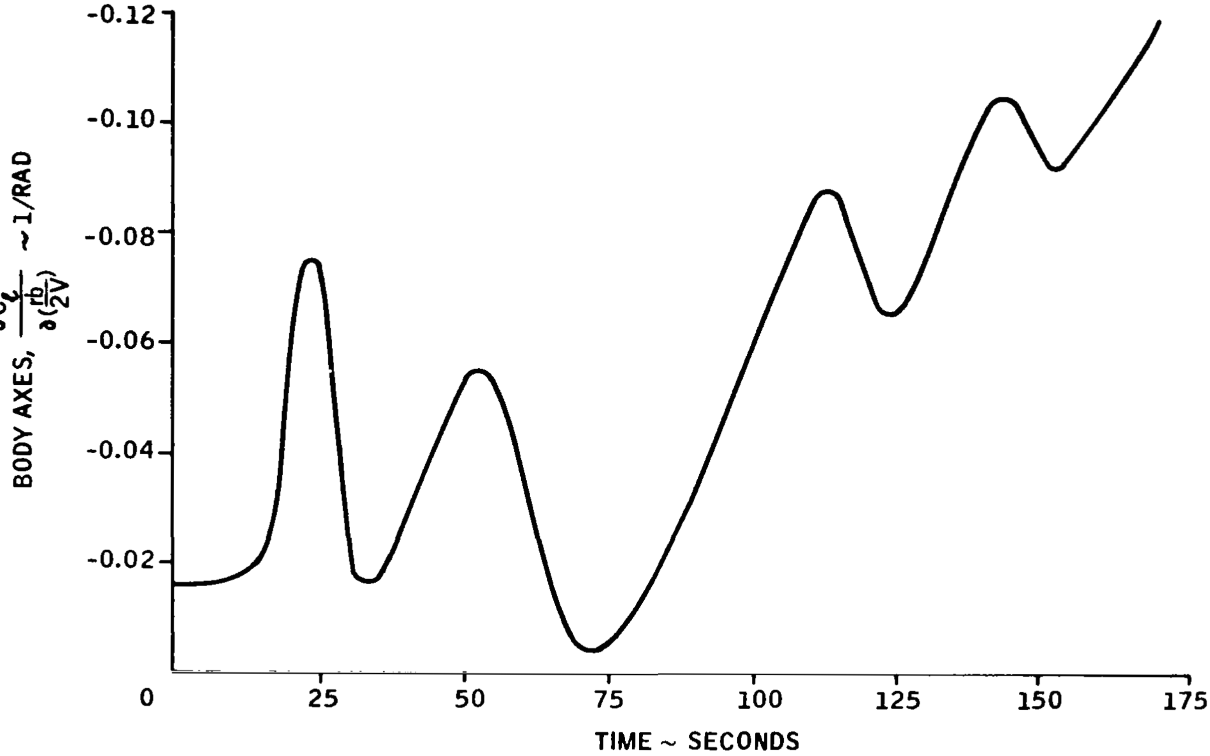


Figure D5. C_{ℓ_r}

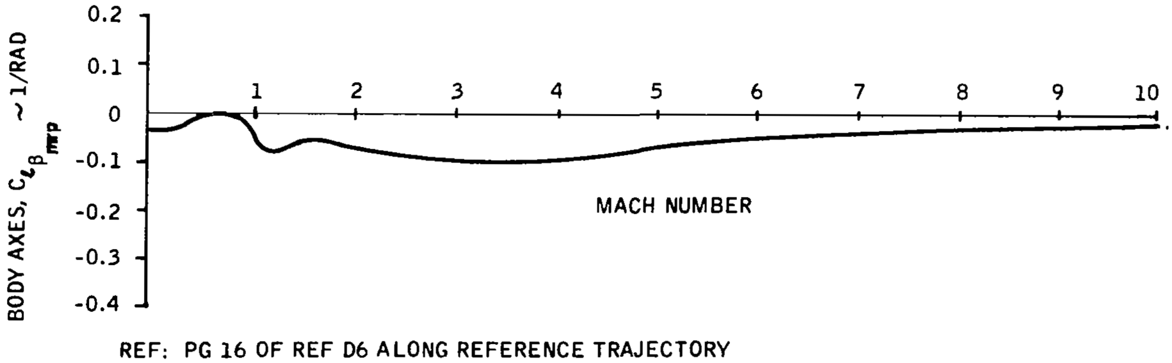


Figure D6. C_{ℓ_β}

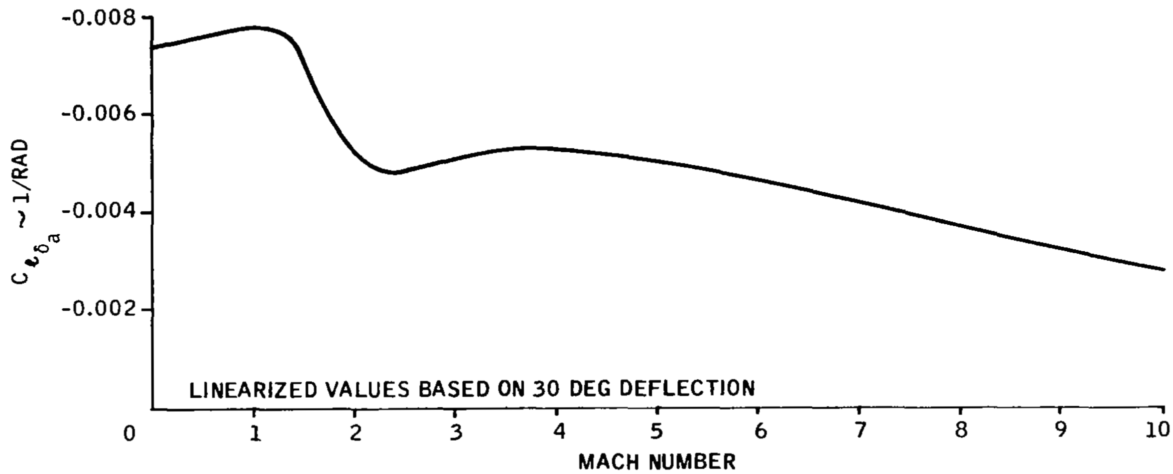


Figure D7. $C_{\ell_{\delta_a}}$

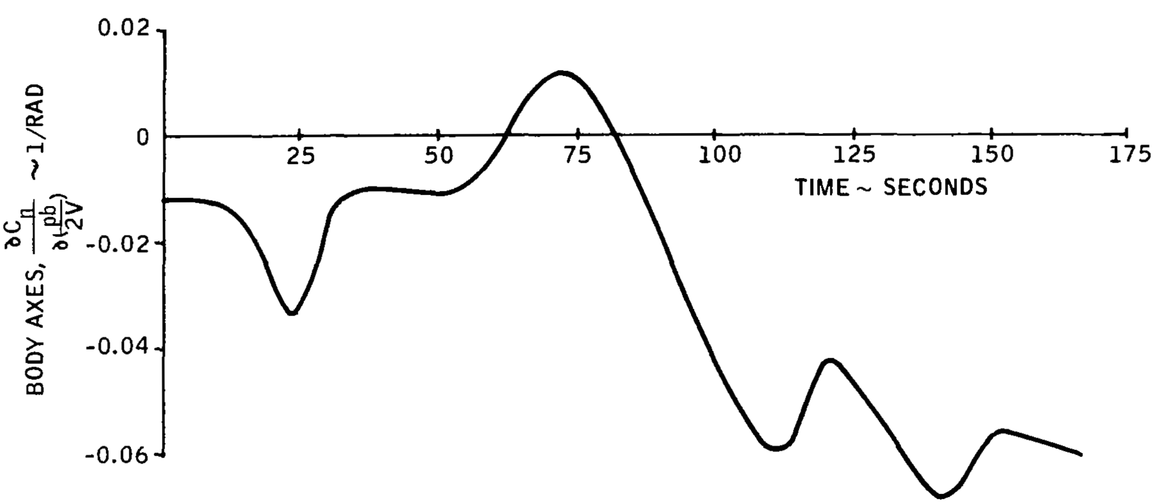


Figure D8. C_{n_p}

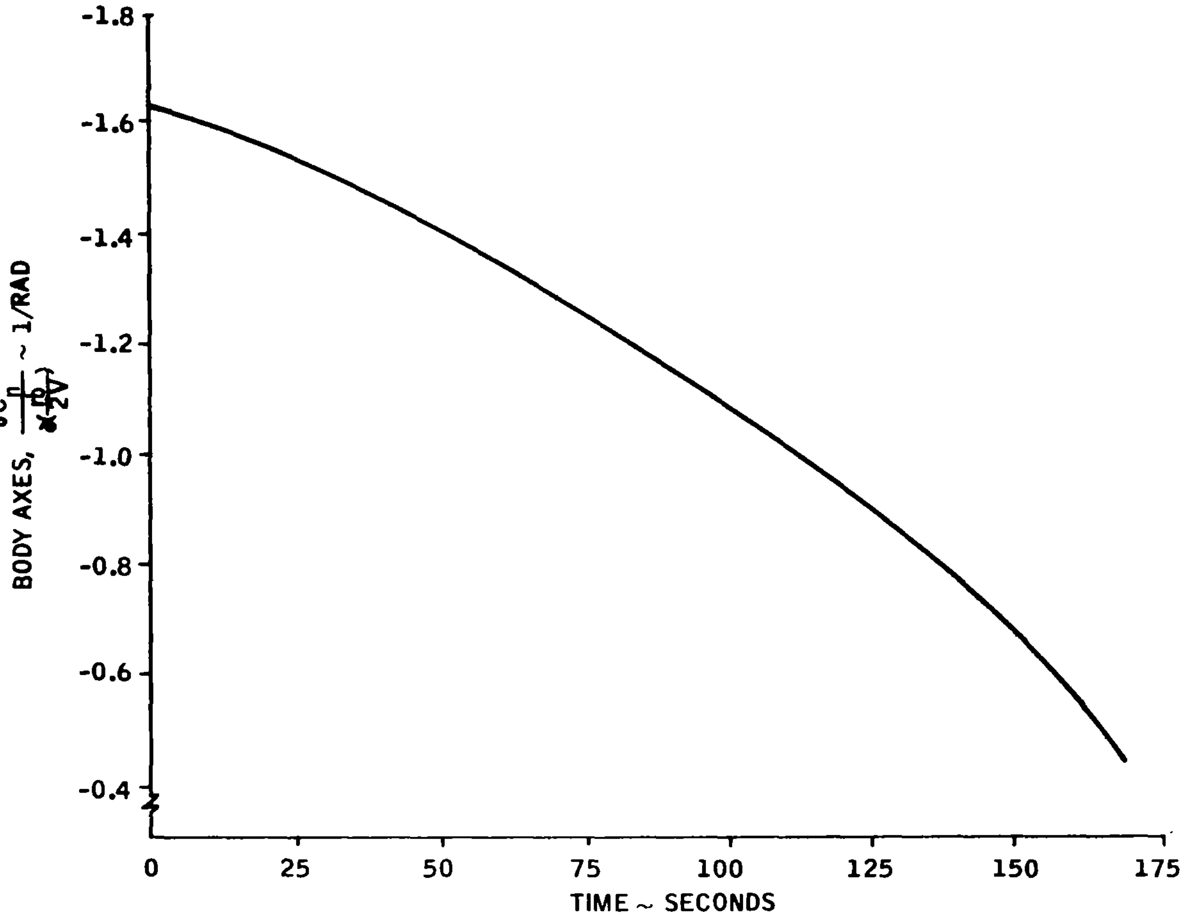


Figure D9. C_{n_r}

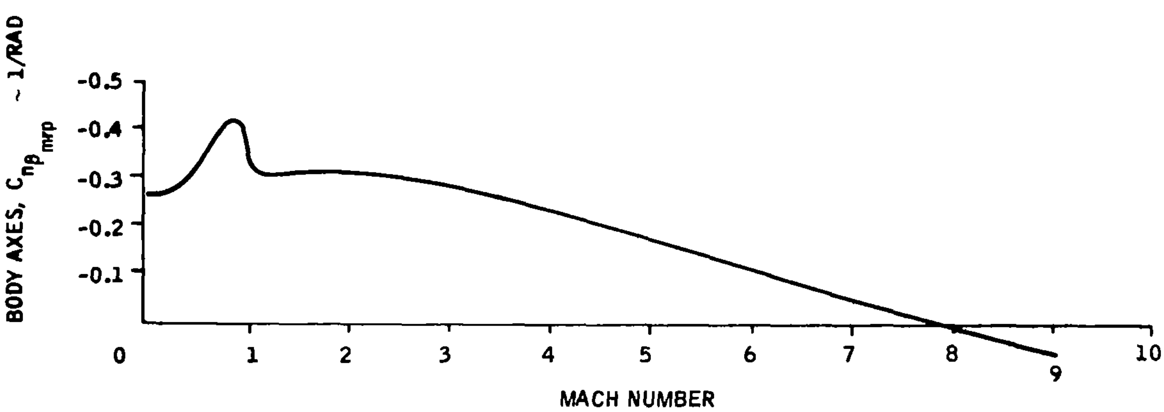


Figure D10. C_{n_β}

Table D2. Response Equations

	=	p	r	v	ϕ	x	y	x_1	x_2	x_3	x_4	$\tilde{v}$	x	p_g	δ_p	δ_r	δ_a		+	u_1	u_2	u_3	$\bar{v}$	
δ_p		0	0	0	0	0	0	0	0	0	0	0	0	0	$h_{1,14}$	0	0			0	0	0	0	
$\dot{\delta}_p$		0	0	0	0	0	0	0	0	0	0	0	0	0	$h_{2,14}$	0	0	p		d_{21}	0	0	0	
δ_r		0	0	0	0	0	0	0	0	0	0	0	0	0	0	$h_{3,15}$	0	r		0	0	0	0	
$\dot{\delta}_r$		0	0	0	0	0	0	0	0	0	0	0	0	0	0	$h_{4,15}$	0	v		0	d_{42}	0	0	
δ_a		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$h_{5,16}$	ϕ		0	0	0	0	
$\dot{\delta}_a$		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$h_{6,16}$	x		0	0	d_{63}	0	
M_1		0	0	h_{73}	0	0	0	h_{77}	0	0	0	0	0	0	0	$h_{7,15}$	0	y		0	0	0	0	
$\dot{M}_1$		0	0	h_{83}	h_{84}	h_{85}	0	h_{87}	h_{88}	h_{89}	0	$h_{8,11}$	0	0	$h_{8,14}$	$h_{8,15}$	$h_{8,16}$	x_1		0	d_{82}	0	d_{84}	u_1
M_2		0	0	h_{93}	0	0	0	h_{97}	0	0	0	0	0	0	0	$h_{9,15}$	0	x_2		0	0	0	0	u_2
$\dot{M}_2$		0	0	$h_{10,3}$	$h_{10,4}$	$h_{10,5}$	0	$h_{10,7}$	$h_{10,8}$	$h_{10,9}$	0	$h_{10,11}$	0	0	$h_{10,14}$	$h_{10,15}$	$h_{10,16}$	x_3		0	$d_{10,2}$	0	$d_{10,4}$	u_3
a_y		$h_{11,1}$	$h_{11,2}$	$h_{11,3}$	0	0	0	$h_{11,7}$	$h_{11,8}$	$h_{11,9}$	$h_{11,10}$	0	0	0	$h_{11,14}$	$h_{11,15}$	$h_{11,16}$	x_4		0	0	0	0	$\bar{v}$
$\dot{a}_y$		$h_{12,1}$	$h_{12,2}$	$h_{12,3}$	$h_{12,4}$	$h_{12,5}$	0	$h_{12,7}$	$h_{12,8}$	$h_{12,9}$	$h_{12,10}$	$h_{12,11}$	0	$h_{12,13}$	$h_{12,14}$	$h_{12,15}$	$h_{12,16}$	$\tilde{v}$		$d_{12,1}$	$d_{12,2}$	$d_{12,3}$	$d_{12,4}$	
$\bar{q}\beta$		0	0	$h_{13,3}$	0	0	0	$h_{13,7}$	$h_{13,8}$	$h_{13,9}$	0	0	0	0	0	0	0	x		0	0	0	0	
$\bar{q}\dot{\beta}$		0	0	$h_{14,3}$	$h_{14,4}$	$h_{14,5}$	0	$h_{14,7}$	$h_{14,8}$	$h_{14,9}$	0	$h_{14,11}$	0	0	$h_{14,14}$	$h_{14,15}$	$h_{14,16}$	p_g		0	0	0	$d_{14,4}$	
ϕ		0	0	0	$h_{15,4}$	0	0	0	0	0	0	0	0	0	0	0	0	δ_p		0	0	0	0	
$\dot{\phi}$		$h_{16,1}$	0	0	0	$h_{16,5}$	0	0	0	0	0	0	0	0	0	0	0	δ_r			0	0	0	0
y		0	0	0	0	0	$h_{17,6}$	0	0	0	0	0	0	0	0	0	0	δ_a		0	0	0	0	
$\dot{y}$		0	0	$h_{18,3}$	$h_{18,4}$	$h_{18,5}$	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0	

Table D3. Numerical A Matrix

a_{11}	a_{12}	a_{13}	a_{17}	a_{18}	a_{19}
-.10942510E-03	-.23103390E-01	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
-.84797199E-01	-.13202627E 00	-.60147640E-03	-.11422768E-01	.67358367E-02	.40854553E-02
-.17467967E 00	-.24283685E 00	-.11789453E-02	-.17422992E-01	.10112008E-01	.61320388E-02
-.26357672E 00	-.29307379E 00	-.16607447E-02	-.22870958E-01	.13203788E-01	.80064249E-02
-.34842418E 00	-.50625468E 00	-.21540495E-02	-.25261668E-01	.14385855E-01	.87217632E-02
-.42706874E 00	-.64655902E 00	-.24155099E-02	-.23660017E-01	.13227087E-01	.80174207E-02
-.48883976E 00	-.58805965E 00	-.25440727E-02	-.12708472E-01	.63320766E-02	.38323227E-02
-.54334984E 00	-.60148619E 00	-.25251617E-02	.12023875E-01	-.90475717E-02	-.55014647E-02
-.58485227E 00	-.65906769E 00	-.27177593E-02	.46010607E-01	-.30317462E-01	-.18410905E-01
-.62068003E 00	-.70244405E 00	-.33133073E-02	.49242667E-01	-.32697905E-01	-.19858070E-01
-.61304345E 00	-.71604642E 00	-.56083615E-02	-.47401886E-01	.26023372E-01	.15770152E-01
-.57349562E 00	-.66593643E 00	-.59842818E-02	-.58511386E-01	.32704040E-01	.19823065E-01
-.50304859E 00	-.56460461E 00	-.51971390E-02	-.46806461E-01	.25907674E-01	.15701648E-01
-.41562944E 00	-.43491984E 00	-.43586164E-02	-.35654633E-01	.19487352E-01	.11808665E-01
-.32402157E 00	-.33837082E 00	-.37740315E-02	-.26300027E-01	.14028100E-01	.84978949E-02
-.25068073E 00	-.27348222E 00	-.33438407E-02	-.18499904E-01	.94405488E-02	.57155145E-02
-.18985170E 00	-.21712020E 00	-.27694113E-02	-.12344139E-01	.59656978E-02	.36090297E-02
-.14076694E 00	-.17237086E 00	-.21609383E-02	-.79593189E-02	.36140343E-02	.21843462E-02
-.10396201E 00	-.13486889E 00	-.16797116E-02	-.51905344E-02	.21892000E-02	.13216227E-02
-.76004863E-01	-.11126729E 00	-.13229625E-02	-.33558861E-02	.12685530E-02	.76437058E-03
-.53880166E-01	-.89458464E-01	-.99557663E-03	-.24495412E-02	.90740810E-03	.54655646E-03
-.39315363E-01	-.71920031E-01	-.73548752E-03	-.17132532E-02	.61038705E-03	.36737859E-03
-.29271441E-01	-.55534495E-01	-.52992214E-03	-.12179963E-02	.42957416E-03	.25850002E-03
-.21195606E-01	-.40699454E-01	-.36324813E-03	-.98333411E-03	.38683186E-03	.23325411E-03
-.14536144E-01	-.24744501E-01	-.24280646E-03	-.70937814E-03	.29098505E-03	.17558663E-03
-.10221221E-01	-.16022124E-01	-.16012421E-03	-.50721867E-03	.21641797E-03	.13067648E-03
-.77182732E-02	-.12655222E-01	-.10443928E-03	-.37046496E-03	.16582311E-03	.10020256E-03
-.60342651E-02	-.10278249E-01	-.66928229E-04	-.26211499E-03	.12164160E-03	.73545165E-04
-.48050249E-02	-.75199463E-02	-.45038493E-04	-.23019704E-03	.11534412E-03	.69814424E-04
-.36394110E-02	-.49970559E-02	-.32868993E-04	-.17532533E-03	.88738252E-04	.53718087E-04
-.26120359E-02	-.28322929E-02	-.23460767E-04	-.14376917E-03	.74938820E-04	.45377584E-04
-.19575419E-02	-.15323952E-02	-.16930664E-04	-.11089256E-03	.58518003E-04	.35443891E-04
-.15042244E-02	-.96147946E-03	-.12251234E-04	-.71793104E-04	.37085695E-04	.22456174E-04
-.11771541E-02	-.84241776E-03	-.90129355E-05	-.45702614E-04	.22856234E-04	.13833844E-04
-.90427398E-03	-.11033880E-02	-.67809549E-05	-.14039601E-04	.45359687E-05	.27240778E-05

Table D3. Numerical A Matrix (Continued)

$a_{1,10}$	$a_{1,14}$	$a_{1,15}$	$a_{1,16}$	a_{21}	a_{22}
.00000000E-80	-.19683964E 01	-.25265932E 01	.00000000E-80	.75973300E-03	-.14729223E-01
-.84765201E-01	-.19626653E 01	-.24996596E 01	-.57693019E-02	-.11100319E-01	-.82781440E-01
-.17464716E 00	-.19619672E 01	-.25052905F 01	-.24309152E-01	-.22988113E-01	-.15483587E 00
-.26271923E 00	-.19653690E 01	-.27717514E 01	-.55871643E-01	-.28882698E-01	-.18411121E 00
-.34659130E 00	-.19697455E 01	-.31920086E 01	-.10044592E 00	-.33904297E-01	-.29647991E 00
-.42515685E 00	-.19817460E 01	-.33253047E 01	-.15726558E 00	-.44428201E-01	-.36452587E 00
-.48701363E 00	-.20005881E 01	-.29349958E 01	-.22560590E 00	-.49467760E-01	-.40006449E 00
-.54166655E 00	-.20253458E 01	-.21396348E 01	-.30271526E 00	-.55233706E-01	-.43607648E 00
-.58325414E 00	-.20478589E 01	-.20348206E 01	-.38394533E 00	-.59753869E-01	-.46991821E 00
-.61907043E 00	-.20700874E 01	-.21659771E 01	-.44814062E 00	-.63108432E-01	-.48889659E 00
-.61146692E 00	-.20922415E 01	-.22795988E 01	-.48625266E 00	-.61249848E-01	-.48645766E 00
-.57195325E 00	-.21150633E 01	-.22480222E 01	-.48668913E 00	-.55378750E-01	-.46419688E 00
-.50155678E 00	-.21416459E 01	-.18044276E 01	-.46111225E 00	-.45192536E-01	-.42702998E 00
-.41420578E 00	-.21635550E 01	-.14677959E 01	-.38486098E 00	-.32661569E-01	-.37938299E 00
-.32267603E 00	-.21818280E 01	-.13757273E 01	-.29890895E 00	-.21247652E-01	-.32785610E 00
-.24943691E 00	-.21982849E 01	-.12577333E 01	-.25068473E 00	-.13588241E-01	-.27599026E 00
-.18871002E 00	-.22130387E 01	-.15036421E 01	-.21139672E 00	-.87882600E-02	-.21855412E 00
-.13972935E 00	-.22265331E 01	-.12917047F 01	-.18311225E 00	-.55445010E-02	-.17119926E 00
-.10279651E 00	-.22417879E 01	-.13213841E 01	-.16138103E 00	-.34356434E-02	-.13258572E 00
-.75162259E-01	-.22512500E 01	-.13958814E 01	-.13990685E 00	-.15893629E-02	-.10392252E 00
-.53125124E-01	-.22677807E 01	-.15712193E 01	-.11976772E 00	.18126116E-02	-.80712604E-01
-.38639610E-01	-.22879168E 01	-.16745998E 01	-.10127779E 00	.26924450E-02	-.62852102E-01
-.28668594E-01	-.23172269E 01	-.18577491E 01	-.83267372E-01	.11558793E-02	-.48256349E-01
-.20626093E-01	-.23038495E 01	-.20231502E 01	-.68010917E-01	.17462773E-02	-.37105313E-01
-.13905402E-01	-.21057217E 01	-.12315931E 01	-.54535841E-01	.23421193E-02	-.27364172E-01
-.96356718E-02	-.20335281E 01	-.12167244E 01	-.43051574E-01	.25319551E-02	-.19991631E-01
-.72907240E-02	-.19616808E 01	-.12025329E 01	-.33965933E-01	.26475981E-02	-.14527324E-01
-.57197917E-02	-.18996742E 01	-.11878371E 01	-.26907511E-01	.26552345E-02	-.10019202E-01
-.45290603E-02	-.18440206E 01	-.11452599E 01	-.21459103E-01	.24974698E-02	-.62609594E-02
-.33930459E-02	-.17951205E 01	-.11423335E 01	-.17434724E-01	.23489148E-02	-.31341476E-02
-.24094743E-02	-.16687406E 01	-.93841336E 00	-.14125172E-01	.22859024E-02	-.14838542E-03
-.18007189E-02	-.16347961E 01	-.97436328E 00	-.11257102E-01	.21741123E-02	.27863374E-02
-.13932889E-02	-.16057608E 01	-.99293832E 00	-.90472173E-02	.19943060E-02	.54167764E-02
-.11196388E-02	-.15772250E 01	-.10027016E 01	-.70828017E-02	.17781070E-02	.81362731E-02
-.90427390E-03	-.15643828E 01	-.10158330E 01	-.56956807E-02	.16485781E-02	.11474533E-01

Table D3. Numerical A Matrix (Continued)

a_{23}	a_{27}	a_{28}	a_{29}	$a_{2,10}$	$a_{2,14}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	-.25423881E 00
-.41997086E-05	-.67114124E-02	.41740256E-02	.25331871E-02	-.11324986E-01	-.25149999E 00
-.38850537E-04	-.10210139E-01	.63298698E-02	.38414187E-02	-.23219079E-01	-.24916353E 00
-.59858085E-04	-.13623668E-01	.84411494E-02	.51226610E-02	-.35048567E-01	-.24679823E 00
-.10283322E-03	-.15072639E-01	.93162362E-02	.56535697E-02	-.47228166E-01	-.24204392E 00
-.14371238E-03	-.14015546E-01	.86330547E-02	.52387785E-02	-.58534652E-01	-.23982172E 00
-.24666648E-03	-.61464034E-02	.36721479E-02	.22275890E-02	-.63133931E-01	-.24012402E 00
-.45963645E-03	.12523016E-01	-.80781379E-02	-.49045142E-02	-.68004701E-01	-.24280016E 00
-.80612143E-03	.39964200E-01	-.25369988E-01	-.15400334E-01	-.72053872E-01	-.24210591E 00
-.93496892E-03	.44812876E-01	-.28467253E-01	-.17280592E-01	-.75673901E-01	-.23999825E 00
-.28443013E-03	-.31449545E-01	.19395329E-01	.11769787E-01	-.73739526E-01	-.23739161E 00
-.19108445E-03	-.41603814E-01	.25772354E-01	.15640375E-01	-.67782557E-01	-.23552534E 00
-.18089770E-03	-.33797191E-01	.20920471E-01	.12695822E-01	-.57364262E-01	-.23801997E 00
-.16898221E-03	-.26015414E-01	.16085121E-01	.97613114E-02	-.44468250E-01	-.23742243E 00
-.18102876E-03	-.18927064E-01	.11666452E-01	.70795832E-02	-.32528363E-01	-.23476486E 00
-.20448460E-03	-.12545080E-01	.76802962E-02	.46682988E-02	-.24229705E-01	-.23160994E 00
-.19679148E-03	-.76444104E-02	.46352924E-02	.28123265E-02	-.18714058E-01	-.22775411E 00
-.16848635E-03	-.43481925E-02	.26015403E-02	.15781658E-02	-.14714841E-01	-.22318431E 00
-.13968163E-03	-.23528722E-02	.13776689E-02	.83552162E-03	-.11580994E-01	-.21784771E 00
-.11712138E-03	-.10266636E-02	.56632747E-03	.34321472E-03	-.92852671E-02	-.20972754E 00
-.86327407E-04	-.70101156E-03	.38275238E-03	.23193177E-03	-.52019303E-02	-.20189908E 00
-.63175199E-04	-.40297095E-03	.21162455E-03	.12817120E-03	-.36917783E-02	-.19343872E 00
-.44131147E-04	-.27567116E-03	.14420576E-03	.87334251E-04	-.46416276E-02	-.18492475E 00
-.25849234E-04	-.43252157E-03	.25314625E-03	.15352609E-03	-.34669721E-02	-.17138115E 00
-.14951956E-04	-.39744065E-03	.23806810E-03	.14442059E-03	-.21781137E-02	-.15577690E 00
-.79423660E-05	-.35662361E-03	.21701097E-03	.13167028E-03	-.15328340E-02	-.13829418E 00
-.32992622E-05	-.33662632E-03	.20744376E-03	.12588330E-03	-.12412399E-02	-.12078591E 00
-.65558571E-06	-.29744263E-03	.18469742E-03	.11208962E-03	-.10497453E-02	-.10252497E 00
.21582122E-05	-.37059771E-03	.23196687E-03	.14078905E-03	-.88645986E-03	-.83579935E-01
.27528356E-05	-.33904136E-03	.21269731E-03	.12909688E-03	-.71916035E-03	-.64254322E-01
.38671050E-05	-.36545943E-03	.22982828E-03	.13949826E-03	-.52219258E-03	-.40631027E-01
.45493548E-05	-.37814558E-03	.23814590E-03	.14454904E-03	-.38660161E-03	-.20583926E-01
.43477798E-05	-.33867745E-03	.21345928E-03	.12956596E-03	-.32510318E-03	.26011626E-02
.52082566E-05	-.38350299E-03	.24188824E-03	.14682300E-03	-.27790604E-03	.30597871E-01
.53948141E-05	-.38549185E-03	.24324156E-03	.14764510E-03	-.23643949E-03	.64277311E-01

Table D3. Numerical A Matrix (Continued)

$a_{2,15}$	$a_{2,16}$	a_{31}	a_{32}	a_{33}	a_{34}
-.15233870E 01	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.29745009E 00
-.15446290E 01	-.18685709E-02	-.76746020E 00	-.80684922E 02	-.96086507E-02	.40746484E 00
-.15887353E 01	-.79811333E-02	-.13915154E 01	-.16623594E 03	-.18315955E-01	.32865352E 00
-.17314486E 01	-.18564862E-01	-.41868660E 01	-.25653954E 03	-.27849760E-01	.99731371E 00
-.19015786E 01	-.33775838E-01	-.11036427E 02	-.35215310E 03	-.37198029E-01	.33494532E 01
-.19959582E 01	-.53623667E-01	-.15251974E 02	-.45530562E 03	-.45847915E-01	.58380564E 01
-.18631020E 01	-.77767144E-01	-.92062779E 01	-.56786391E 03	-.53032128E-01	.77095716E 01
-.15549365E 01	-.10552477E 00	-.27827076E 01	-.69080640E 03	-.55038938E-01	.95995430E 01
-.15336096E 01	-.13503347E 00	-.46389543E 01	-.82499496E 03	-.50567205E-01	.11721487E 02
-.15954602E 01	-.15321173E 00	-.13897009E 02	-.96666171E 03	-.56118613E-01	.14010692E 02
-.16767950E 01	-.15759971E 00	-.24730495E 02	-.11075996E 04	-.94745824E-01	.16208472E 02
-.17035732E 01	-.14183503E 00	-.25162093E 02	-.12497550E 04	-.10080074E 00	.18030510E 02
-.15783547E 01	-.11641581E 00	-.12841343E 02	-.14001131E 04	-.95538817E-01	.19530135E 02
-.14146521E 01	-.81246874E-01	.11371274E 01	-.15639041E 04	-.87996684E-01	.20955005E 02
-.13806915E 01	-.46658681E-01	.60933596E 01	-.17484512E 04	-.78057182E-01	.22423230E 02
-.13170035E 01	-.38491173E-01	.34489159E 01	-.19573850E 04	-.65704681E-01	.23835464E 02
-.13844000E 01	-.31113299E-01	-.48100478E 01	-.21933307E 04	-.51605602E-01	.25123964E 02
-.13812148E 01	-.25628850E-01	-.18111662E 02	-.24569701E 04	-.39581759E-01	.26265445E 02
-.14037517E 01	-.21882939E-01	-.36532754E 02	-.27481702E 04	-.30409756E-01	.27258657E 02
-.14875102E 01	-.18667354E-01	-.63213889E 02	-.30654922E 04	-.23270669E-01	.28127083E 02
-.15590079E 01	-.15756891E-01	-.10736062E 03	-.34078824E 04	-.17776720E-01	.28912521E 02
-.16290037E 01	-.13134042E-01	-.18550220E 03	-.37734651E 04	-.13569252E-01	.29657510E 02
-.17158548E 01	-.10701826E-01	-.27808652E 03	-.41621461E 04	-.10199461E-01	.30273255E 02
-.18079024E 01	-.86534747E-02	-.32136733E 03	-.45767503E 04	-.77797505E-02	.30640710E 02
-.13644883E 01	-.68859673E-02	-.30098431E 03	-.50050241E 04	-.59154731E-02	.30824966E 02
-.13482162E 01	-.54101339E-02	-.30869462E 03	-.54351613E 04	-.44969235E-02	.31034878E 02
-.13370298E 01	-.42476135E-02	-.40418164E 03	-.58638536E 04	-.34662220E-02	.31327426E 02
-.13303479E 01	-.33477103E-02	-.55778480E 03	-.62905771E 04	-.26715745E-02	.31611503E 02
-.12535278E 01	-.26548591E-02	-.71652192E 03	-.67180850E 04	-.21196550E-02	.31821554E 02
-.12175341E 01	-.21428855E-02	-.80975329E 03	-.71546522E 04	-.17158169E-02	.31935249E 02
-.12140470E 01	-.17355795E-02	-.82448774E 03	-.76028802E 04	-.13986735E-02	.31986307E 02
-.12731309E 01	-.13984528E-02	-.92063053E 03	-.80449632E 04	-.11404598E-02	.32057692E 02
-.12992987E 01	-.11319331E-02	-.11730395E 04	-.84686942E 04	-.93026218E-03	.32139373E 02
-.12836415E 01	-.91452961E-03	-.14669728E 04	-.88846937E 04	-.75843583E-03	.32169910E 02
-.13280436E 01	-.74462166E-03	-.16519861E 04	-.93023877E 04	-.62307968E-03	.32161031E 02

Table D3. Numerical A Matrix (Continued)

a_{35}	a_{37}	a_{38}	a_{39}	$a_{13,13}$	$a_{3,15}$
.32168625E 02	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.40148159E 02
.32167419E 02	-.10583982E-01	.72227739E-03	.25305371E-03	-.39607877E 00	.40990228E 02
.32168321E 02	-.20175125E-01	.13768010E-02	.48236954E-03	-.81603664E 00	.42465534E 02
.32154537E 02	-.30676664E-01	.20934523E-02	.73345212E-03	-.12594521E 01	.45644448E 02
.31995157E 02	-.40973834E-01	.27961570E-02	.97964842E-03	-.17294747E 01	.51201458E 02
.31635834E 02	-.50501730E-01	.34463645E-02	.12074521E-02	-.22362280E 01	.54457040E 02
.31232538E 02	-.58415181E-01	.39863982E-02	.13966557E-02	-.27878594E 01	.54043553E 02
.30704359E 02	-.60625693E-01	.41372490E-02	.14495071E-02	-.33910126E 01	.46631747E 02
.29958565E 02	-.55700054E-01	.38011111E-02	.13317394E-02	-.40497451E 01	.45921042E 02
.28958754E 02	-.61814961E-01	.42144076E-02	.14779415E-02	-.47455759E 01	.48258715E 02
.27788385E 02	-.10436305E 00	.71219954E-02	.24952289E-02	-.54382675E 01	.52010795E 02
.26642253E 02	-.11103256E 00	.75771401E-02	.26546912E-02	-.61359587E 01	.53931039E 02
.25563308E 02	-.10523653E 00	.71816043E-02	.25161131E-02	-.68730724E 01	.48900031E 02
.24408946E 02	-.96928832E-01	.66146661E-02	.23174833E-02	-.76767918E 01	.46292559E 02
.23067459E 02	-.85980416E-01	.58675187E-02	.20557163E-02	-.85827345E 01	.47142855E 02
.21605082E 02	-.72374067E-01	.49389875E-02	.17384004E-02	-.96082978E 01	.47956813E 02
.20092170E 02	-.56843854E-01	.38791669E-02	.13590867E-02	-.10766504E 02	.49536024E 02
.18575126E 02	-.43599525E-01	.29753407E-02	.10424264E-02	-.12060941E 02	.51143030E 02
.17084335E 02	-.33496514E-01	.22858859E-02	.80087226E-03	-.13491229E 02	.53648318E 02
.15613332E 02	-.25632770E-01	.17492443E-02	.61285703E-03	-.15050886E 02	.56272334E 02
.14105852E 02	-.19581155E-01	.13362670E-02	.46816823E-03	-.16736689E 02	.59957166E 02
.12463587E 02	-.14946606E-01	.10199938E-02	.35736022E-03	-.18545306E 02	.63847710E 02
.10882966E 02	-.11234763E-01	.76668832E-03	.26861332E-03	-.20476421E 02	.68101825E 02
.98008068E 01	-.85694380E-02	.58479989E-03	.20488774E-03	-.22521368E 02	.72166837E 02
.92049092E 01	-.65159261E-02	.44466310E-03	.15579008E-03	-.24612718E 02	.66069507E 02
.84702581E 01	-.49533860E-02	.33803145E-03	.11843111E-03	-.26722760E 02	.65789892E 02
.73144587E 01	-.38180626E-02	.26055415E-03	.91286527E-04	-.28852395E 02	.65578337E 02
.59683990E 01	-.29427540E-02	.20082090E-03	.70358667E-04	-.30999924E 02	.65395592E 02
.47220328E 01	-.23348117E-02	.15933339E-03	.55823299E-04	-.33164330E 02	.65266450E 02
.38792782E 01	-.18899817E-02	.12897708E-03	.45187804E-04	-.35344506E 02	.65176257E 02
.34329386E 01	-.15406465E-02	.10513757E-03	.36835507E-04	-.37539325E 02	.45668318E 02
.26857579E 01	-.12562228E-02	.85727787E-04	.30035185E-04	-.39748321E 02	.51445802E 02
.14034307E 01	-.10246889E-02	.69927335E-04	.24499413E-04	-.41967469E 02	.57219103E 02
.76009597E-01	-.83542124E-03	.57011236E-04	.19974189E-04	-.44203089E 02	.62993996E 02
.75960143E 00	-.68632570E-03	.46836583E-04	.16409445E-04	-.46377403E 02	.68768965E 02

Table D3. Numerical A Matrix (Continued)

a_{45}	a_{54}	a_{64}	a_{65}	a_{77}	$a_{7,11}$
.82997700E-03	-.82997700E-03	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
.24574100E-03	-.24574100E-03	.76746020E 00	.80684922E 02	-.81218256E 00	.81218256E 00
.25294600E-03	-.25294600E-03	.13915154E 01	.16623594E 03	-.16733306E 01	.16733306E 01
.67615700E-02	-.67615700E-02	.41868660E 01	.25653954E 03	-.25825799E 01	.25825799E 01
.14663200E-01	-.14663200E-01	.11036427E 02	.35215310E 03	-.35463886E 01	.35463886E 01
.15512100E-01	-.15512100E-01	.15251974E 02	.45530562E 03	-.45855156E 01	.45855156E 01
.15049300E-01	-.15049300E-01	.92062779E 01	.56786391E 03	-.57166679E 01	.57166679E 01
.14085700E-01	-.14085700E-01	.27827076E 01	.69080640E 03	-.69534687E 01	.69534687E 01
.13588500E-01	-.13588500E-01	.46389543E 01	.82499496E 03	-.83042381E 01	.83042381E 01
.13906700E-01	-.13906700E-01	.13897009E 02	.96666171E 03	-.97310796E 01	.97310796E 01
.13849100E-01	-.13849100E-01	.24730495E 02	.11075996E 04	-.11151484E 02	.11151484E 02
.13781900E-01	-.13781900E-01	.25162093E 02	.12497550E 04	-.12582140E 02	.12582140E 02
.13555000E-01	-.13555000E-01	.12841343E 02	.14081131E 04	-.14093635E 02	.14093635E 02
.13178800E-01	-.13178800E-01	-.11371274E 01	.15639041E 04	-.15741708E 02	.15741708E 02
.12631100E-01	-.12631100E-01	-.60933596E 01	.17484512E 04	-.17599397E 02	.17599397E 02
.11943900E-01	-.11943900E-01	-.34489159E 01	.19573850E 04	-.19702374E 02	.19702374E 02
.11175800E-01	-.11175800E-01	.48100478E 01	.21933307E 04	-.22077343E 02	.22077343E 02
.10361100E-01	-.10361100E-01	.18111662E 02	.24569701E 04	-.24731662E 02	.24731662E 02
.95498200E-02	-.95498200E-02	.36532754E 02	.27481702E 04	-.27664551E 02	.27664551E 02
.87675400E-02	-.87675400E-02	.63213889E 02	.30654922E 04	-.30862718E 02	.30862718E 02
.80305900E-02	-.80305900E-02	.10736062E 03	.34078824E 04	-.34319554E 02	.34319554E 02
.73503900E-02	-.73503900E-02	.18550220E 03	.37734651E 04	-.38028230E 02	.38028230E 02
.67176700E-02	-.67176700E-02	.27808652E 03	.41621461E 04	-.41988092E 02	.41988092E 02
.61468600E-02	-.61468600E-02	.32136733E 03	.45767503E 04	-.46181375E 02	.46181375E 02
.56389600E-02	-.56389600E-02	.30098431E 03	.50050241E 04	-.50469811E 02	.50469811E 02
.51987100E-02	-.51987100E-02	.30869462E 03	.54351613E 04	-.54796574E 02	.54796574E 02
.48031800E-02	-.48031800E-02	.40418164E 03	.58638536E 04	-.59163516E 02	.59163516E 02
.44587100E-02	-.44587100E-02	.55778480E 03	.62985771E 04	-.63567148E 02	.63567148E 02
.41397700E-02	-.41397700E-02	.71652192E 03	.67180850E 04	-.68005388E 02	.68005388E 02
.38598600E-02	-.38598600E-02	.80973329E 03	.71546522E 04	-.72475966E 02	.72475966E 02
.36028100E-02	-.36028100E-02	.82448774E 03	.76028802E 04	-.76976571E 02	.76976571E 02
.33621700E-02	-.33621700E-02	.92063053E 03	.80449632E 04	-.81506245E 02	.81506245E 02
.31502000E-02	-.31502000E-02	.11730395E 04	.84686942E 04	-.86056739E 02	.86056739E 02
.28946400E-02	-.28946400E-02	.14669728E 04	.88846937E 04	-.90641007E 02	.90641007E 02
.27913700E-02	-.27913700E-02	.16519861E 04	.93023877E 04	-.95099565E 02	.95099565E 02

Table D3. Numerical A Matrix (Continued)

a_{88}	a_{89}	$a_{8,11}$	$a_{9,8}$	a_{99}	$a_{9,11}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
-.34005731E 01	-.18538950E 01	.52544681E 01	.62749931E 01	.17762080E 01	-.80512011E 01
-.70061626E 01	-.38195590E 01	.10825722E 02	.12928298E 02	.36595013E 01	-.16587799E 02
-.10813150E 02	-.58950194E 01	.16708169E 02	.19953237E 02	.56479900E 01	-.25601227E 02
-.14848575E 02	-.80950175E 01	.22943592E 02	.27399707E 02	.77557977E 01	-.35155505E 02
-.19199355E 02	-.10466938E 02	.29666292E 02	.35428093E 02	.10028323E 02	-.45456416E 02
-.23935440E 02	-.13048916E 02	.36984356E 02	.44167473E 02	.12502104E 02	-.56669578E 02
-.29113871E 02	-.15872048E 02	.44985919E 02	.53723104E 02	.15206934E 02	-.68930038E 02
-.34769484E 02	-.18955326E 02	.53724810E 02	.64159265E 02	.18161008E 02	-.82320273E 02
-.40743607E 02	-.22212247E 02	.62959854E 02	.75183167E 02	.21281448E 02	-.96464615E 02
-.46690779E 02	-.25454475E 02	.72145253E 02	.86157336E 02	.24387811E 02	-.11054515E 03
-.52680875E 02	-.28720103E 02	.81400978E 02	.97210711E 02	.27516594E 02	-.12472731E 03
-.59009437E 02	-.32170254E 02	.91179691E 02	.10888865E 03	.30822167E 02	-.13971082E 03
-.65909848E 02	-.35932160E 02	.10184201E 03	.12162181E 03	.34426432E 02	-.15604824E 03
-.73687909E 02	-.40172536E 02	.11386044E 03	.13597447E 03	.38489115E 02	-.17446358E 03
-.82492982E 02	-.44972810E 02	.12746579E 03	.15222225E 03	.43088235E 02	-.19531049E 03
-.92436874E 02	-.50393934E 02	.14283081E 03	.17057147E 03	.48282189E 02	-.21885366E 03
-.10355040E 03	-.56452708E 02	.16000310E 03	.19107897E 03	.54087070E 02	-.24516605E 03
-.11583027E 03	-.63147345E 02	.17897762E 03	.21373873E 03	.60501170E 02	-.27423990E 03
-.12922086E 03	-.70447508E 02	.19966836E 03	.23844804E 03	.67495422E 02	-.30594346E 03
-.14369448E 03	-.78338113E 02	.22203259E 03	.26515586E 03	.75055373E 02	-.34021123E 03
-.15922255E 03	-.86803569E 02	.24602612E 03	.29380941E 03	.83166086E 02	-.37697550E 03
-.17580232E 03	-.95842385E 02	.27164470E 03	.32440365E 03	.91826132E 02	-.41622979E 03
-.19335941E 03	-.10541401E 03	.29877342E 03	.35680132E 03	.10099666E 03	-.45779798E 03
-.21131490E 03	-.11520283E 03	.32651773E 03	.38993415E 03	.11037528E 03	-.50030943E 03
-.22943087E 03	-.12507914E 03	.35451001E 03	.42336310E 03	.11983772E 03	-.54320082E 03
-.24771507E 03	-.13504716E 03	.38278223E 03	.45710247E 03	.12938804E 03	-.58649051E 03
-.26615289E 03	-.14509893E 03	.41125181E 03	.49112532E 03	.13901859E 03	-.63014391E 03
-.28473560E 03	-.15522969E 03	.43996530E 03	.52541554E 03	.14872483E 03	-.67414037E 03
-.30345372E 03	-.16543427E 03	.46888799E 03	.55995562E 03	.15850179E 03	-.71845741E 03
-.32229756E 03	-.17570739E 03	.49800495E 03	.59472768E 03	.16834441E 03	-.76387210E 03
-.34126311E 03	-.18604686E 03	.52730997E 03	.62972434E 03	.17825062E 03	-.80797496E 03
-.36031582E 03	-.19643386E 03	.55674968E 03	.66488185E 03	.18820235E 03	-.85308419E 03
-.37950996E 03	-.20689795E 03	.58640791E 03	.70030030E 03	.19822794E 03	-.89852824E 03
-.39817774E 03	-.21707509E 03	.61529284E 03	.73474751E 03	.20797861E 03	-.94272612E 03

Table D3. Numerical A Matrix (Concluded)

$a_{10,10}$	$a_{10,13}$	$a_{11,11}$	$a_{11,12}$	$a_{12,11}$	$a_{12,12}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
-.16279273E 01	.16279273E 01	.41036039E-02	.12555344E 04	-.58113625E-08	-.46549826E-02
-.33540004E 01	.33540004E 01	.81347159E-02	.26524554E 04	-.14541286E-07	-.96140281E-02
-.51764869E 01	.51764869E 01	.12347064E-01	.42888222E 04	-.20673621E-07	-.14824705E-01
-.71083316E 01	.71083316E 01	.16523451E-01	.59839900E 04	-.27271141E-07	-.20316386E-01
-.91911432E 01	.91911432E 01	.19847599E-01	.83538353E 04	-.32551303E-07	-.26069286E-01
-.11458409E 02	.11458409E 02	.21989842E-01	.11939223E 05	-.34457560E-07	-.32047960E-01
-.13937435E 02	.13937435E 02	.24171994E-01	.16326898E 05	-.35750056E-07	-.38233935E-01
-.16644898E 02	.16644898E 02	.26300000E-01	.21550000E 05	-.36900000E-07	-.44500000E-01
-.19504839E 02	.19504839E 02	.28245285E-01	.28101492E 05	-.36461587E-07	-.50593973E-01
-.22351878E 02	.22351878E 02	.34152265E-01	.36529247E 05	-.34411297E-07	-.56112526E-01
-.25219466E 02	.25219466E 02	.37650936E-01	.47124992E 05	-.31351431E-07	-.60842082E-01
-.28249084E 02	.28249084E 02	.20700551E-01	.58941463E 05	-.28498717E-07	-.64894305E-01
-.31552459E 02	.31552459E 02	-.10012253E-01	.64468107E 05	-.29150206E-07	-.68610404E-01
-.35275984E 02	.35275984E 02	-.36361934E-01	.59419078E 05	-.35267868E-07	-.72308361E-01
-.39491161E 02	.39491161E 02	-.41818923E-01	.52120907E 05	-.44155589E-07	-.76049768E-01
-.44251516E 02	.44251516E 02	-.29530865E-01	.46601270E 05	-.54211855E-07	-.79732630E-01
-.49571797E 02	.49571797E 02	-.17902946E-01	.42307724E 05	-.65144389E-07	-.83153736E-01
-.55450438E 02	.55450438E 02	-.17648978E-01	.38733698E 05	-.76755601E-07	-.86212929E-01
-.61860798E 02	.61860798E 02	-.21493652E-01	.35737869E 05	-.88984034E-07	-.89045832E-01
-.68789633E 02	.68789633E 02	-.20998089E-01	.33228514E 05	-.10175118E-06	-.91792023E-01
-.76223251E 02	.76223251E 02	-.17113033E-01	.31115225E 05	-.11471638E-06	-.94384559E-01
-.84160343E 02	.84160343E 02	-.14917164E-01	.29304929E 05	-.12744593E-06	-.96663734E-01
-.92565300E 02	.92565300E 02	-.16378800E-01	.27577923E 05	-.14045649E-06	-.98461586E-01
-.10116098E 03	.10116098E 03	-.19400000E-01	.25558000E 05	-.15550000E-06	-.99600000E-01
-.10983348E 03	.10983348E 03	-.22107769E-01	.22978566E 05	-.17402203E-06	-.99967327E-01
-.11858652E 03	.11858652E 03	-.24615898E-01	.20231455E 05	-.19591246E-06	-.99720500E-01
-.12741310E 03	.12741310E 03	-.27507173E-01	.17793875E 05	-.22068979E-06	-.99071576E-01
-.13630905E 03	.13630905E 03	-.30949843E-01	.15623838E 05	-.24813490E-06	-.98052717E-01
-.14526981E 03	.14526981E 03	-.34800702E-01	.13274708E 05	-.27829155E-06	-.96557804E-01
-.15429076E 03	.15429076E 03	-.40530958E-01	.10542561E 05	-.32412592E-06	-.94520045E-01
-.16336997E 03	.16336997E 03	-.53232105E-01	.77857787E 04	-.42742430E-06	-.91968334E-01
-.17249092E 03	.17249092E 03	-.79451022E-01	.53776117E 04	-.64062162E-06	-.88976780E-01
-.18167956E 03	.18167956E 03	-.13287049E 00	.32179279E 04	-.10660333E-05	-.85857943E-01
-.19061623E 03	.19061623E 03	-.22900000E 00	.10000000E 04	-.18180000E-05	-.83000000E-01

Table D4. Numerical G Matrix

g_{74}	g_{84}	g_{94}	$g_{11,5}$	$g_{12,5}$	$g_{13,6}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
.81218256E 00	.52544681E 01	-.80512011E 01	.10820374E 01	-.15071135E-05	.20777371E-01
.16733306E 01	.10825722E 02	-.16587799E 02	.15278645E 01	-.20748258E-05	.29823228E-01
.25825799E 01	.16708169E 02	-.25601227E 02	.20279125E 01	-.26010943E-05	.38974894E-01
.35463886E 01	.22943592E 02	-.35155505E 02	.24461378E 01	-.30552883E-05	.49055245E-01
.45855156E 01	.29660292E 02	-.45456416E 02	.29857845E 01	-.34462563E-05	.61551460E-01
.57166679E 01	.36984356E 02	-.56669578E 02	.38452125E 01	-.38199523E-05	.76957860E-01
.69534687E 01	.44985919E 02	-.68930038E 02	.48106218E 01	-.41766140E-05	.95929033E-01
.83042381E 01	.53724810E 02	-.82320273E 02	.58700000E 01	-.45100000E-05	.11906991E 00
.97310796E 01	.62955854E 02	-.96464615E 02	.71938670E 01	-.48114902E-05	.15037631E 00
.11151484E 02	.72145253E 02	-.11054515E 03	.88865514E 01	-.50641504E-05	.18747383E 00
.12582140E 02	.81400978E 02	-.12472731E 03	.11004029E 02	-.52646777E-05	.23737109E 00
.14093635E 02	.91179691E 02	-.13971082E 03	.13358246E 02	-.54306652E-05	.29337632E 00
.15741708E 02	.10184201E 03	-.15604824E 03	.14258429E 02	-.55836747E-05	.32371698E 00
.17599397E 02	.11386044E 03	-.17446358E 03	.12769456E 02	-.57382402E-05	.29706609E 00
.19702374E 02	.12746579E 03	-.19531049E 03	.10877721E 02	-.58915939E-05	.26381095E 00
.22077343E 02	.14283081E 03	-.21885366E 03	.95097554E 01	-.60391135E-05	.23635006E 00
.24731662E 02	.16000310E 03	-.24516605E 03	.84814833E 01	-.61764465E-05	.21814101E 00
.27664551E 02	.17897762E 03	-.27423990E 03	.76337293E 01	-.63003208E-05	.21102779E 00
.30862718E 02	.19966836E 03	-.30594346E 03	.69266290E 01	-.64098607E-05	.19295148E 00
.34319554E 02	.22203259E 03	-.34021123E 03	.63369727E 01	-.65047508E-05	.18242199E 00
.38028230E 02	.24602612E 03	-.37697550E 03	.58453254E 01	-.65864219E-05	.17540812E 00
.41988092E 02	.27164470E 03	-.41622979E 03	.54333842E 01	-.66569750E-05	.16976344E 00
.46181375E 02	.29877342E 03	-.45779798E 03	.50610690E 01	-.67141469E-05	.16379564E 00
.50469811E 02	.32651773E 03	-.50030943E 03	.46600000E 01	-.67500000E-05	.15740575E 00
.54796574E 02	.35451001E 03	-.54320082E 03	.41852524E 01	-.67591619E-05	.14739114E 00
.59163516E 02	.38276223E 03	-.58649051E 03	.36932846E 01	-.67480366E-05	.13818194E 00
.63567148E 02	.41125181E 03	-.63014391E 03	.32601122E 01	-.67253700E-05	.12771538E 00
.68005388E 02	.43996530E 03	-.67414037E 03	.28751335E 01	-.66909006E-05	.11358017E 00
.72475966E 02	.46888799E 03	-.71845741E 03	.24612601E 01	-.66374577E-05	.99411048E-01
.76976571E 02	.49800495E 03	-.76307210E 03	.19803648E 01	-.65630183E-05	.85375976E-01
.81506245E 02	.52730997E 03	-.80797496E 03	.14850739E 01	-.64774424E-05	.70281631E-01
.86056739E 02	.55674968E 03	-.85308419E 03	.10330448E 01	-.63894156E-05	.51385100E-01
.90641007E 02	.58640791E 03	-.89852824E 03	.62836345E 00	-.62870614E-05	.32781833E-01
.95099565E 02	.61525284E 03	-.94272612E 03	.25000000E 00	-.61500000E-05	.14599309E-01

Table D5. Numerical H Matrix

$h_{14,15}$	h_{73}	h_{77}	$h_{7,15}$	h_{83}	h_{84}
.00000000E-80	.00000000E-80	.00000000E-80	-.77973840E 08	.00000000E-80	.00000000E-80
.37266019E 01	-.35705580E 05	-.35705580E 05	-.77973840E 08	.34308244E 03	-.14548768E 05
.79346546E 01	-.68061771E 05	-.68061771E 05	-.78902100E 08	.12466163E 04	-.22368740E 05
.12769363E 02	-.10348923E 06	-.10348923E 06	-.82615140E 08	.28821502E 04	-.10321123E 06
.18831533E 02	-.13822723E 06	-.13822723E 06	-.90041220E 08	.51417807E 04	-.46298565E 06
.24412296E 02	-.17037006E 06	-.17037006E 06	-.92826000E 08	.78111119E 04	-.99463000E 06
.27990693E 02	-.19706647E 06	-.19706647E 06	-.89112960E 08	.10450854E 05	-.15192981E 07
.26742451E 02	-.20452374E 06	-.20452374E 06	-.74260800E 08	.11256770E 05	-.19633344E 07
.28124946E 02	-.18790686E 06	-.18790686E 06	-.70547760E 08	.95019245E 04	-.22025478E 07
.30402532E 02	-.20853580E 06	-.20853580E 06	-.71476020E 08	.11702740E 05	-.29217308E 07
.32409321E 02	-.35207384E 06	-.35207384E 06	-.74260800E 08	.33357526E 05	-.57065788E 07
.32168282E 02	-.37457379E 06	-.37457379E 06	-.74260800E 08	.37727313E 05	-.67537563E 07
.27153401E 02	-.35502059E 06	-.35502059E 06	-.64978200E 08	.33918247E 05	-.69336001E 07
.23241552E 02	-.32699416E 06	-.32699416E 06	-.59408640E 08	.28774402E 05	-.68521642E 07
.20596660E 02	-.29005914E 06	-.29005914E 06	-.58480380E 08	.22641199E 05	-.65040627E 07
.17417637E 02	-.24415746E 06	-.24415746E 06	-.57552120E 08	.16042288E 05	-.58196062E 07
.14158991E 02	-.19176552E 06	-.19176552E 06	-.57552120E 08	.98961751E 04	-.48179102E 07
.11236217E 02	-.14708513E 06	-.14708513E 06	-.57552120E 08	.58218881E 04	-.38632564E 07
.90032867E 01	-.11300213E 06	-.11300213E 06	-.58480380E 08	.34363672E 04	-.30802863E 07
.71827430E 01	-.86473402E 05	-.86473402E 05	-.59408640E 08	.20122939E 04	-.24322445E 07
.58087520E 01	-.66057984E 05	-.66057984E 05	-.61265160E 08	.11742943E 04	-.19099028E 07
.46494652E 01	-.50423105E 05	-.50423105E 05	-.63121680E 08	.68420381E 03	-.14954237E 07
.36999738E 01	-.37901022E 05	-.37901022E 05	-.64978200E 08	.38627000E 03	-.11473873E 07
.29149130E 01	-.28909418E 05	-.28909418E 05	-.67762980E 08	.22490806E 03	-.88580509E 06
.19773945E 01	-.21981795E 05	-.21981795E 05	-.62193420E 08	.13003272E 03	-.67758811E 06
.14592351E 01	-.16710490E 05	-.16710490E 05	-.62193420E 08	.75145794E 02	-.51868801E 06
.10833409E 01	-.12880421E 05	-.12880421E 05	-.62193420E 08	.44646399E 02	-.40351043E 06
.81194915E 00	-.99275247E 04	-.99275247E 04	-.62193420E 08	.26522122E 02	-.31382398E 06
.61576082E 00	-.78766014E 04	-.78766014E 04	-.62193420E 08	.16695678E 02	-.25064570E 06
.47763574E 00	-.63759458E 04	-.63759458E 04	-.62193420E 08	.10939955E 02	-.20361741E 06
.26321468E 00	-.51974464E 04	-.51974464E 04	-.43628220E 08	.72695305E 01	-.16624712E 06
.23368856E 00	-.42379291E 04	-.42379291E 04	-.49197780E 08	.48331879E 01	-.13585822E 06
.20531287E 00	-.34568381E 04	-.34568381E 04	-.54767340E 08	.32157658E 01	-.11110061E 06
.17940548E 00	-.28183344E 04	-.28183344E 04	-.60336900E 08	.21375258E 01	-.90665565E 05
.15569931E 00	-.23153533E 04	-.23153533E 04	-.65906460E 08	.14426496E 01	-.74464149E 05

Table D5. Numerical H Matrix (Continued)

h_{85}	h_{87}	h_{88}	h_{89}	$h_{8,11}$	$h_{8,14}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
-.11485564E 07	.29377356E 05	-.25789333E 02	-.90354295E 01	-.28999449E 05	.00000000E-80
-.21894329E 07	.11526300E 06	-.93707516E 02	-.32830925E 02	-.11388985E 06	.00000000E-80
-.33276482E 07	.27044390E 06	-.21664976E 03	-.75904393E 02	-.26726920E 06	.00000000E-80
-.44226020E 07	.49587119E 06	-.38650504E 03	-.13541409E 03	-.49020749E 06	.00000000E-80
-.53897989E 07	.78983855E 06	-.58715731E 03	-.20571368E 03	-.78123456E 06	.00000000E-80
-.61548860E 07	.11380752E 07	-.78558542E 03	-.27523402E 03	-.11265636E 07	.00000000E-80
-.62797704E 07	.14345488E 07	-.84616565E 03	-.29645862E 03	-.14221494E 07	.00000000E-80
-.56294199E 07	.15708897E 07	-.71422484E 03	-.25024297E 03	-.15604233E 07	.00000000E-80
-.60389367E 07	.20421690E 07	-.87968899E 03	-.30820370E 03	-.20292784E 07	.00000000E-80
-.97835635E 07	.39628893E 07	-.25074683E 04	-.87850481E 03	-.39261458E 07	.00000000E-80
-.99794894E 07	.47545299E 07	-.28381980E 04	-.99437773E 03	-.47129400E 07	.00000000E-80
-.90755007E 07	.50408917E 07	-.25496174E 04	-.89327197E 03	-.50035306E 07	.00000000E-80
-.79815828E 07	.51791418E 07	-.21629571E 04	-.75780350E 03	-.51474466E 07	.00000000E-80
-.66909273E 07	.51298052E 07	-.17019274E 04	-.59627930E 03	-.51048658E 07	.00000000E-80
-.52750418E 07	.48281521E 07	-.12058976E 04	-.42249017E 03	-.48104814E 07	.00000000E-80
-.38529855E 07	.42445738E 07	-.74389046E 03	-.26062597E 03	-.42336731E 07	.00000000E-80
-.27321248E 07	.36440726E 07	-.43762837E 03	-.15332542E 03	-.36376598E 07	.00000000E-80
-.19305662E 07	.31299383E 07	-.25830998E 03	-.90500269E 02	-.31261531E 07	.00000000E-80
-.13501379E 07	.26710207E 07	-.15126311E 03	-.52995832E 02	-.26688042E 07	.00000000E-80
-.93180413E 06	.22683740E 07	-.88271104E 02	-.30926249E 02	-.22678806E 07	.00000000E-80
-.62845274E 06	.19182551E 07	-.51431253E 02	-.18019212E 02	-.19175014E 07	.00000000E-80
-.41247552E 06	.15918174E 07	-.29058271E 02	-.10180719E 02	-.15913916E 07	.00000000E-80
-.28333562E 06	.13353244E 07	-.16906225E 02	-.59231854E 01	-.13350767E 07	.00000000E-80
-.20234043E 06	.11095603E 07	-.97744934E 01	-.34245456E 01	-.11094171E 07	.00000000E-80
-.14154216E 06	.91576037E 06	-.56486712E 01	-.19790419E 01	-.91567759E 06	.00000000E-80
-.94213308E 05	.76210018E 06	-.33560472E 01	-.11758089E 01	-.76205100E 06	.00000000E-80
-.59251428E 05	.63109365E 06	-.19936544E 01	-.69848740E 00	-.63106444E 06	.00000000E-80
-.37193570E 05	.53566973E 06	-.12550056E 01	-.43969787E 00	-.53565134E 06	.00000000E-80
-.24734067E 05	.46211488E 06	-.82235088E 00	-.28811499E 00	-.46210283E 06	.00000000E-80
-.17842515E 05	.40008961E 06	-.54644692E 00	-.19145057E 00	-.40008161E 06	.00000000E-80
-.11382051E 05	.34542301E 06	-.36330828E 00	-.12728698E 00	-.34541769E 06	.00000000E-80
-.48514329E 04	.29748776E 06	-.24172748E 00	-.84690504E-01	-.29748422E 06	.00000000E-80
-.21422046E 03	.25545902E 06	-.16067673E 00	-.56293944E-01	-.25545667E 06	.00000000E-80
-.17587457E 04	.22019068E 06	-.10844324E 00	-.37993663E-01	-.22018909E 06	.00000000E-80

Table D5. Numerical H Matrix (Continued)

$h_{8,15}$	h_{93}	h_{97}	$h_{9,15}$	$h_{10,3}$	$h_{10,4}$
.24639733E 10	.00000000E-80	.00000000E-80	-.10974096E 10	.00000000E-80	.00000000E-80
.24625098E 10	-.77707456E 05	-.77707456E 05	-.10974096E 10	.74666380E 03	-.31663056E 05
.24904161E 10	-.14812551E 06	-.14812551E 06	-.11104740E 10	.27130601E 04	-.48681968E 05
.26059147E 10	-.22522767E 06	-.22522767E 06	-.11627316E 10	.62725466E 04	-.22462264E 06
.28382251E 10	-.30082936E 06	-.30082936E 06	-.12672468E 10	.11190259E 05	-.10076139E 07
.29240238E 10	-.37078305E 06	-.37078305E 06	-.13064400E 10	.16999630E 05	-.21646523E 07
.28053194E 10	-.42888350E 06	-.42888350E 06	-.12541824E 10	.22744605E 05	-.33065081E 07
.23371040E 10	-.44511305E 06	-.44511305E 06	-.10451520E 10	.24498550E 05	-.42728819E 07
.22206803E 10	-.40894907E 06	-.40894907E 06	-.99289440E 09	.20679412E 05	-.47934912E 07
.22485786E 10	-.45384464E 06	-.45384464E 06	-.10059588E 10	.25469132E 05	-.63586775E 07
.23283296E 10	-.76623213E 06	-.76623213E 06	-.10451520E 10	.72597294E 05	-.12419452E 08
.23264401E 10	-.81519965E 06	-.81519965E 06	-.10451520E 10	.82172724E 05	-.14698465E 08
.20359506E 10	-.77264526E 06	-.77264526E 06	-.91450800E 09	.73817614E 05	-.15089866E 08
.18621756E 10	-.71165023E 06	-.71165023E 06	-.83612160E 09	.62622860E 05	-.14912634E 08
.18343058E 10	-.63126710E 06	-.63126710E 06	-.82305720E 09	.49214931E 05	-.14155047E 08
.18069380E 10	-.53136946E 06	-.53136946E 06	-.80999280E 09	.34913461E 05	-.12665438E 08
.18091477E 10	-.41734684E 06	-.41734684E 06	-.80999280E 09	.21537435E 05	-.10485407E 08
.18111246E 10	-.32010715E 06	-.32010715E 06	-.80999280E 09	.12670404E 05	-.84077567E 07
.18419176E 10	-.24593097E 06	-.24593097E 06	-.82305720E 09	.74787009E 04	-.67037481E 07
.18724470E 10	-.18819546E 06	-.18819546E 06	-.83612160E 09	.43794343E 04	-.52933893E 07
.19320184E 10	-.14376459E 06	-.14376459E 06	-.86225040E 09	.25556628E 04	-.41565965E 07
.19914257E 10	-.10973778E 06	-.10973778E 06	-.88837920E 09	.14890596E 04	-.32545495E 07
.20507300E 10	-.82485482E 05	-.82485482E 05	-.91450800E 09	.84130749E 03	-.24971040E 07
.21392239E 10	-.62916702E 05	-.62916702E 05	-.95370120E 09	.48947625E 03	-.19278124E 07
.19638597E 10	-.47839845E 05	-.47839845E 05	-.87531480E 09	.28299531E 03	-.14746616E 07
.19642127E 10	-.36367696E 05	-.36367696E 05	-.87531480E 09	.16354274E 03	-.11286670E 07
.19644674E 10	-.28032166E 05	-.28032166E 05	-.87531480E 09	.97165713E 02	-.87817561E 06
.19646629E 10	-.21605662E 05	-.21605662E 05	-.87531480E 09	.57721136E 02	-.68298745E 06
.19647980E 10	-.17142157E 05	-.17142157E 05	-.87531480E 09	.36335460E 02	-.54549008E 06
.19648965E 10	-.13876221E 05	-.13876221E 05	-.87531480E 09	.23809054E 02	-.44314057E 06
.13784144E 10	-.11311407E 05	-.11311407E 05	-.61402680E 09	.15820965E 02	-.36181013E 06
.15544318E 10	-.92231715E 04	-.92231715E 04	-.69241320E 09	.10518657E 02	-.29567359E 06
.17304501E 10	-.75232527E 04	-.75232527E 04	-.77079960E 09	.69985974E 01	-.24179262E 06
.19064685E 10	-.61336519E 04	-.61336519E 04	-.84918600E 09	.46519814E 01	-.19731903E 06
.20824849E 10	-.50389944E 04	-.50389944E 04	-.92757240E 09	.31396950E 01	-.16205925E 06

Table D5. Numerical H Matrix (Continued)

$h_{10,5}$	$h_{10,7}$	$h_{10,8}$	$h_{10,9}$	$h_{10,11}$	$h_{10,14}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
-.24996483E 07	.63935095E 05	-.56126338E 02	-.19664160E 02	-.63112641E 05	.00000000E-80
-.47649489E 07	.25085140E 06	-.20393935E 03	-.71451232E 02	-.24786295E 06	.00000000E-80
-.72420915E 07	.58857769E 06	-.47150339E 03	-.16519371E 03	-.58166846E 06	.00000000E-80
-.96250825E 07	.10791839E 07	-.84116610E 03	-.29470700E 03	-.10668578E 07	.00000000E-80
-.11730031E 08	.17189567E 07	-.12778535E 04	-.44770276E 03	-.17002315E 07	.00000000E-80
-.13395120E 08	.24768379E 07	-.17097004E 04	-.59900260E 03	-.24517846E 07	.00000000E-80
-.13666911E 08	.31220650E 07	-.18415435E 04	-.64519454E 03	-.30950797E 07	.00000000E-80
-.12251528E 08	.34187890E 07	-.15544609E 04	-.54461360E 03	-.33960105E 07	.00000000E-80
-.13142775E 08	.44444527E 07	-.19145017E 04	-.67075582E 03	-.44163983E 07	.00000000E-80
-.21292354E 08	.86245917E 07	-.54571017E 04	-.19119245E 04	-.85446254E 07	.00000000E-80
-.21718755E 08	.10347470E 08	-.61768819E 04	-.21641033E 04	-.10256956E 08	.00000000E-80
-.19751369E 08	.10970691E 08	-.55488325E 04	-.19440629E 04	-.10889380E 08	.00000000E-80
-.17370632E 08	.11271570E 08	-.47073286E 04	-.16492375E 04	-.11242590E 08	.00000000E-80
-.14561728E 08	.11164197E 08	-.37039715E 04	-.12977061E 04	-.11109920E 08	.00000000E-80
-.11480281E 08	.10507697E 08	-.26244271E 04	-.91948195E 03	-.10469240E 08	.00000000E-80
-.83854038E 07	.92376328E 07	-.16189580E 04	-.56721053E 03	-.92139092E 07	.00000000E-80
-.59460305E 07	.79307384E 07	-.95242782E 03	-.33368814E 03	-.79167819E 07	.00000000E-80
-.42015671E 07	.68118077E 07	-.56217015E 03	-.19695929E 03	-.68035699E 07	.00000000E-80
-.29383582E 07	.58130474E 07	-.32914985E 03	-.11533691E 03	-.58082234E 07	.00000000E-80
-.20279219E 07	.49367515E 07	-.19210787E 03	-.67306011E 02	-.49339365E 07	.00000000E-80
-.13677264E 07	.41747739E 07	-.11193186E 03	-.39215919E 02	-.41731337E 07	.00000000E-80
-.89768669E 06	.34643348E 07	-.63240656E 02	-.22156699E 02	-.34634081E 07	.00000000E-80
-.61663445E 06	.29061190E 07	-.36793681E 02	-.12890861E 02	-.29055798E 07	.00000000E-80
-.44036143E 06	.24147797E 07	-.21272614E 02	-.74529731E 01	-.24144679E 07	.00000000E-80
-.30804377E 06	.19930053E 07	-.12293425E 02	-.43070666E 01	-.19928251E 07	.00000000E-80
-.20504012E 06	.16585886E 07	-.73038973E 01	-.25589591E 01	-.16584815E 07	.00000000E-80
-.12895121E 06	.13734739E 07	-.43388685E 01	-.15201456E 01	-.13734103E 07	.00000000E-80
-.80945828E 05	.11657991E 07	-.27313180E 01	-.95693176E 00	-.11657591E 07	.00000000E-80
-.53829722E 05	.10057188E 07	-.17897145E 01	-.62703597E 00	-.10056925E 07	.00000000E-80
-.38831366E 05	.87073074E 06	-.11892539E 01	-.41666140E 00	-.87071332E 06	.00000000E-80
-.24771205E 05	.75175767E 06	-.79068208E 00	-.27701966E 00	-.75174608E 06	.00000000E-80
-.10558364E 05	.64743430E 06	-.52608101E 00	-.18431527E 00	-.64742659E 06	.00000000E-80
-.46621641E 03	.55596551E 06	-.34960708E 00	-.12251472E 00	-.55596039E 06	.00000000E-80
-.38276273E 04	.47920963E 06	-.23600928E 00	-.82687102E-01	-.47920617E 06	.00000000E-80

Table D5. Numerical H Matrix (Continued)

$h_{10,15}$	$h_{11,1}$	$h_{11,2}$	$h_{11,3}$	$h_{11,7}$	$h_{11,8}$
.34678143E 11	.21108264E-01	-.10338011E 01	.00000000E-80	.00000000E-80	.00000000E-80
.34674958E 11	-.24473265E 01	-.59423821E 01	-.24541671E-01	-.51004056E 00	.30228839E 00
.35084688E 11	-.50452498E 01	-.11162192E 02	-.48440972E-01	-.79068734E 00	.46221067E 00
.36732038E 11	-.74099595E 01	-.13556041E 02	-.70266477E-01	-.10625394E 01	.61795283E 00
.40029596E 11	-.96246973E 01	-.22936275E 02	-.92834212E-01	-.11955603E 01	.68683618E 00
.41263312E 11	-.11880209E 02	-.29124476E 02	-.10981181E 00	-.11416118E 01	.64331883E 00
.39608985E 11	-.13516054E 02	-.29449153E 02	-.12295637E 00	-.59803743E 00	.29646886E 00
.33006047E 11	-.14994922E 02	-.31600390E 02	-.13284605E 00	.72334193E 00	-.53195841E 00
.31356684E 11	-.16113633E 02	-.34793070E 02	-.14728147E 00	.26690482E 01	-.17517932E 01
.31766396E 11	-.17035490E 02	-.37084922E 02	-.17256557E 00	.29814522E 01	-.19655585E 01
.32986951E 11	-.16722040E 02	-.37792144E 02	-.23558290E 00	-.25730127E 01	.14561252E 01
.32982839E 11	-.15500905E 02	-.36174549E 02	-.24496966E 00	-.33266237E 01	.19193501E 01
.28860670E 11	-.13381432E 02	-.32656392E 02	-.22038143E 00	-.27373075E 01	.15677969E 01
.26388498E 11	-.10774780E 02	-.27941387E 02	-.19261133E 00	-.21419901E 01	.12144594E 01
.25978848E 11	-.81373668E 01	-.23710800E 02	-.16952957E 00	-.16026360E 01	.89302080E 00
.25570290E 11	-.60995182E 01	-.20057362E 02	-.14825860E 00	-.11148605E 01	.60253562E 00
.25575099E 11	-.44974369E 01	-.16175332E 02	-.12084013E 00	-.72349912E 00	.37584391E 00
.25579401E 11	-.32472968E 01	-.12944918E 02	-.93979519E-01	-.44730238E 00	.22049496E 00
.25995414E 11	-.23317879E 01	-.10233525E 02	-.72819913E-01	-.27263839E 00	.12482538E 00
.26410852E 11	-.16275290E 01	-.82782229E 01	-.56791065E-01	-.15299896E 00	.60237997E-01
.27238493E 11	-.95812497E 00	-.66116124E 01	-.42666192E-01	-.11012173E 00	.42256607E-01
.28065776E 11	-.59553864E 00	-.52780701E 01	-.31727227E-01	-.73053057E-01	.25927692E-01
.28892835E 11	-.48064444E 00	-.41310610E 01	-.23052195E-01	-.51894190E-01	.18104592E-01
.30132417E 11	-.27639259E 00	-.31962805E 01	-.16191319E-01	-.55225944E-01	.24407092E-01
.27656787E 11	-.10200921E 00	-.23056190E 01	-.11296587E-01	-.46293861E-01	.21864350E-01
.27657555E 11	-.82143439E-03	-.16827302E 01	-.78506771E-02	-.38837622E-01	.19346373E-01
.27658109E 11	.60951167E-01	-.12660308E 01	-.54738991E-02	-.34462268E-01	.18086767E-01
.27658535E 11	.99302036E-01	-.91627970E 00	-.38173040E-02	-.29439622E-01	.15980244E-01
.27658829E 11	.11612408E 00	-.60054569E 00	-.26659187E-02	-.34483227E-01	.19827316E-01
.27659043E 11	.13085282E 00	-.32454809E 00	-.19977750E-02	-.31440012E-01	.18343736E-01
.19402730E 11	.14870042E 00	-.53480892E-01	-.14251344E-02	-.33510407E-01	.19984075E-01
.21879783E 11	.15575113E 00	.21324389E 00	-.99375358E-03	-.34648542E-01	.20957264E-01
.24356837E 11	.15290182E 00	.45686849E 00	-.71629659E-03	-.31344949E-01	.19071350E-01
.26833891E 11	.14385848E 00	.71563497E 00	-.40730980E-03	-.35645123E-01	.21937293E-01
.29310941E 11	.14063224E 00	.10407203E 01	-.20843249E-03	-.36259096E-01	.22441355E-01

Table D5. Numerical H Matrix (Continued)

$h_{11, 9}$	$n_{11, 10}$	$h_{11, 14}$	$h_{11, 15}$	$h_{11, 16}$	$h_{12, 1}$
.00000000E-80	.00000000E-80	-.56707881E 02	-.70168471E 02	.00000000E-80	-.78772259E-03
.18321050E 00	-.24538522E 01	-.56467892E 02	-.70779071E 02	-.20274681E 00	.27348877E 00
.28003569E 00	-.50522528E 01	-.56362238E 02	-.72399468E 02	-.86355874E 00	.11379003E 01
.37432013E 00	-.76048219E 01	-.56352160E 02	-.82219747E 02	-.20059624E 01	.23446278E 01
.41588990E 00	-.10064069E 02	-.56235276E 02	-.94596569E 02	-.36437696E 01	.41311156E 01
.38928118E 00	-.12363045E 02	-.56389485E 02	-.99872800E 02	-.57710714E 01	.63676139E 01
.17861219E 00	-.14002011E 02	-.56773958E 02	-.87752347E 02	-.83655495E 01	.80639682E 01
-.32422957E 00	-.15466282E 02	-.57370820E 02	-.65926869E 02	-.11344936E 02	.98928953E 01
-.10645365E 01	-.16584585E 02	-.57780365E 02	-.64920072E 02	-.14537028E 02	.11503115E 02
-.11944593E 01	-.17534209E 02	-.58075645E 02	-.69843394E 02	-.16691010E 02	.12913960E 02
.88130461E 00	-.17235640E 02	-.58318089E 02	-.73942175E 02	-.18061424E 02	.12566100E 02
.11623039E 01	-.16029739E 02	-.58589660E 02	-.74391583E 02	-.17465044E 02	.10893002E 02
.94912920E 00	-.13918519E 02	-.59107448E 02	-.65478589E 02	-.15780712E 02	.82073358E 01
.73491935E 00	-.11313301E 02	-.59342227E 02	-.54489170E 02	-.12439573E 02	.53909254E 01
.54008558E 00	-.86694079E 01	-.59357189E 02	-.51633803E 02	-.88533631E 01	.31404812E 01
.36406627E 00	-.66188338E 01	-.59259261E 02	-.46735961E 02	-.73776230E 01	.18015759E 01
.22681507E 00	-.49983617E 01	-.59055412E 02	-.55649936E 02	-.61362710E 01	.99599907E 00
.13282789E 00	-.37258325E 01	-.58753776E 02	-.51224699E 02	-.52287620E 01	.52888514E 00
.74993098E-01	-.27660709E 01	-.58369689E 02	-.52507623E 02	-.45507419E 01	.27757610E 00
.35969893E-01	-.20571017E 01	-.57645740E 02	-.58244690E 02	-.39093849E 01	.13685722E 00
.25198935E-01	-.13638372E 01	-.57009946E 02	-.64652622E 02	-.33163417E 01	.39639647E-01
.15398138E-01	-.97698754E 00	-.56294341E 02	-.69278461E 02	-.27744474E 01	.92029047E-02
.10737402E-01	-.83916542E 00	-.55688325E 02	-.76572640E 02	-.22599675E 01	.92941474E-02
.14627533E-01	-.60934305E 00	-.53839091E 02	-.84388381E 02	-.18261597E 01	.27671616E-03
.13132924E-01	-.39806166E 00	-.48442691E 02	-.48857225E 02	-.14485237E 01	-.39172142E-02
.11640572E-01	-.27584379E 00	-.45218203E 02	-.50070526E 02	-.11315072E 01	-.42522014E-02
.10901603E-01	-.21333765E 00	-.41968099E 02	-.51581710E 02	-.88276510E 00	-.38223784E-02
.96420744E-02	-.17208796E 00	-.38783751E 02	-.53368782E 02	-.69082719E 00	-.30321523E-02
.11989992E-01	-.13981695E 00	-.35592417E 02	-.49272166E 02	-.54359725E 00	-.20578238E-02
.11098501E-01	-.10865838E 00	-.32414014E 02	-.48744052E 02	-.43523862E 00	-.12385630E-02
.12101198E-01	-.77860529E-01	-.27685278E 02	-.67262520E 02	-.34809032E 00	-.51066294E-03
.12697524E-01	-.57699035E-01	-.24559644E 02	-.69370397E 02	-.27494501E 00	.15872681E-03
.11557302E-01	-.46726436E-01	-.21139883E 02	-.68648070E 02	-.21852178E 00	.68113692E-03
.13300520E-01	-.38941816E-01	-.17180607E 02	-.64246747E 02	-.17105168E 00	.11031319E-02
.13609308E-01	-.32496651E-01	-.12747353E 02	-.65315780E 02	-.13629460E 00	.15885386E-02

Table D5. Numerical H Matrix (Continued)

$h_{12,2}$	$h_{12,3}$	$h_{12,4}$	$h_{12,5}$	$h_{12,7}$	$h_{12,8}$
.14739415E-01	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
.81503034E 00	.17327777E-02	-.99998678E-02	-.78944221E 00	.48234282E 00	.80384653E-01
.29534803E 01	.72689733E-02	-.15920296E-01	-.15582647E 01	.15259295E 01	.26032222E 00
.46674840E 01	.15074394E-01	-.70077721E-01	-.22593861E 01	.31004045E 01	.57446647E 00
.11672693E 02	.26543935E-01	-.31094385E 00	-.29702452E 01	.48325713E 01	.84432411E 00
.18297881E 02	.37880274E-01	-.63641711E 00	-.34486797E 01	.59296656E 01	.10312340E 01
.19729806E 02	.48170581E-01	-.94794093E 00	-.38402394E 01	.37787387E 01	.59852010E 00
.22799426E 02	.59701001E-01	-.12752613E 01	-.40789528E 01	-.55977109E 01	-.15408600E 01
.26969872E 02	.79288027E-01	-.17265578E 01	-.44123414E 01	-.24288083E 02	-.60202680E 01
.30097171E 02	.10080120E 00	-.24177630E 01	-.49972838E 01	-.31561223E 02	-.81072860E 01
.30358035E 02	.12685297E 00	-.38184388E 01	-.65464685E 01	.30698698E 02	.67734062E 01
.27114730E 02	.12436730E 00	-.44169279E 01	-.65265437E 01	.44295225E 02	.10434245E 02
.21500477E 02	.96507611E-01	-.43040792E 01	-.56336785E 01	.40331837E 02	.98031340E 01
.15286653E 02	.68633889E-01	-.40361713E 01	-.47014395E 01	.34848330E 02	.86766990E 01
.10527178E 02	.48236016E-01	-.38014005E 01	-.39106164E 01	.28882791E 02	.72412468E 01
.72037464E 01	.34238523E-01	-.35338124E 01	-.32031391E 01	.22340590E 02	.55016671E 01
.45116698E 01	.21874448E-01	-.30359833E 01	-.24279406E 01	.16158975E 02	.38440675E 01
.27758996E 01	.12918125E-01	-.24684139E 01	-.17456814E 01	.11148762E 02	.25025852E 01
.16713049E 01	.75606024E-02	-.19849730E 01	-.12440798E 01	.75810394E 01	.15510017E 01
.10413845E 01	.44442827E-02	-.15973670E 01	-.88669773E 00	.47373800E 01	.78609272E 00
.61935284E 00	.22831151E-02	-.12335871E 01	-.60184298E 00	.37871461E 01	.60614685E 00
.37456896E 00	.12019691E-02	-.94099056E 00	-.39543504E 00	.27816999E 01	.39433184E 00
.22604227E 00	.67213256E-03	-.69786498E 00	-.25087625E 00	.21809213E 01	.29960436E 00
.12984802E 00	.30898492E-03	-.49611351E 00	-.15868799E 00	.25522030E 01	.49885678E 00
.65615522E-01	.12606666E-03	-.34821691E 00	-.10398406E 00	.23375047E 01	.50012904E 00
.33653683E-01	.48800285E-04	-.24364480E 00	-.66497261E-01	.21288080E 01	.48916509E 00
.17620688E-01	.16785021E-04	-.17148317E 00	-.40038609E-01	.20393335E 01	.50253101E 00
.81597399E-02	.41528026E-05	-.12067072E 00	-.22783193E-01	.18716506E 01	.48212093E 00
.28867453E-02	-.87533071E-06	-.84839677E-01	-.12588556E-01	.23452473E 01	.65405919E 00
.36330275E-03	-.17666120E-05	-.63799440E-01	-.77499248E-02	.22787361E 01	.64813501E 00
-.41322737E-03	-.17021445E-05	-.45589788E-01	-.48923991E-02	.25795166E 01	.75609737E 00
.35550339E-03	-.53351187E-06	-.31857446E-01	-.26689815E-02	.28239759E 01	.84405878E 00
.23277425E-02	.77947132E-06	-.23021323E-01	-.10052727E-02	.26972791E 01	.81263409E 00
.57014126E-02	.27395992E-05	-.13103120E-01	-.30959453E-04	.32396291E 01	.98911310E 00
.11786607E-01	.47908120E-05	-.67034036E-02	-.15832561E-03	.34478212E 01	.10640109E 01

Table D5. Numerical H Matrix (Continued)

$h_{12,9}$	$h_{12,10}$	$h_{12,11}$	$h_{12,13}$	$h_{12,14}$	$h_{12,15}$
.00000000E-80	.00000000E-80	.00000000E-80	.00080000E-80	.17921903E 04	.22188452E 04
-.26004882E 00	.42694386E 01	-.30094588E 00	-.39946931E 01	.17906832E 04	.22509089E 04
-.81448965E 00	.18085572E 02	-.96449312E 00	-.16945258E 02	.17937266E 04	.23161397E 04
-.16575094E 01	.41788120E 02	-.20022871E 01	-.39366261E 02	.17986372E 04	.26389469E 04
-.25481000E 01	.75958499E 02	-.31022514E 01	-.71538737E 02	.18015445E 04	.30588414E 04
-.30776976E 01	.12038626E 03	-.38453217E 01	-.11363052E 03	.18124360E 04	.32476806E 04
-.17531392E 01	.16888251E 03	-.25759489E 01	-.16044076E 03	.18281686E 04	.28608601E 04
.37500179E 01	.22583152E 03	.34482539E 01	-.21556030E 03	.18509604E 04	.21583145E 04
.14705051E 02	.28795405E 03	.15682588E 02	-.27604873E 03	.18672816E 04	.21308583E 04
.19218534E 02	.35535447E 03	.20550777E 02	-.34200194E 03	.18793556E 04	.22947895E 04
-.16280913E 02	.39826067E 03	-.21064338E 02	-.38524892E 03	.18868097E 04	.24258091E 04
-.24014998E 02	.41557924E 03	-.30590105E 02	-.40426145E 03	.18927387E 04	.24340349E 04
-.21807470E 02	.40177028E 03	-.28230994E 02	-.39318542E 03	.19042265E 04	.21340359E 04
-.18737925E 02	.36266795E 03	-.24718470E 02	-.35696247E 03	.19051601E 04	.17682838E 04
-.15324856E 02	.30921890E 03	-.20750946E 02	-.30582189E 03	.18990080E 04	.16675682E 04
-.11539338E 02	.26339286E 03	-.16268680E 02	-.26138544E 03	.18906466E 04	.15038336E 04
-.80510112E 01	.22233650E 03	-.11930157E 02	-.22118508E 03	.18797880E 04	.17817077E 04
-.52908864E 01	.18534044E 03	-.83475429E 01	-.18469621E 03	.18667386E 04	.16359683E 04
-.33569116E 01	.15373805E 03	-.57675688E 01	-.15337984E 03	.18519389E 04	.16727807E 04
-.18199337E 01	.12745315E 03	-.36990947E 01	-.12725395E 03	.18270055E 04	.18519222E 04
-.14210645E 01	.93903155E 02	-.29699453E 01	-.93817861E 02	.18090220E 04	.20522780E 04
-.97091996E 00	.74511663E 02	-.22039098E 01	-.74469166E 02	.17812847E 04	.21967689E 04
-.74970440E 00	.70657404E 02	-.17301481E 01	-.70624450E 02	.17616288E 04	.24261068E 04
-.10960759E 01	.56420805E 02	-.19546749E 01	-.56404022E 02	.17024998E 04	.26693141E 04
-.10696374E 01	.40274749E 02	-.17678703E 01	-.40268308E 02	.15313630E 04	.15464136E 04
-.10250707E 01	.30299471E 02	-.15928537E 01	-.30296884E 02	.14291296E 04	.15839818E 04
-.10321832E 01	.25300097E 02	-.15096645E 01	-.25298970E 02	.13262253E 04	.16312425E 04
-.97838428E 00	.21926655E 02	-.13753831E 01	-.21926261E 02	.12254718E 04	.16873049E 04
-.12946552E 01	.19058321E 02	-.17046522E 01	-.19058315E 02	.11245564E 04	.15574463E 04
-.12755854E 01	.15784571E 02	-.16512874E 01	-.15784782E 02	.10240688E 04	.15404275E 04
-.14741814E 01	.12012830E 02	-.18614343E 01	-.12013160E 02	.87460882E 03	.21253559E 04
-.16356555E 01	.94259270E 01	-.20323797E 01	-.94262899E 01	.77582573E 03	.21916302E 04
-.15710850E 01	.80595244E 01	-.19388274E 01	-.80598860E 01	.66777595E 03	.21684926E 04
-.19021393E 01	.70745722E 01	-.23176001E 01	-.70749321E 01	.54278219E 03	.20291087E 04
-.20408602E 01	.61940159E 01	-.24709672E 01	-.61943892E 01	.40266325E 03	.20624393E 04

Table D5. Numerical H Matrix (Continued)

$h_{12,16}$	$h_{13,3}$	$h_{13,7}$	$h_{13,8}$	$h_{13,9}$	$h_{14,3}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
.20526912E 01	.90914396E-01	.10014271E 00	-.68339890E-02	-.23943243E-02	-.87356468E-03
.88473201E 01	.18684929E 00	.20581552E 00	-.14045366E-01	-.49208684E-02	-.34223231E-02
.20725296E 02	.27975721E 00	.30815410E 00	-.21029207E-01	-.73676942E-02	-.77911712E-02
.38179150E 02	.36779290E 00	.40512590E 00	-.27646805E-01	-.96862048E-02	-.13681171E-01
.61140823E 02	.44828540E 00	.49378883E 00	-.33697386E-01	-.11806058E-01	-.20552951E-01
.88994973E 02	.51792843E 00	.57050101E 00	-.38932417E-01	-.13640179E-01	-.27466847E-01
.12132318E 03	.57348164E 00	.63169318E 00	-.43108324E-01	-.15103230E-01	-.31563821E-01
.15625526E 03	.61246315E 00	.67463153E 00	-.46038544E-01	-.16129848E-01	-.30970550E-01
.18222624E 03	.62999051E 00	.69393801E 00	-.47356066E-01	-.16591449E-01	-.35354194E-01
.19470141E 03	.62312683E 00	.68637763E 00	-.46840127E-01	-.16410687E-01	-.59038665E-01
.18732538E 03	.59647065E 00	.65701570E 00	-.44836396E-01	-.15708669E-01	-.60124680E-01
.16777918E 03	.55528392E 00	.61164829E 00	-.41740410E-01	-.14623974E-01	-.53051169E-01
.13081267E 03	.50205805E 00	.55301971E 00	-.37739449E-01	-.13222216E-01	-.44179444E-01
.92072278E 02	.43689886E 00	.48124650E 00	-.32841465E-01	-.11506182E-01	-.34103094E-01
.76077318E 02	.36319422E 00	.40006043E 00	-.27301125E-01	-.95650938E-02	-.23863560E-01
.62816722E 02	.28583221E 00	.31484575E 00	-.21485862E-01	-.75276857E-02	-.14750543E-01
.53214003E 02	.21970183E 00	.24200277E 00	-.16514875E-01	-.57860740E-02	-.86961848E-02
.46107665E 02	.16782048E 00	.18485519E 00	-.12614981E-01	-.44197253E-02	-.51033800E-02
.39476084E 02	.12764253E 00	.14059895E 00	-.95948240E-02	-.33615975E-02	-.29703270E-02
.33382348E 02	.96881698E-01	.10671572E 00	-.72825480E-02	-.25514793E-02	-.17222388E-02
.27874111E 02	.72821175E-01	.80212924E-01	-.54739307E-02	-.19178206E-02	-.98812886E-03
.22683907E 02	.54330024E-01	.59844821E-01	-.40839603E-02	-.14308372E-02	-.55413698E-03
.18308054E 02	.40391309E-01	.44491249E-01	-.30361942E-02	-.10637967E-02	-.31423430E-03
.14506677E 02	.29929004E-01	.32966962E-01	-.22497480E-02	-.78821114E-03	-.17704422E-03
.11324212E 02	.22180232E-01	.24431648E-01	-.16672768E-02	-.58413926E-03	-.99742807E-04
.88309584E 01	.16519798E-01	.18196648E-01	-.12417848E-02	-.43506589E-03	-.57261287E-04
.69086673E 01	.12415961E-01	.13676250E-01	-.93330152E-03	-.32698713E-03	-.33170166E-04
.54350750E 01	.94345690E-02	.10392230E-01	-.70919176E-03	-.24846909E-03	-.19998032E-04
.43508003E 01	.73283703E-02	.80722401E-02	-.55086987E-03	-.19300018E-03	-.12574141E-04
.34788956E 01	.57636168E-02	.63486556E-02	-.43324815E-03	-.15179078E-03	-.80614179E-05
.27473986E 01	.45424222E-02	.50035031E-02	-.34145157E-03	-.11962937E-03	-.51804502E-05
.21833173E 01	.35881875E-02	.39524083E-02	-.26972223E-03	-.94498613E-04	-.33379551E-05
.17088426E 01	.28479775E-02	.31370628E-02	-.21408102E-03	-.75004420E-04	-.21680081E-05
.13613701E 01	.22640926E-02	.24939105E-02	-.17019069E-03	-.59627211E-04	-.14107101E-05

Table D5. Numerical H Matrix (Concluded)

$h_{14,4}$	$h_{14,5}$	$h_{14,7}$	$h_{14,8}$	$h_{14,9}$	$h_{14,11}$
.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80	.00000000E-80
.37044420E-01	.29244815E 01	-.82296397E-01	.82807761E-02	.84396863E-02	.64702370E-01
.61408674E-01	.60106278E 01	-.34816711E 00	.35042918E-01	.35729310E-01	.27397256E 00
.27900570E 00	.89954636E 01	-.80441462E 00	.80968278E-01	.82560109E-01	.63309506E 00
.12319051E 01	.11767591E 02	-.14518038E 01	.14614490E 00	.14903743E 00	.11429403E 01
.26171154E 01	.14181883E 02	-.22869156E 01	.23024691E 00	.23485476E 00	.18012610E 01
.39930063E 01	.16176219E 02	-.32916197E 01	.33147697E 00	.33821827E 00	.25944576E 01
.55051617E 01	.17608386E 02	-.44272265E 01	.44603044E 00	.45537484E 00	.34942574E 01
.71789788E 01	.18348517E 02	-.56364151E 01	.56818525E 00	.58055696E 00	.44567023E 01
.88266029E 01	.18243740E 02	-.67917088E 01	.68471684E 00	.69972567E 00	.53719121E 01
.10099933E 02	.17315688E 02	-.77191606E 01	.77753887E 00	.79362494E 00	.60889581E 01
.10754670E 02	.15891322E 02	-.83328915E 01	.83948922E 00	.85704029E 00	.65762373E 01
.10844770E 02	.14194894E 02	-.86787840E 01	.87468116E 00	.89345418E 00	.68575975E 01
.10520629E 02	.12254708E 02	-.87541388E 01	.88261249E 00	.90202972E 00	.69253172E 01
.97966836E 01	.10078147E 02	-.85072128E 01	.85803550E 00	.87736034E 00	.67377138E 01
.86569026E 01	.78468407E 01	-.79084259E 01	.79792489E 00	.81629375E 00	.62783437E 01
.71812383E 01	.57429895E 01	-.69672054E 01	.70318631E 00	.71969246E 00	.55295761E 01
.57705663E 01	.40809891E 01	-.59947098E 01	.60517843E 00	.61958664E 00	.47612485E 01
.45745611E 01	.28671014E 01	-.51195571E 01	.51691379E 00	.52933837E 00	.40682016E 01
.35902119E 01	.19929251E 01	-.43425374E 01	.43850833E 00	.44911723E 00	.34519415E 01
.28010941E 01	.13665989E 01	-.36643331E 01	.37005173E 00	.37904419E 00	.29135149E 01
.21596947E 01	.90761302E 00	-.30514440E 01	.30817371E 00	.31568511E 00	.24265970E 01
.16447467E 01	.59127180E 00	-.25133802E 01	.25384255E 00	.26004285E 00	.19989407E 01
.12376184E 01	.39586741E 00	-.20550132E 01	.20755410E 00	.21263081E 00	.16345140E 01
.92256053E 00	.27549376E 00	-.16640314E 01	.16806815E 00	.17218297E 00	.13236032E 01
.68836079E 00	.18787229E 00	-.13388805E 01	.13522926E 00	.13854225E 00	.10650092E 01
.51752273E 00	.12083338E 00	-.10766408E 01	.10874342E 00	.11140869E 00	.85643138E 00
.39248720E 00	.74103412E-01	-.86939674E 00	.87811727E-01	.89964631E-01	.69158721E 00
.30022265E 00	.44550344E-01	-.70674964E 00	.71384124E-01	.73134621E-01	.56221090E 00
.23403333E 00	.28428787E-01	-.58505726E 00	.59092922E-01	.60542213E-01	.46540955E 00
.18435682E 00	.19786143E-01	-.48870662E 00	.49361243E-01	.50571983E-01	.38876533E 00
.14561957E 00	.12199846E-01	-.40782246E 00	.41191688E-01	.42202122E-01	.32442346E 00
.11532210E 00	.50357726E-02	-.34013504E 00	.34355026E-01	.35197806E-01	.27057887E 00
.91619179E-01	.21647362E-03	-.28434891E 00	.28720422E-01	.29425009E-01	.22620132E 00
.72815553E-01	.17198080E-02	-.23717135E 00	.23955307E-01	.24543013E-01	.18867162E 00

Table D6. Numerical D Matrix

d_{82}	d_{84}	$d_{10,2}$	$d_{10,4}$
-.24639733E 10	.00000000E-80	-.34678143E 11	.00000000E-80
-.24639733E 10	-.28999449E 05	-.34678143E 11	-.63112641E 05
-.24933064E 10	-.11388985E 06	-.35090978E 11	-.24786295E 06
-.26106384E 10	-.26726920E 06	-.36742319E 11	-.58166846E 06
-.28453026E 10	-.49020749E 06	-.40044999E 11	-.10668578E 07
-.29333016E 10	-.78123456E 06	-.41283504E 11	-.17002315E 07
-.28159695E 10	-.11265636E 07	-.39632164E 11	-.24517846E 07
-.23466413E 10	-.14221494E 07	-.33026803E 11	-.30950797E 07
-.22293092E 10	-.15604233E 07	-.31375463E 11	-.33960105E 07
-.22586422E 10	-.20292784E 07	-.31788298E 11	-.44163983E 07
-.23466413E 10	-.39261458E 07	-.33026803E 11	-.85446254E 07
-.23466413E 10	-.47129400E 07	-.33026803E 11	-.10256956E 08
-.20533111E 10	-.50035306E 07	-.28898453E 11	-.10889380E 08
-.18773130E 10	-.51474466E 07	-.26421443E 11	-.11202590E 08
-.18479800E 10	-.51048658E 07	-.26008608E 11	-.11109920E 08
-.18186470E 10	-.48104814E 07	-.25595772E 11	-.10469240E 08
-.18186470E 10	-.42336731E 07	-.25595772E 11	-.92139092E 07
-.18186470E 10	-.36376598E 07	-.25595772E 11	-.79167819E 07
-.18479800E 10	-.31261531E 07	-.26008608E 11	-.68035699E 07
-.18773130E 10	-.26688042E 07	-.26421443E 11	-.58082234E 07
-.19359791E 10	-.22670806E 07	-.27247113E 11	-.49339365E 07
-.19946451E 10	-.19175014E 07	-.28072783E 11	-.41731337E 07
-.20533111E 10	-.15913916E 07	-.28898453E 11	-.34634081E 07
-.21413102E 10	-.13350767E 07	-.30136958E 11	-.29055798E 07
-.19653121E 10	-.11094171E 07	-.27659948E 11	-.24144679E 07
-.19653121E 10	-.91567759E 06	-.27659948E 11	-.19928251E 07
-.19653121E 10	-.76205100E 06	-.27659948E 11	-.16584815E 07
-.19653121E 10	-.63106444E 06	-.27659948E 11	-.13734103E 07
-.19653121E 10	-.53565134E 06	-.27659948E 11	-.11657591E 07
-.19653121E 10	-.46210283E 06	-.27659948E 11	-.10056925E 07
-.13786518E 10	-.40008161E 06	-.19403247E 11	-.87071332E 06
-.15546498E 10	-.34541769E 06	-.21880257E 11	-.75174608E 06
-.17306479E 10	-.29748422E 06	-.24357267E 11	-.64742659E 06
-.19066460E 10	-.25545667E 06	-.26834278E 11	-.55596039E 06
-.20826441E 10	-.22018909E 06	-.29311288E 11	-.47920617E 06

Table D6. Numerical D Matrix (Concluded)

$d_{12,1}$	$d_{12,2}$	$d_{12,3}$	$d_{12,4}$	$d_{14,4}$
-.17919691E 04	-.22173237E 04	.00000000E-80	.00000000E-80	.00000000E-80
-.17843854E 04	-.22366186E 04	-.20274681E 01	-.30094588E 00	.64702370E-01
-.17810467E 04	-.22878232E 04	-.86355874E 01	-.96449312E 00	.27397256E 00
-.17807283E 04	-.25981440E 04	-.20059624E 02	-.20022871E 01	.63309506E 00
-.17770347E 04	-.29892516E 04	-.36437696E 02	-.31022514E 01	.11429403E 01
-.17819077E 04	-.31559805E 04	-.57710714E 02	-.38453217E 01	.18012610E 01
-.17940571E 04	-.27729742E 04	-.83655495E 02	-.25759489E 01	.25944576E 01
-.18129179E 04	-.20832891E 04	-.11344936E 03	.34482539E 01	.34942574E 01
-.18258595E 04	-.20514743E 04	-.14537028E 03	.15682588E 02	.44567023E 01
-.18351904E 04	-.22070513E 04	-.16891010E 03	.20550777E 02	.53719121E 01
-.18428516E 04	-.23365727E 04	-.18061424E 03	-.21064338E 02	.60889581E 01
-.18514333E 04	-.23507740E 04	-.17465044E 03	-.30590105E 02	.65762373E 01
-.18677954E 04	-.20691234E 04	-.15780712E 03	-.28230994E 02	.68575975E 01
-.18752144E 04	-.17218578E 04	-.12439573E 03	-.24718470E 02	.69253172E 01
-.18756872E 04	-.16316282E 04	-.88533631E 02	-.20750946E 02	.67377138E 01
-.18725926E 04	-.14768564E 04	-.73776230E 02	-.16268680E 02	.62703437E 01
-.18661510E 04	-.17585380E 04	-.61362710E 02	-.11930157E 02	.55295761E 01
-.18566193E 04	-.16187005E 04	-.52287620E 02	-.83475429E 01	.47612485E 01
-.18444822E 04	-.16592409E 04	-.45507419E 02	-.57675688E 01	.40682016E 01
-.18216054E 04	-.18405322E 04	-.39093849E 02	-.36990947E 01	.34519415E 01
-.18015143E 04	-.20430229E 04	-.33163417E 02	-.29699453E 01	.29135149E 01
-.17789012E 04	-.21891994E 04	-.27744474E 02	-.22039098E 01	.24265970E 01
-.17597511E 04	-.24196954E 04	-.22599675E 02	-.17381481E 01	.19989407E 01
-.17013153E 04	-.26641448E 04	-.18261597E 02	-.19546749E 01	.16345140E 01
-.15307890E 04	-.15438883E 04	-.14485237E 02	-.17678703E 01	.13236032E 01
-.14288952E 04	-.15822286E 04	-.11315072E 02	-.15928537E 01	.10650092E 01
-.13261919E 04	-.16299820E 04	-.88276510E 01	-.15096645E 01	.85643138E 00
-.12255665E 04	-.16864535E 04	-.69082719E 01	-.13753831E 01	.69158721E 00
-.11247204E 04	-.15570005E 04	-.54359725E 01	-.17046522E 01	.56221090E 00
-.10242829E 04	-.15403121E 04	-.43523862E 01	-.16512874E 01	.46590955E 00
-.87485479E 03	-.21254956E 04	-.34809032E 01	-.18614343E 01	.38876533E 00
-.77608474E 03	-.21921046E 04	-.27494501E 01	-.20323797E 01	.32442346E 00
-.66802029E 03	-.21692790E 04	-.21852178E 01	-.19388274E 01	.27057887E 00
-.54290719E 03	-.20301972E 04	-.17105160E 01	-.23176001E 01	.22620132E 00
-.40281636E 03	-.20639786E 04	-.13629460E 01	-.24709672E 01	.18867162E 00

Table D7. Ten-Second Gimbal Positions

Engine	Flight Coordinates		
	x ft.	y ft.	z ft.
1	-100.54	-16.0	- 3.92
2	-100.54	- 8.0	- 3.92
3	-100.54	0.0	- 3.92
4	-100.54	+ 8.0	- 3.92
5	-100.54	+16.0	- 3.92
6	-100.54	-16.0	4.08
7	-100.54	- 8.0	4.08
8	-100.54	0.0	4.08
9	-100.54	+ 8.0	4.08
10	-100.54	+16.0	4.08
11	-100.54	- 8.0	12.08
12	-100.54	0.0	12.08
13	-100.54	+ 8.0	12.08

$x_{cm} = 93.46$ $z_{cm} = 8.08$

$x_g = 194.00$

100.54 ft.

Table D8. Roll Gimbaling

$$\frac{\partial \delta_{z_i}}{\partial \delta_p}$$

ENGINE t~sec	1	2	3	4	5	6	7	8	9	10	11	12	13	L_{δ_p}/T	N_{δ_p}/T
10	-1.0	-1.0	-1.0	-1.0	-1.0	+1.0	-.00418	- .00418	-.00418	+1.0	+1.0	+1.0	+1.0	-9.24	+ .0972
24	-1.0	-1.0	-1.0	-1.0	-1.0	+1.0	-.01433	- .01433	-.01433	+1.0	+1.0	+1.0	+1.0	-9.21	+ .321
38	-1.0	-1.0	-1.0	-1.0	-1.0	+1.0	-.00372	- .00372	-.00372	+1.0	+1.0	+1.0	+1.0	-9.20	+ .0805
54	-1.0	-1.0	-1.0	-1.0	-1.0	+1.0	-.0118	- .0118	-.0118	+1.0	+1.0	+1.0	+1.0	-9.21	+ .243
64	-1.0	-1.0	-1.0	-1.0	-1.0	+1.0	0.0	0.0	0.0	+1.0	+1.0	+1.0	+1.0	-9.23	0.0
90	-1.0	-1.0	-1.0	-1.0	-1.0	+1.0	-.00623	- .00623	-.00623	+1.0	+1.0	+1.0	+1.0	-9.22	+ .1125
115	-1.0	-1.0	-1.0	-1.0	-1.0	+1.0	-.0429	- .0429	-.0429	+1.0	+1.0	+1.0	+1.0	-9.35	+ .711
120	-1.0	-1.0	-1.0	-1.0	-1.0	+ .986	+.986	+ .986	+.986	+ .986				-8.73	+ .455
145	-1.0	-1.0	-1.0	-1.0	-1.0	.965	.965	.965	.965	.965				-8.365	+ .962
150	-1.0	- .0601	-1.0	- .0601	-1.0	+1.0		+1.0		+1.0				-7.91	+ .791
160	-1.0	- .0926	-1.0	- .0926	-1.0	+1.0		+1.0		+1.0				-7.84	+1.104

Table D9. Yaw Gimbaling

$$\frac{\partial \delta_{z_i}}{\partial \delta_r}$$

ENGINE t~sec	1	2	3	4	5	6	7	8	9	10	11	12	13	L_{δ_r}/T	N_{δ_r}/T
10	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+ .294	+ .294	+ .294	- .871	-84.2
24	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	-3.33	-96.5
38	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	- .0749	- .0749	- .0749	- .612	-70.3
54	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+ .1538	+ .1538	+ .1538	-1.88	-71.7
64	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	- .539	- .539	- .539	0.0	-55.5
90	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	- .639	- .639	- .639	- .67	-48.5
115	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	- .2085	- .2085	- .2085	-3.80	-49.4
120	+1.0	+1.0	+1.0	+1.0	+1.0	+ .129	+ .129	+ .129	+ .129	+ .129				-1.985	-38.1
145	1.0	1.0	1.0	1.0	1.0	+ .138	+ .138	+ .138	+ .138	+ .138				-3.565	-31.3
150	+1.0	+1.0	+1.0	+1.0	+1.0	- .127		- .127		- .127				-3.025	-30.25
160	+1.0	+1.0	+1.0	+1.0	+1.0	- .0958		- .0958		- .0958				-3.96	-28.0

Table D10. Rocket Gains

t sec	$\frac{L_{\delta_p}}{T}$ ft/rad	$\frac{N_{\delta_p}}{T}$ ft/rad	$\frac{N_{\delta_r}}{T}$ ft/rad	$\frac{L_{\delta_r}}{T}$ ft/rad	$\frac{Y_{\delta_r}}{T}$ 1/rad	$\frac{Y_{\delta_p}}{T}$ 1/rad
0	-9.22	.110	-84.	- .9	.84	-.0020
5	-9.22	.100	-84.	- .9	.84	-.0020
10	-9.22	.097	-85.	- .9	.85	-.0020
15	-9.22	.115	-90.	-1.6	.89	-.0025
20	-9.22	.280	-95.	-3.0	.97	-.0032
25	-9.22	.330	-97.	-3.4	1.00	-.0034
30	-9.22	.260	-89.	-2.6	.96	-.0025
35	-9.22	.090	-74.	- .8	.80	-.0012
40	-9.22	.090	-71.	- .7	.76	-.0010
45	-9.22	.150	-71.	-1.3	.77	-.0015
50	-9.22	.220	-72.	-1.7	.80	-.0023
55	-9.22	.240	-71.	-1.7	.80	-.0028
60	-9.22	.06	-65.	- .5	.70	-.0008
65	-9.22	.000	-57.	.0	.64	-.0000
70	-9.22	.005	-54.	.0	.63	-.0001
75	-9.22	.012	-50.	.0	.62	-.0001
80	-9.22	.030	-50.	- .1	.62	-.0003
85	-9.22	.060	-49.	- .4	.62	-.0009
90	-9.22	.112	-48.	- .7	.63	-.0015
95	-9.22	.230	-49.	-1.0	.64	-.0027
100	-9.23	.340	-49.	-1.8	.66	-.0042
105	-9.25	.460	-49.	-2.3	.68	-.0060
110	-9.28	.580	-49.	-3.1	.70	-.0081
115	-9.32	.720	-50.	-3.9	.73	-.0100
120	-8.73	.455	-38.	-2.0	.67	-.0070
125	-8.67	.560	-37.	-2.3	.67	-.0090
130	-8.58	.650	-36.	-2.6	.67	-.0110
135	-8.51	.760	-35.	-2.9	.67	-.0135
140	-8.44	.870	-32.	-3.2	.67	-.0155
145	-8.37	.962	-30.	-3.6	.67	-.0175
150	-7.91	1.020	-29.	-3.0	.47	-.0150
155	-7.87	1.060	-29.	-3.5	.53	-.0190
160	-7.84	1.104	-28.	-4.0	.59	-.230
165	-7.77	1.160	-26.	-4.5	.65	-.0270
170	-7.70	1.210	-25.	-5.0	.71	-.0310

Table D11. Heading (u_{21D}) Covariance Results

MEAN RESPONSES

$\tilde{t}$	δ_p	$\dot{\delta}_p$	δ_r	$\dot{\delta}_r$	δ_a	$\dot{\delta}_a$	M_{660}	$\dot{M}_{660}$	M_{1880}
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.918E-04	.753E-03	.133E-03	.115E-02	.000E-80	.000E-80	-.155E 05	-.104E 06	-.157E 06
3	-.197E-02	-.813E-03	.175E-02	-.473E-04	.000E-80	.000E-80	-.331E 06	-.321E 05	-.236E 07
4	-.653E-02	-.147E-02	.258E-02	.376E-04	.000E-80	.000E-80	-.883E 06	-.794E 05	-.446E 07
5	-.143E-01	-.224E-02	.312E-02	-.382E-04	.000E-80	.000E-80	-.181E 07	-.118E 06	-.727E 07
6	-.224E-01	-.203E-02	.325E-02	-.117E-03	.000E-80	.000E-80	-.304E 07	-.155E 06	-.102E 08
7	-.279E-01	-.111E-02	.168E-02	-.585E-03	.000E-80	.000E-80	-.431E 07	-.138E 06	-.112E 08
8	-.280E-01	.216E-03	-.529E-02	-.228E-02	.000E-80	.000E-80	-.481E 07	.135E 05	-.578E 07
9	-.268E-01	.624E-03	-.176E-01	-.312E-02	.000E-80	.000E-80	-.417E 07	.107E 06	.568E 07
10	-.341E-01	-.169E-02	-.209E-01	-.537E-03	.000E-80	.000E-80	-.487E 07	-.103E 06	.716E 07
11	-.871E-01	-.147E-01	.119E-01	.818E-02	.000E-80	.000E-80	-.113E 08	-.118E 07	-.351E 08
12	-.110E 00	-.598E-02	.167E-01	.169E-02	.000E-80	.000E-80	-.143E 08	-.859E 06	-.477E 08
13	-.112E 00	.113E-02	.190E-01	-.475E-03	.000E-80	.000E-80	-.163E 08	-.779E 06	-.501E 08
14	-.887E-01	.607E-02	.138E-01	-.857E-03	.000E-80	.000E-80	-.142E 08	-.148E 06	-.407E 08
15	-.426E-01	.973E-02	.434E-02	-.112E-02	.000E-80	.000E-80	-.693E 07	.911E 06	-.181E 08
16	.104E-01	.108E-01	-.164E-02	-.471E-03	.000E-80	.000E-80	.175E 07	.148E 07	.507E 07
17	.499E-01	.722E-02	-.383E-02	.132E-03	.000E-80	.000E-80	.762E 07	.137E 07	.192E 08
18	.600E-01	.736E-03	-.290E-02	.387E-03	.000E-80	.000E-80	.907E 07	.798E 06	.217E 08
19	.501E-01	-.288E-02	-.135E-02	.327E-03	.000E-80	.000E-80	.753E 07	.192E 06	.173E 08
20	.345E-01	-.365E-02	-.263E-03	.196E-03	.000E-80	.000E-80	.508E 07	-.133E 06	.112E 08
21	.187E-01	-.346E-02	-.464E-04	.235E-04	.000E-80	.000E-80	.281E 07	-.263E 06	.615E 07
22	.755E-02	-.231E-02	.344E-04	.198E-05	.000E-80	.000E-80	.118E 07	-.264E 06	.255E 07
23	.173E-02	-.113E-02	.195E-04	-.713E-05	.000E-80	.000E-80	.284E 06	-.185E 06	.604E 06
24	-.371E-03	-.367E-03	.139E-04	.417E-05	.000E-80	.000E-80	-.707E 05	-.102E 06	-.165E 06
25	-.837E-03	-.588E-04	.278E-04	.808E-05	.000E-80	.000E-80	-.162E 06	-.419E 05	-.372E 06
26	-.567E-03	.744E-04	.199E-04	-.272E-06	.000E-80	.000E-80	-.121E 06	-.863E 04	-.277E 06
27	-.384E-03	.496E-04	.156E-04	-.692E-06	.000E-80	.000E-80	-.912E 05	-.679E 04	-.210E 06
28	-.255E-03	.348E-04	.139E-04	-.774E-07	.000E-80	.000E-80	-.693E 05	-.551E 04	-.161E 06
29	-.180E-03	.204E-04	.195E-04	.161E-05	.000E-80	.000E-80	-.549E 05	-.461E 04	-.134E 06
30	-.137E-03	.117E-04	.174E-04	-.384E-06	.000E-80	.000E-80	-.441E 05	-.400E 04	-.109E 06
31	-.105E-03	.927E-05	.144E-04	-.717E-06	.000E-80	.000E-80	-.355E 05	-.313E 04	-.847E 05
32	-.779E-04	.729E-05	.132E-04	-.249E-06	.000E-80	.000E-80	-.289E 05	-.312E 04	-.706E 05
33	-.588E-04	.514E-05	.141E-04	.331E-06	.000E-80	.000E-80	-.237E 05	-.195E 04	-.607E 05
34	-.478E-04	.291E-05	.145E-04	.233E-06	.000E-80	.000E-80	-.195E 05	-.215E 04	-.528E 05
35	-.388E-04	.239E-05	.155E-04	.334E-06	.000E-80	.000E-80	-.163E 05	-.181E 04	-.476E 05

Table D11. Heading (u_{21D}) Covariance Results (Continued)

MEAN RESPONSES

$\tilde{t}$	$\dot{M}_{1880}$	a_y	$\dot{a}_y$	$\bar{q}\beta$	$\bar{q}\dot{\beta}$	ϕ	$\dot{\phi}$	y	$\dot{y}$
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.129E 07	.138E-01	.397E-01	.107E-01	.300E-01	.286E-05	.197E-04	-.245E-02	-.163E-02
3	-.248E 05	.236E-01	-.329E-01	.523E 00	.991E-01	-.149E-03	-.471E-04	.879E 00	.330E 00
4	-.209E 06	-.613E-01	-.132E 00	.180E 01	.208E 00	-.514E-03	-.891E-04	.290E 01	.408E 00
5	-.215E 06	-.251E 00	-.331E 00	.405E 01	.327E 00	-.114E-02	-.137E-03	.397E 01	-.151E 00
6	-.210E 06	-.555E 00	-.723E 00	.720E 01	.451E 00	-.181E-02	-.126E-03	-.545E 00	-.193E 01
7	.320E 06	-.103E 01	-.560E 00	.109E 02	.525E 00	-.229E-02	-.711E-04	-.185E 02	-.569E 01
8	.205E 07	-.164E 01	.181E 01	.146E 02	.495E 00	-.232E-02	.124E-04	-.622E 02	-.124E 02
9	.284E 07	-.227E 01	.850E 01	.176E 02	.446E 00	-.223E-02	.363E-04	-.148E 03	-.227E 02
10	.239E 06	-.272E 01	.148E 02	.192E 02	.585E 00	-.279E-02	-.106E-03	-.294E 03	-.360E 02
11	-.980E 07	-.216E 01	-.148E 02	.184E 02	.125E 01	-.693E-02	-.895E-03	-.508E 03	-.487E 02
12	-.342E 07	-.250E 01	-.276E 02	.206E 02	.149E 01	-.898E-02	-.370E-03	-.778E 03	-.597E 02
13	-.124E 07	-.307E 01	-.298E 02	.235E 02	.169E 01	-.932E-02	.567E-04	-.111E 04	-.727E 02
14	.283E 06	-.290E 01	-.272E 02	.205E 02	.799E 00	-.745E-02	.377E-03	-.151E 04	-.876E 02
15	.274E 07	-.155E 01	-.187E 02	.101E 02	-.809E 00	-.371E-02	.618E-03	-.198E 04	-.989E 02
16	.358E 07	.305E 00	-.880E 01	-.244E 01	-.180E 01	.656E-03	.689E-03	-.248E 04	-.102E 03
17	.289E 07	.178E 01	-.230E 01	-.110E 02	-.185E 01	.399E-02	.466E-03	-.298E 04	-.963E 02
18	.147E 07	.224E 01	.179E 00	-.133E 02	-.114E 01	.494E-02	.577E-04	-.344E 04	-.859E 02
19	.193E 06	.193E 01	.306E 00	-.111E 02	-.287E 00	.419E-02	-.175E-03	-.384E 04	-.754E 02
20	-.429E 06	.135E 01	.187E-01	-.747E 01	.194E 00	.292E-02	-.228E-03	-.420E 04	-.671E 02
21	-.589E 06	.753E 00	-.212E 00	-.412E 01	.399E 00	.162E-02	-.218E-03	-.452E 04	-.619E 02
22	-.577E 06	.321E 00	-.278E 00	-.171E 01	.407E 00	.670E-03	-.147E-03	-.482E 04	-.591E 02
23	-.395E 06	.780E-01	-.240E 00	-.410E 00	.284E 00	.166E-03	-.724E-04	-.511E 04	-.582E 02
24	-.221E 06	-.182E-01	-.258E 00	.973E-01	.156E 00	-.238E-04	-.242E-04	-.540E 04	-.580E 02
25	-.106E 06	-.421E-01	-.166E 00	.218E 00	.636E-01	-.647E-04	-.309E-05	-.569E 04	-.582E 02
26	-.169E 05	-.309E-01	-.553E-01	.158E 00	.896E-02	-.454E-04	.435E-05	-.598E 04	-.584E 02
27	-.148E 05	-.234E-01	-.940E-02	.115E 00	.528E-02	-.304E-04	.289E-05	-.628E 04	-.585E 02
28	-.968E 04	-.173E-01	.305E-01	.856E-01	.504E-02	-.201E-04	.200E-05	-.657E 04	-.586E 02
29	-.141E 05	-.134E-01	.583E-01	.642E-01	.355E-02	-.140E-04	.117E-05	-.686E 04	-.587E 02
30	-.985E 04	-.106E-01	.850E-01	.495E-01	.327E-02	-.105E-04	.666E-06	-.716E 04	-.587E 02
31	-.655E 04	-.802E-02	.124E 00	.387E-01	-.434E-02	-.760E-05	.570E-06	-.745E 04	-.588E 02
32	-.599E 04	-.708E-02	.115E 00	.303E-01	-.117E-02	-.561E-05	.386E-06	-.774E 04	-.588E 02
33	-.588E 04	-.566E-02	.110E 00	.238E-01	-.441E-02	-.422E-05	.271E-06	-.804E 04	-.589E 02
34	-.420E 04	-.395E-02	.127E 00	.188E-01	.232E-02	-.338E-05	.157E-06	-.833E 04	-.589E 02
35	-.420E 04	-.290E-02	.116E 00	.149E-01	-.797E-03	-.272E-05	.128E-06	-.863E 04	-.589E 02

Table D11. Heading (u_{21D}) Covariance Results (Continued)

RESPONSE COVARIANCES

$\tilde{t}$	δ_p	$\dot{\delta}_p$	δ_r	$\dot{\delta}_r$	δ_a	$\dot{\delta}_a$	M_{660}	$\dot{M}_{660}$	M_{1880}
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.584E-05	.359E-03	.138E-04	.900E-03	.000E-80	.000E-80	.175E 12	.773E 14	.189E 14
3	.184E-03	.620E-03	.296E-04	.301E-03	.000E-80	.000E-80	.212E 13	.183E 15	.576E 14
4	.356E-03	.341E-02	.436E-04	.831E-03	.000E-80	.000E-80	.427E 13	.293E 15	.976E 14
5	.536E-03	.787E-02	.417E-04	.122E-02	.000E-80	.000E-80	.659E 13	.331E 15	.123E 15
6	.567E-03	.105E-01	.330E-04	.138E-02	.000E-80	.000E-80	.858E 13	.274E 15	.124E 15
7	.434E-03	.367E-02	.774E-05	.424E-03	.000E-80	.000E-80	.952E 13	.571E 14	.716E 14
8	.315E-03	.107E-01	.615E-04	.411E-02	.000E-80	.000E-80	.814E 13	.358E 15	.639E 14
9	.843E-03	.154E 00	.719E-03	.585E-01	.000E-80	.000E-80	.677E 13	.362E 16	.590E 15
10	.128E-02	.250E 00	.105E-02	.954E-01	.000E-80	.000E-80	.876E 13	.542E 16	.870E 15
11	.335E-02	.166E 00	.402E-03	.469E-01	.000E-80	.000E-80	.474E 14	.211E 16	.869E 15
12	.723E-02	.411E 00	.107E-02	.123E 00	.000E-80	.000E-80	.991E 14	.563E 16	.208E 16
13	.716E-02	.333E 00	.105E-02	.140E 00	.000E-80	.000E-80	.125E 15	.431E 16	.192E 16
14	.498E-02	.189E 00	.714E-03	.998E-01	.000E-80	.000E-80	.109E 15	.255E 16	.134E 16
15	.290E-02	.726E-01	.267E-03	.380E-01	.000E-80	.000E-80	.708E 14	.100E 16	.686E 15
16	.181E-02	.224E-01	.779E-04	.105E-01	.000E-80	.000E-80	.434E 14	.334E 15	.342E 15
17	.119E-02	.737E-02	.178E-04	.244E-02	.000E-80	.000E-80	.264E 14	.108E 15	.173E 15
18	.703E-03	.217E-02	.373E-05	.501E-03	.000E-80	.000E-80	.157E 14	.410E 14	.916E 14
19	.412E-03	.760E-03	.670E-06	.884E-04	.000E-80	.000E-80	.920E 13	.190E 14	.494E 14
20	.242E-03	.291E-03	.473E-07	.977E-05	.000E-80	.000E-80	.518E 13	.978E 13	.256E 14
21	.130E-03	.133E-03	.107E-07	.304E-05	.000E-80	.000E-80	.291E 13	.556E 13	.141E 14
22	.674E-04	.581E-04	.231E-08	.763E-06	.000E-80	.000E-80	.165E 13	.322E 13	.777E 13
23	.333E-04	.256E-04	.156E-08	.271E-06	.000E-80	.000E-80	.914E 12	.184E 13	.424E 13
24	.157E-04	.127E-04	.153E-08	.461E-06	.000E-80	.000E-80	.523E 12	.109E 13	.253E 13
25	.824E-05	.584E-05	.476E-08	.366E-06	.000E-80	.000E-80	.295E 12	.639E 12	.150E 13
26	.371E-05	.235E-05	.402E-08	.228E-06	.000E-80	.000E-80	.163E 12	.349E 12	.851E 12
27	.164E-05	.923E-06	.390E-08	.147E-06	.000E-80	.000E-80	.926E 11	.192E 12	.498E 12
28	.697E-06	.346E-06	.310E-08	.799E-07	.000E-80	.000E-80	.522E 11	.105E 12	.288E 12
29	.346E-06	.171E-06	.623E-08	.829E-07	.000E-80	.000E-80	.318E 11	.761E 11	.198E 12
30	.193E-06	.743E-07	.529E-08	.414E-07	.000E-80	.000E-80	.200E 11	.487E 11	.130E 12
31	.115E-06	.362E-07	.618E-08	.507E-07	.000E-80	.000E-80	.126E 11	.254E 11	.812E 11
32	.667E-07	.127E-07	.597E-08	.173E-07	.000E-80	.000E-80	.820E 10	.202E 11	.586E 11
33	.377E-07	.334E-08	.444E-08	.363E-08	.000E-80	.000E-80	.532E 10	.154E 11	.408E 11
34	.259E-07	.812E-09	.576E-08	.864E-09	.000E-80	.000E-80	.362E 10	.216E 11	.344E 11
35	.174E-07	.130E-09	.531E-08	.682E-10	.000E-80	.000E-80	.250E 10	.231E 11	.276E 11

Table D11 Heading (u_{21D}) Covariance Results (Concluded)

RESPONSE COVARIANCES

$\tilde{t}$	$\dot{M}_{1880}$	a_y	$\dot{a}y$	$\bar{q}\beta$	$\dot{\bar{q}\beta}$	ϕ	$\dot{\phi}$	y	$\dot{y}$
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.113E 16	.132E 00	.102E 01	.715E-01	.512E 00	.606E-08	.254E-06	.998E-02	.334E-02
3	.374E 15	.784E-01	.713E 00	.111E 02	.737E-01	.102E-05	.747E-06	.874E 02	.451E 01
4	.113E 16	.232E 00	.898E 01	.234E 02	.435E 00	.211E-05	.257E-05	.274E 03	.531E 00
5	.198E 16	.492E 00	.369E 02	.370E 02	.147E 01	.314E-05	.450E-05	.223E 03	.208E 01
6	.242E 16	.753E 00	.810E 02	.498E 02	.408E 01	.338E-05	.486E-05	.513E 01	.160E 02
7	.724E 15	.710E 00	.392E 02	.613E 02	.109E 02	.283E-05	.166E-05	.668E 03	.498E 02
8	.431E 16	.164E 01	.245E 03	.734E 02	.249E 02	.190E-05	.298E-05	.481E 04	.113E 03
9	.569E 17	.124E 02	.470E 04	.884E 02	.506E 02	.198E-05	.401E-04	.172E 05	.219E 03
10	.949E 17	.215E 02	.104E 05	.104E 03	.978E 02	.293E-05	.613E-04	.452E 05	.379E 03
11	.542E 17	.144E 02	.896E 04	.116E 03	.183E 03	.168E-04	.463E-04	.990E 05	.566E 03
12	.141E 18	.360E 02	.270E 05	.189E 03	.300E 03	.374E-04	.111E-03	.188E 06	.751E 03
13	.125E 18	.346E 02	.289E 05	.250E 03	.436E 03	.408E-04	.888E-04	.324E 06	.988E 03
14	.761E 17	.231E 02	.212E 05	.221E 03	.467E 03	.298E-04	.529E-04	.516E 06	.125E 04
15	.292E 17	.106E 02	.101E 05	.143E 03	.329E 03	.182E-04	.226E-04	.771E 06	.140E 04
16	.837E 16	.441E 01	.364E 04	.880E 02	.192E 03	.118E-04	.841E-05	.107E 07	.134E 04
17	.220E 16	.210E 01	.123E 04	.552E 02	.106E 03	.797E-05	.341E-05	.141E 07	.117E 04
18	.581E 15	.112E 01	.381E 03	.338E 02	.581E 02	.484E-05	.126E-05	.175E 07	.998E 03
19	.173E 15	.639E 00	.116E 03	.198E 02	.322E 02	.286E-05	.534E-06	.211E 07	.857E 03
20	.595E 14	.371E 00	.288E 02	.112E 02	.181E 02	.169E-05	.241E-06	.247E 07	.745E 03
21	.311E 14	.210E 00	.138E 02	.624E 01	.102E 02	.915E-06	.113E-06	.283E 07	.657E 03
22	.167E 14	.122E 00	.550E 01	.345E 01	.577E 01	.479E-06	.514E-07	.319E 07	.587E 03
23	.925E 13	.681E-01	.261E 01	.188E 01	.325E 01	.239E-06	.229E-07	.357E 07	.534E 03
24	.596E 13	.376E-01	.283E 01	.102E 01	.182E 01	.115E-06	.107E-07	.394E 07	.494E 03
25	.343E 13	.202E-01	.171E 01	.539E 00	.986E 00	.530E-07	.448E-08	.433E 07	.466E 03
26	.185E 13	.110E-01	.109E 01	.283E 00	.503E 00	.236E-07	.180E-08	.473E 07	.444E 03
27	.997E 12	.604E-02	.867E 00	.149E 00	.248E 00	.103E-07	.698E-09	.515E 07	.428E 03
28	.522E 12	.331E-02	.669E 00	.793E-01	.123E 00	.430E-08	.264E-09	.557E 07	.415E 03
29	.319E 12	.178E-02	.940E 00	.433E-01	.618E-01	.207E-08	.114E-09	.602E 07	.406E 03
30	.168E 12	.106E-02	.702E 00	.248E-01	.303E-01	.113E-08	.496E-10	.647E 07	.399E 03
31	.845E 11	.675E-03	.595E 00	.146E-01	.134E-01	.603E-09	.204E-10	.695E 07	.394E 03
32	.354E 11	.381E-03	.390E 00	.865E-02	.515E-02	.344E-09	.750E-11	.744E 07	.390E 03
33	.117E 11	.222E-03	.160E 00	.517E-02	.170E-02	.194E-09	.254E-11	.795E 07	.386E 03
34	.323E 10	.104E-03	.767E-01	.315E-02	.436E-03	.129E-09	.686E-12	.847E 07	.384E 03
35	.373E 09	.513E-04	.126E-01	.196E-02	.487E-04	.854E-10	.219E-12	.902E 07	.382E 03

Table D12. Drift (u_{22D}) Covariance Results

MEAN RESPONSES

τ	δ_p	δ_p	δ_r	$\dot{\delta}_r$	δ_a	$\dot{\delta}_a$	M_{660}	$\dot{M}_{660}$	M_{1880}
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.831E-04	.663E-03	.145E-03	.125E-02	.000E-80	.000E-80	-.164E 05	-.112E 06	-.170E 06
3	-.189E-02	-.950E-03	.169E-02	.229E-04	.000E-80	.000E-80	-.329E 06	-.353E 05	-.230E 07
4	-.627E-02	-.136E-02	.248E-02	.217E-04	.000E-80	.000E-80	-.856E 06	-.755E 05	-.430E 07
5	-.132E-01	-.192E-02	.288E-02	-.696E-04	.000E-80	.000E-80	-.168E 07	-.122E 06	-.674E 07
6	-.198E-01	-.153E-02	.285E-02	-.148E-03	.000E-80	.000E-80	-.270E 07	-.191E 06	-.903E 07
7	-.233E-01	-.460E-03	.114E-02	-.567E-03	.000E-80	.000E-80	-.360E 07	-.241E 06	-.905E 07
8	-.215E-01	.821E-03	-.533E-02	-.194E-02	.000E-80	.000E-80	-.366E 07	-.207E 06	-.325E 07
9	-.195E-01	.772E-03	-.154E-01	-.237E-02	.000E-80	.000E-80	-.290E 07	-.213E 06	.662E 07
10	-.250E-01	-.156E-02	-.182E-01	-.576E-03	.000E-80	.000E-80	-.347E 07	-.463E 06	.793E 07
11	-.826E-01	-.210E-01	.117E-01	.849E-02	.000E-80	.000E-80	-.108E 08	-.167E 07	-.338E 08
12	-.115E 00	-.569E-02	.189E-01	.172E-02	.000E-80	.000E-80	-.149E 08	-.125E 07	-.492E 08
13	-.109E 00	.603E-02	.181E-01	-.963E-03	.000E-80	.000E-80	-.158E 08	-.123E 07	-.483E 08
14	-.892E-01	.533E-02	.137E-01	-.761E-03	.000E-80	.000E-80	-.143E 08	-.578E 06	-.408E 08
15	-.670E-01	.369E-02	.713E-02	-.686E-03	.000E-80	.000E-80	-.109E 08	.833E 06	-.288E 08
16	-.459E-01	.407E-02	.315E-02	-.382E-03	.000E-80	.000E-80	-.719E 07	.182E 07	-.178E 08
17	-.269E-01	.482E-02	.806E-03	-.339E-03	.000E-80	.000E-80	-.399E 07	.190E 07	-.923E 07
18	-.140E-01	.399E-02	.127E-03	-.156E-03	.000E-80	.000E-80	-.208E 07	.125E 07	-.460E 07
19	-.891E-02	.222E-02	.105E-03	-.557E-04	.000E-80	.000E-80	-.133E 07	.486E 06	-.296E 07
20	-.740E-02	.904E-03	.461E-04	-.304E-04	.000E-80	.000E-80	-.109E 07	.303E 05	-.240E 07
21	-.783E-02	.201E-03	.534E-04	.264E-05	.000E-80	.000E-80	-.118E 07	-.188E 06	-.261E 07
22	-.850E-02	.360E-04	.139E-04	-.915E-05	.000E-80	.000E-80	-.134E 07	-.228E 06	-.292E 07
23	-.814E-02	.213E-03	-.138E-04	-.346E-05	.000E-80	.000E-80	-.135E 07	-.169E 06	-.294E 07
24	-.698E-02	.401E-03	.555E-04	.285E-04	.000E-80	.000E-80	-.128E 07	-.949E 05	-.283E 07
25	-.580E-02	.451E-03	.134E-03	.410E-04	.000E-80	.000E-80	-.110E 07	-.390E 05	-.250E 07
26	-.418E-02	.470E-03	.127E-03	.503E-05	.000E-80	.000E-80	-.881E 06	-.589E 04	-.201E 07
27	-.298E-02	.348E-03	.134E-03	.705E-05	.000E-80	.000E-80	-.709E 06	-.536E 04	-.164E 07
28	-.207E-02	.261E-03	.130E-03	.283E-05	.000E-80	.000E-80	-.566E 06	-.450E 04	-.133E 07
29	-.154E-02	.149E-03	.198E-03	.230E-04	.000E-80	.000E-80	-.469E 06	-.519E 04	-.117E 07
30	-.121E-02	.937E-04	.191E-03	.911E-06	.000E-80	.000E-80	-.391E 06	-.358E 04	-.993E 06
31	-.965E-03	.785E-04	.208E-03	.952E-05	.000E-80	.000E-80	-.322E 06	-.325E 04	-.808E 06
32	-.764E-03	.555E-04	.218E-03	.500E-06	.000E-80	.000E-80	-.270E 06	-.293E 04	-.714E 06
33	-.593E-03	.472E-04	.199E-03	-.676E-05	.000E-80	.000E-80	-.224E 06	-.140E 04	-.617E 06
34	-.504E-03	.241E-04	.231E-03	.818E-05	.000E-80	.000E-80	-.190E 06	-.253E 04	-.578E 06
35	-.421E-03	.284E-04	.226E-03	-.577E-05	.000E-80	.000E-80	-.161E 06	-.135E 04	-.528E 06

Table D12. Drift (u_{22D}) Covariance Results (Continued)

MEAN RESPONSES

$\tilde{t}$	$\dot{M}_{1880}$	a_y	$\dot{a}_y$	$\bar{\bar{q}}\beta$	$\bar{q}\dot{\beta}$	ϕ	$\dot{\phi}$	y	$\dot{y}$
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.140E 07	.135E-01	.375E-01	.106E-01	.300E-01	.274E-05	.173E-04	-.249E-02	-.117E-02
3	-.978E 05	.227E-01	-.295E-01	.531E 00	.927E-01	-.142E-03	-.435E-04	.733E 00	.209E 00
4	-.185E 06	-.587E-01	-.136E 00	.175E 01	.201E 01	-.499E-03	-.322E-03	.151E 01	.336E-01
5	-.191E 06	-.232E 00	-.353E 00	.377E 01	.347E 01	-.116E-02	-.118E-03	.563E 01	-.490E 00
6	-.254E 06	-.493E 00	-.775E 00	.690E 01	.553E 01	-.151E-02	-.957E-04	-.377E 01	-.131E 01
7	.757E 05	-.879E 00	-.664E 00	.919E 01	.733E 01	-.190E-02	-.312E-04	-.123E 02	-.235E 01
8	.127E 07	-.133E 01	.162E 01	.114E 02	.104E 01	-.170E-02	.494E-04	-.271E 02	-.356E 01
9	.152E 07	-.179E 01	.824E 01	.130E 02	.132E 01	-.163E-02	.165E-04	-.175E 02	-.445E 01
10	-.512E 06	-.216E 01	.145E 02	.144E 02	.169E 01	-.204E-02	-.158E-04	-.705E 02	-.165E 01
11	-.111E 08	-.204E 01	-.147E 02	.175E 02	.337E 01	-.649E-02	-.125E-02	-.307E 02	-.306E 01
12	-.429E 07	-.264E 01	-.279E 02	.215E 02	.211E 01	-.339E-02	-.357E-03	-.104E 03	-.251E 01
13	-.185E 07	-.301E 01	-.304E 02	.228E 02	.245E 01	-.913E-02	.363E-03	-.117E 03	-.319E 01
14	-.720E 06	-.293E 01	-.274E 02	.207E 02	.145E 01	-.747E-02	.329E-03	-.131E 03	-.250E 01
15	.226E 07	-.245E 01	-.184E 02	.159E 02	-.730E 00	-.561E-02	.231E-03	-.138E 03	.309E-01
16	.427E 07	-.178E 01	-.819E 01	.104E 02	-.232E 01	-.387E-02	.253E-03	-.129E 03	.326E 01
17	.436E 07	-.103E 01	-.182E 01	.599E 01	-.259E 01	-.231E-02	.297E-03	-.106E 03	.558E 01
18	.282E 07	-.545E 00	.281E 00	.310E 01	-.176E 01	-.123E-02	.247E-03	-.761E 02	.596E 01
19	.110E 07	-.345E 00	.206E 00	.195E 01	-.690E 00	-.777E-03	.136E-03	-.491E 02	.476E 01
20	.888E 05	-.288E 00	-.132E 00	.163E 01	-.285E-01	-.629E-03	.553E-04	-.296E 02	.302E 01
21	-.410E 06	-.315E 00	-.371E 00	.173E 01	.291E 00	-.552E-03	.115E-04	-.184E 02	.152E 01
22	-.492E 06	-.361E 00	-.388E 00	.193E 01	.357E 00	-.705E-03	.771E-05	-.135E 02	.544E 00
23	-.363E 06	-.368E 00	-.304E 00	.194E 01	.261E 00	-.581E-03	.117E-04	-.120E 02	.129E 00
24	-.226E 06	-.340E 00	-.296E 00	.179E 01	.144E 00	-.590E-03	.234E-04	-.114E 02	.137E 00
25	-.124E 06	-.287E 00	-.190E 00	.149E 01	.569E-01	-.464E-03	.319E-04	-.107E 02	.167E 00
26	-.148E 05	-.227E 00	-.719E-01	.116E 01	.408E-02	-.333E-03	.272E-04	-.963E 01	.265E 00
27	-.175E 05	-.180E 00	-.214E-01	.838E 00	.282E-02	-.235E-03	.202E-04	-.926E 01	.280E 00
28	-.958E 04	-.141E 00	.220E-01	.698E 00	.355E-02	-.162E-03	.149E-04	-.690E 01	.264E 00
29	-.311E 05	-.110E 00	.529E-01	.547E 00	.265E-02	-.119E-03	.849E-05	-.564E 01	.241E 00
30	-.991E 04	-.895E-01	.824E-01	.436E 00	.270E-02	-.928E-04	.532E-05	-.449E 01	.209E 00
31	-.120E 05	-.734E-01	.122E 00	.347E 00	-.471E-02	-.730E-04	.133E-05	-.360E 01	.148E 00
32	-.593E 04	-.586E-01	.114E 00	.279E 00	-.140E-02	-.543E-04	.296E-05	-.288E 01	.136E 00
33	-.273E 02	-.465E-01	.110E 00	.221E 00	-.456E-02	-.124E-04	.259E-05	-.230E 01	.103E 00
34	-.107E 05	-.328E-01	.127E 00	.177E 00	.224E-02	-.355E-04	.132E-05	-.184E 01	.869E-01
35	.164E 04	-.236E-01	.116E 00	.143E 00	-.845E-03	-.295E-04	.142E-05	-.142E 01	.799E-01

Table D12. Drift (u_{22D}) Covariance Results (Continued)

RESPONSE COVARIANCES

$\tilde{t}$	δ_p	$\dot{\delta}_p$	δ_r	$\dot{\delta}_r$	δ_a	$\dot{\delta}_a$	M_{660}	$\dot{M}_{660}$	M_{1880}
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.445E-05	.272E-03	.166E-04	.107E-02	.000E-80	.000E-80	.200E 12	.342E 14	.226E 14
3	.172E-03	.104E-02	.377E-04	.454E-03	.000E-80	.000E-80	.198E 13	.233E 15	.535E 14
4	.321E-03	.455E-02	.564E-04	.107E-02	.000E-80	.000E-80	.343E 13	.330E 15	.137E 15
5	.452E-03	.966E-02	.536E-04	.143E-02	.000E-80	.000E-80	.475E 13	.425E 15	.127E 15
6	.479E-03	.122E-01	.415E-04	.152E-02	.000E-80	.000E-80	.657E 13	.346E 15	.122E 15
7	.351E-03	.396E-02	.885E-05	.438E-03	.000E-80	.000E-80	.752E 13	.551E 14	.599E 14
8	.270E-03	.122E-01	.939E-04	.449E-02	.000E-80	.000E-80	.613E 13	.530E 15	.375E 14
9	.105E-02	.170E 00	.102E-02	.615E-01	.000E-80	.000E-80	.366E 13	.512E 16	.990E 15
10	.161E-02	.276E 00	.153E-02	.996E-01	.000E-80	.000E-80	.556E 13	.789E 16	.133E 16
11	.275E-02	.173E 00	.455E-03	.498E-01	.000E-80	.000E-80	.370E 14	.230E 16	.544E 15
12	.620E-02	.433E 00	.130E-02	.121E 00	.000E-80	.000E-80	.732E 14	.635E 15	.211E 16
13	.488E-02	.350E 00	.123E-02	.137E 00	.000E-80	.000E-80	.752E 14	.593E 16	.165E 16
14	.282E-02	.197E 00	.816E-03	.971E-01	.000E-80	.000E-80	.515E 14	.233E 16	.110E 16
15	.137E-02	.749E-01	.290E-03	.367E-01	.000E-80	.000E-80	.236E 14	.117E 16	.417E 15
16	.684E-03	.227E-01	.756E-04	.11[illegible]E-01	.000E-80	.000E-80	.151E 14	.325E 15	.156E 15
17	.384E-03	.733E-02	.144E-04	.228E-02	.000E-80	.000E-80	.810E 13	.367E 14	.519E 14
18	.205E-03	.211E-02	.258E-05	.469E-03	.000E-80	.000E-80	.449E 13	.373E 14	.272E 14
19	.114E-03	.718E-03	.577E-06	.833E-04	.000E-80	.000E-80	.251E 13	.137E 14	.136E 14
20	.631E-04	.267E-03	.251E-06	.163E-04	.000E-80	.000E-80	.133E 13	.105E 14	.658E 13
21	.323E-04	.120E-03	.132E-06	.634E-05	.000E-80	.000E-80	.717E 12	.673E 13	.349E 13
22	.161E-04	.520E-04	.708E-07	.277E-05	.000E-80	.000E-80	.390E 12	.350E 13	.195E 13
23	.774E-05	.226E-04	.334E-07	.122E-05	.000E-80	.000E-80	.211E 12	.193E 13	.990E 12
24	.364E-05	.113E-04	.117E-07	.731E-06	.000E-80	.000E-80	.120E 12	.114E 13	.583E 12
25	.180E-05	.530E-05	.901E-08	.533E-06	.000E-80	.000E-80	.637E 11	.656E 12	.331E 12
26	.746E-06	.210E-05	.484E-08	.279E-06	.000E-80	.000E-80	.324E 11	.353E 12	.173E 12
27	.291E-06	.818E-06	.255E-08	.151E-06	.000E-80	.000E-80	.151E 11	.137E 12	.894E 11
28	.106E-06	.302E-06	.133E-08	.824E-07	.000E-80	.000E-80	.779E 10	.343E 11	.433E 11
29	.445E-07	.153E-06	.126E-08	.754E-07	.000E-80	.000E-80	.370E 10	.559E 11	.254E 11
30	.203E-07	.664E-07	.752E-09	.373E-07	.000E-80	.000E-80	.204E 10	.310E 11	.134E 11
31	.887E-08	.324E-07	.546E-09	.419E-07	.000E-80	.000E-80	.951E 09	.145E 11	.613E 10
32	.349E-08	.112E-07	.335E-09	.131E-07	.000E-80	.000E-80	.424E 09	.533E 10	.330E 10
33	.105E-08	.276E-08	.125E-09	.305E-08	.000E-80	.000E-80	.137E 09	.246E 10	.112E 10
34	.253E-09	.661E-09	.515E-10	.638E-09	.000E-80	.000E-80	.355E 08	.795E 09	.325E 09
35	.295E-10	.640E-10	.762E-11	.521E-10	.000E-80	.000E-80	.144E 07	.111E 09	.451E 08

Table D12. Drift (u_{22D}) Covaraiance Results (Concluded)

RESPONSE COVARIANCES

$\tilde{t}$	$\dot{M}_{1880}$	a_y	$\dot{a}_y$	$\bar{q}\beta$	$\bar{q}\dot{\beta}$	ϕ	$\dot{\phi}$	y	$\dot{y}$
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.135E 16	.126E 00	.913E 00	.711E-01	.515E 00	.493E-08	.188E-05	.963E-02	.236E-02
3	.563E 15	.880E-01	.933E 00	.106E 02	.774E-01	.831E-06	.134E-05	.493E 02	.543E 00
4	.146E 16	.219E 00	.106E 02	.181E 02	.440E 00	.176E-05	.377E-05	.289E 02	.142E 01
5	.233E 16	.458E 00	.410E 02	.266E 02	.147E 01	.241E-05	.616E-05	.643E 01	.333E 01
6	.266E 16	.697E 00	.861E 02	.372E 02	.498E 01	.262E-05	.629E-05	.129E 03	.332E 01
7	.745E 15	.610E 00	.402E 02	.438E 02	.109E 02	.223E-05	.190E-05	.377E 03	.298E 01
8	.470E 16	.150E 01	.251E 03	.557E 02	.248E 02	.153E-05	.396E-05	.709E 03	.379E 01
9	.597E 17	.124E 02	.476E 04	.596E 02	.504E 02	.215E-05	.519E-04	.111E 04	.608E 01
10	.990E 17	.215E 02	.105E 05	.641E 02	.978E 02	.314E-05	.313E-04	.158E 04	.812E 01
11	.531E 17	.140E 02	.895E 04	.857E 02	.183E 03	.123E-04	.514E-04	.274E 04	.464E 01
12	.139E 18	.356E 02	.269E 05	.145E 03	.300E 03	.297E-04	.129E-03	.232E 04	.670E 01
13	.122E 18	.328E 02	.288E 05	.145E 03	.436E 03	.242E-04	.102E-03	.262E 04	.174E 02
14	.741E 17	.206E 02	.211E 05	.104E 03	.466E 03	.142E-04	.591E-04	.283E 04	.179E 02
15	.282E 17	.853E 01	.100E 05	.575E 02	.328E 03	.729E-05	.245E-04	.277E 04	.993E 01
16	.802E 16	.287E 01	.363E 04	.299E 02	.191E 03	.395E-05	.873E-05	.213E 04	.776E 01
17	.208E 16	.103E 01	.123E 04	.167E 02	.105E 03	.236E-05	.334E-05	.144E 04	.547E 01
18	.550E 15	.413E 00	.380E 03	.962E 01	.581E 02	.134E-05	.117E-05	.457E 03	.459E 01
19	.168E 15	.197E 00	.116E 03	.541E 01	.322E 02	.764E-06	.467E-05	.492E 03	.286E 01
20	.618E 14	.101E 00	.288E 02	.239E 01	.181E 02	.427E-06	.201E-05	.273E 03	.169E 01
21	.328E 14	.541E-01	.138E 02	.154E 01	.132E 02	.222E-06	.307E-07	.153E 03	.970E 00
22	.178E 14	.296E-01	.552E 01	.816E 00	.577E 01	.112E-06	.399E-07	.129E 02	.554E 00
23	.986E 13	.161E-01	.262E 01	.435E 00	.325E 01	.544E-07	.171E-07	.433E 02	.309E 00
24	.612E 13	.898E-02	.283E 01	.233E 00	.182E 01	.260E-07	.792E-08	.226E 02	.169E 00
25	.350E 13	.457E-02	.171E 01	.116E 00	.936E 00	.114E-07	.345E-09	.115E 02	.898E-01
26	.188E 13	.229E-02	.109E 01	.560E-01	.503E 00	.467E-08	.134E-08	.581E 01	.467E-01
27	.100E 13	.112E-02	.867E 00	.258E-01	.248E 00	.179E-08	.503E-09	.292E 01	.239E-01
28	.521E 12	.531E-03	.669E 00	.118E-01	.123E 00	.646E-09	.181E-09	.148E 01	.122E-01
29	.313E 12	.263E-03	.940E 00	.532E-02	.618E-01	.262E-09	.359E-10	.737E 00	.623E-02
30	.164E 12	.127E-03	.702E 00	.253E-02	.303E-01	.116E-09	.378E-10	.355E 00	.317E-02
31	.821E 11	.620E-04	.595E 00	.111E-02	.134E-01	.462E-10	.150E-10	.169E 00	.157E-02
32	.342E 11	.251E-04	.390E 00	.449E-03	.515E-02	.130E-10	.547E-11	.798E-01	.735E-03
33	.114E 11	.767E-05	.160E 00	.144E-03	.170E-02	.551E-11	.154E-11	.360E-01	.350E-03
34	.311E 10	.143E-05	.767E-01	.314E-04	.436E-03	.132E-11	.420E-12	.150E-01	.168E-03
35	.359E 09	.127E-06	.126E-01	.356E-05	.487E-04	.161E-12	.524E-11	.527E-12	.779E-04

Table D13. Accelerometer Load Relief (u_{24D}) Covariance Results

MEAN RESPONSES

$\tilde{t}$	δ_p	$\dot{\delta}_p$	δ_r	$\dot{\delta}_r$	δ_a	$\dot{\delta}_a$	M_{660}	$\dot{M}_{660}$	M_{1880}
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.918E-04	.753E-03	.133E-03	.115E-02	.000E-80	.000E-80	-.155E 05	-.104E 06	-.157E 06
3	-.197E-02	-.813E-03	.175E-02	-.473E-04	.000E-80	.000E-80	-.331E 06	-.321E 05	-.236E 07
4	-.653E-02	-.147E-02	.258E-02	.376E-04	.000E-80	.000E-80	-.883E 06	-.794E 05	-.446E 07
5	-.143E-01	-.224E-02	.312E-02	-.382E-04	.000E-80	.000E-80	-.181E 07	-.118E 06	-.727E 07
6	-.224E-01	-.203E-02	.325E-02	-.117E-03	.000E-80	.000E-80	-.304E 07	-.155E 06	-.102E 08
7	-.279E-01	-.111E-02	.168E-02	-.585E-03	.000E-80	.000E-80	-.431E 07	-.138E 06	-.112E 08
8	-.281E-01	.141E-03	-.525E-02	-.228E-02	.000E-80	.000E-80	-.482E 07	.143E 05	-.585E 07
9	-.278E-01	.230E-03	-.177E-01	-.327E-02	.000E-80	.000E-80	-.434E 07	.136E 06	.540E 07
10	-.382E-01	-.324E-02	-.217E-01	-.762E-03	.000E-80	.000E-80	-.552E 07	-.651E 04	.642E 07
11	-.855E-01	-.376E-02	.105E-01	.657E-02	.000E-80	.000E-80	-.110E 08	-.101E 07	-.332E 08
12	-.602E-01	.621E-02	.126E-01	.216E-03	.000E-80	.000E-80	-.798E 07	-.137E 07	-.285E 08
13	-.441E-01	.171E-02	.109E-01	-.574E-03	.000E-80	.000E-80	-.663E 07	-.180E 07	-.229E 08
14	-.314E-01	.189E-02	.697E-02	-.425E-03	.000E-80	.000E-80	-.520E 07	-.116E 07	-.162E 08
15	-.772E-02	.373E-02	.873E-03	-.360E-03	.000E-80	.000E-80	-.126E 07	.188E 06	-.334E 07
16	.213E-01	.524E-02	-.255E-02	.246E-04	.000E-80	.000E-80	.345E 07	.113E 07	.926E 07
17	.425E-01	.354E-02	-.329E-02	.251E-03	.000E-80	.000E-80	.648E 07	.128E 07	.164E 08
18	.443E-01	-.269E-03	-.224E-02	.321E-03	.000E-80	.000E-80	.671E 07	.806E 06	.161E 08
19	.334E-01	-.245E-02	-.936E-03	.234E-03	.000E-80	.000E-80	.502E 07	.217E 06	.116E 08
20	-.120E-01	-.938E-02	-.520E-03	-.417E-03	.000E-80	.000E-80	-.180E 07	.624E 05	-.356E 07
21	-.240E-01	.102E-02	.113E-04	.954E-04	.000E-80	.000E-80	-.362E 07	-.147E 06	-.788E 07
22	-.215E-01	.109E-02	-.271E-04	-.310E-04	.000E-80	.000E-80	-.338E 07	-.196E 06	-.733E 07
23	-.176E-01	.125E-02	-.827E-04	-.224E-05	.000E-80	.000E-80	-.294E 07	-.150E 06	-.632E 07
24	-.132E-01	.129E-02	.700E-04	.546E-04	.000E-80	.000E-80	-.242E 07	-.863E 05	-.532E 07
25	-.997E-02	.984E-03	.212E-03	.525E-04	.000E-80	.000E-80	-.189E 07	-.343E 05	-.428E 07
26	-.668E-02	.885E-03	.197E-03	.529E-05	.000E-80	.000E-80	-.140E 07	-.318E 04	-.320E 07
27	-.447E-02	.595E-03	.200E-03	.674E-05	.000E-80	.000E-80	-.106E 07	-.394E 04	-.246E 07
28	-.296E-02	.412E-03	.185E-03	.637E-06	.000E-80	.000E-80	-.810E 06	-.364E 04	-.190E 07
29	-.211E-02	.227E-03	.272E-03	.277E-04	.000E-80	.000E-80	-.643E 06	-.511E 04	-.160E 07
30	-.161E-02	.137E-03	.258E-03	-.220E-05	.000E-80	.000E-80	-.518E 06	-.317E 04	-.132E 07
31	-.126E-02	.100E-03	.280E-03	.771E-05	.000E-80	.000E-80	-.419E 06	-.305E 04	-.106E 07
32	-.974E-03	.773E-04	.281E-03	.135E-05	.000E-80	.000E-80	-.343E 06	-.290E 04	-.912E 06
33	-.745E-03	.620E-04	.249E-03	-.734E-05	.000E-80	.000E-80	-.281E 06	-.132E 04	-.774E 06
34	-.623E-03	.323E-04	.286E-03	.108E-04	.000E-80	.000E-80	-.235E 06	-.267E 04	-.716E 06
35	-.514E-03	.291E-04	.278E-03	-.149E-05	.000E-80	.000E-80	-.196E 06	-.162E 04	-.645E 06

Table D13. Accelerometer Load Relief (u_{24D}) Covariance Results (Continued)

MEAN RESPONSES

$\tilde{t}$	$\dot{M}_{1880}$	a_y	$\dot{a}_y$	$\tilde{q}\beta$	$\dot{\tilde{q}\beta}$	ϕ	$\dot{\phi}$	y	$\dot{y}$
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.129E 07	.138E-01	.397E-01	.107E-01	.300E-01	.286E-05	.197E-04	-.245E-02	-.163E-02
3	-.248E 05	.236E-01	-.329E-01	.523E 00	.991E-01	-.149E-03	-.471E-04	.879E 00	.330E 00
4	-.209E 06	-.613E-01	-.132E 00	.180E 01	.208E 00	-.514E-03	-.891E-04	.290E 01	.408E 00
5	-.215E 06	-.251E 00	-.331E 00	.405E 01	.327E 00	-.114E-02	-.137E-03	.397E 01	-.151E 00
6	-.210E 06	-.555E 00	-.723E 00	.720E 01	.451E 00	-.181E-02	-.126E-03	-.545E 00	-.193E 01
7	.320E 06	-.103E 01	-.560E 00	.109E 02	.525E 00	-.229E-02	-.711E-04	-.185E 02	-.569E 01
8	.205E 07	-.165E 01	.181E 01	.146E 02	.492E 00	-.232E-02	.819E-05	-.622E 02	-.124E 02
9	.303E 07	-.233E 01	.855E 01	.182E 02	.386E 00	-.230E-02	.134E-04	-.149E 03	-.229E 02
10	.641E 06	-.295E 01	.150E 02	.213E 02	.342E 00	-.310E-02	-.192E-03	-.299E 03	-.379E 02
11	-.800E 07	-.214E 01	-.153E 02	.182E 02	.116E 01	-.697E-02	-.325E-03	-.530E 03	-.537E 02
12	-.322E 07	-.124E 01	-.286E 02	.112E 02	.247E 01	-.509E-02	.387E-03	-.819E 03	-.605E 02
13	-.339E 07	-.103E 01	-.305E 02	.925E 01	.329E 01	-.368E-02	.117E-03	-.112E 04	-.593E 02
14	-.223E 07	-.912E 00	-.275E 02	.735E 01	.232E 01	-.263E-02	.123E-03	-.141E 04	-.542E 02
15	.635E 06	-.246E 00	-.188E 02	.183E 01	.213E 00	-.712E-03	.244E-03	-.166E 04	-.448E 02
16	.249E 07	.716E 00	-.868E 01	-.490E 01	-.132E 01	.166E-02	.336E-03	-.184E 04	-.303E 02
17	.261E 07	.151E 01	-.214E 01	-.937E 01	-.173E 01	.344E-02	.238E-03	-.195E 04	-.114E 02
18	.154E 07	.166E 01	.243E 00	-.982E 01	-.115E 01	.367E-02	-.119E-04	-.196E 04	.892E 01
19	.313E 06	.129E 01	.299E 00	-.737E 01	-.316E 00	.281E-02	-.153E-03	-.186E 04	.280E 02
20	.430E 06	-.443E 00	.478E 00	.271E 01	-.411E-01	-.799E-03	-.646E-03	-.169E 04	.392E 02
21	-.388E 06	-.961E 00	-.394E 00	.530E 01	.222E 00	-.200E-02	.501E-04	-.150E 04	.357E 02
22	-.404E 06	-.910E 00	-.426E 00	.488E 01	.312E 00	-.180E-02	.635E-04	-.133E 04	.308E 02
23	-.323E 06	-.798E 00	-.350E 00	.421E 01	.234E 00	-.149E-02	.747E-04	-.119E 04	.264E 02
24	-.228E 06	-.645E 00	-.341E 00	.337E 01	.129E 00	-.113E-02	.783E-04	-.107E 04	.227E 02
25	-.122E 06	-.492E 00	-.213E 00	.256E 01	.494E-01	-.801E-03	.667E-04	-.960E 03	.198E 02
26	-.911E 04	-.362E 00	-.893E-01	.185E 01	.127E-02	-.535E-03	.518E-04	-.866E 03	.177E 02
27	-.142E 05	-.270E 00	-.312E-01	.135E 01	.103E-02	-.355E-03	.347E-04	-.782E 03	.161E 02
28	-.608E 04	-.203E 00	.166E-01	.998E 00	.265E-02	-.233E-03	.237E-04	-.705E 03	.149E 02
29	-.344E 05	-.151E 00	.499E-01	.750E 00	.220E-02	-.164E-03	.130E-04	-.633E 03	.139E 02
30	-.674E 04	-.118E 00	.812E-01	.577E 00	.246E-02	-.123E-03	.780E-05	-.565E 03	.133E 02
31	-.106E 05	-.959E-01	.121E 00	.451E 00	-.486E-02	-.913E-04	.624E-05	-.500E 03	.127E 02
32	-.633E 04	-.743E-01	.113E 00	.353E 00	-.148E-02	-.700E-04	.412E-05	-.437E 03	.123E 02
33	.539E 03	-.588E-01	.110E 00	.278E 00	-.460E-02	-.533E-04	.327E-05	-.377E 03	.120E 02
34	-.129E 05	-.403E-01	.126E 00	.220E 00	.222E-02	-.440E-04	.175E-05	-.317E 03	.117E 02
35	-.229E 04	-.286E-01	.115E 00	.174E 00	-.857E-03	-.360E-04	.156E-05	-.259E 03	.116E 02

Table D13. Accelerometer Load Relief (u_{24D}) Covariance Results (Continued)

RESPONSE COVARIANCES

$\tilde{t}$	δ_p	$\dot{\delta}_p$	δ_r	$\dot{\delta}_r$	δ_a	$\dot{\delta}_a$	M_{660}	$\dot{M}_{660}$	M_{1880}
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.584E-05	.359E-03	.138E-04	.900E-03	.000E-80	.000E-80	.175E 12	.773E 14	.189E 14
3	.184E-03	.620E-03	.296E-04	.301E-03	.000E-80	.000E-80	.212E 13	.183E 15	.576E 14
4	.356E-03	.341E-02	.436E-04	.831E-03	.000E-80	.000E-80	.427E 13	.293E 15	.976E 14
5	.536E-03	.787E-02	.417E-04	.122E-02	.000E-80	.000E-80	.659E 13	.331E 15	.123E 15
6	.567E-03	.105E-01	.330E-04	.138E-02	.000E-80	.000E-80	.858E 13	.274E 15	.124E 15
7	.434E-03	.367E-02	.774E-05	.424E-03	.000E-80	.000E-80	.952E 13	.571E 14	.716E 14
8	.312E-03	.100E-01	.562E-04	.375E-02	.000E-80	.000E-80	.818E 13	.328E 15	.587E 14
9	.750E-03	.136E 00	.599E-03	.494E-01	.000E-80	.000E-80	.676E 13	.302E 16	.473E 15
10	.111E-02	.207E 00	.801E-03	.759E-01	.000E-80	.000E-80	.103E 14	.416E 16	.615E 15
11	.307E-02	.136E 00	.268E-03	.359E-01	.000E-80	.000E-80	.442E 14	.138E 16	.675E 15
12	.308E-02	.333E 00	.674E-03	.934E-01	.000E-80	.000E-80	.371E 14	.349E 16	.115E 16
13	.250E-02	.274E 00	.664E-03	.106E 00	.000E-80	.000E-80	.372E 14	.268E 16	.958E 15
14	.188E-02	.158E 00	.455E-03	.755E-01	.000E-80	.000E-80	.368E 14	.161E 16	.672E 15
15	.123E-02	.614E-01	.171E-03	.286E-01	.000E-80	.000E-80	.285E 14	.657E 15	.354E 15
16	.860E-03	.193E-01	.489E-04	.775E-02	.000E-80	.000E-80	.202E 14	.232E 15	.180E 15
17	.599E-03	.635E-02	.110E-04	.173E-02	.000E-80	.000E-80	.131E 14	.831E 14	.915E 14
18	.364E-03	.195E-02	.224E-05	.338E-03	.000E-80	.000E-80	.807E 13	.355E 14	.483E 14
19	.218E-03	.700E-03	.389E-06	.537E-04	.000E-80	.000E-80	.483E 13	.179E 14	.263E 14
20	.626E-03	.309E-03	.121E-06	.538E-05	.000E-80	.000E-80	.137E 14	.990E 13	.625E 14
21	.606E-03	.135E-03	.785E-08	.183E-05	.000E-80	.000E-80	.137E 14	.556E 13	.650E 14
22	.270E-03	.608E-04	.306E-08	.561E-06	.000E-80	.000E-80	.664E 13	.322E 13	.312E 14
23	.117E-03	.270E-04	.394E-08	.269E-06	.000E-80	.000E-80	.322E 13	.185E 13	.149E 14
24	.504E-04	.133E-04	.215E-08	.461E-06	.000E-80	.000E-80	.168E 13	.110E 13	.811E 13
25	.251E-04	.607E-05	.115E-07	.367E-06	.000E-80	.000E-80	.908E 12	.668E 12	.458E 13
26	.111E-04	.248E-05	.101E-07	.228E-06	.000E-80	.000E-80	.489E 12	.374E 12	.254E 13
27	.491E-05	.981E-06	.105E-07	.147E-06	.000E-80	.000E-80	.278E 12	.218E 12	.149E 13
28	.212E-05	.374E-06	.882E-08	.799E-07	.000E-80	.000E-80	.159E 12	.128E 12	.877E 12
29	.107E-05	.179E-06	.187E-07	.830E-07	.000E-80	.000E-80	.992E 11	.125E 12	.618E 12
30	.617E-06	.773E-07	.166E-07	.414E-07	.000E-80	.000E-80	.640E 11	.924E 11	.417E 12
31	.377E-06	.378E-07	.201E-07	.507E-07	.000E-80	.000E-80	.415E 11	.519E 11	.267E 12
32	.225E-06	.137E-07	.202E-07	.173E-07	.000E-80	.000E-80	.277E 11	.545E 11	.198E 12
33	.131E-06	.398E-08	.154E-07	.364E-08	.000E-80	.000E-80	.185E 11	.482E 11	.142E 12
34	.917E-07	.982E-09	.204E-07	.886E-09	.000E-80	.000E-80	.128E 11	.748E 11	.122E 12
35	.623E-07	.271E-09	.190E-07	.688E-10	.000E-80	.000E-80	.895E 10	.824E 11	.986E 11

Table D13. Accelerometer Load Relief (u_{24D}) Covariance Results (Concluded)

RESPONSE COVARIANCES

$\tilde{t}$	$\dot{M}_{1880}$	a_y	$\dot{a}_y$	$\bar{q}\beta$	$\dot{\bar{q}\beta}$	ϕ	$\dot{\phi}$	y	$\dot{y}$
1	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00
2	.113E 16	.132E 00	.102E 01	.715E-01	.512E 00	.606E-08	.254E-06	.998E-02	.334E-02
3	.374E 15	.784E-01	.713E 00	.111E 02	.737E-01	.102E-05	.747E-06	.874E 02	.451E 01
4	.113E 16	.232E 00	.898E 01	.234E 02	.435E 00	.211E-05	.257E-05	.274E 03	.531E 00
5	.198E 16	.492E 00	.369E 02	.370E 02	.147E 01	.314E-05	.450E-05	.223E 03	.208E 01
6	.242E 16	.753E 00	.810E 02	.498E 02	.408E 01	.338E-05	.486E-05	.513E 01	.160E 02
7	.724E 15	.710E 00	.392E 02	.613E 02	.109E 02	.283E-05	.166E-05	.668E 03	.498E 02
8	.392E 16	.162E 01	.235E 03	.739E 02	.250E 02	.191E-05	.273E-05	.481E 04	.113E 03
9	.479E 17	.118E 02	.440E 04	.956E 02	.506E 02	.193E-05	.340E-04	.172E 05	.222E 03
10	.753E 17	.203E 02	.953E 04	.136E 03	.979E 02	.315E-05	.470E-04	.458E 05	.408E 03
11	.421E 17	.131E 02	.822E 04	.112E 03	.183E 03	.169E-04	.358E-04	.103E 06	.660E 03
12	.108E 18	.306E 02	.250E 05	.590E 02	.299E 03	.133E-04	.835E-04	.202E 06	.816E 03
13	.963E 17	.281E 02	.271E 05	.611E 02	.435E 03	.106E-04	.689E-04	.343E 06	.820E 03
14	.592E 17	.182E 02	.202E 05	.657E 02	.465E 03	.898E-05	.420E-04	.522E 06	.781E 03
15	.229E 17	.787E 01	.969E 04	.538E 02	.327E 03	.676E-05	.183E-04	.731E 06	.779E 03
16	.665E 16	.296E 01	.355E 04	.390E 02	.191E 03	.525E-05	.710E-05	.970E 06	.910E 03
17	.177E 16	.127E 01	.120E 04	.271E 02	.105E 03	.388E-05	.296E-05	.125E 07	.124E 04
18	.485E 15	.627E 00	.375E 03	.172E 02	.580E 02	.245E-05	.115E-05	.161E 07	.180E 04
19	.152E 15	.348E 00	.114E 03	.104E 02	.322E 02	.149E-05	.501E-06	.209E 07	.256E 04
20	.565E 14	.922E 00	.286E 02	.300E 02	.181E 02	.386E-05	.385E-06	.275E 07	.307E 04
21	.301E 14	.975E 00	.137E 02	.294E 02	.103E 02	.433E-05	.133E-06	.353E 07	.261E 04
22	.164E 14	.486E 00	.549E 01	.139E 02	.578E 01	.195E-05	.641E-07	.438E 07	.222E 04
23	.926E 13	.230E 00	.261E 01	.664E 01	.325E 01	.852E-06	.285E-07	.527E 07	.196E 04
24	.596E 13	.120E 00	.283E 01	.327E 01	.182E 01	.371E-06	.131E-07	.621E 07	.179E 04
25	.343E 13	.611E-01	.171E 01	.164E 01	.986E 00	.163E-06	.553E-08	.721E 07	.168E 04
26	.185E 13	.326E-01	.109E 01	.847E 00	.503E 00	.709E-07	.226E-08	.825E 07	.159E 04
27	.997E 12	.179E-01	.867E 00	.446E 00	.248E 00	.308E-07	.898E-09	.936E 07	.153E 04
28	.522E 12	.999E-02	.669E 00	.242E 00	.123E 00	.131E-07	.359E-09	.105E 08	.149E 04
29	.320E 12	.546E-02	.940E 00	.135E 00	.618E-01	.645E-08	.141E-09	.117E 08	.146E 04
30	.168E 12	.333E-02	.702E 00	.793E-01	.303E-01	.361E-08	.594E-10	.130E 08	.143E 04
31	.845E 11	.219E-02	.595E 00	.480E-01	.134E-01	.198E-08	.266E-10	.144E 08	.141E 04
32	.354E 11	.127E-02	.390E 00	.292E-01	.515E-02	.116E-08	.102E-10	.158E 08	.140E 04
33	.117E 11	.765E-03	.160E 00	.179E-01	.170E-02	.671E-09	.430E-11	.172E 08	.139E 04
34	.325E 10	.366E-03	.767E-01	.112E-01	.436E-03	.456E-09	.118E-11	.188E 08	.138E 04
35	.374E 09	.183E-03	.126E-01	.700E-02	.487E-04	.305E-09	.626E-12	.204E 08	.137E 04

Table D14. Sideslip Load Relief (u_{25D}) Covariance Results

MEAN RESPONSES

$\tilde{t}$	δ_p	$\dot{\delta}_p$	δ_r	$\dot{\delta}_r$	δ_a	$\dot{\delta}_a$	M_{660}	$\dot{M}_{660}$	M_{1880}
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.918E-04	.753E-03	.133E-03	.115E-02	.000E-80	.000E-80	-.155E 05	-.104E 06	-.157E 06
3	-.197E-02	-.813E-03	.175E-02	-.473E-04	.000E-80	.000E-80	-.331E 06	-.321E 05	-.236E 07
4	-.653E-02	-.147E-02	.258E-02	.376E-04	.000E-80	.000E-80	-.883E 06	-.794E 05	-.446E 07
5	-.143E-01	-.224E-02	.312E-02	-.382E-04	.000E-80	.000E-80	-.181E 07	-.118E 06	-.727E 07
6	-.224E-01	-.203E-02	.325E-02	-.117E-03	.000E-80	.000E-80	-.304E 07	-.155E 06	-.102E 08
7	-.279E-01	-.111E-02	.168E-02	-.585E-03	.000E-80	.000E-80	-.431E 07	-.198E 06	-.112E 08
8	-.281E-01	.134E-03	-.525E-02	-.228E-02	.000E-80	.000E-80	-.483E 07	.149E 05	-.587E 07
9	-.279E-01	.204E-03	-.177E-01	-.328E-02	.000E-80	.000E-80	-.436E 07	.139E 06	.538E 07
10	-.387E-01	-.344E-02	-.217E-01	-.795E-03	.000E-80	.000E-80	-.559E 07	.507E 04	.632E 07
11	-.908E-01	-.702E-02	.113E-01	.724E-02	.000E-80	.000E-80	-.117E 08	-.989E 06	-.355E 08
12	-.745E-01	.394E-02	.143E-01	.515E-03	.000E-80	.000E-80	-.988E 07	-.118E 07	-.340E 08
13	-.625E-01	.817E-03	.132E-01	-.443E-03	.000E-80	.000E-80	-.923E 07	-.150E 07	-.303E 08
14	-.517E-01	.175E-02	.954E-02	-.381E-03	.000E-80	.000E-80	-.838E 07	-.802E 06	-.250E 08
15	-.280E-01	.412E-02	.307E-02	-.504E-03	.000E-80	.000E-80	-.457E 07	.560E 06	-.121E 08
16	.325E-02	.619E-02	-.105E-02	-.185E-03	.000E-80	.000E-80	.600E 06	.144E 07	.202E 07
17	.294E-01	.503E-02	-.255E-02	.669E-04	.000E-80	.000E-80	.451E 07	.149E 07	.116E 08
18	.367E-01	.108E-02	-.195E-02	.224E-03	.000E-80	.000E-80	.556E 07	.929E 06	.134E 08
19	.295E-01	-.161E-02	-.844E-03	.195E-03	.000E-80	.000E-80	.444E 07	.290E 06	.103E 08
20	.165E-01	-.245E-02	-.210E-03	.970E-04	.000E-80	.000E-80	.242E 07	-.625E 05	.541E 07
21	.603E-02	-.197E-02	-.141E-05	.152E-04	.000E-80	.000E-80	.902E 06	-.297E 06	.196E 07
22	-.944E-03	-.131E-02	.168E-04	-.804E-05	.000E-80	.000E-80	-.152E 06	-.244E 06	-.343E 06
23	-.392E-02	-.429E-03	-.104E-04	-.570E-05	.000E-80	.000E-80	-.655E 06	-.175E 06	-.142E 07
24	-.412E-02	.116E-03	.303E-04	.189E-04	.000E-80	.000E-80	-.756E 06	-.974E 05	-.167E 07
25	-.350E-02	.245E-03	.814E-04	.210E-04	.000E-80	.000E-80	-.667E 06	-.397E 05	-.151E 07
26	-.235E-02	.311E-03	.715E-04	.135E-05	.000E-80	.000E-80	-.495E 06	-.704E 04	-.113E 07
27	-.158E-02	.209E-03	.695E-04	.148E-05	.000E-80	.000E-80	-.375E 06	-.596E 04	-.868E 06
28	-.104E-02	.145E-03	.638E-04	.131E-06	.000E-80	.000E-80	-.285E 06	-.497E 04	-.668E 06
29	-.744E-03	.808E-04	.933E-04	.921E-05	.000E-80	.000E-80	-.226E 06	-.476E 04	-.562E 06
30	-.567E-03	.481E-04	.875E-04	-.912E-06	.000E-80	.000E-80	-.182E 06	-.376E 04	-.462E 06
31	-.442E-03	.357E-04	.919E-04	.174E-05	.000E-80	.000E-80	-.147E 06	-.311E 04	-.368E 06
32	-.339E-03	.277E-04	.914E-04	.217E-06	.000E-80	.000E-80	-.121E 06	-.306E 04	-.316E 06
33	-.259E-03	.217E-04	.827E-04	-.191E-05	.000E-80	.000E-80	-.988E 05	-.177E 04	-.269E 06
34	-.216E-03	.115E-04	.938E-04	.333E-05	.000E-80	.000E-80	-.822E 05	-.230E 04	-.246E 06
35	-.177E-03	.107E-04	.920E-04	-.199E-06	.000E-80	.000E-80	-.688E 05	-.176E 04	-.222E 06

Table D14. Sideslip Load Relief (u_{24D}) Covariance Results (Continued)

MEAN RESPONSES

$\tilde{t}$	$\dot{M}_{1880}$	a_y	$\dot{a}_y$	$\bar{q}\beta$	$\dot{\bar{q}\beta}$	ϕ	$\dot{\phi}$	y	$\dot{y}$
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.129E 07	.138E-01	.397E-01	.107E-01	.300E-01	.286E-05	.197E-04	-.245E-02	-.163E-02
3	-.248E 05	.236E-01	-.329E-01	.523E 00	.991E-01	-.149E-03	-.471E-04	.879E 00	.330E 00
4	-.209E 06	-.613E-01	-.132E 00	.188E 01	.208E 00	-.514E-03	-.891E-04	.290E 01	.408E 00
5	-.215E 06	-.251E 00	-.331E 00	.405E 01	.327E 00	-.114E-02	-.137E-03	.397E 01	-.151E 00
6	-.210E 06	-.595E 00	-.723E 00	.720E 01	.451E 00	-.181E-02	-.126E-03	-.545E 00	-.193E 01
7	.320E 06	-.103E 01	-.560E 00	.109E 02	.525E 00	-.229E-02	-.711E-04	-.185E 02	-.569E 01
8	.205E 07	-.165E 01	.182E 01	.146E 02	.491E 00	-.232E-02	.775E-05	-.622E 02	-.124E 02
9	.305E 07	-.234E 01	.856E 01	.182E 02	.379E 00	-.231E-02	.119E-04	-.149E 03	-.230E 02
10	.694E 06	-.298E 01	.150E 02	.216E 02	.314E 00	-.314E-02	-.204E-03	-.300E 03	-.381E 02
11	-.856E 07	-.228E 01	-.151E 02	.193E 02	.103E 01	-.736E-02	-.502E-03	-.593E 03	-.546E 02
12	-.308E 07	-.160E 01	-.284E 02	.139E 02	.214E 01	-.624E-02	.246E-03	-.832E 03	-.639E 02
13	-.785E 07	-.158E 01	-.302E 02	.131E 02	.282E 01	-.519E-02	.613E-04	-.116E 04	-.673E 02
14	-.148E 07	-.161E 01	-.273E 02	.120E 02	.176E 01	-.431E-02	.113E-03	-.150E 04	-.691E 02
15	.155E 07	-.999E 00	-.186E 02	.663E 01	-.335E 00	-.240E-02	.266E-03	-.185E 04	-.688E 02
16	.330E 07	.469E-01	-.855E 01	-.788E 00	-.177E 01	.152E-03	.392E-03	-.218E 04	-.649E 02
17	.319E 07	.103E 01	-.210E 01	-.649E 01	-.202E 01	.233E-02	.320E-03	-.249E 04	-.573E 02
18	.187E 07	.137E 01	.244E 00	-.812E 01	-.132E 01	.301E-02	.719E-04	-.276E 04	-.484E 02
19	.497E 06	.114E 01	.297E 00	-.652E 01	-.420E 00	.247E-02	-.108E-03	-.298E 04	-.405E 02
20	-.205E 06	.644E 00	-.350E-02	-.355E 01	.980E-01	.141E-02	-.160E-03	-.317E 04	-.355E 02
21	-.504E 06	.243E 00	-.273E 00	-.132E 01	.347E 00	.537E-03	-.126E-03	-.334E 04	-.334E 02
22	-.526E 06	-.393E-01	-.322E 00	.217E 00	.379E 00	-.530E-04	-.844E-04	-.350E 04	-.329E 02
23	-.374E 06	-.177E 00	-.272E 00	.939E 00	.270E 00	-.318E-03	-.293E-04	-.367E 04	-.335E 02
24	-.223E 06	-.201E 00	-.282E 00	.105E 01	.148E 00	-.346E-03	.571E-05	-.384E 04	-.345E 02
25	-.111E 06	-.173E 00	-.180E 00	.901E 00	.595E-01	-.279E-03	.173E-04	-.401E 04	-.354E 02
26	-.146E 05	-.127E 00	-.652E-01	.651E 00	.672E-02	-.188E-03	.182E-04	-.419E 04	-.362E 02
27	-.147E 05	-.954E-01	-.157E-01	.475E 00	.404E-02	-.125E-03	.122E-04	-.437E 04	-.367E 02
28	-.863E 04	-.713E-01	.264E-01	.352E 00	.434E-02	-.821E-04	.832E-05	-.456E 04	-.372E 02
29	-.200E 05	-.535E-01	.559E-01	.264E 00	.315E-02	-.577E-04	.463E-05	-.475E 04	-.375E 02
30	-.894E 04	-.420E-01	.839E-01	.203E 00	.304E-02	-.434E-04	.275E-05	-.493E 04	-.377E 02
31	-.773E 04	-.336E-01	.123E 00	.159E 00	-.449E-02	-.320E-04	.222E-05	-.512E 04	-.379E 02
32	-.609E 04	-.267E-01	.114E 00	.124E 00	-.126E-02	-.244E-04	.147E-05	-.531E 04	-.381E 02
33	-.401E 04	-.209E-01	.110E 00	.979E-01	-.447E-02	-.185E-04	.115E-05	-.550E 04	-.382E 02
34	-.673E 04	-.145E-01	.127E 00	.774E-01	.229E-02	-.152E-04	.622E-06	-.569E 04	-.383E 02
35	-.364E 04	-.104E-01	.116E 00	.613E-01	-.814E-03	-.124E-04	.546E-06	-.589E 04	-.383E 02

Table D14. Sideslip Load Relief (u_{25D}) Covariance Results (Continued)

RESPONSE COVARIANCES

$\tilde{t}$	δ_p	$\dot{\delta}_p$	δ_r	$\dot{\delta}_r$	δ_a	$\dot{\delta}_a$	M_{660}	$\dot{M}_{660}$	M_{1880}
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.584E-05	.359E-03	.138E-04	.900E-03	.000E-80	.000E-80	.175E 12	.773E 14	.189E 14
3	.184E-03	.620E-03	.296E-04	.301E-03	.000E-80	.000E-80	.212E 13	.183E 15	.576E 14
4	.356E-03	.341E-02	.436E-04	.831E-03	.000E-80	.000E-80	.427E 13	.293E 15	.976E 14
5	.536E-03	.787E-02	.417E-04	.122E-02	.000E-80	.000E-80	.659E 13	.331E 15	.123E 15
6	.567E-03	.105E-01	.330E-04	.138E-02	.000E-80	.000E-80	.858E 13	.274E 15	.124E 15
7	.434E-03	.367E-02	.774E-05	.424E-03	.000E-80	.000E-80	.952E 13	.571E 14	.716E 14
8	.313E-03	.103E-01	.566E-04	.387E-02	.000E-80	.000E-80	.818E 13	.331E 15	.592E 14
9	.770E-03	.143E 00	.610E-03	.532E-01	.000E-80	.000E-80	.688E 13	.308E 16	.483E 15
10	.116E-02	.273E 00	.823E-03	.844E-01	.000E-80	.000E-80	.104E 14	.426E 16	.635E 15
11	.306E-02	.149E 00	.279E-03	.418E-01	.000E-80	.000E-80	.436E 14	.146E 16	.684E 15
12	.308E-02	.365E 00	.704E-03	.109E 00	.000E-80	.000E-80	.357E 14	.369E 16	.117E 16
13	.249E-02	.299E 00	.700E-03	.126E 00	.000E-80	.000E-80	.357E 14	.286E 16	.975E 15
14	.186E-02	.172E 00	.480E-03	.897E-01	.000E-80	.000E-80	.354E 14	.173E 16	.679E 15
15	.120E-02	.661E-01	.180E-03	.344E-01	.000E-80	.000E-80	.274E 14	.706E 15	.353E 15
16	.833E-03	.206E-01	.515E-04	.953E-02	.000E-80	.000E-80	.195E 14	.247E 15	.177E 15
17	.578E-03	.676E-02	.116E-04	.223E-02	.000E-80	.000E-80	.126E 14	.878E 14	.888E 14
18	.349E-03	.204E-02	.236E-05	.462E-03	.000E-80	.000E-80	.773E 13	.369E 14	.465E 14
19	.209E-03	.724E-03	.411E-06	.821E-04	.000E-80	.000E-80	.463E 13	.183E 14	.252E 14
20	.654E-03	.315E-03	.126E-06	.930E-05	.000E-80	.000E-80	.143E 14	.100E 14	.653E 14
21	.636E-03	.137E-03	.876E-08	.285E-05	.000E-80	.000E-80	.144E 14	.559E 13	.683E 14
22	.284E-03	.613E-04	.334E-08	.718E-06	.000E-80	.000E-80	.699E 13	.393E 13	.328E 14
23	.123E-03	.271E-04	.414E-08	.270E-06	.000E-80	.000E-80	.339E 13	.185E 13	.157E 14
24	.530E-04	.134E-04	.220E-08	.461E-06	.000E-80	.000E-80	.177E 13	.110E 13	.854E 13
25	.264E-04	.609E-05	.120E-07	.367E-06	.000E-80	.000E-80	.947E 12	.670E 12	.482E 13
26	.117E-04	.249E-05	.106E-07	.228E-06	.000E-80	.000E-80	.515E 12	.376E 12	.267E 13
27	.517E-05	.986E-06	.111E-07	.147E-06	.000E-80	.000E-80	.292E 12	.220E 12	.157E 13
28	.223E-05	.376E-06	.927E-08	.799E-07	.000E-80	.000E-80	.168E 12	.129E 12	.924E 12
29	.113E-05	.180E-06	.197E-07	.830E-07	.000E-80	.000E-80	.105E 12	.178E 12	.651E 12
30	.651E-06	.775E-07	.175E-07	.414E-07	.000E-80	.000E-80	.675E 11	.959E 11	.439E 12
31	.398E-06	.379E-07	.212E-07	.507E-07	.000E-80	.000E-80	.438E 11	.541E 11	.282E 12
32	.238E-06	.137E-07	.213E-07	.173E-07	.000E-80	.000E-80	.293E 11	.572E 11	.209E 12
33	.138E-06	.403E-08	.163E-07	.364E-08	.000E-80	.000E-80	.195E 11	.508E 11	.150E 12
34	.969E-07	.996E-09	.216E-07	.888E-09	.000E-80	.000E-80	.135E 11	.790E 11	.129E 12
35	.659E-07	.282E-09	.201E-07	.689E-10	.000E-80	.000E-80	.946E 10	.871E 11	.104E 12

Table D14. Sideslip Load Relief (u_{25D}) Covariance Results (Concluded)

RESPONSE COVARIANCES

$\tilde{t}$	$\dot{M}_{1880}$	a_y	$\dot{a}_y$	$\bar{q}\beta$	$\dot{\bar{q}\beta}$	ϕ	$\dot{\phi}$	y	$\dot{y}$
1	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00	.000E-00
2	.113E 16	.132E 00	.102E 01	.715E-01	.512E 00	.606E-08	.254E-06	.998E-02	.334E-02
3	.374E 15	.784E-01	.713E 00	.111E 02	.737E-01	.102E-05	.747E-06	.874E 02	.451E 01
4	.113E 16	.232E 00	.898E 01	.234E 02	.435E 00	.211E-05	.257E-05	.274E 03	.531E 00
5	.198E 16	.492E 00	.369E 02	.370E 02	.147E 01	.314E-05	.450E-05	.273E 03	.208E 01
6	.242E 16	.753E 00	.810E 02	.498E 02	.408E 01	.338E-05	.486E-05	.513E 01	.160E 02
7	.724E 15	.710E 00	.392E 02	.613E 02	.109E 02	.283E-05	.166E-05	.668E 03	.498E 02
8	.406E 16	.163E 01	.240E 03	.738E 02	.250E 02	.191E-05	.279E-05	.481E 04	.113E 03
9	.517E 17	.121E 02	.459E 04	.957E 02	.507E 02	.195E-05	.353E-04	.172E 05	.222E 03
10	.840E 17	.211E 02	.101E 05	.136E 03	.981E 02	.319E-05	.501E-04	.459E 05	.409E 03
11	.482E 17	.139E 02	.877E 04	.110E 03	.183E 03	.167E-04	.383E-04	.103E 06	.669E 03
12	.125E 18	.374E 02	.265E 05	.557E 02	.298E 03	.128E-04	.896E-04	.2?2E 06	.811E 03
13	.112E 18	.296E 02	.285E 05	.578E 02	.434E 03	.101E-04	.735E-04	.342E 06	.810E 03
14	.684E 17	.190E 02	.210E 05	.625E 02	.464E 03	.860E-05	.444E-04	.520E 06	.773E 03
15	.263E 17	.813E 01	.999E 04	.515E 02	.327E 03	.649E-05	.192E-04	.727E 06	.784E 03
16	.758E 16	.300E 01	.363E 04	.382E 02	.191E 03	.5?4E-05	.734E-05	.966E 06	.940E 03
17	.200E 16	.126E 01	.123E 04	.260E 02	.105E 03	.372E-05	.304E-05	.125E 07	.131E 04
18	.526E 15	.611E 00	.380E 03	.165E 02	.580E 02	.234E-05	.117E-05	.162E 07	.190E 04
19	.155E 15	.336E 00	.116E 03	.994E 01	.322E 02	.143E-05	.505E-06	.212E 07	.271E 04
20	.544E 14	.963E 00	.287E 02	.313E 02	.181E 02	.402E-05	.390E-06	.281E 07	.325E 04
21	.292E 14	.102E 01	.137E 02	.309E 02	.103E 02	.455E-05	.134E-06	.363E 07	.276E 04
22	.162E 14	.511E 00	.549E 01	.146E 02	.578E 01	.206E-05	.649E-07	.452E 07	.235E 04
23	.926E 13	.251E 00	.261E 01	.700E 01	.325E 01	.898E-06	.289E-07	.546E 07	.207E 04
24	.596E 13	.127E 00	.283E 01	.344E 01	.182E 01	.391E-06	.133E-07	.646E 07	.189E 04
25	.343E 13	.643E-01	.171E 01	.173E 01	.986E 00	.171E-06	.561E-08	.750E 07	.177E 04
26	.185E 13	.343E-01	.109E 01	.891E 00	.503E 00	.746E-07	.229E-08	.860E 07	.169E 04
27	.997E 12	.189E-01	.867E 00	.470E 00	.248E 00	.324E-07	.914E-09	.977E 07	.162E 04
28	.522E 12	.105E-01	.669E 00	.254E 00	.123E 00	.138E-07	.363E-09	.110E 08	.157E 04
29	.320E 12	.576E-02	.940E 00	.142E 00	.618E-01	.680E-08	.144E-09	.123E 08	.154E 04
30	.168E 12	.351E-02	.702E 00	.836E-01	.303E-01	.381E-08	.602E-10	.136E 08	.151E 04
31	.849E 11	.231E-02	.595E 00	.507E-01	.134E-01	.209E-08	.271E-10	.150E 08	.149E 04
32	.354E 11	.134E-02	.390E 00	.309E-01	.515E-02	.123E-08	.104E-10	.165E 08	.148E 04
33	.117E 11	.808E-03	.160E 00	.190E-01	.170E-02	.709E-09	.444E-11	.181E 08	.146E 04
34	.325E 10	.386E-03	.767E-01	.118E-01	.436E-03	.482E-09	.122E-11	.197E 08	.145E 04
35	.374E 09	.194E-03	.126E-01	.739E-02	.487E-04	.322E-09	.658E-12	.214E 08	.145E 04

Table D15. Heading (u_{21D}) Including Rolling Gust Covariance Results

MEAN RESPONSES

$\tilde{t}$	δ_p	$\dot{\delta}_p$	δ_r	$\dot{\delta}_r$	$\dot{\delta}_a$	δ_a	M_{660}	$\dot{M}_{660}$	M_{1880}
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.918E-04	.753E-03	.133E-03	.115E-02	.000E-80	.000E-80	-.155E 05	-.104E 06	-.157E 06
3	-.197E-02	-.813E-03	.175E-02	-.473E-04	.000E-80	.000E-80	-.331E 06	-.321E 05	-.236E 07
4	-.653E-02	-.147E-02	.258E-02	.376E-04	.000E-80	.000E-80	-.883E 06	-.794E 05	-.446E 07
5	-.143E-01	-.224E-02	.312E-02	-.382E-04	.000E-80	.000E-80	-.181E 07	-.118E 06	-.727E 07
6	-.224E-01	-.203E-02	.325E-02	-.117E-03	.000E-80	.000E-80	-.304E 07	-.155E 06	-.102E 08
7	-.279E-01	-.111E-02	.168E-02	-.585E-03	.000E-80	.000E-80	-.431E 07	-.138E 06	-.112E 08
8	-.280E-01	.216E-03	-.529E-02	-.228E-02	.000E-80	.000E-80	-.481E 07	.135E 05	-.578E 07
9	-.268E-01	.624E-03	-.176E-01	-.312E-02	.000E-80	.000E-80	-.417E 07	.107E 06	.568E 07
10	-.341E-01	-.169E-02	-.209E-01	-.537E-03	.000E-80	.000E-80	-.487E 07	-.103E 06	.716E 07
11	-.871E-01	-.147E-01	.119E-01	.818E-02	.000E-80	.000E-80	-.113E 08	-.118E 07	-.351E 08
12	-.110E 00	-.598E-02	.187E-01	.169E-02	.000E-80	.000E-80	-.143E 08	-.359E 06	-.477E 08
13	-.112E 00	.113E-02	.190E-01	-.475E-03	.000E-80	.000E-80	-.163E 08	-.779E 06	-.501E 08
14	-.887E-01	.607E-02	.138E-01	-.857E-03	.000E-80	.000E-80	-.142E 08	-.148E 06	-.407E 08
15	-.426E-01	.973E-02	.434E-02	-.112E-02	.000E-80	.000E-80	-.693E 07	.911E 06	-.161E 08
16	.104E-01	.108E-01	-.184E-02	-.471E-03	.000E-80	.000E-80	.175E 07	.148E 07	.507E 07
17	.499E-01	.722E-02	-.383E-02	.132E-03	.000E-80	.000E-80	.762E 07	.137E 07	.192E 08
18	.600E-01	.736E-03	-.290E-02	.387E-03	.000E-80	.000E-80	.337E 07	.798E 06	.217E 08
19	.501E-01	-.288E-02	-.135E-02	.327E-03	.000E-80	.000E-80	.753E 07	.192E 06	.173E 08
20	.345E-01	-.365E-02	-.263E-03	.196E-03	.000E-80	.000E-80	.508E 07	-.133E 06	.112E 08
21	.187E-01	-.346E-02	-.464E-04	.235E-04	.000E-80	.000E-80	.281E 07	-.263E 06	.615E 07
22	.755E-02	-.231E-02	.344E-04	.198E-05	.000E-80	.000E-80	.118E 07	-.264E 06	.255E 07
23	.173E-02	-.113E-02	.195E-04	-.713E-05	.000E-80	.000E-80	.284E 06	-.185E 06	.694E 06
24	-.371E-03	-.367E-03	.139E-04	.417E-05	.000E-80	.000E-80	-.797E 05	-.102E 06	-.165E 06
25	-.837E-03	-.588E-04	.278E-04	.838E-05	.000E-80	.000E-80	-.162E 06	-.419E 05	-.372E 06
26	-.567E-03	.744E-04	.199E-04	-.272E-06	.000E-80	.000E-80	-.121E 06	-.963E 04	-.277E 06
27	-.384E-03	.496E-04	.156E-04	-.692E-06	.000E-80	.000E-80	-.912E 05	-.679E 04	-.210E 06
28	-.255E-03	.348E-04	.139E-04	-.771E-07	.000E-80	.000E-80	-.693E 05	-.551E 04	-.161E 06
29	-.180E-03	.204E-04	.195E-04	.161E-05	.000E-80	.000E-80	-.549E 05	-.461E 04	-.134E 06
30	-.137E-03	.117E-04	.174E-04	-.384E-06	.000E-80	.000E-80	-.441E 05	-.401E 04	-.109E 06
31	-.105E-03	.927E-05	.144E-04	-.717E-06	.000E-80	.000E-80	-.355E 05	-.313E 04	-.847E 05
32	-.779E-04	.729E-05	.132E-04	-.249E-06	.000E-80	.000E-80	-.239E 05	-.312E 04	-.706E 05
33	-.588E-04	.514E-05	.141E-04	.331E-06	.000E-80	.000E-80	-.237E 05	-.195E 04	-.607E 05
34	-.478E-04	.291E-05	.145E-04	.233E-06	.000E-80	.000E-80	-.195E 05	-.215E 04	-.528E 05
35	-.388E-04	.239E-05	.155E-04	.332E-06	.000E-80	.000E-80	-.163E 05	-.181E 04	-.476E 05

Table D15. Heading (u_{21D}) Including Rolling Gust Covariance Results (Continued)

MEAN RESPONSES

$\tilde{t}$	$\dot{M}_{1880}$	a_y	$\dot{a}_y$	$\bar{q}\beta$	$\bar{q}\dot{\beta}$	ϕ	$\dot{\phi}$	y	$\dot{y}$
1	.000E-30	.000E-30	.000E-30	.000E-30	.000E-30	.000E-30	.000E-80	.000E-80	.000E-80
2	-.129E 07	.138E-01	.397E-01	.107E-01	[illegible]	.236E-05	.197E-04	-.245E-02	-.163E-02
3	-.248E 05	.236E-01	-.329E-01	.523E 00	.291E-01	-.149E-03	-.471E-04	.979E 00	.330E 00
4	-.209E 06	-.613E-01	-.132E 00	.131E 01	.218E 00	-.514E-03	-.891E-04	.290E 01	.408E 00
5	-.215E 06	-.251E 00	-.331E 00	.145E 01	.327E 00	-.114E-02	-.137E-03	.397E 01	-.151E 00
6	-.210E 06	-.555E 00	-.723E 00	.721E 01	.451E 00	-.131E-02	-.125E-03	-.545E 00	-.193E 01
7	.320E 06	-.103E 01	-.560E 00	.129E 02	.325E 00	[illegible]	-.711E-04	-.135E 02	-.569E 01
8	.205E 07	-.164E 01	.181E 01	.135E 02	.295E 00	-.232E-02	.123E-04	-.622E 02	-.124E 02
9	.284E 07	-.227E 01	.850E 01	.176E 02	.446E 00	-.223E-02	.303E-04	-.148E 03	-.227E 02
10	.239E 06	-.272E 01	.148E 02	.192E 02	.585E 00	-.279E-02	-.116E-03	-.294E 03	-.360E 02
11	-.980E 07	-.216E 01	-.148E 02	.164E 02	.125E 01	-.693E-02	-.895E-03	-.508E 03	-.487E 02
12	-.342E 07	-.259E 01	-.276E 02	.276E 02	.140E 01	[illegible]	-.373E-03	-.779E 03	-.597E 02
13	-.124E 07	-.307E 01	-.298E 02	.235E 02	.159E 01	-.932E-02	.567E-04	-.111E 04	-.727E 02
14	.233E 06	-.290E 01	-.272E 02	[illegible]	.799E 00	-.745E-02	.377E-03	-.151E 04	-.976E 02
15	.274E 07	-.155E 01	-.187E 02	[illegible]	-.399E 00	-.371E-02	.618E-03	-.198E 04	-.989E 02
16	.358E 07	.305E 00	-.880E 01	-.244E 01	-.180E 01	.656E-03	.629E-03	-.248E 04	-.102E 03
17	.289E 07	.178E 01	-.230E 01	-.113E 02	-.185E 01	.399E-02	.166E-03	-.293E 04	-.963E 02
18	.147E 07	.224E 01	.179E 00	-.133E 02	-.114E 01	[illegible]	.577E-03	-.344E 04	-.859E 02
19	.193E 06	.193E 01	.306E 00	-.111E 02	-.737E 00	[illegible]	-.175E-03	-.384E 04	-.754E 02
20	-.429E 06	.135E 01	.187E-01	-.747E 01	[illegible]	[illegible]	-.228E-03	-.420E 04	-.671E 02
21	-.589E 06	.753E 00	-.212E 00	-.412E 01	.299E 00	.152E-02	-.218E-03	-.452E 04	-.619E 02
22	-.577E 06	.321E 00	-.278E 00	-.171E 01	[illegible]	.671E-03	-.147E-03	-.482E 04	-.591E 02
23	-.395E 06	.780E-01	-.240E 00	[illegible]	.294E 00	.165E-03	-.724E-04	-.511E 04	-.582E 02
24	-.221E 06	-.182E-01	-.258E 00	.973E-01	.154E 00	-.233E-04	-.242E-04	-.540E 04	-.580E 02
25	-.106E 06	-.421E-01	-.166E 00	.211E 00	.436E-01	-.547E-04	-.319E-05	-.569E 04	-.582E 02
26	-.169E 05	-.309E-01	-.553E-01	.153E 00	.396E-02	-.151E-04	.435E-05	-.598E 04	-.584E 02
27	-.148E 05	-.234E-01	-.940E-02	.115E 00	.528E-02	-.104E-04	.289E-05	-.629E 04	-.585E 02
28	-.968E 04	-.173E-01	.305E-01	.855E-01	.504E-02	-.201E-04	.200E-05	-.657E 04	-.586E 02
29	-.141E 05	-.134E-01	.583E-01	.642E-01	.755E-02	[illegible]	.117E-05	-.686E 04	-.587E 02
30	-.985E 04	-.106E-01	.350E-01	.395E-01	.727E-02	-.175E-04	.066E-06	-.716E 04	-.587E 02
31	-.655E 04	-.802E-02	.124E 00	.387E-01	-.334E-02	[illegible]	.570E-06	-.745E 04	-.589E 02
32	-.599E 04	-.708E-02	.115E 00	.333E-01	-.117E-02	-.551E-05	.336E-06	-.771E 04	-.588E 02
33	-.593E 04	-.566E-02	.110E 00	.239E-01	-.941E-02	-.422E-05	.271E-06	-.904E 04	-.589E 02
34	-.420E 04	-.395E-02	.127E 00	.133E-01	.232E-02	-.339E-05	.157E-06	-.833E 04	-.589E 02
35	-.420E 04	-.290E-02	.116E 00	.119E-01	-.797E-03	-.272E-05	.128E-06	-.963E 04	-.589E 02

Table D15. Heading (u_{21D}) Including Rolling Gust Covariance Results (Continued)

RESPONSE COVARIANCES

$\tilde{t}$	δ_p	$\dot{\delta}_p$	δ_r	δ_r	δ_a	$\dot{\delta}_a$	M_{660}	$\dot{M}_{660}$	M_{1880}
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.590E-05	.360E-03	.138E-04	.933E-03	.000E-80	.000E-80	.175E 12	.773E 14	.189E 14
3	.187E-03	.639E-03	.296E-04	.391E-03	.000E-80	.000E-80	.212E 13	.183E 15	.576E 14
4	.366E-03	.350E-02	.436E-04	.832E-03	.000E-80	.000E-80	.427E 13	.293E 15	.976E 14
5	.555E-03	.817E-02	.418E-04	.122E-02	.000E-80	.000E-80	.659E 13	.331E 15	.123E 15
6	.601E-03	.113E-01	.331E-04	.139E-02	.000E-80	.000E-80	.858E 13	.275E 15	.124E 15
7	.492E-03	.541E-02	.792E-05	.411E-03	.000E-80	.000E-80	.952E 13	.585E 14	.718E 14
8	.406E-03	.143E-01	.620E-04	.416E-02	.000E-80	.000E-80	.314E 13	.360E 15	.644E 14
9	.976E-03	.160E 00	.720E-03	.587E-01	.000E-80	.000E-80	.677E 13	.362E 16	.591E 15
10	.147E-02	.261E 00	.105E-02	.956E-01	.000E-80	.000E-80	.877E 13	.543E 16	.871E 15
11	.360E-02	.183E 00	.404E-03	.472E-01	.000E-80	.000E-80	.475E 14	.212E 16	.871E 15
12	.753E-02	.435E 00	.107E-02	.123E 00	.000E-80	.000E-80	.991E 14	.565E 16	.208E 16
13	.748E-02	.361E 00	.105E-02	.141E 00	.000E-80	.000E-80	.125E 15	.432E 16	.192E 16
14	.522E-02	.213E 00	.717E-03	.100E 00	.000E-80	.000E-80	.109E 15	.256E 16	.134E 16
15	.300E-02	.845E-01	.269E-03	.333E-01	.000E-80	.000E-80	.708E 14	.100E 16	.687E 15
16	.185E-02	.278E-01	.786E-04	.106E-01	.000E-80	.000E-80	.434E 14	.336E 15	.342E 15
17	.120E-02	.971E-02	.181E-04	.210E-02	.000E-80	.000E-80	.264E 14	.109E 15	.174E 15
18	.710E-03	.321E-02	.382E-05	.525E-03	.000E-80	.000E-80	.157E 14	.414E 14	.916E 14
19	.415E-03	.125E-02	.712E-06	.993E-04	.000E-80	.000E-80	.920E 13	.191E 14	.494E 14
20	.243E-03	.493E-03	.642E-07	.147E-04	.000E-80	.000E-80	.513E 13	.983E 13	.256E 14
21	.130E-03	.215E-03	.154E-07	.445E-05	.000E-80	.000E-80	.291E 13	.558E 13	.141E 14
22	.675E-04	.944E-04	.403E-08	.131E-05	.000E-80	.000E-80	.165E 13	.323E 13	.777E 13
23	.333E-04	.428E-04	.310E-08	.769E-06	.000E-80	.000E-80	.914E 12	.185E 13	.424E 13
24	.157E-04	.202E-04	.220E-08	.675E-06	.000E-80	.000E-80	.523E 12	.110E 13	.253E 13
25	.825E-05	.910E-05	.504E-08	.339E-06	.000E-80	.000E-80	.293E 12	.640E 12	.150E 13
26	.372E-05	.362E-05	.413E-08	.255E-06	.000E-80	.000E-80	.163E 12	.359E 12	.351E 12
27	.165E-05	.152E-05	.396E-08	.164E-06	.000E-80	.000E-80	.926E 11	.192E 12	.498E 12
28	.698E-06	.636E-06	.314E-08	.888E-07	.000E-80	.000E-80	.522E 11	.195E 12	.288E 12
29	.346E-06	.306E-06	.625E-08	.874E-07	.000E-80	.000E-80	.318E 11	.762E 11	.198E 12
30	.194E-06	.129E-06	.530E-08	.434E-07	.000E-80	.000E-80	.200E 11	.487E 11	.130E 12
31	.115E-06	.572E-07	.618E-08	.523E-07	.000E-80	.000E-80	.126E 11	.254E 11	.812E 11
32	.667E-07	.202E-07	.597E-08	.173E-07	.000E-80	.000E-80	.823E 10	.202E 11	.586E 11
33	.377E-07	.562E-08	.444E-08	.375E-08	.000E-80	.000E-80	.532E 10	.154E 11	.408E 11
34	.259E-07	.139E-08	.576E-08	.391E-09	.000E-80	.000E-80	.362E 10	.216E 11	.344E 11
35	.174E-07	.205E-09	.531E-08	.715E-10	.000E-80	.000E-80	.250E 10	.231E 11	.276E 11

Table D15. Heading (u_{21D}) Including Rolling Gust Covariance Results (Concluded)

RESPONSE COVARIANCES

$\tilde{t}$	$\dot{M}_{1880}$	a_y	$\dot{a}_y$	$\bar{q}\beta$	$\bar{q}\dot{\beta}$	ϕ	$\dot{\phi}$	y	$\dot{y}$
1	.000E-80	.000E-80	.000E-80	.000E-30	.000E-81	.000E-31	.000E-80	.000E-30	.000E-81
2	.113E 16	.132E 00	.102E 01	.715E-01	.512E 00	.624E-03	.256E-06	.998E-02	.334E-02
3	.374E 15	.786E-01	.746E 00	.111E 02	.737E-01	.114E-05	.775E-06	.874E 02	.451E 01
4	.114E 16	.234E 00	.923E 01	.231E 02	.135E 01	.216E-05	.271E-05	.274E 03	.531E 00
5	.199E 16	.498E 00	.381E 02	.377E 02	.117E 01	.323E-05	.434E-05	.223E 03	.208E 01
6	.243E 16	.771E 00	.849E 02	.733E 02	.338E 01	.353E-05	.561E-05	.513E 01	.160E 02
7	.751E 15	.752E 00	.500E 02	.613E 02	.149E 02	.317E-05	.311E-05	.663E 03	.193E 02
8	.436E 16	.173E 01	.271E 03	.739E 02	.249E 02	.225E-05	.556E-05	.481E 04	.113E 03
9	.570E 17	.125E 02	.476E 04	.884E 02	.566E 02	.235E-05	.442E-04	.172E 05	.219E 03
10	.951E 17	.218E 02	.105E 05	.101E 03	.378E 02	.359E-05	.679E-04	.352E 05	.379E 03
11	.545E 17	.149E 02	.920E 04	.116E 03	.183E 03	.176E-04	.554E-04	.991E 05	.566E 03
12	.141E 18	.367E 02	.274E 05	.139E 03	.311E 03	.333E-04	.122E-03	.138E 06	.751E 03
13	.125E 18	.354E 02	.294E 05	.253E 03	.436E 03	.117E-04	.112E-03	.324E 06	.383E 03
14	.764E 17	.238E 02	.217E 05	.221E 03	.167E 03	.315E-04	.623E-04	.516E 06	.125E 04
15	.294E 17	.119E 02	.103E 05	.113E 03	.329E 03	.135E-04	.274E-04	.771E 06	.140E 04
16	.845E 16	.456E 01	.380E 04	.833E 02	.192E 03	.119E-04	.103E-04	.197E 07	.134E 04
17	.224E 16	.217E 01	.132E 04	.552E 02	.146E 03	.311E-05	.423E-05	.141E 07	.117E 04
18	.596E 15	.115E 01	.429E 03	.333E 02	.581E 02	.435E-05	.169E-05	.175E 07	.958E 03
19	.180E 15	.654E 00	.146E 03	.198E 02	.322E 02	.317E-05	.681E-06	.211E 07	.857E 03
20	.629E 14	.378E 00	.452E 02	.112E 02	.181E 02	.143E-05	.298E-06	.247E 07	.745E 03
21	.322E 14	.213E 00	.217E 02	.624E 01	.102E 02	.915E-06	.135E-06	.283E 07	.657E 03
22	.171E 14	.123E 00	.100E 02	.315E 01	.577E 01	.479E-06	.617E-07	.319E 07	.587E 03
23	.967E 13	.688E-01	.638E 01	.138E 01	.325E 01	.233E-06	.269E-07	.357E 07	.534E 03
24	.616E 13	.380E-01	.508E 01	.102E 01	.182E 01	.115E-06	.124E-07	.394E 07	.494E 03
25	.349E 13	.203E-01	.278E 01	.539E 00	.996E 00	.531E-07	.514E-08	.433E 07	.466E 03
26	.188E 13	.110E-01	.163E 01	.233E 00	.503E 00	.236E-07	.205E-08	.473E 07	.444E 03
27	.101E 13	.606E-02	.121E 01	.149E 00	.249E 00	.173E-07	.899E-09	.515E 07	.428E 03
28	.528E 12	.332E-02	.892E 00	.793E-01	.123E 00	.430E-08	.317E-09	.557E 07	.415E 03
29	.323E 12	.179E-02	.108E 01	.433E-01	.618E-01	.207E-08	.138E-09	.602E 07	.406E 03
30	.170E 12	.106E-02	.777E 00	.248E-01	.303E-01	.113E-08	.590E-10	.647E 07	.399E 03
31	.851E 11	.676E-03	.628E 00	.146E-01	.134E-01	.633E-09	.235E-10	.695E 07	.394E 03
32	.356E 11	.381E-03	.404E 00	.965E-02	.515E-02	.344E-09	.859E-11	.744E 07	.390E 03
33	.118E 11	.222E-03	.166E 00	.517E-02	.170E-02	.194E-09	.286E-11	.795E 07	.386E 03
34	.325E 10	.104E-03	.786E-01	.315E-02	.936E-03	.129E-09	.767E-12	.847E 07	.384E 03
35	.376E 09	.513E-04	.129E-01	.196E-02	.487E-04	.354E-10	.230E-12	.902E 07	.382E 03

Table D16. Heading (u_{21D} with Δt = 0.04) Covariance Results

MEAN RESPONSES

$\tilde{t}$	δ_p	$\dot{\delta}_p$	δ_r	$\dot{\delta}_r$	δ_a	$\dot{\delta}_a$	M_{660}	$\dot{M}_{660}$	M_{1880}
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.128E-03	.868E-03	.335E-03	.206E-02	.000E-80	.000E-80	-.326E 05	-.174E 06	-.382E 06
3	-.197E-02	-.103E-02	.174E-02	-.614E-04	.000E-80	.000E-80	-.329E 06	-.310E 05	-.235E 07
4	-.649E-02	-.191E-02	.256E-02	.470E-04	.000E-80	.000E-80	-.878E 06	-.811E 05	-.442E 07
5	-.141E-01	-.290E-02	.316E-02	-.178E-04	.000E-80	.000E-80	-.180E 07	-.127E 06	-.731E 07
6	-.224E-01	-.276E-02	.335E-02	-.134E-03	.000E-80	.000E-80	-.305E 07	-.164E 06	-.103E 08
7	-.280E-01	-.143E-02	.168E-02	-.815E-03	.000E-80	.000E-80	-.431E 07	-.125E 06	-.112E 08
8	-.280E-01	.280E-03	-.523E-02	-.295E-02	.000E-80	.000E-80	-.481E 07	.503E 05	-.584E 07
9	-.266E-01	.954E-03	-.182E-01	-.449E-02	.000E-80	.000E-80	-.413E 07	.191E 06	.631E 07
10	-.340E-01	-.233E-02	-.211E-01	-.463E-03	.000E-80	.000E-80	-.483E 07	-.139E 06	.738E 07
11	-.874E-01	-.196E-01	.125E-01	.112E-01	.000E-80	.000E-80	-.113E 08	-.148E 07	-.356E 08
12	-.109E 00	-.677E-02	.178E-01	.146E-02	.000E-80	.000E-80	-.143E 08	-.917E 06	-.468E 08
13	-.114E 00	.153E-03	.217E-01	.100E-02	.000E-80	.000E-80	-.164E 08	-.107E 07	-.524E 08
14	-.907E-01	.793E-02	.163E-01	-.128E-02	.000E-80	.000E-80	-.145E 08	-.190E 06	-.430E 08
15	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
16	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
17	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
18	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
19	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
20	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
21	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
22	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
23	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
24	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
25	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
26	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
27	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
28	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
29	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
30	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
31	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
32	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
33	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
34	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
35	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80

Table D16. Heading (u_{21D} with Δt = 0.04) Covariance Results (Continued)

MEAN RESPONSES

$\tilde{t}$	$\dot{M}_{1880}$	a_y	$\dot{a}_y$	$\bar{q}\beta$	$\bar{q}\dot{\beta}$	ϕ	$\dot{\phi}$	y	$\dot{y}$
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	-.229E 07	.221E-01	-.188E-01	.134E-01	.290E-01	.544E-05	.219E-04	-.157E-02	.332E-02
3	-.921E 04	.236E-01	-.207E-01	.521E 00	.990E-01	-.149E-03	-.476E-04	.887E 00	.371E 00
4	-.222E 06	-.620E-01	-.117E 00	.179E 01	.210E 00	-.511E-03	-.858E-04	.290E 01	.500E 00
5	-.256E 06	-.250E 00	-.355E 00	.403E 01	.347E 00	-.113E-02	-.128E-03	.397E 01	.216E-01
6	-.210E 06	-.552E 00	-.735E 00	.719E 01	.477E 00	-.182E-02	-.122E-03	-.420E 00	-.167E 01
7	.592E 06	-.102E 01	-.580E 00	.109E 02	.547E 00	-.229E-02	-.654E-04	-.181E 02	-.548E 01
8	.272E 07	-.164E 01	.181E 01	.146E 02	.528E 00	-.232E-02	.372E-05	-.614E 02	-.127E 02
9	.417E 07	-.231E 01	.920E 01	.176E 02	.511E 00	-.222E-02	.131E-04	-.147E 03	-.244E 02
10	.984E 05	-.273E 01	.141E 02	.191E 02	.671E 00	-.278E-02	-.148E-03	-.293E 03	-.387E 02
11	-.131E 08	-.210E 01	-.132E 02	.183E 02	.139E 01	-.697E-02	-.895E-03	-.507E 03	-.474E 02
12	-.334E 07	-.247E 01	-.228E 02	.206E 02	.156E 01	-.889E-02	-.291E-03	-.776E 03	-.569E 02
13	-.302E 07	-.306E 01	-.238E 02	.234E 02	.193E 01	-.940E-02	.313E-04	-.111E 04	-.690E 02
14	.492E 06	-.297E 01	-.183E 02	.208E 02	.780E 00	-.761E-02	.399E-03	-.150E 04	-.539E 02
15	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
16	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
17	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
18	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
19	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
20	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
21	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
22	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
23	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
24	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
25	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
26	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
27	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
28	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
29	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
30	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
31	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
32	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
33	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
34	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
35	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80

Table D16. Heading (u_{21D} with Δt = 0.04) Covariance Results (Continued)

RESPONSE COVARIANCES

$\tilde{t}$	δ_p	$\dot{\delta}_p$	δ_r	$\dot{\delta}_r$	δ_a	$\dot{\delta}_a$	M_{660}	$\dot{M}_{660}$	M_{1880}
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.105E-04	.443E-03	.889E-04	.287E-02	.000E-80	.000E-80	.812E 12	.525E 15	.115E 15
3	.198E-03	.153E-02	.309E-04	.571E-03	.000E-80	.000E-80	.213E 13	.190E 15	.588E 14
4	.385E-03	.994E-02	.460E-04	.163E-02	.000E-80	.000E-80	.427E 13	.310E 15	.100E 15
5	.590E-03	.256E-01	.457E-04	.259E-02	.000E-80	.000E-80	.664E 13	.362E 15	.130E 15
6	.641E-03	.361E-01	.372E-04	.319E-02	.000E-80	.000E-80	.868E 13	.311E 15	.133E 15
7	.458E-03	.123E-01	.889E-05	.102E-02	.000E-80	.000E-80	.957E 13	.668E 14	.736E 14
8	.361E-03	.347E-01	.683E-04	.984E-02	.000E-80	.000E-80	.820E 13	.394E 15	.715E 14
9	.144E-02	.487E 00	.825E-03	.130E 00	.000E-80	.000E-80	.707E 13	.413E 16	.688E 15
10	.225E-02	.793E 00	.122E-02	.212E 00	.000E-80	.000E-80	.930E 13	.625E 16	.103E 16
11	.384E-02	.461E 00	.456E-03	.986E-01	.000E-80	.000E-80	.475E 14	.244E 16	.930E 15
12	.861E-02	.123E 01	.124E-02	.269E 00	.000E-80	.000E-80	.994E 14	.667E 16	.225E 16
13	.846E-02	.102E 01	.129E-02	.314E 00	.000E-80	.000E-80	.127E 15	.546E 16	.216E 16
14	.576E-02	.573E 00	.886E-03	.223E 00	.000E-80	.000E-80	.112E 15	.328E 16	.149E 16
15	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
16	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
17	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
18	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
19	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
20	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
21	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
22	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
23	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
24	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
25	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
26	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
27	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
28	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
29	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
30	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
31	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
32	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
33	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
34	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
35	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80

Table D16. Heading (u_{21D} with Δt = 0.04) Covariance Results (Concluded)

RESPONSE COVARIANCES

$\tilde{t}$	$\dot{M}_{1880}$	a_y	$\dot{a}_y$	$\bar{q}\beta$	$\dot{\bar{q}\beta}$	ϕ	$\dot{\phi}$	y	$\dot{y}$
1	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
2	.354E 16	.349E 00	.242E 00	.119E 00	.481E 00	.196E-07	.291E-06	.645E-02	.773E-02
3	.708E 15	.816E-01	.269E 01	.112E 02	.754E-01	.107E-05	.106E-05	.981E 02	.494E 01
4	.222E 16	.286E 00	.308E 02	.234E 02	.451E 00	.216E-05	.426E-05	.299E 03	.763E 00
5	.419E 16	.696E 00	.121E 03	.369E 02	.155E 01	.320E-05	.812E-05	.249E 03	.193E 01
6	.552E 16	.112E 01	.245E 03	.499E 02	.439E 01	.350E-05	.921E-05	.103E 02	.150E 02
7	.168E 16	.834E 00	.103E 03	.616E 02	.120E 02	.288E-05	.298E-05	.602E 03	.483E 02
8	.967E 16	.207E 01	.503E 03	.736E 02	.284E 02	.196E-05	.605E-05	.459E 04	.116E 03
9	.127E 18	.182E 02	.874E 04	.886E 02	.597E 02	.250E-05	.816E-04	.167E 05	.240E 03
10	.212E 18	.308E 02	.177E 05	.104E 03	.118E 03	.378E-05	.128E-03	.445E 05	.420E 03
11	.111E 18	.188E 02	.135E 05	.115E 03	.221E 03	.175E-04	.807E-04	.980E 05	.554E 03
12	.301E 18	.483E 02	.397E 05	.190E 03	.370E 03	.384E-04	.211E-03	.187E 06	.733E 03
13	.271E 18	.450E 02	.406E 05	.249E 03	.553E 03	.423E-04	.173E-03	.322E 06	.956E 03
14	.164E 18	.289E 02	.280E 05	.223E 03	.609E 03	.310E-04	.106E-03	.513E 06	.122E 04
15	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
16	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
17	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
18	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
19	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
20	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
21	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
22	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
23	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
24	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
25	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
26	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
27	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
28	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
29	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
30	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
31	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
32	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
33	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
34	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80
35	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80	.000E-80

APPENDIX E

LATERAL EQUATIONS AND DATA FOR NORTH AMERICAN 130G.

This appendix presents the vehicle equations and data used in Section VII.

VECTOR REPRESENTATION

A three-view of the airplane is presented as Figure 70. All data except for the rudder aerodynamics and actuator dynamics are taken from ref. 27. Honeywell obtained the missing data from North American.

The state equations are presented in Table E2, and the numerical data for them are presented in Table E1. The FC (flight conditions) referred to correspond to those being used by Honeywell Aerospace in the Phase B shuttle program. Table E3 identifies the flight conditions used.

DISCUSSION

The weights, inertias, and centers of gravity used (Table E3) were obtained from North American.

Stability derivatives except for rudder were obtained from Figures E1 through E11. The signs of the derivatives for aileron δ_a (differential tail deflection) and spoilers are reversed in going to Tables E1 and E4 to conform to conventional NASA practice. It is noted that both the ailerons and spoilers yield proverse yaw. The spoiler data were resolved from stability axes as presented in Figures E10 and E11 to body axes in Table E4. Table E4 also assumes a spoiler gearing has been provided to yield the linear effectiveness between 0 and $\pi/2$ radians.

The generic form of the state perturbation equations of Table E2 is:

$$\dot{p} = L_p' p + L_r' r + L_\beta' \beta + L_{\delta a}' \delta_a + L_{\delta r}' \delta_r + L_{\delta s}' \delta_s$$

$$\dot{r} = N_p' p + N_r' r + N_\beta' \beta + N_{\delta a}' \delta_a + N_{\delta r}' \delta_r + N_{\delta s}' \delta_s$$

$$\dot{\beta} = \frac{w_o}{V} p - \frac{u_o}{V} r + Y_\beta \beta + Y_{\delta r} \delta_r + \frac{g}{V}(c\theta_o)\phi$$

$$\dot{\phi} = p + (\tan \theta_o) r$$

$$\ddot{\delta}_a = -\frac{T_{a_1} + T_{a_2}}{T_{a_1} T_{a_2}} \dot{\delta}_a - \frac{1}{T_{a_1} T_{a_2}} \delta_a + \frac{1}{T_{a_1} T_{a_2}} u_1$$

$$\ddot{\delta}_r = -\frac{T_{r_1} + T_{r_2}}{T_{r_1} T_{r_2}} \dot{\delta}_r - \frac{1}{T_{r_1} T_{r_2}} \delta_r + \frac{1}{T_{r_1} T_{r_2}} u_2$$

$$\dot{\delta}_s = -\frac{1}{T_s} \delta_s + \frac{1}{T_s} u_3$$

where

$$L'_{p,\,r} = \left(\frac{\bar{q}Sb}{I}\right)\left(\frac{b}{2V}\right) \left\{ I_{zz} C_{\ell_{p,\,r}} + I_{xz} C_{n_{p,\,r}} \right\}$$

$$L'_{\beta,\,\delta a,\,\delta r,\,\delta s} = \frac{\bar{q}Sb}{I} \left\{ I_{zz} C_{\ell_{\beta,\,\delta a,\,\delta r,\,\delta s}} + I_{xz} C_{n_{\beta,\,\delta a,\,\delta r,\,\delta s}} \right\}$$

$$N'_{p,\,r} = \left(\frac{\bar{q}Sb}{I}\right)\left(\frac{b}{2V}\right) \left\{ I_{xx} C_{n_{p,\,r}} + I_{xz} C_{\ell_{p,\,r}} \right\}$$

$$N'_{\beta,\,\delta r} = \frac{\bar{q}Sb}{I} \left\{ I_{xx} C_{n_{\beta,\,\delta r}} + I_{xz} C_{\ell_{\beta,\,\delta r}} \right\}$$

$$Y_{\beta,\,\delta r} = \frac{g}{V} \frac{\bar{q}S}{W} \left\{ C_{y_{\beta,\,\delta r}} \right\}$$

$$I = I_{xx} I_{yy} - I_{xz}^{\;2}$$

The time constants (T_{a_1}, T_{r_1}, T_{a_2}, and T_{r_2}) for the aileron and rudder servo and actuator are taken as 0.030 second. The spoiler time constant is taken as 0.15 second.

Table E1. State Data

	FC 9	FC 11
a_{11}	-2.85	-1.299
a_{12}	+1.367	+1.336
a_{13}	-6.37	-1.668
a_{16}	-7.48	-1.555
a_{18}	+4.46	+ .963
a_{19}	- .698	- .212
a_{21}	+ .1766	+ .0846
a_{22}	- .586	- .405
a_{23}	+2.15	+ .491
a_{26}	- .985	- .1633
a_{28}	-1.286	- .332
a_{29}	- .0466	- .01603
a_{31}	+ .0262	+ .191
a_{32}	-1.00	- .982
a_{33}	- .444	- .325
a_{34}	+ .0477	+ .1275
a_{38}	+ .0723	+ .0405
a_{41}	+1.0	+1.0
a_{42}	+ .0262	+ .1942
a_{44}	0.0	0.0

Table E1. State Data (Continued)

ALL FLIGHT CONDITIONS

a_{55}	- 66.7
a_{56}	-1111.0
a_{65}	+ 1.0
a_{77}	- 66.7
a_{78}	-1111.0
a_{87}	+ 1.0
a_{99}	- .15
b_{51}	+1111.0
b_{72}	+1111.0
b_{93}	+ .15
$\lvert\dot{\delta}_a\rvert \le$	.262 rad/sec
$\lvert\delta_a\rvert \le$	.262 rad
$\lvert\dot{\delta}_r\rvert \le$	.349 rad/sec
$\lvert\delta_r\rvert \le$	.1742 rad
$\lvert\dot{\delta}_s\rvert \le$	.523 rad/sec
$\lvert\delta_s\rvert \le$	1.572 rad

Table E2. State Equations

$$
\begin{array}{c}
\\
\begin{bmatrix} \dot{p} \\ \dot{r} \\ \dot{\beta} \\ \dot{\phi} \\ \ddot{\delta}_a \\ \dot{\delta}_a \\ \ddot{\delta}_r \\ \dot{\delta}_r \\ \dot{\delta}_s \end{bmatrix}
\end{array}
=
\begin{array}{c}
\begin{array}{ccccccccc} p & r & \beta & \phi & \dot{\delta}_a & \delta_a & \dot{\delta}_r & \delta_r & \delta_s \end{array} \\
\begin{bmatrix}
a_{11} & a_{12} & a_{13} & 0 & 0 & a_{16} & 0 & a_{18} & a_{19} \\
a_{21} & a_{22} & a_{23} & 0 & 0 & a_{26} & 0 & a_{28} & a_{29} \\
a_{31} & a_{32} & a_{33} & a_{34} & 0 & 0 & 0 & a_{38} & 0 \\
a_{41} & a_{42} & 0 & a_{44} & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & a_{55} & a_{56} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & a_{65} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & a_{77} & a_{78} & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & a_{87} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & a_{99}
\end{bmatrix}
\end{array}
\begin{array}{c}
\\
\begin{bmatrix} p \\ r \\ \beta \\ \phi \\ \dot{\delta}_a \\ \delta_a \\ \dot{\delta}_r \\ \delta_r \\ \delta_s \end{bmatrix}
\end{array}
+
\begin{array}{c}
\begin{array}{ccc} u_1 & u_2 & u_3 \end{array} \\
\begin{bmatrix}
0 & 0 & 0 \\
0 & 0 & 0 \\
0 & 0 & 0 \\
0 & 0 & 0 \\
b_{51} & 0 & 0 \\
0 & 0 & 0 \\
0 & b_{72} & 0 \\
0 & 0 & 0 \\
0 & 0 & b_{93}
\end{bmatrix}
\end{array}
\begin{bmatrix} u_1 \\ u_2 \\ u_3 \end{bmatrix}
$$

Table E3. Flight Data

		FC 9	FC 11	
C_L		0.234	0.922	
I_{xx}		$1.91 \cdot 10^6$	$1.92 \cdot 10^6$	slug ft^2
I_{xz}		$.220 \cdot 10^6$	$.222 \cdot 10^6$	slug ft^2
I_{zz}		$13.4 \cdot 10^6$	$13.47 \cdot 10^6$	slug ft^2
M	Mach	0.650	0.226	
S	Wing area	3084		ft^2
W	Weight	208,000	214,495	lb
V	Speed	674.	252.	ft/sec
b	Span	124.2		ft
h	Altitude	20,000	0	ft
$\bar{q}$	Dynamic pressure	287.	75.5	lb/ft^2
u_o		674.	247.	ft/sec
w_o		+17.67	+48.1	ft/sec
x_{cm}	Center of mass	1615.	1465.	in.
x_{cm}	Center of mass	67.0	59.8	%
α_o	Attack	1.5/57.3	11/57.3	rad

Table E4. Body Axis Stability Derivatives

F.C.	9	11	9	11	9	11
$(\cdot)$	$C_{\ell(\cdot)}$		$C_{n(\cdot)}$		$C_{y(\cdot)}$	
p	-.540	-.350	+.295	+.200	—	—
r	+.270	+.370	-.804	-.806	—	—
β	-.115	-.115	+.275	+.241	-2.18	-2.35
δ_a	-.128	-.101	-.105	-.064	—	—
δ_r	+.080	+.066	-.166	-.162	.355	+ .292
δ_s	-.0120	-.01377	-.00427	-.0058	—	—

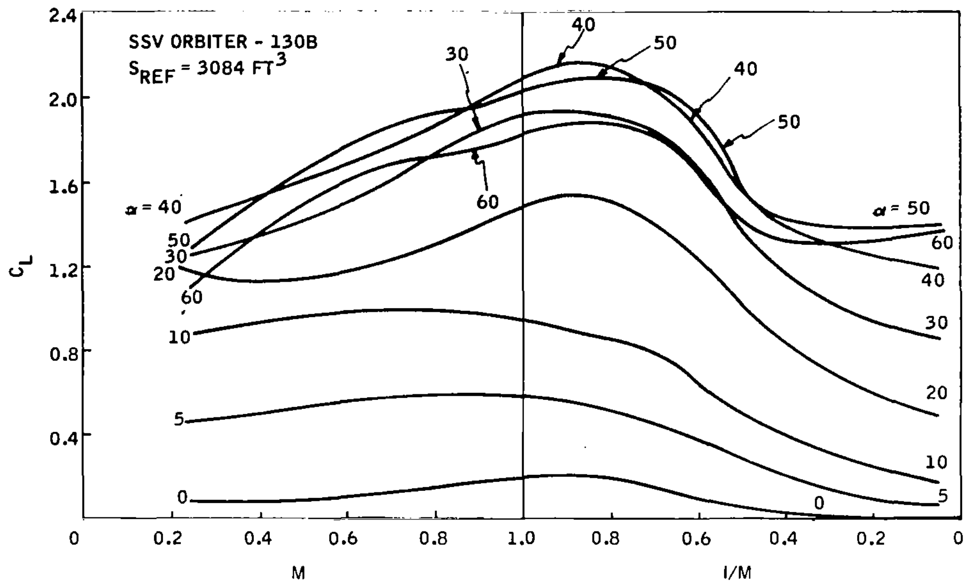


Figure E1. Trim Data

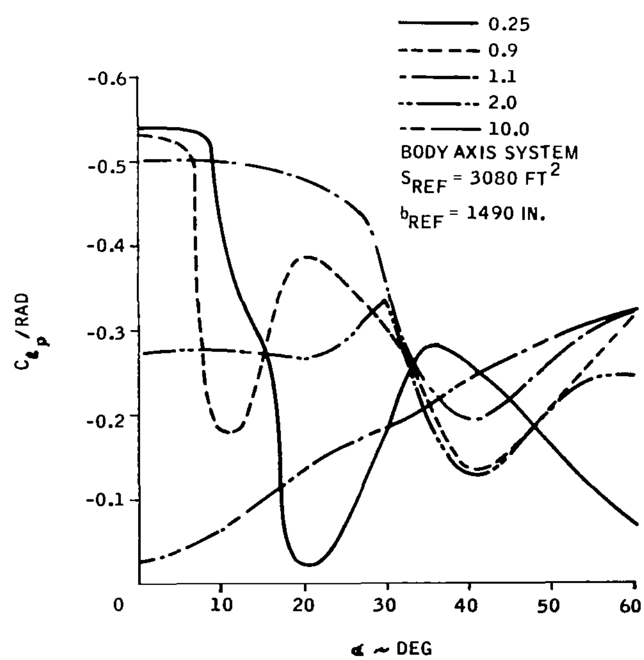


Figure E2. C_{ℓ_p}

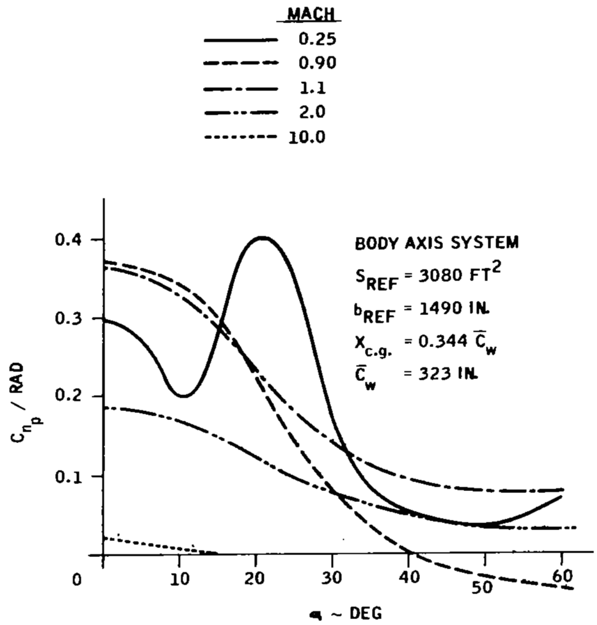


Figure E3. C_{n_p}

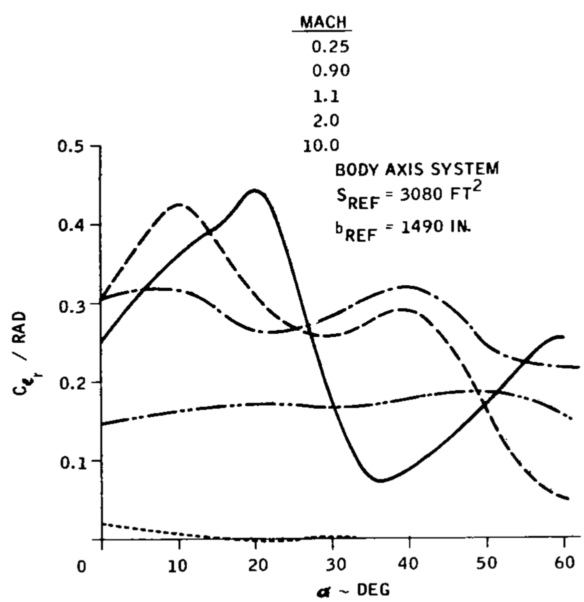


Figure E4. C_{ℓ_r}

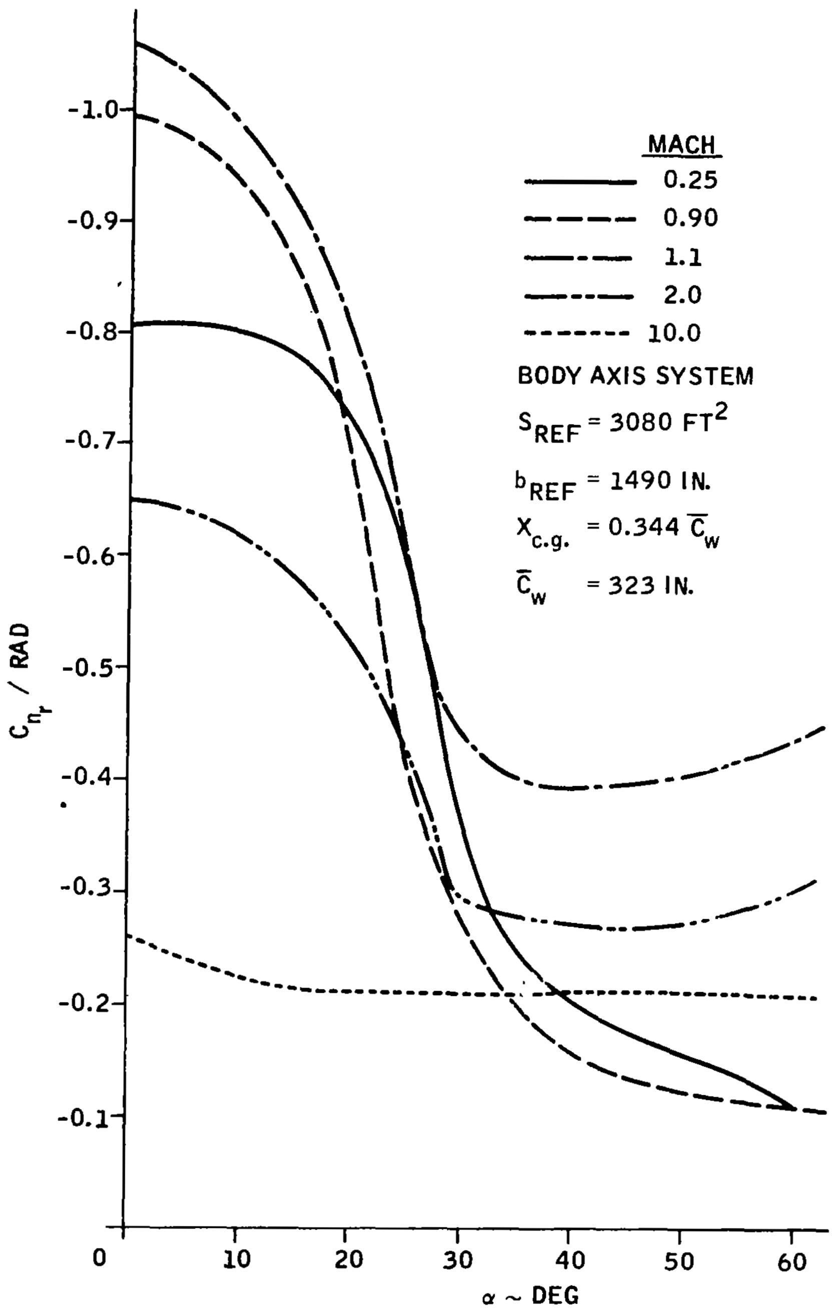


Figure E5. C_{n_r}

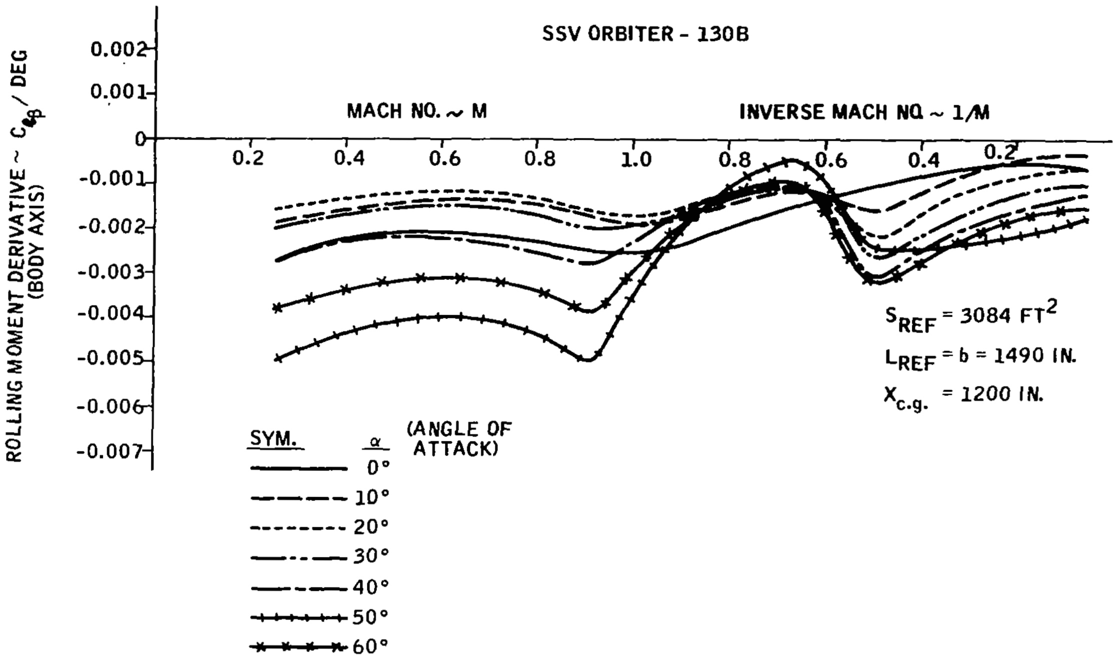


Figure E6. C_{ℓ_β}

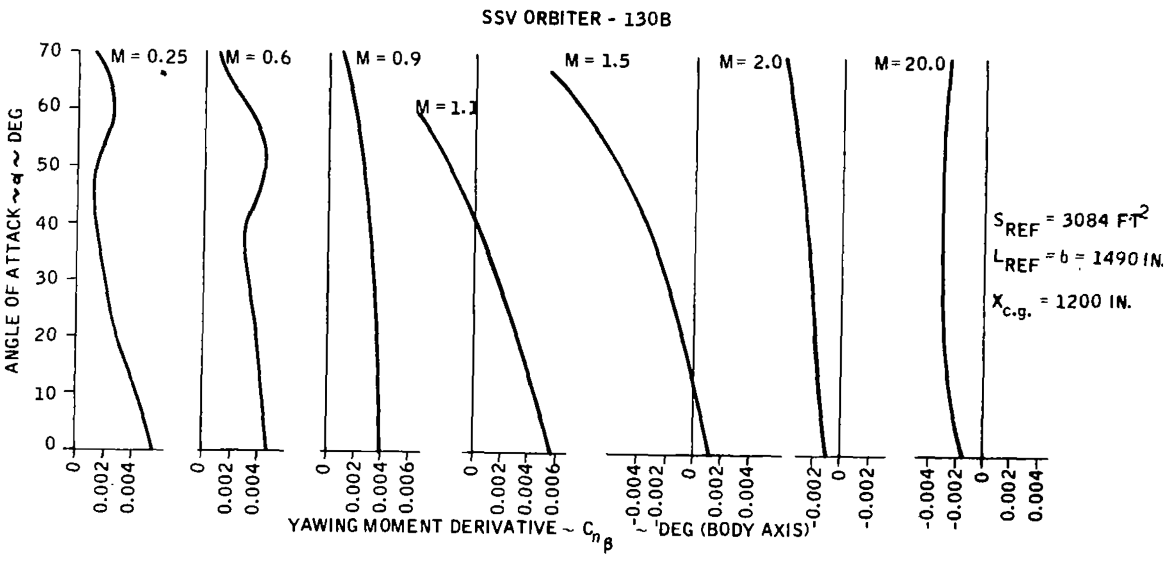


Figure E7. C_{n_β}

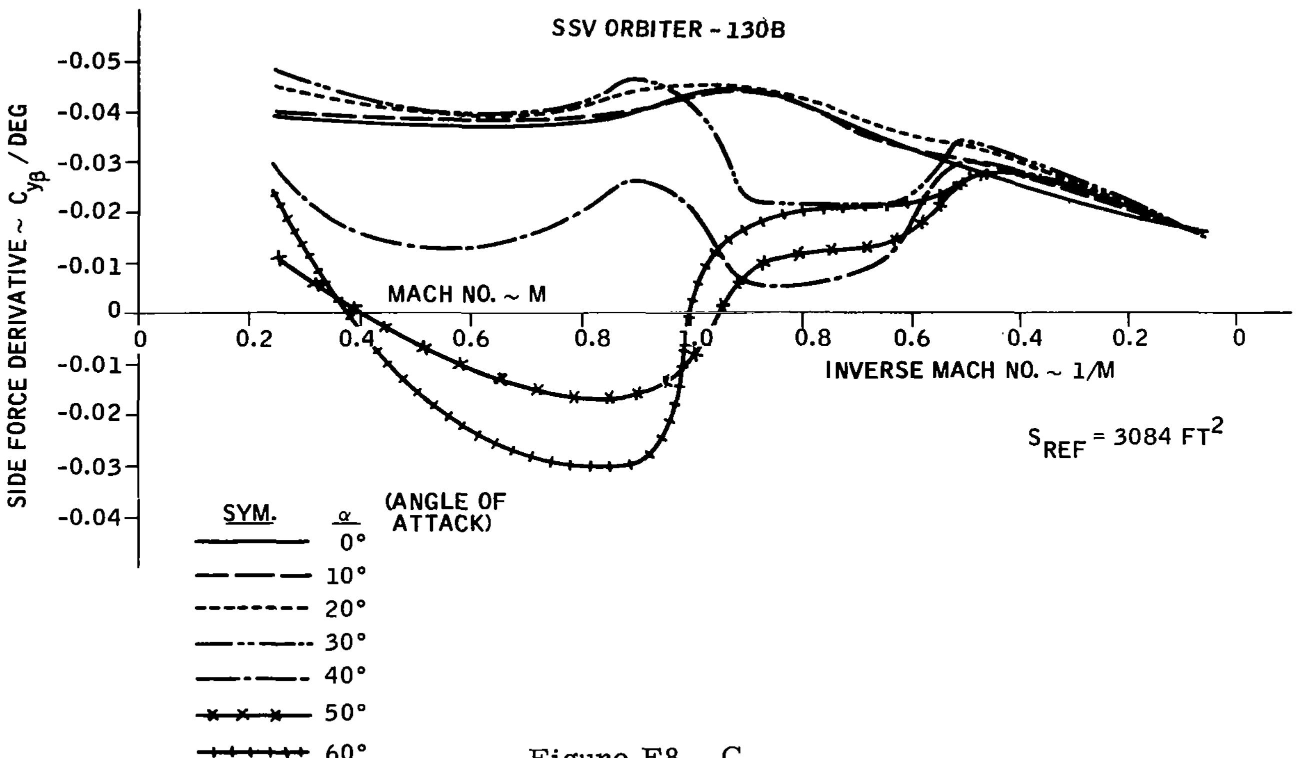


Figure E8. C_{y_β}

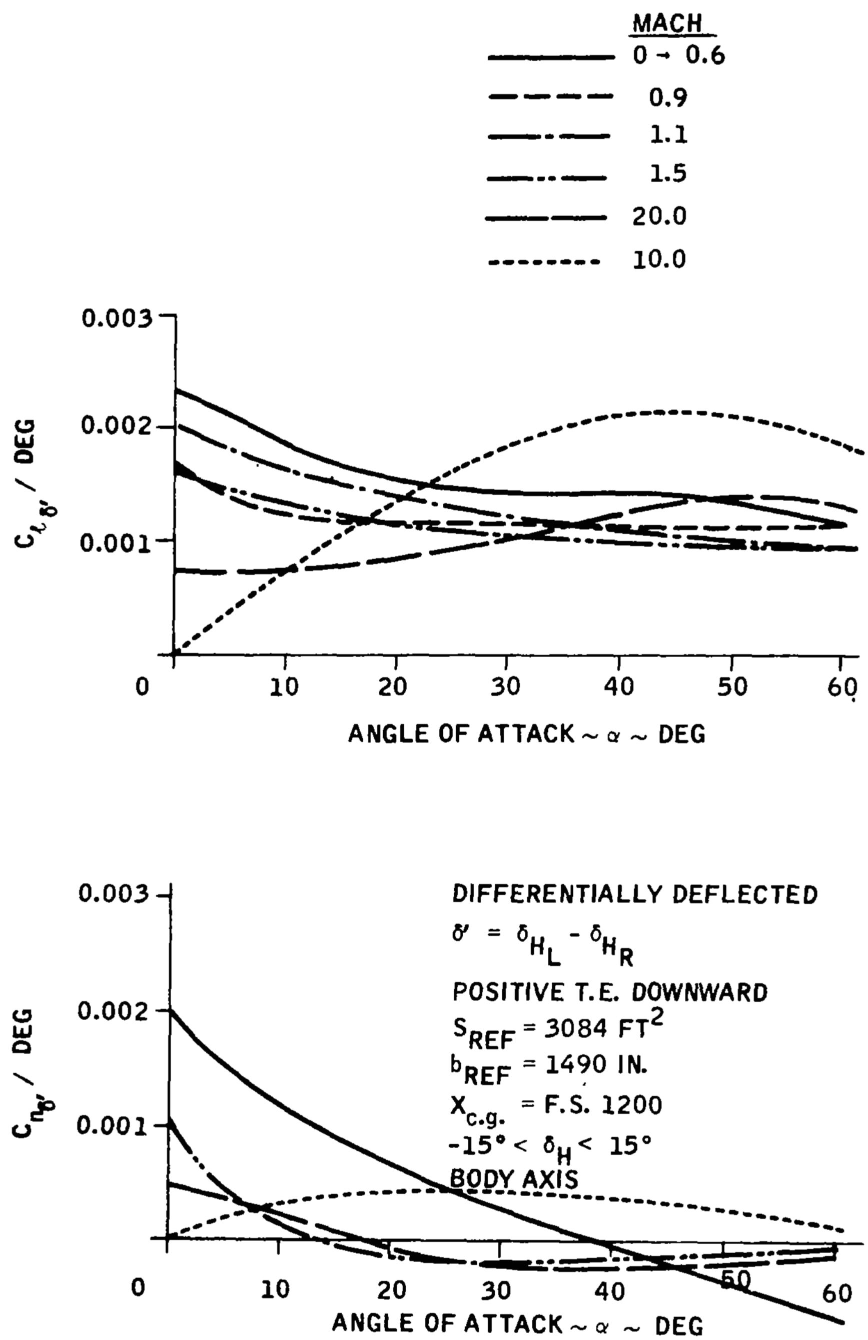


Figure E9. $C_{1_{\delta a}}$ and $C_{n_{\delta a}}$

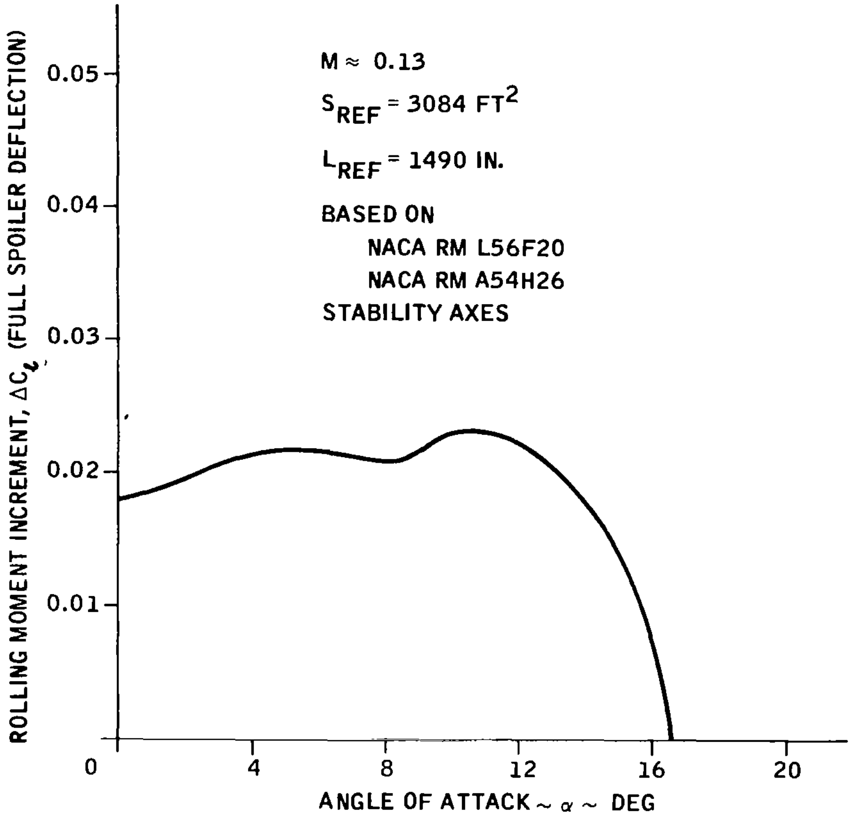


Figure E10. C_ℓ Spoiler

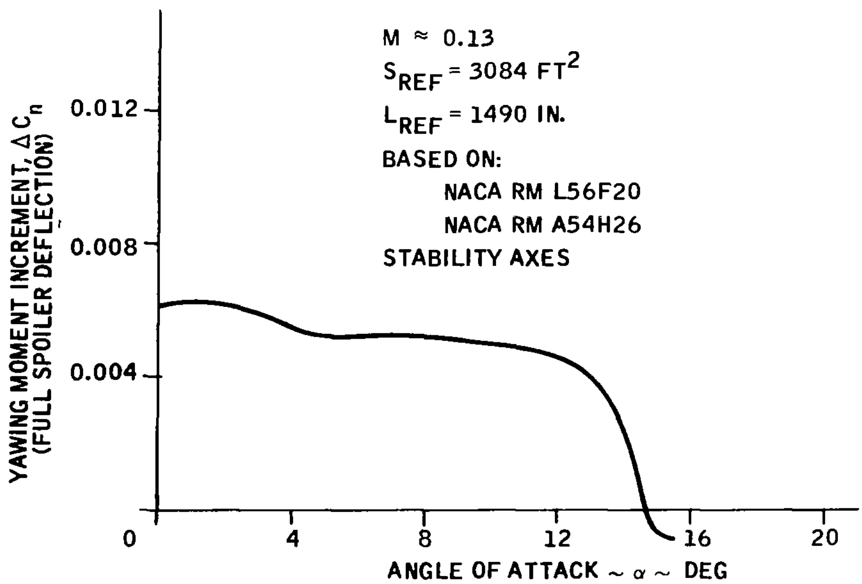


Figure E11. C_n Spoiler

APPENDIX F

LATERAL EQUATIONS AND DATA FOR NORTH AMERICAN 134D

This appendix presents the equations and data used to generate the results of Section VIII. The nomenclature, representations, and derivations are presented below.

NOMENCLATURE

A = Matrix [Equation (F1)]

A[x] = Slender body area [Equations (F19) and (F20)] ft^2

B = Matrix [Equation (F22)]

$$C_L = 0.345 = \frac{W}{\bar{q}S[c\gamma - (s\gamma)\,C_D/C_L]}$$

$$C_{\ell_p} = (c\alpha)^2\,\bar{C}_{\ell_{\bar{p}}} - (s\alpha)(c\alpha)\left(\bar{C}_{\ell_{\bar{r}}} + \bar{C}_{n_{\bar{p}}}\right) + (s\alpha)^2\,\bar{C}_{n_{\bar{r}}}$$ 1/rad

$$\bar{C}_{\ell_{\bar{p}}} = \frac{\partial \bar{C}_\ell}{\partial\left(\frac{\bar{p}b}{2V}\right)}$$ (Figure F4) 1/rad

$$C_{\ell_r} = (c\alpha)^2\,\bar{C}_{\ell_{\bar{r}}} + (s\alpha)(c\alpha) + \left(\bar{C}_{\ell_{\bar{p}}} - \bar{C}_{n_{\bar{r}}}\right) - (s\alpha)^2\,\bar{C}_{n_p}$$ 1/rad

$$\bar{C}_{\ell_{\bar{r}}} = \frac{\partial \bar{C}_\ell}{\partial\left(\frac{\bar{r}b}{2V}\right)}$$ (Figure F5) 1/rad

$$C_{\ell_\beta} = 57.3\left[(c\alpha)\,\bar{C}_{\ell_\beta} - (s\alpha)\,\bar{C}_{n_\beta}\right]$$ 1/rad

$$\bar{C}_{\ell_\beta} = \frac{\partial \bar{C}_\ell}{\partial \beta}$$ (Figure F6) 1/deg

$$C_{\ell_{\delta a}} = 57.3\left[(c\alpha)\,\bar{C}_{\ell_{\delta a}} - (s\alpha)\,\bar{C}_{n_{\delta a}}\right]$$ 1/rad

$$\bar{C}_{\ell_{\delta a}} = \frac{\partial \bar{C}_\ell}{\partial \delta_a} \quad \text{(Figure F7)} \qquad 1/\text{deg}$$

$$C_{\ell_{\delta r}} = 57.3 \left\{ (c\alpha)\, C_{\ell_{\delta r}} - (s\alpha)\, \bar{C}_{n_{\delta r}} \right\} \qquad 1/\text{rad}$$

$$\bar{C}_{\ell_{\delta r}} = \frac{\partial \bar{C}_\ell}{\partial \delta_r} \quad \text{(Figure F8)} \qquad 1/\text{deg}$$

$$C_{n_p} = (c\alpha)^2\, \bar{C}_{n_{\bar{p}}} + (s\alpha)(c\alpha)\left(+ \bar{C}_{\ell_{\bar{p}}} - \bar{C}_{n_{\bar{r}}} \right) - (s\alpha)^2\, C_{\ell_{\bar{r}}} \qquad 1/\text{rad}$$

$$\bar{C}_{n_{\bar{p}}} = \frac{\partial \bar{C}_n}{\partial \left(\frac{\bar{p} b}{2V} \right)} \quad \text{(Figure F4)} \qquad 1/\text{rad}$$

$$C_{n_r} = (c\alpha)^2\, \bar{C}_{n_{\bar{r}}} + (s\alpha)(c\alpha)\left(+ \bar{C}_{\ell_{\bar{r}}} + \bar{C}_{n_{\bar{p}}} \right) + (s\alpha)^2\, \bar{C}_{\ell_{\bar{p}}} \qquad 1/\text{rad}$$

$$\bar{C}_{n_{\bar{r}}} = \frac{\partial \bar{C}_n}{\partial \left(\frac{\bar{r} b}{2V} \right)} \quad \text{(Figure F5)} \qquad 1/\text{rad}$$

$$C_{n_\beta} = 57.3 \left\{ + (s\alpha)\, \bar{C}_{\ell_\beta} + (c\alpha)\, \bar{C}_{n_\beta} + \frac{x_{cm} - x_{mrp}}{b}\, \bar{C}_{y_\beta} \right\} \qquad 1/\text{rad}$$

$$\bar{C}_{n_\beta} = \frac{\partial \bar{C}_n}{\partial \beta} \quad \text{(Figure F6)} \qquad 1/\text{deg}$$

$$C_{n_{\delta a}} = 57.3 \left\{ + (s\alpha)\, \bar{C}_{\ell_{\delta a}} + (c\alpha)\, \bar{C}_{n_{\delta a}} + \frac{x_{cm} - x_{mrp}}{b}\, \bar{C}_{y_{\delta a}} \right\} \qquad 1/\text{rad}$$

$$\bar{C}_{n_{\delta a}} = \frac{\partial \bar{C}_n}{\partial \delta_a} \quad \text{(Figure F7)} \qquad 1/\text{deg}$$

$$C_{n_{\delta r}} = 57.3 \left\{ + (s\alpha)\, \bar{C}_{\ell_{\delta r}} + (c\alpha)\, \bar{C}_{n_{\delta r}} \right\} \qquad 1/\text{rad}$$

$$\bar{C}_{n_{\delta r}} = \frac{\partial \bar{C}_n}{\partial \delta_r} \quad \text{(Figure F8)} \qquad 1/\text{deg}$$

$C_{y_\beta} = 57.3\ \bar{C}_{y_\beta}$ — 1/rad

$\bar{C}_{y_\beta} = \frac{\partial \bar{C}_y}{\partial \beta}$ (Figure F6) — 1/deg

$C_{y_{\delta r}} = 57.3\ \bar{C}_{y_{\delta r}}$ — 1/rad

$\bar{C}_{y_{\delta r}} = \frac{\partial \bar{C}_y}{\partial \delta_r}$ (Figure F8) — 1/deg

D = Matrix [Equation (F2)]

$E_o = 2.5/57.3$ (Elevation angle) — rad

G = Matrix [Equation (F1)]

H = Matrix [Equation (F2)]

H = Heading angle (rotation sequence H, E, ϕ) — rad

$I = I_{xx} I_{zz} - I_{xz}^2$ — $slug^2/ft^4$

$I_{xx} = 2.75 \cdot 10^6$ (Inertia about x axes) — $slug/ft^2$

$I_{xz} = -0.006 \cdot 10^6$ (Product of inertia) — $slug/ft^2$

$I_{zz} = 14.394 \cdot 10^6$ (Inertia about z axis) — $slug/ft^2$

L = Rolling moment — ft/lb

L = 172 (Slender body length) — ft

$L_v = 1220$ (Side gust scale of turbulence) — ft

$L_w = 600$ (Vertical gust scale of turbulence) — ft

N = Yawing moment — ft/lb

S = 6084 (Reference area) — ft^2

$T_a = 1/6$ (Aileron actuator time constant) — sec

T_r = 1/6 (Rudder actuator time constant) sec

V = 291 (Airspeed) ft/sec

W = 212, 740 (Weight) lb

Y = Side force lb

a_{i_j} = Element of A matrix

$$a_{11} = \frac{1}{I}\left\{\frac{\bar{q}Sb^2}{2V}\left(I_{zz}C_{\ell_p} + I_{xz}C_{n_p}\right) + I_{zz}I_{xz}q_o + I_{xz}(I_{xx} - I_{yy})q_o\right\}$$

$$a_{12} = \frac{1}{I}\left\{\frac{\bar{q}Sb^2}{2V}\left(I_{zz}C_{\ell_r} + I_{xz}C_{n_r}\right) + I_{zz}(I_{yy} - I_{zz})q_o - I_{xz}{}^2q_o\right\}$$

$$a_{13} = \frac{1}{I}\left\{\frac{\bar{q}Sb}{V}\left(I_{zz}C_{\ell_\beta} + I_{xz}C_{n_\beta}\right)\right\}$$

$$a_{17} = \frac{\bar{q}Sb}{IV}\left\{I_{zz}C_{\ell_\beta}\mu_{21} + I_{xz}C_{n_\beta}\mu_{11}\right\}$$

$$a_{18} = \frac{\bar{q}Sb}{IV}\left\{I_{zz}C_{\ell_\beta}\mu_{22} + I_{xz}C_{n_\beta}\mu_{12}\right\}$$

$$a_{19} = \frac{\bar{q}Sb}{IV}\left\{I_{zz}C_{\ell_\beta}\mu_{23} + I_{xz}C_{n_\beta}\mu_{13}\right\}$$

$$a_{1,10} = \frac{\bar{q}Sb^2}{2IV}\left\{I_{zz}C_{\ell_p} + I_{xz}C_{n_p}\right\}$$

$$a_{1,14} = \frac{\bar{q}Sb}{I}\left\{I_{zz}C_{\ell_{\delta a}} + I_{xz}C_{n_{\delta a}}\right\}$$

$$a_{1,15} = \frac{\bar{q}Sb}{I}\left\{I_{zz}C_{\ell_{\delta r}} + I_{xz}C_{n_{\delta r}}\right\}$$

$$a_{21} = \frac{1}{I}\left\{\frac{\bar{q}Sb^2}{2V}\left(I_{xx}C_{n_p} + I_{xz}C_{\ell_p}\right) + I_{xx}(I_{xx} - I_{yy})q_o + I_{xz}{}^2q_o\right\}$$

$$a_{22} = \frac{1}{I}\left\{\frac{\bar{q}Sb^2}{2V}\left(I_{xx}C_{n_r} + I_{xz}C_{\ell_r}\right) - I_{xx}I_{xz}q_o + I_{xz}(I_{yy} - I_{zz})q_o\right\}$$

$$a_{23} = \frac{1}{I}\left\{\frac{\bar{q}Sb}{V}\left(I_{xx}C_{n_\beta} + I_{xz}C_{\ell_\beta}\right)\right\}$$

$$a_{27} = \frac{\bar{q}Sb}{IV}\left\{I_{xx}C_{n_\beta}\mu_{11} + I_{xz}C_{\ell_\beta}\mu_{21}\right\}$$

$$a_{28} = \frac{\bar{q}Sb}{IV}\left\{I_{xx}C_{n_\beta}\mu_{12} + I_{xz}C_{\ell_\beta}\mu_{22}\right\}$$

$$a_{29} = \frac{\bar{q}Sb}{IV}\left\{I_{xx}C_{n_\beta}\mu_{13} + I_{xz}C_{\ell_\beta}\mu_{23}\right\}$$

$$a_{2,10} = \frac{\bar{q}Sb^2}{2IV}\left\{I_{xx}C_{n_p} + I_{xz}C_{\ell_p}\right\}$$

$$a_{2,14} = \frac{\bar{q}Sb}{I}\left\{I_{xx}C_{n_{\delta a}} + I_{xz}C_{\ell_{\delta a}}\right\}$$

$$a_{2,15} = \frac{\bar{q}Sb}{I}\left\{I_{xx}C_{n_{\delta r}} + I_{xz}C_{\ell_{\delta r}}\right\}$$

$$a_{31} = w_o$$

$$a_{32} = -u_o$$

$$a_{33} = \frac{g}{W}\frac{\bar{q}S}{V}C_{y_\beta}$$

$$a_{34} = g\cos E_o$$

$$a_{37} = a_{33}\mu_{31}$$

$$a_{38} = a_{33}\mu_{32}$$

$$a_{39} = a_{33}\mu_{33}$$

$$a_{3,14} = \frac{g}{W}\bar{q}SC_{y_{\delta a}}$$

$$a_{3,15} = \frac{g}{W} \bar{q} S C_{y_{\delta r}}$$

$$a_{41} = 1$$

$$a_{42} = \tan E_o$$

$$a_{44} = q_o \tan E_o$$

$$a_{52} = \frac{1}{\cos E}$$

$$a_{54} = \frac{q_o}{\cos E}$$

$$a_{63} = 1.0$$

$$a_{64} = -w_o$$

$$a_{65} = u_o \cos E + w_o \sin E$$

$$a_{77} = -a_{7,11}$$

$$a_{7,11} = +2.3 \frac{V}{L}$$

$$a_{88} = -20.34 \frac{V}{L}$$

$$a_{89} = -51.86 \frac{V}{L}$$

$$a_{8,11} = +72.2 \frac{V}{L}$$

$$a_{98} = +7.04 \frac{V}{L}$$

$$a_{99} = +15.76 \frac{V}{L}$$

$$a_{9,11} = -22.8 \frac{V}{L}$$

$$a_{10,10} = -a_{10,13}$$

$a_{10,13} = 2.3 \frac{V}{r.c.}$

$a_{11,12} = 1.0$

$a_{12,11} = -\left(\frac{V}{L_v}\right)^2$

$a_{12,12} = -2\left(\frac{V}{L_v}\right)$

$a_{13,13} = -\frac{\pi}{4}\frac{V}{b}$

$a_{14,14} = -g_{14,1}$

$a_{15,15} = -g_{15,2}$

b = 118.5 Span ft

c = Cosine

cm = Center of mass (subscript)

d[x] = Slender body diameter [Equation (F21)] ft

d_{ij} = Element of D matrix

$d_{81} = g_{14,1}$

$d_{10,2} = g_{15,2}$

$d_{12,1} = h_{11,14} g_{14,1}$

$d_{12,2} = h_{11,15} g_{15,2}$

e = Earth (subscript)

f = Equation (F2)

$\tilde{f}$ = Equation (F1)

f_i = Step response of x_i [i = 1, 2, 3; Equations (F16) through (F18) ft/sec

g = 32.17 (Gravity) ft/sec^2

g_{ij} = Element of G matrix

$$g_{11,3} = \sigma_v \sqrt{\frac{3V}{\pi L_v}}$$

$$g_{12,3} = \frac{\left(1 - 2\sqrt{3}\right)}{\sqrt{\pi}} \sigma_v \left(\frac{V}{L_v}\right)^{3/2}$$

$$g_{13,4} = \frac{\pi}{4} \frac{\sigma_w}{b} \sqrt{\frac{V}{L_w}} \sqrt{0.8\left(\frac{\pi}{4} \frac{L_w}{b}\right)^{1/3}}$$

$$g_{14,1} = \frac{1}{T_a}$$

$$g_{15,2} = \frac{1}{T_r}$$

h = 600 (Altitude) ft

h_{ij} = Element of H matrix

$h_{14} = 1.0$

$h_{21} = a_{41}$

$h_{22} = a_{42}$

$h_{24} = a_{44}$

$h_{35} = 1.0$

$h_{42} = a_{52}$

$h_{44} = a_{54}$

$h_{56} = 1.0$

$h_{63} = a_{63}$

$h_{64} = a_{64}$

$h_{65} = a_{65}$

$h_{7,14} = 1.0$

$h_{8,14} = -g_{14,1}$

$h_{9,15} = 1.0$

$h_{10,15} = -g_{15,2}$

$h_{11,1} = +x_p a_{21} - z_p a_{11}$

$h_{11,2} = +x_p a_{22} - z_p a_{12}$

$h_{11,3} = a_{33} + x_p a_{23} - z_p a_{13}$

$h_{11,4} = \text{zero}$

$h_{11,7} = a_{37} + x_p a_{27} - z_p a_{17}$

$h_{11,8} = a_{38} + x_p a_{28} - z_p a_{18}$

$h_{11,9} = a_{39} + x_p a_{29} - z_p a_{19}$

$h_{11,10} = x_p a_{2,10} - z_p a_{1,10}$

$h_{11,14} = a_{3,14} + x_p a_{2,14} - z_p a_{1,14}$

$h_{11,15} = a_{3,15} + x_p a_{2,15} - z_p a_{1,15}$

$h_{12,1} = h_{11,1} a_{11} + h_{11,2} a_{21} + h_{11,3} a_{31}$

$h_{11,2} = h_{11,1} a_{12} + h_{11,2} a_{22} + h_{11,3} a_{32}$

$h_{12,3} = h_{11,1} a_{13} + h_{11,2} a_{23} + h_{11,3} a_{33}$

$h_{12,4} = h_{11,3} a_{34}$

$h_{12,7} = h_{11,1}a_{17} + h_{11,2}a_{27} + h_{11,3}a_{37} + h_{11,7}a_{77}$

$h_{12,8} = h_{11,1}a_{18} + h_{11,2}a_{28} + h_{11,3}a_{38} + H_{11,8}a_{88} + h_{11,9}a_{98}$

$h_{12,9} = h_{11,1}a_{19} + h_{11,2}a_{29} + h_{11,3}a_{39} + h_{11,8}a_{89} + h_{11,9}a_{99}$

$h_{12,10} = h_{11,1}a_{1,10} + h_{11,2}a_{2,10} + h_{11,10}a_{10,10}$

$h_{12,11} = h_{11,7}a_{7,11} + h_{11,8}a_{8,11} + h_{11,9}a_{9,11}$

$h_{12,13} = h_{11,10}a_{10,13}$

$h_{12,14} = h_{11,1}a_{1,14} + h_{11,2}a_{2,14} + h_{11,3}a_{3,14} + h_{11,14}a_{14,14}$

$h_{12,15} = h_{11,1}a_{1,15} + h_{11,2}a_{2,15} + h_{11,3}a_{3,15} + h_{11,15}a_{15,15}$

i, j, k = Unit vectors in aircraft (Figure F3)

i_e, j_e, k_e = Unit vectors relative to flat earth

mrp = Moment reference point (subscript)

o = Reference trajectory (subscript)

p = Roll rate (Figure F3)	rad/sec
p_g = Rolling wind	rad/sec
q = Pitch rate (Figure F3)	rad/sec
q_o = 0 (Reference pitch rate)	rad/sec
$\bar{q}$ = 100 (Dynamic pressure)	lb/ft^2
r = Yaw rate	rad/sec
r = Response vector [Equation (F2)]	
r.c. = 90 Root chord	ft
s = Sine	
s = Differentiation operator	

s. g. = Side gust (subscript)	
u_o = 282 = V(cα)	ft/sec
v = Side velocity (Figure F3)	ft/sec
$\tilde{v}$ = Side gust at aircraft nose	ft/sec
w_o = 72.8 = V(sα)	ft/sec
x = State vector [Equation (F1)]	
x = Side gust state at aircraft nose	ft/sec^2
x = Distance forward of cm (Figure F2)	ft
x = Distance aft of nose	ft
x_{cm} = 117 (Aft of the nose; Figure 90)	ft
x_{mrp} = 117 (Aft of the nose; Figure 90)	ft
x_p = 58.6 Distance pilot is forward of cm	ft
x_1, x_2, x_3 = Side gust distribution states	ft/sec
x_4 = Rolling gust distribution state	rad/sec
y = Lateral displacement relative to ground	ft
z_p = -7.5 (Distance pilot is below x axis)	ft
Δ = Perturbation symbol	
ϕ = Roll angle	rad
α = 14.5/57.3 (Angle of attack)	rad
β = Sideslip angle (Figure F3)	rad
γ = -12/57.3 (Flight path angle)	rad
δ_a = Aileron deflection; each (Figure F3)	rad
δ_r = Rudder deflection (Figure F3)	rad

η_1 = Unity white noise (drives $\tilde{v}$) $1/sec^{1/2}$

η_2 = Unity white noise independent of η_1 (drives p_g) $1/sec^{1/2}$

μ_{ij} = Wind weights [Equations (F23) and (F26)]

σ_v = 9.54 (Standard deviation of side gusts) ft/sec

σ_w = 6.7 (Standard deviation of up gusts) ft/sec

$\overline{}$ = Overscore indicating quantity is in stability axes

REPRESENTATIONS

The generic forms for the perturbation state transition and response are given by Equations (F1) and (F2).

$$\dot{x} = Ax + G\tilde{f} = Ax + G_1u + G_2\eta \quad \text{(F1)}$$

$$r = Hx + Df = Hx + Du \quad \text{(F2)}$$

They are presented explicitly in Tables F1 and F2. These tables and the nomenclature provide for generating all data.

Evaluation of these data for the flight condition investigated yields the numerical values for the matrices A, G_1, G_2, H, and D listed in Tables F2 through F7. Gain matrices are listed in Tables 24 and 27.

The analog simulation for the plant and quadratic controller are presented as Figures F1 and F2. Pot settings are given in Tables F8 and F9, Table F10 lists the amplifiers used.

DERIVATIONS

Euler Angles

The aircraft body axes ($\hat{i}$, $\hat{j}$, $\hat{k}$: Figure F3) relative to their initial position $\hat{i}_e$, $\hat{j}_e$, $\hat{k}_e$ over a flat earth are given by (Equation 1-4B of ref 28).

$$\begin{Bmatrix} \hat{i} \\ \hat{j} \\ \hat{k} \end{Bmatrix} = \begin{bmatrix} (cEcH) & (cEsH) & (-sE) \\ (-sHc\Phi+sEcHs\Phi) & (cHc\Phi+sEsHs\Phi) & (cEs\Phi) \\ (sHs\Phi+sEcHc\Phi) & (-cHs\Phi+sEsHc\Phi) & (cEc\Phi) \end{bmatrix} \begin{Bmatrix} \hat{i}_e \\ \hat{j}_e \\ \hat{k}_e \end{Bmatrix} \quad \text{(F3)}$$

These equations are for the Euler rotation sequence heading H, elevation E, and roll ϕ. The inverse of the above system is required but it will not be written explicitly, because it is available by transposing (inverting) the matrix. For example, the cross-course velocity $\dot{y}$ (in earth's coordinates) is required. By use of Equation (F3)

$$\dot{y} = (cEsH)u + (cHc\Phi+sEsHs\Phi)v + (-cHs\Phi+sEsHc\Phi)w \qquad (F4)$$

Taking perturbations in $\dot{y}$, H, Φ, and v yields

$$\Delta\dot{y} = (u_o cE+w_o sE)\Delta H - w_o\Delta\phi + \Delta v \qquad (F5)$$

Equation (F5) corresponds to rows 6 of Tables F1 and F2; the perturbation symbol is dropped in Tables F1 and F2.

Evaluation of the goodness of roll control requires determination of the excursions in heading and roll. Their rates are given by (Equations 1 - 15, ref. 28).

$$\dot{H} = \frac{1}{cE}(qs\Phi+rc\Phi) \qquad (F6)$$

$$\dot{\phi} = p + \tan E\,(qs\Phi+rc\Phi) \qquad (F7)$$

Taking perturbations yields

$$\Delta\dot{H} = \frac{1}{cE}(q_o\Delta\phi + \Delta r) \qquad (F8)$$

$$\Delta\dot{\phi} = \Delta p + \tan E(q_o\Delta\phi+\Delta r) \qquad (F9)$$

which agree with rows 5 and 4 of Table F1.

Winds

The clear air wind turbulence models of the Dryden form for shuttle in post entry flight are specified on pages 48-53 of ref. 13. The lateral axis is forced by side gusts

$$\tilde{v} = \sigma_v\sqrt{\frac{L_v}{\pi V}}\;\frac{1+\frac{\sqrt{3}\,L_v}{V}s}{\left(1+\frac{L_v}{V}s\right)^2}\,\eta_1 \qquad (F10)$$

and by rolling gusts

$$p_g = \sigma_w \sqrt{\frac{1}{L_w V}} \frac{\sqrt{0.8\left(\frac{\pi}{4}\frac{L_w}{b}\right)^{1/3}}}{1 + \frac{4b}{\pi V}\, s}\, \eta_2 \qquad \text{(F11)}$$

State representations for Equations (F10) and (F11) are given by

$$\begin{Bmatrix} \dot{\tilde{v}} \\ \dot{x} \end{Bmatrix} = \begin{bmatrix} 0 & 1 \\ -\left(\frac{V}{L_v}\right)^2 & -2\frac{V}{L_v} \end{bmatrix} \begin{Bmatrix} \tilde{v} \\ x \end{Bmatrix} + \begin{Bmatrix} \sqrt{\frac{3}{\pi}}\, \sigma_v \sqrt{\frac{V}{L_v}} \\ \frac{1-2\ \ 3}{\sqrt{\pi}}\, \sigma_v \left(\frac{V}{L_v}\right)^{3/2} \end{Bmatrix} \eta_1 \qquad \text{(F12)}$$

and

$$\dot{p}_g = \frac{\pi}{4}\frac{V}{b}\, p_g + \sigma_w \sqrt{0.8 \frac{V}{L_w}}\, \frac{\pi}{4b} \left(\frac{\pi}{4}\frac{L_w}{b}\right)^{1/6} \eta_2 \qquad \text{(F13)}$$

They correspond to rows 11 through 13 of Table F1.

Numerical values of σ_w, σ_v, L_w, and L_v are needed. For 600-feet altitude these are

$$\sigma_w = 6.7 \text{ ft/sec}$$
$$\sigma_v = 9.54 \text{ ft/sec}$$
$$L_w = 600 \text{ ft}$$
$$L_v = 1220 \text{ ft}$$

σ_w is taken directly from ref 13. For altitudes below 1750 feet

$$L_w = h$$
$$L_v = 145 h^{1/3}$$

Furthermore,

$$\sigma_v = \sqrt{\frac{L_v}{L_w}}\, \sigma_w$$

Distributing the Wind Gust Loads

The side force due to winds on the vehicle is the integrated sum of the local body and fin pressure developed by side gusts ($\tilde{v}$). Analogous statements prevail for the yawing and rolling moments due to side gusts and for the rolling moment developed by the rolling wind (p_g).

These are all distributed forces for which it is desirable (mandatory in the present content) to find a lumped parameter representation. Lumped parameter approximations for the side gusts are discussed first. Then the rolling gust approximation is presented.

The side force and yawing moment coefficients due to side gusts are taken to be

$$C_{y_{sg}} = \frac{C_{y_\beta}}{V} \{ \mu_{31}x_1 + \mu_{32}x_2 + \mu_{33}x_3 \} \tag{F14}$$

$$C_{n_{sg}} = \frac{C_{n_\beta}}{V} \{ \mu_{11}x_1 + \mu_{12}x_2 + \mu_{13}x_3 \} \tag{F15}$$

where x_1, x_2, and x_3 are system states driven by the wind $\tilde{v}$. For constant winds $x_1 = x_2 = x_3 = \tilde{v}$. Rows 7, 8, and 9 of Table F1 show this and how the x_i's are driven by the wind $\tilde{v}$. The μ_{ij}'s are constants to be determined.

The step responses of x_1, x_2, and x_3 (called f_1, f_2, and f_3) for a sharpedged side gust $\tilde{v}$ are

$$f_1 [x] = 1 - e^{-\frac{2.3}{L_s} x} \tag{F16}$$

$$f_2 [x] = 1 - e^{-\frac{2.3}{L_s} x} \{\cos \frac{2\pi}{L_s} x - 2.00 \sin \frac{2\pi}{L_s} x\} \tag{F17}$$

$$f_3 [x] = 1 - e^{-\frac{2.3}{L_s} x} \{\cos \frac{2\pi}{L_s} x + 3.985 \sin \frac{2\pi}{L_s} x \} \tag{F18}$$

The most gross result of slender body theory (ref. 22 or 23) gives the step responses for gust penetration as

$$C_{y_\beta}[x] = \frac{2}{S} \int_o^x A'[\tilde{x}]\, d\tilde{x} \qquad \text{(F19)}$$

$$C_{n_{\beta_o}}[x] = \frac{2}{Sb} \int_o^x \tilde{x} A'[\tilde{x}]\, d\tilde{x} \qquad \text{(F20)}$$

$A[x]$ is taken as

$$A[x] = \frac{\pi}{4} (d[x])^2 \qquad \text{(F21)}$$

where d[x] is the "slender body maximum" projected side dimension.

Step responses for $C_{y_\beta}[x]$, $C_{n_{\beta_o}}[x]$, and $C_{n_{\beta_{cm}}}[x]$ are presented in Figure F9.

The μ_{ij}'s are determined to provide a least squared fit of $C_{y_\beta}[x]$ and $C_{n_{\beta_{cm}}}[x]$ from the solution of

$$B\tilde{\mu}_{ij} = c_{ij} \quad \text{for } i = 1, 3 \qquad \text{(F22)}$$

$$\mu_{ij} = k_i \tilde{\mu}_{ij} \quad \text{for } i = 1, 3 \qquad \text{(F23)}$$

$$k_i = \frac{1}{\sum_{j=1}^{3} \tilde{\mu}_{ij}} \quad \text{for } i = 1, 3 \qquad \text{(F24)}$$

where

$$B = \begin{vmatrix} \int_0^1 f_1^2 \, d\left(\frac{x}{L}\right) & + \int_0^1 f_1 f_2 \, d\left(\frac{x}{L}\right) & + \int_0^1 f_1 f_3 \, d\left(\frac{x}{L}\right) \\ \int_0^1 f_1 f_2 \, d\left(\frac{x}{L}\right) & + \int_0^1 f_2^2 \, d\left(\frac{x}{L}\right) & + \int_0^1 f_2 f_3 \, d\left(\frac{x}{L}\right) \\ \int_0^1 f_1 f_3 \, d\left(\frac{x}{L}\right) & + \int_0^1 f_2 f_3 \, d\left(\frac{x}{L}\right) & + \int_0^1 f_3^2 \, d\left(\frac{x}{L}\right) \end{vmatrix}$$

$$c_{i_j} = \begin{vmatrix} \int_0^1 f_1 g_i \, d\left(\frac{x}{L}\right) \\ \int_0^1 f_2 g_i \, d\left(\frac{x}{L}\right) \\ \int_0^1 f_3 g_i \, d\left(\frac{x}{L}\right) \end{vmatrix}$$

$$g_1 = c_{n_{\beta_{cm}}}$$

$$g_3 = c_{y_\beta}$$

The k_i's may be considered as scale factors that enforce agreement between dsta sets for steady winds.

For a constant side gust $(\tilde{v})$, the rolling moment coefficient is

$$C_\ell = C_{\ell_\beta} \frac{\tilde{v}}{V} \tag{F25}$$

For a sharp-edged side gust it is assumed that

$$-g_2 = \frac{C_{\ell_\beta}[x/L]}{C_{\ell_\beta}[1]} = \begin{cases} 0 & \text{for} \quad 0 \le x/L \le 0.6 \\ \frac{(0.6-x/L)^2}{0.16} & \text{for} \quad 0.6 \le x/L \le 1 \end{cases} \tag{F26}$$

C_{ℓ_β} is generated primarily by the wing which starts at $x/L = 0.6$ and extends to $x/L = 1.0$. The quadratic variation for $0.6 \le x/L \le 1.0$ is motivated by slender body theory.

The μ_{2j}'s are obtained by use of Equations (F22 through (F24) (with a notational adjustment) and (F26).

Treatment of the rolling gusts is analogous to, but simpler than, those for the side gusts.

The rolling gust (p_g) drives x_4 through the equation shown in row 10 of Table F1. Time to 90 percent is taken as the time to traverse the wing root chord. x_4 "distributes" p_g over the wing chord. Steady-state values of x_4 and p_g are the same. x_4 drives the equation of motion in the same manner as the geometric p.

Dynamic Equations

The equations of motion are

$$\dot{p} = \frac{1}{I}\{I_{zz}[L - (I_{zz}-I_{yy})qr + I_{xz}pq] + I_{xz}[N - (I_{yy}-I_{zz})pq - I_{xz}qr]\} \tag{F27}$$

$$\dot{r} = \frac{1}{I}\{I_{xx}[N - (I_{yy}-I_{xx})pq - I_{xz}qr] + I_{xz}[L - (I_{zz}-I_{yy})qr + I_{xz}pq]\} \tag{F28}$$

$$\dot{v} = \frac{g}{W} Y + gcEs\phi - ur + wp \tag{F29}$$

The corresponding perturbation equations are

$$\Delta\dot{p} = \frac{1}{I}\{I_{xx}[(\Delta L - I_{zz}-I_{yy})q_o\Delta r + I_{xz}q_o\Delta p$$

$$+ I_{xz}[\Delta N - (I_{yy}- I_{xx})q_o\Delta p - I_{xz}q_o\Delta r]\} \tag{F30}$$

$$\Delta\dot{r} = \frac{1}{I}\{I_{xx}[\Delta N - (I_{yy} - I_{xx})q_o\Delta p - I_{xz}q_o\Delta r]$$

$$+ I_{xz}[\Delta L - (I_{zz}-I_{yy})q_o\Delta r + I_{xz}q_o\Delta p]\} \tag{F31}$$

$$\Delta\dot{v} = \frac{g}{w}\Delta Y + g(cE)(c\phi_o)\Delta\phi - u_o\Delta r + w_o\Delta p \tag{F32}$$

Aerodynamic forces are given by

$$L = \bar{q}Sb\left\{\frac{b}{2V} C_{\ell_p} p + \frac{b}{2V} C_{\ell_r} r + C_{\ell_\beta}\beta + C_{\ell_{\delta a}}\delta a + C_{\ell_{\delta r}}\delta r + \frac{b}{2V} C_{\ell_p} x_4\right.$$

$$\left.+ \frac{C_{\ell_\beta}}{V}[\mu_{21}x_1 + \mu_{22}x_2 + \mu_{23}x_3]\right\} \tag{F33}$$

$$N = \bar{q}Sb\left\{\frac{b}{2V} C_{n_p} p + \frac{b}{2V} C_{n_r} r + C_{n_\beta}\beta + C_{n_{\delta a}}\delta a + C_{n_{\delta r}}\delta r + \frac{b}{2V} C_{n_p} x_4\right.$$

$$\left.+ \frac{C_{n_\beta}}{V}[\mu_{11}x_1 + \mu_{12}x_2 + \mu_{13}x_3]\right\} \tag{F34}$$

$$Y = \bar{q}S\left\{C_{y_\beta}\beta + C_{y_{\delta a}}\delta a + C_{y_{\delta r}}\delta r + \frac{C_{y_\beta}}{V}[\mu_{31}x_1 + \mu_{32}x_2 + \mu_{33}x_3]\right\} \tag{F35}$$

and their perturbations by

$$\Delta L = \bar{q}Sb\left\{\frac{b}{2V} C_{\ell_p}\Delta p + \frac{b}{2V} C_{\ell_r}\Delta r + C_{\ell_\beta}\Delta\beta + C_{\ell_{\delta a}}\delta a + C_{\ell_{\delta r}}\delta r\right.$$

$$\left.+ \frac{b}{2V} C_{\ell_p} x_4 + \frac{C_{\ell_\beta}}{V}[\mu_{21}x_1 + \mu_{22}x_2 + \mu_{23}x_3]\right\} \tag{F36}$$

$$\Delta N = \left\{ \bar{q}Sb \; \frac{b}{2V} C_{n_p} \Delta p + \frac{b}{2V} C_{n_r} \Delta r + C_{n_\beta} \Delta\beta + C_{n_{\delta a}} \delta a + C_{n_{\delta r}} \delta r \right.$$

$$\left. + \frac{b}{2V} C_{n_p} x_4 + \frac{C_{n_\beta}}{V} [\mu_{11}x_1 + \mu_{12}x_2 + \mu_{13}x_3] \right\} \tag{F37}$$

$$\Delta y = \bar{q}S \left\{ C_{y_\beta} \Delta\beta + C_{y_{\delta a}} \delta a + C_{y_{\delta r}} \delta r + \frac{C_{y_\beta}}{V} [\mu_{31}x_1 + \mu_{32}x_2 + \mu_{33}x_3] \right\} \tag{F38}$$

Substituting Equations (F36) through (F38) into Equations (F30) through (F32 yield Equations (F39 through (F41).

$$\Delta\dot{p} = \frac{1}{I} \left\{ \frac{\bar{q}Sb^2}{2V} \left[I_{zz} C_{\ell_p} + I_{xz} C_{n_p} \right] + I_{zz} I_{xz} q_o + I_{xz} (I_{xx} - I_{tt}) q_o \right\} \Delta p$$

$$+ \frac{1}{I} \left\{ \frac{\bar{q}Sb^2}{2V} \left[I_{zz} C_{\ell_r} + I_{xz} C_{n_r} \right] + I_{zz} (I_{yy} - I_{zz}) q_o - I_{xz}^2 \, q_o \right\} \Delta r$$

$$+ \frac{1}{I} \left\{ \frac{\bar{q}Sb}{V} \left[I_{zz} C_{\ell_\beta} + I_{xz} C_{n_\beta} \right] \right\} \Delta v$$

$$+ \frac{\bar{q}Sb}{IV} \left\{ I_{zz} \left[C_{\ell_\beta} (\mu_{21}x_1 + \mu_{22}x_2 + \mu_{23}x_3) + \frac{b}{2} C_{\ell_p} x_4 \right] \right.$$

$$\left. + I_{xz} \left[C_{n_\beta} (\mu_{11}x_1 + \mu_{12}x_2 + \mu_{13}x_3) + \frac{b}{2} C_{n_p} x_4 \right] \right\}$$

$$+ \frac{\bar{q}Sb}{I} \left\{ I_{zz} C_{\ell_{\delta a}} + I_{xz} C_{n_{\delta a}} \right\} \delta a$$

$$+ \frac{\bar{q}Sb}{I} \left\{ I_{zz} C_{\ell_{\delta r}} + I_{xz} C_{n_{\delta r}} \right\} \delta r \tag{F39}$$

$$\Delta\dot{r} = \frac{1}{I}\left\{\frac{\bar{q}Sb^2}{2V}\left[I_{xx}C_{n_p} + I_{xz}C_{\ell_p}\right] + I_{xx}(I_{xx} - I_{yy})q_o + I_{xx}{}^2 q_o\right\}\Delta p$$

$$+ \frac{1}{I}\left\{\frac{\bar{q}Sb^2}{2V}\left[I_{xx}C_{n_r} + I_{xz}C_{\ell_r}\right] - I_{xx}I_{xz}q_o + I_{xz}(I_{yy} - I_{zz})q_o\right\}\Delta r$$

$$+ \frac{\bar{q}Sb}{IV}\left\{I_{xx}C_{n_\beta} + I_{xz}C_{\ell_\beta}\right\}\Delta v$$

$$+ \frac{\bar{q}Sb}{IV}\left\{I_{xx}\left[C_{n_\beta}(\mu_{11}x_1 + \mu_{12}x_2 + \mu_{13}x_3) + \frac{b}{2}C_{n_p}x_4\right]\right.$$

$$\left. + I_{xz}\left[C_{\ell_\beta}(\mu_{21}x_1 + \mu_{22}x_2 + \mu_{23}x_3) + \frac{b}{2}C_{\ell_p}x_4\right]\right\}$$

$$+ \frac{qSb}{I}\left\{I_{xx}C_{n_{\delta a}} + I_{xz}C_{\ell_{\delta a}}\right\}\delta a$$

$$+ \frac{qSb}{I}\left\{I_{xx}C_{n_{\delta r}} + I_{xz}C\ell_{\delta r}\right\}\delta r \qquad \text{(F40)}$$

$$\Delta\dot{v} = + w_o\Delta_p - u_o\Delta r + \frac{g\bar{q}S}{VW}C_{y_\beta}\Delta v + g(cE)\Delta\phi$$

$$+ \frac{g\bar{q}S}{VW}\left\{\mu_{31}x_1 + \mu_{32}x_2 + \mu_{32}x_3\right\} + \frac{g\bar{q}S}{W}\left\{C_{y_{\delta a}}\delta a + C_{y_{\delta r}}\delta r\right\} \qquad \text{(F41)}$$

Equations (F39) through (F41) correspond to rows 1 - 3 of Table F1.

Control Surface Dyamics

Tail-wags-dog and dog-wags-tail dynamics are neglected.

Servo dynamics are also neglected. Actuator dynamics are taken as 6 rad/sec.

For aileron actuation

$$\dot{\delta a} = -\frac{1}{T_a}\,\delta a + \frac{1}{T_a}\,u_1 \tag{F42}$$

Equation (F42) corresponds to row 14 of Table F2. With an obvious notation change it also corresponds to row 15.

Pilot's Lateral Acceleration

The lateral acceleration at the pilot's station is approximated by

$$a_y = \dot{v} + ur - wp + x_p\dot{r} - z_p\dot{p} - g(CE(s\phi) \tag{F43}$$

The perturbation equation is

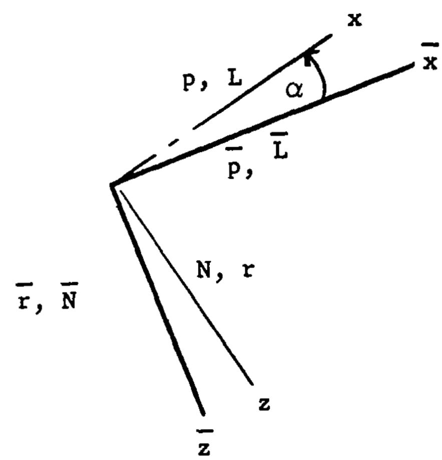
$$\Delta a_y = \Delta\dot{v} + u_o\Delta r - w_o\Delta p + x_p\Delta\dot{r} - z_p\Delta\dot{p} - g(CE_o)(C\phi_o)\Delta\phi \tag{F44}$$

Row 11 of Table F2 is the equivalent of Equation (F44). The $\Delta\dot{v}$ of Equation (F44) is obtained from row 3 of Table F1. Similarly, $\Delta\dot{r}$ and $\Delta\dot{p}$ are obtained from rows 2 and 1 of Table F1.

$\Delta\dot{a}_y$ is obtained from differentiation of row 11 of Table F1.

Resolution From Stability to Body Axes

The aerodynamic data of Figures F4 through F9 are given in stability axes (which here are the "barred" axes). The equations of motion are in body (unbarred) axes. From the sketch on the following page



$$\begin{Bmatrix} L \\ N \end{Bmatrix} = \begin{bmatrix} c\alpha & -s\alpha \\ s\alpha & c\alpha \end{bmatrix} \begin{Bmatrix} \bar{L} \\ \bar{N} \end{Bmatrix} \tag{F45}$$

This implies $L_\beta = (c\alpha)\, L_\beta - (s\alpha) N_B$, etc.; as listed in the nomenclature.

Also from the previous sketch

$$\begin{bmatrix} \frac{\partial \bar{p}}{\partial p} & \frac{\partial p}{\partial r} \\ \frac{\partial \bar{r}}{\partial p} & \frac{\partial \bar{r}}{\partial r} \end{bmatrix} = \begin{bmatrix} c\alpha & s\alpha \\ -s\alpha & c\alpha \end{bmatrix} \tag{F46}$$

Therefore,

$$\begin{bmatrix} L_p & L_r \\ N_p & N_r \end{bmatrix} = \begin{bmatrix} c\alpha & -s\alpha \\ s\alpha & c\alpha \end{bmatrix} \begin{bmatrix} \bar{L}_{\bar{p}} & \bar{L}_{\bar{r}} \\ \bar{N}_{\bar{p}} & \bar{N}_r \end{bmatrix} \begin{bmatrix} c\alpha & s\alpha \\ -s\alpha & c\alpha \end{bmatrix}$$

with the particular implication

$$L_r = (c\alpha)^2\, \bar{L}_{\bar{r}} + (s\alpha c\alpha)\,(\bar{L}_{\bar{p}} - \bar{N}_{\bar{r}}) - (s\alpha)^2\, \bar{N}_p \tag{F47}$$

etc., as listed in the nomenclature.

Table F1. State Equations

$$p \quad r \quad v \quad \phi \quad H \quad y \quad x_1 \quad x_2 \quad x_3 \quad x_4 \quad \tilde{v} \quad x \quad p_g \quad \delta a \quad \delta r \qquad\qquad u_1 \quad u_2 \quad \eta_1 \quad \eta_2$$

$$\begin{bmatrix} \dot{p} \\ \dot{r} \\ \dot{v} \\ \dot{\phi} \\ \dot{H} \\ \dot{y} \\ \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \\ \dot{\tilde{v}} \\ \dot{x} \\ \dot{p}_g \\ \dot{\delta a} \\ \dot{\delta r} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & 0 & 0 & 0 & a_{17} & a_{18} & a_{19} & a_{1,10} & 0 & 0 & 0 & a_{1,14} & a_{1,15} \\ a_{21} & a_{22} & a_{23} & 0 & 0 & 0 & a_{27} & a_{28} & a_{29} & a_{2,10} & 0 & 0 & 0 & a_{2,14} & a_{2,15} \\ a_{31} & a_{32} & a_{33} & a_{34} & 0 & 0 & a_{37} & a_{38} & a_{39} & 0 & 0 & 0 & 0 & a_{3,14} & a_{3,15} \\ a_{41} & a_{42} & 0 & a_{44} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & a_{52} & 0 & a_{54} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & a_{63} & a_{64} & a_{65} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & a_{77} & 0 & 0 & 0 & a_{7,11} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & a_{88} & a_{89} & 0 & a_{8,11} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & a_{98} & a_{99} & 0 & a_{9,11} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & a_{10,10} & 0 & 0 & a_{10,13} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & a_{11,12} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & a_{12,11} & a_{12,12} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & a_{13,13} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & a_{14,14} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & a_{15,15} \end{bmatrix} \begin{bmatrix} p \\ r \\ v \\ \phi \\ H \\ y \\ x_1 \\ x_2 \\ x_3 \\ x_4 \\ \tilde{v} \\ x \\ p_g \\ \delta a \\ \delta r \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & g_{11,3} & 0 \\ 0 & 0 & g_{12,3} & 0 \\ 0 & 0 & 0 & g_{13,4} \\ g_{14,1} & 0 & 0 & 0 \\ 0 & g_{15,2} & 0 & 0 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \\ \eta_1 \\ \eta_2 \end{bmatrix}$$

Table F2. Response Equations

$$
\begin{array}{c} \\ \end{array}
\begin{array}{ccccccccccccccc}
p & p & v & \phi & H & y & x_1 & x_2 & x_3 & x_4 & \tilde{v} & x & p_g & \delta a & \delta r
\end{array}
\qquad
\begin{array}{c} p \end{array}
\qquad
\begin{array}{cc} u_1 & u_2 \end{array}
$$

$$
\begin{bmatrix} \phi \\ \dot{\phi} \\ H \\ \dot{H} \\ y \\ \dot{y} \\ \delta a \\ \dot{\delta} a \\ \delta r \\ \delta r \\ a_y \\ \dot{a}_y \end{bmatrix}
=
\begin{bmatrix}
0 & 0 & 0 & h_{14} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
h_{21} & h_{22} & 0 & h_{24} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & h_{35} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & h_{42} & 0 & h_{44} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & h_{56} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & h_{63} & h_{64} & h_{65} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & h_{7,14} & 0 \\
- & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & h_{8,14} & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & h_{9,15} \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & h_{10,15} \\
h_{11,1} & h_{11,2} & h_{11,3} & h_{11,4} & 0 & 0 & h_{11,7} & h_{11,8} & h_{11,9} & h_{11,10} & 0 & 0 & 0 & h_{11,14} & h_{11,15} \\
h_{12,1} & h_{12,2} & h_{12,3} & h_{12,4} & 0 & 0 & h_{12,7} & h_{12,8} & h_{12,9} & h_{12,10} & h_{12,11} & 0 & h_{12,13} & h_{12,14} & h_{12,15}
\end{bmatrix}
\begin{bmatrix} r \\ v \\ \phi \\ H \\ y \\ x_1 \\ x_2 \\ x_3 \\ x_4 \\ \tilde{v} \\ x \\ p_g \\ \delta a \\ \delta r \end{bmatrix}
+
\begin{bmatrix}
0 & 0 \\
0 & 0 \\
0 & 0 \\
0 & 0 \\
0 & 0 \\
0 & 0 \\
0 & 0 \\
d_{81} & 0 \\
0 & 0 \\
0 & d_{10,2} \\
0 & 0 \\
d_{12,1} & d_{12,2}
\end{bmatrix}
\begin{bmatrix} u_1 \\ u_2 \end{bmatrix}
$$

Table F3. A Matrix

		$p/\tilde{v}$	r/x	v/P_g	ϕ/δ_a	H/δ_r	y	x_1	x_2	x_3	x_4		
$\dot{p}$	ROW 1	-.10640E 01	.17830E 01	-.17790E-01	.00000E 00	.00000E 00	.00000E 00	-.39080E-01	.45750E-02	.16700E-01	-.10640E01	=	p
		.00000E 00	.00000E 00	.00000E 00	-.30080E 01	.10590E 01							
$\dot{r}$	ROW 2	-.21220E 00	-.11800E 00	.12780E-02	.00000E 00	.00000E 00	.00000E 00	-.29180E-02	.93300E-03	.32630E-02	-.21220E 00		r
		.00000E 00	.00000E 00	.00000E 00	.42610E-01	-.43790E 00							
$\dot{v}$	ROW 3	.72600E 02	-.28100E 03	-.17310E 00	.32170E 02	.00000E 00	.00000E 00	-.25600E 00	.17750E-01	.65980E-01	.00000E 00		v
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	.17960E 02							
$\dot{\phi}$	ROW 4	.10000E 01	.43660E-01	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00		ϕ
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00							
$\dot{H}$	ROW 5	.00000E 00	.10010E 01	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00		H
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00							
$\dot{y}$	ROW 6	.00000E 00	.00000E 00	.10000E 01	-.72600E 02	.28390E 03	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00		y
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00							
$\dot{x}_1$	ROW 7	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	-.38780E 01	.00000E 00	.00000E 00	.00000E 00		x_1
		.38780E 01	.00000E 00	.00000E 00	.00000E 00	.00000E 00							
$\dot{x}_2$	ROW 8	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	-.34250E 02	-.87600E 02	.00000E 00		x_2
		.12160E 03	.00000E 00	.00000E 00	.00000E 00	.00000E 00							
$\dot{x}_3$	ROW 9	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.11850E 02	.26600E 02	.00000E 00		x_3
		-.38450E 02	.00000E 00	.00000E 00	.00000E 00	.00000E 00							
$\dot{x}_4$	ROW 10	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	-.74110E 01		x_4
		.00000E 00	.00000E 00	.74110E 01	.00000E 00	.00000E 00							
$\dot{\tilde{v}}$	ROW 11	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00		$\tilde{v}$
		.00000E 00	.10000E 01	.00000E 00	.00000E 00	.00000E 00							
$\dot{x}$	ROW 12	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00		x
		-.47540E 00	-.56500E-01	.00000E 00	.00000E 00	.00000E 00							
$\dot{P}_g$	ROW 13	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00		P_g
		.00000E 00	.00000E 00	-.32080E 00	.00000E 00	.00000E 00							
$\dot{\delta}_a$	ROW 14	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00		δ_a
		.00000E 00	.00000E 00	.00000E 00	-.60000E 01	.00000E 00							
$\dot{\delta}_r$	ROW 15	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00		δ_r
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	-.60000E 01							

Table F4. G1 Matrix

ROW 1	.00000E 00	.00000E 00
ROW 2	.00000E 00	.00000E 00
ROW 3	.00000E 00	.00000E 00
ROW 4	.00000E 00	.00000E 00
ROW 5	.00000E 00	.00000E 00
ROW 6	.00000E 00	.00000E 00
ROW 7	.00000E 00	.00000E 00
ROW 8	.00000E 00	.00000E 00
ROW 9	.00000E 00	.00000E 00
ROW 10	.00000E 00	.00000E 00
ROW 11	.00000E 00	.00000E 00
ROW 12	.00000E 00	.00000E 00
ROW 13	.00000E 00	.00000E 00
ROW 14	.60000E 01	.00000E 00
ROW 15	.00000E 00	.60000E 01

Table F5. G2 Matrix

ROW 1	.00000E 00	.00000E 00
ROW 2	.00000E 00	.00000E 00
ROW 3	.00000E 00	.00000E 00
ROW 4	.00000E 00	.00000E 00
ROW 5	.00000E 00	.00000E 00
ROW 6	.00000E 00	.00000E 00
ROW 7	.00000E 00	.00000E 00
ROW 8	.00000E 00	.00000E 00
ROW 9	.00000E 00	.00000E 00
ROW 10	.00000E 00	.00000E 00
ROW 11	.45500E 01	.00000E 00
ROW 12	-.15400E 01	.00000E 00
ROW 13	.00000E 00	.34600E-01
ROW 14	.00000E 00	.00000E 00
ROW 15	.00000E 00	.00000E 00

Table F6. H Matrix

	ROW	$p/\tilde{v}$	r/x	v/p_g	ϕ/δ_a	H/δ_r	y	x_1	x_2	x_3	x_4
ϕ	ROW 1	.00000E 00	.00000E 00	.00000E 00	.10000E 01	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00					
$\dot{\phi}$	ROW 2	.10000E 01	.43660E-01	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00					
H	ROW 3	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.10000E 01	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00					
$\dot{H}$	ROW 4	.00000E 00	.10010E 01	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00					
y	ROW 5	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.10000E 01	.00000E 00	.00000E 00	.00000E 00	.00000E 00
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00					
$\dot{y}$	ROW 6	.00000E 00	.00000E 00	.10000E 01	-.72600E 02	.28390E 03	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00					
δ_a	ROW 7	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00
		.00000E 00	.00000E 00	.00000E 00	.10000E 01	.00000E 00					
$\dot{\delta}_a$	ROW 8	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00
		.00000E 00	.00000E 00	.00000E 00	-.60000E 01	.00000E 00					
δ_r	ROW 9	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	.10000E 01					
$\dot{\delta}_r$	ROW 10	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00	.00000E 00
		.00000E 00	.00000E 00	.00000E 00	.00000E 00	-.60000E 01					
a_y	ROW 11	-.20420E 02	.64570E 01	-.23140E 00	.00000E 00	.00000E 00	.00000E 00	-.72070E 00	.10650E 00	.38250E 00	-.20420E 02
		.00000E 00	.00000E 00	.00000E 00	-.20060E 02	.24540E 00					
$\dot{e}_y$	ROW 12	.35740E 01	.27760E 02	.41140E 00	-.55670E 01	.00000E 00	.00000E 00	.36340E 01	.22050E 00	-.76030E 00	.17170E 03
		-.26910E 01	.00000E 00	-.15130E 03	.18240E 03	-.30380E 02					

Table F7. D Matrix

```
RØW    1
 .00000E 00   .00000E 00
RØW    2
 .00000E 00   .00000E 00
RØW    3
 .00000E 00   .00000E 00
RØW    4
 .00000E 00   .00000E 00
RØW    5
 .00000E 00   .00000E 00
RØW    6
 .00000E 00   .00000E 00
RØW    7
 .00000E 00   .00000E 00
RØW    8
 .60000E 01   .00000E 00
RØW    9
 .00000E 00   .00000E 00
RØW   10
 .00000E 00   .60000E 01
RØW   11
 .00000E 00   .00000E 00
RØW   12
 .00000E 00   .00000E 00
```

Table F8. P Pots

00		28	.2696
01		29	.0243
02	.2000	30	
03	.6010	31	
04	.0865	32	
05	.0113	33	
06	.3484	34	
07	.0703	35	.0073
08	.2000	36	.2618
09	.0188	37	.8350
10	.6400	38	.1328
11	.0444	39	.0264
12	.1650	40	
13	.1796	41	
14		42	
15	.0422	43	
16	.0168	44	
17	.1435	45	.9770
18	.0208	46	.5008
19	.0988	47	.0706
20		48	.1612
21		49	.2287
22			
23			
24			
25	.2128		
26	.7411		
27	.7411		

Table F9. Q Pots

00	.2500	40		80	.2825
01	.2500	41		81	.4754
02	.2400	42		82	.1820
03	.2400	43		83	.3080
04	.6000	44		84	.1021
05	.3845	45	.1134	85	
06	.2743	46	.2904	86	
07	.0246	47		87	.4000
08	.1914	48		88	.0437
09	.0703	49		89	.3592
10	.0181	50	.2042	90	.5000
11	.0403	51	.9562	91	.5000
12	.0160	52	.3217	92	.3460
13	.0820	53	.1278	93	.4180
14	.6000	54	.1783	94	.4639
15	.5925	55		95	
16	.6080	56		96	
17		57	.1731	97	.3299
18	.0025	58	.2810	98	.0887
19	.2006	59	.8758	99	.1280
20	.0289	60	.1779		
21	.1188	61	.1180		
22	.0244	62	.7260		
23	.2236	63	.2662		
24		64	.1802		
25	.8760	65			
26	.3343	66			
27		67	.4665		
28		68	.1459		
29		69	.2122		
30		70	.1064		
31		71	.3208		
32		72	.1157		
33		73	.2000		
34		74	.0326		
35	.3878	75			
36	.3878	76			
37		77	.0852		
38		78	.4244		
39		79	.1630		

Table F10. Amplifiers

00	$-500.\delta_a$	20		40		60	$+10.v$	80	$+2.\tilde{v}$
01	$-500.\delta_r$	21		41		61	$+1000.r$	81	$+10.x$
02	$+500.\delta_r'$	22		42		62	$-1000.p$	82	$-5.\eta_1$
03	$+500.\delta_a$	23		43	(1000. r)	63	$+200.\dot{\delta}_a$	83	$+5.\eta_1$
04	$+200.u_{1Q}$	24	$-5.a_{cm}$	44	$+5.a_y$	64	$+200.\dot{\delta}_r$	84	$+5.\eta_2$
05		25	$+500.x_4$	45	$+2.x_1$	65		85	
06		26		46	$+4.y$	66		86	
07	$-1000.H$	27		47	$-4.y$	67		87	
08		28		48	$-2.x_1$	68		88	
09		29		49	$-2.x_2$	69		89	
10		30		50	$+1000.H$	70	$+1000.p$	90	NM_1
11		31		51	$+1000.\phi$	71	$+500.p_g$	91	NM_2
12	$-200.u_{1Q}$	32		52	$-1000.\phi$	72	$-500.p_g$	92	$-5.\eta_2$
13	$-200.u_{2Q}$	33		53	$-10.v$	73	$-10.x$	93	$-WN_1$
14	$+200.u_{2Q}$	34	(4. y)	54	$-1000.r$	74	$-2.\tilde{v}$	94	$-WN_2$
15		35	$+2.x_3$	55		75		95	
16		36	$+2.x_2$	56		76		96	
17		37	$-2.x_3$	57		77		97	
18		38	$-500.x_4$	58		78		98	
19		39		59		79		99	

$$
\begin{aligned}
+\,1000.p = -\int \Bigg\{ & \begin{pmatrix} -.1a_{11} \\ Q70 \end{pmatrix}(10)(+1000.p) + \begin{pmatrix} +.1a_{12} \\ Q54 \end{pmatrix}(10)(-1000.r) + \begin{pmatrix} -10.a_{13} \\ Q60 \end{pmatrix}(10)(+10.v) \\
& + \begin{pmatrix} -.25.a_{17} \\ P45 \end{pmatrix}(20)(+2.x_1) + \begin{pmatrix} +50.a_{18} \\ P49 \end{pmatrix}(10)(-2.x_2) + \begin{pmatrix} +50.a_{19} \\ P37 \end{pmatrix}(10)(-2.x_3) \\
& + \begin{pmatrix} -.2a_{1,10} \\ P25 \end{pmatrix}(10)(+500.x_4) + \begin{pmatrix} -.2a_{1,14} \\ P03 \end{pmatrix}(10)(+500.\delta_a) \\
& + \begin{pmatrix} .2a_{1,15} \\ P01 \end{pmatrix}(10)(-500.\delta_r) \Bigg\}\, dt
\end{aligned}
$$

$$
-\,1000.p = -\,\{(1)(+1000.p)\}
$$

$$
\begin{aligned}
+\,1000.r = -\int \Bigg\{ & \begin{pmatrix} -a_{21} \\ Q69 \end{pmatrix}(1)(+1000.p) + \begin{pmatrix} -a_{22} \\ Q61 \end{pmatrix}(1)(+1000.r) + \begin{pmatrix} +100.a_{23} \\ Q53 \end{pmatrix}(1)(-10.v) \\
& + \begin{pmatrix} -50.a_{27} \\ Q68 \end{pmatrix}(10)(+2.x_1) + \begin{pmatrix} +500.a_{28} \\ Q67 \end{pmatrix}(1)(-2.x_2) + \begin{pmatrix} +50.a_{29} \\ Q79 \end{pmatrix}(10)(-2.x_3) \\
& + \begin{pmatrix} -2.a_{2,10} \\ Q78 \end{pmatrix}(1)(+500.x_4) + \begin{pmatrix} +2.a_{2,14} \\ Q77 \end{pmatrix}(1)(-500.\delta_a) \\
& + \begin{pmatrix} -2.a_{2,15} \\ Q59 \end{pmatrix}(1)(+500.\delta_r) \Bigg\}\, dt
\end{aligned}
$$

$$
-\,1000.r = -\,\{(1)(+1000.r)\}
$$

Figure F1. Analog of Plant

$$+10.v = - \int \left\{ \begin{pmatrix} +.01a_{31} \\ Q62 \end{pmatrix} (1)(-1000.p) + \begin{pmatrix} -.001a_{32} \\ Q58 \end{pmatrix} (10)(+1000.r) + \begin{pmatrix} -a_{33} \\ Q57 \end{pmatrix} (1)(+10.v) \right.$$

$$+ \begin{pmatrix} +.01a_{34} \\ Q52 \end{pmatrix} (1)(-1000.\phi) + \begin{pmatrix} -.5a_{37} \\ Q99 \end{pmatrix} (10)(+2.x_1) + \begin{pmatrix} +5.a_{38} \\ Q98 \end{pmatrix} (1)(-2.x_2)$$

$$\left. + \begin{pmatrix} +5.a_{39} \\ Q97 \end{pmatrix} (1)(-2.x_3) + \begin{pmatrix} +.02a_{3,15} \\ Q89 \end{pmatrix} (1)(-500.\delta_r) \right\} dt$$

$$-10.v = - \{(1)(+10.v)\}$$

$$+1000.\phi = - \int \left\{ (1)(-1000.p) + \begin{pmatrix} +a_{42} \\ Q88 \end{pmatrix} (1)(-1000.r) \right\} dt$$

$$-1000.\phi = - \{(1)(+1000.\phi)\}$$

$$+1000.H = - \int \{(1)(-1000.r)\} dt$$

$$-1000.H = - \{(1)(+1000.H)\}$$

$$+4.y = - \int \left\{ \begin{pmatrix} +.4a_{63} \\ Q87 \end{pmatrix} (1)(-10.v) + \begin{pmatrix} -.004a_{64} \\ Q46 \end{pmatrix} (1)(+1000.\phi) \right.$$

$$\left. + \begin{pmatrix} .0004a_{65} \\ Q45 \end{pmatrix} (10)(-1000.H) \right\} dt$$

$$-4.y = - \{(1)(+4.y)\}$$

Figure F1. Analog of Plant (Continued)

$$- 10.x = - \{(1)(+10.x)\}$$

$$+ 2.x_1 = - \int \left\{ \begin{pmatrix} -.1a_{77} \\ Q36 \end{pmatrix} (10)(+2.x_1) + \begin{pmatrix} +.1a_{7,11} \\ Q37 \end{pmatrix} (10)(-2.\tilde{v}) \right\} dt$$

$$- 2.x_1 = - \{(1)(+2.x_1)\}$$

$$+ 2.x_2 = - \int \left\{ \begin{pmatrix} -.00978a_{88} \\ Q26 \end{pmatrix} (102.3)(+2.x_2) + \begin{pmatrix} -.01a_{89} \\ Q25 \end{pmatrix} (100)(+2.x_3) \right.$$

$$\left. + \begin{pmatrix} +.005a_{8,11} \\ Q16 \end{pmatrix} (200)(-2.\tilde{v}) \right\} dt$$

$$- 2.x_2 = - \{(1)(+2.x_2)\}$$

$$+ 2.x_3 = - \int \left\{ \begin{pmatrix} +.05a_{98} \\ Q15 \end{pmatrix} (20)(-2.x_2) + \begin{pmatrix} .01032a_{99} \\ Q06 \end{pmatrix} (96.7)(-2.x_3) \right.$$

$$\left. + \begin{pmatrix} -.01a_{9,11} \\ Q05 \end{pmatrix} (100)(+2.\tilde{v}) \right\} dt$$

$$- 2.x_3 = - \{(1)(+2.x_3)\}$$

$$+ 500.x_4 = - \int \left\{ \begin{pmatrix} -.1a_{10,10} \\ P26 \end{pmatrix} (10)(+500.x_4) + \begin{pmatrix} +.1a_{10,13} \\ P27 \end{pmatrix} (10)(-500.p_g) \right\} dt$$

$$- 500.x_4 = - \{(1)(+500.x_4)\}$$

Figure F1. Analog of Plant (Continued)

$$\int\left\{\left(\begin{matrix}\ldots_{11,12}\\ Q73\end{matrix}\right)(1)(-10.x) + \left(\begin{matrix}.04g_{11,3}\\ Q82\end{matrix}\right)(10)(-5.\eta_1)\right\} dt$$

$$-2.\tilde{v} = -\{(1)(+2.\tilde{v})\}$$

$$+10.x = -\int\left\{\left(\begin{matrix}-a_{12,12}\\ Q81\end{matrix}\right)(1)(+10.x) + \left(\begin{matrix}-5.a_{12,11}\\ Q80\end{matrix}\right)(1)(+2.\tilde{v}) + \left(\begin{matrix}-.2g_{12,3}\\ Q83\end{matrix}\right)(10)(+5.\eta_1)\right\}$$

$$+500.p_g = -\int\left\{\left(\begin{matrix}-a_{13,13}\\ Q71\end{matrix}\right)(1)(+500.p_g) + \left(\begin{matrix}+10.g_{13,4}\\ Q92\end{matrix}\right)(10)(-5.\eta_2)\right\} dt$$

$$-500.p_g = -\{(1)(+500.p_g)\}$$

$$-500.\delta_a = -\int\left\{\left(\begin{matrix}.250\\ Q00\end{matrix}\right)(10)(+200.\dot{\delta}_a)\right\} dt$$

$$+500.\delta_a = -\{(1)(-500.\delta_a)\}$$

$$-500.\delta_r = -\int\left\{\left(\begin{matrix}.250\\ Q01\end{matrix}\right)(10)(+200.\dot{\delta}_r)\right\} dt$$

$$+500.\delta_r = -\{(1)(-500.\delta_r)\}$$

$$-5.a_{cm} = -\left\{\left(\begin{matrix}-.5a_{33}\\ P04\end{matrix}\right)(1)(-10.v) + \left(\begin{matrix}-2.5a_{37}\\ P10\end{matrix}\right)(1)(-2.x_1) + \left(\begin{matrix}+2.5a_{38}\\ P11\end{matrix}\right)(1)(+2.x_2)\right.$$
$$\left. + \left(\begin{matrix}+2.5a_{39}\\ P12\end{matrix}\right)(1)(+2.0x_3) + \left(\begin{matrix}+.01a_{3,15}\\ P13\end{matrix}\right)(1)(+500.\delta_r)\right\}$$

Figure F1. Analog of Plant (Continued)

$$
\begin{aligned}
+5.a_y = -\Bigg\{ & \begin{pmatrix} -.005h_{11,1} \\ Q84 \end{pmatrix}(1)(+1000.p) + \begin{pmatrix} +.005h_{11,2} \\ Q74 \end{pmatrix}(1)(-1000.r) + \begin{pmatrix} -.5h_{11,3} \\ Q72 \end{pmatrix}(1)(+10.v) \\
& + \begin{pmatrix} -.25h_{11,7} \\ Q64 \end{pmatrix}(10)(+2.x_1) + \begin{pmatrix} +2.5h_{11,8} \\ Q63 \end{pmatrix}(1)(-2.x_2) + \begin{pmatrix} +2.5h_{11,9} \\ Q51 \end{pmatrix}(1)(-2.x_3) \\
& + \begin{pmatrix} -.01h_{11,10} \\ Q50 \end{pmatrix}(1)(+500.x_4) + \begin{pmatrix} -.01h_{11,14} \\ Q19 \end{pmatrix}(1)(+500.\delta_a) \\
& + \begin{pmatrix} +.01h_{11,15} \\ Q18 \end{pmatrix}(1)(-500.\delta_r \Bigg\}
\end{aligned}
$$

Figure F1. Analog of Plant (Continued)

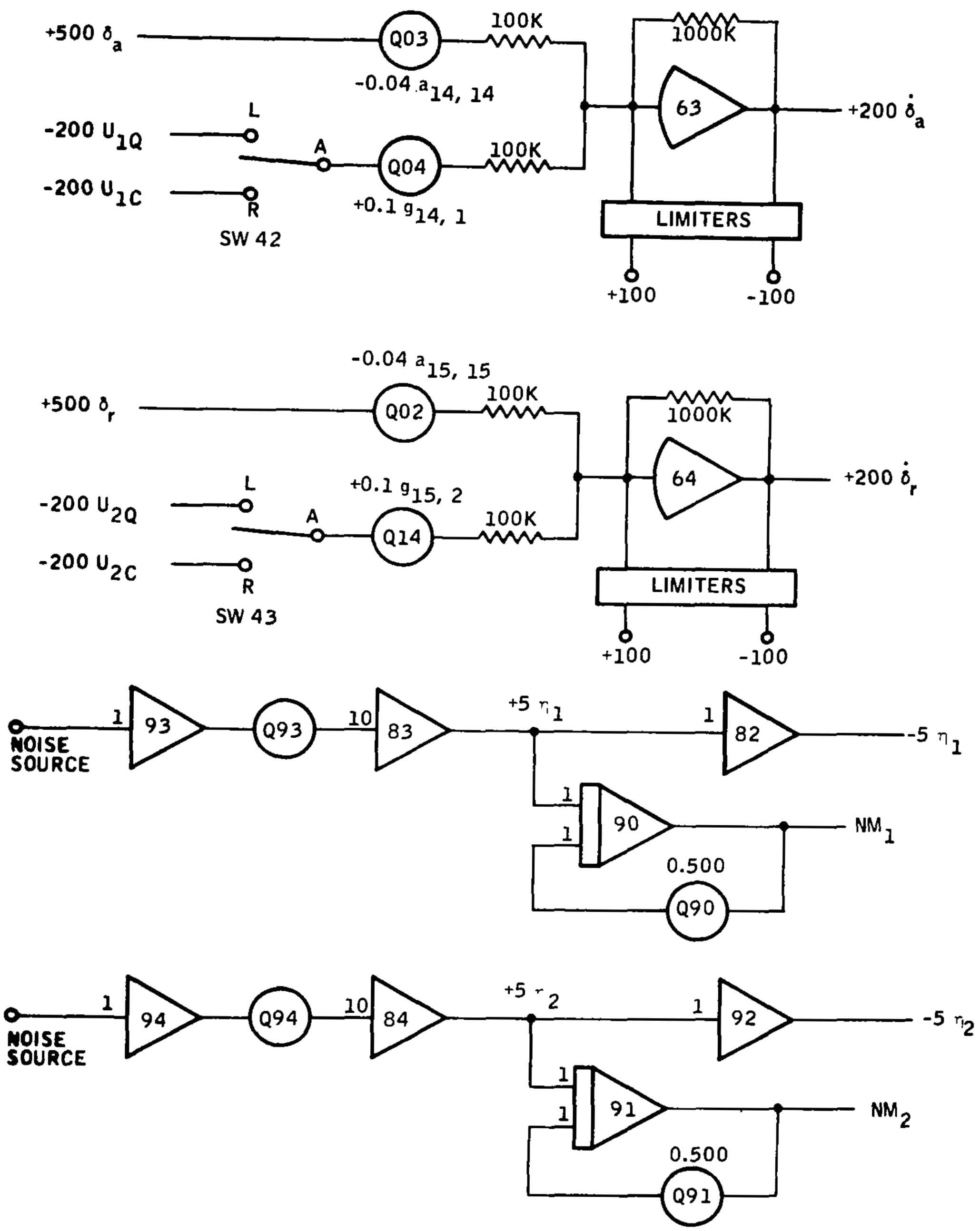


Figure F1. Analog of Plant (Concluded)

$$+200.u_{1Q} = -\left\{ \begin{pmatrix} .2k_{11} \\ Q07 \end{pmatrix} (1)(-1000p.) + \begin{pmatrix} .2k_{12} \\ Q08 \end{pmatrix} (1)(-1000.r) + \begin{pmatrix} 20.k_{13} \\ Q09 \end{pmatrix} (1)(-10.v) \right.$$

$$+ \begin{pmatrix} .2k_{14} \\ P05 \end{pmatrix} (1)(-1000.\phi) + \begin{pmatrix} .2k_{15} \\ P06 \end{pmatrix} (1)(-1000.H) + \begin{pmatrix} 50.k_{16} \\ P07 \end{pmatrix} (1)(-4.y)$$

$$+ \begin{pmatrix} -100.k_{17} \\ P08 \end{pmatrix} (1)(+2.x_1) + \begin{pmatrix} 100.k_{18} \\ P09 \end{pmatrix} (1)(-2.x_2) + \begin{pmatrix} 100.k_{19} \\ P15 \end{pmatrix} (1)(-2.x_3)$$

$$+ \begin{pmatrix} -.4k_{1,10} \\ P16 \end{pmatrix} (1)(+500.x_4) + \begin{pmatrix} -100.k_{1,11} \\ P17 \end{pmatrix} (1)(+2.\tilde{v}) + \begin{pmatrix} -20.k_{1,12} \\ P18 \end{pmatrix} (1)(+10.x)$$

$$\left. + \begin{pmatrix} -.4k_{1,13} \\ P19 \end{pmatrix} (1)(+500.p_g) + \begin{pmatrix} +.4k_{1,14} \\ P28 \end{pmatrix} (1)(-500.\delta_a) + \begin{pmatrix} +.4k_{1,15} \\ P29 \end{pmatrix} (1)(+500.\delta_r) \right\}$$

$$+200.u_{2Q} = -\left\{ \begin{pmatrix} +.2k_{21} \\ P35 \end{pmatrix} (1)(-1000.p) + \begin{pmatrix} +.2k_{22} \\ P36 \end{pmatrix} (1)(-1000.r) + \begin{pmatrix} +20.k_{23} \\ P38 \end{pmatrix} (1)(-10.v) \right.$$

$$+ \begin{pmatrix} -.2k_{24} \\ P39 \end{pmatrix} (1)(+1000.\phi) + \begin{pmatrix} +.2k_{25} \\ P46 \end{pmatrix} (1)(-1000.H) + \begin{pmatrix} +50.k_{26} \\ P47 \end{pmatrix} (1)(-4.y)$$

$$+ \begin{pmatrix} -100.k_{27} \\ P48 \end{pmatrix} (1)(+2.x_1) + \begin{pmatrix} +100.k_{28} \\ Q10 \end{pmatrix} (1)(-2.x_2) + \begin{pmatrix} +100.k_{29} \\ Q11 \end{pmatrix} (1)(-2.x_3)$$

$$+ \begin{pmatrix} -.4k_{2,10} \\ Q12 \end{pmatrix} (1)(+500.x_4) + \begin{pmatrix} -100.k_{2,11} \\ Q13 \end{pmatrix} (1)(+2.\tilde{v}) + \begin{pmatrix} -20.k_{2,12} \\ Q20 \end{pmatrix} (1)(+10.x)$$

$$\left. + \begin{pmatrix} -.4k_{2,13} \\ Q21 \end{pmatrix} (1)(+500.p_g) + \begin{pmatrix} -.4k_{2,14} \\ Q22 \end{pmatrix} (1)(+500.\delta_a) + \begin{pmatrix} +.4k_{2,15} \\ Q23 \end{pmatrix} (1)(-500.\delta_a) \right\}$$

$$-200.u_{1Q} = 1\ \{(1)\ (+200.u_{1Q})\}$$

$$-200.u_{2Q} = 1\ \{1)\ (\pm 200.u_{2Q})\}$$

Figure F2. Analog of Quadratic Controller

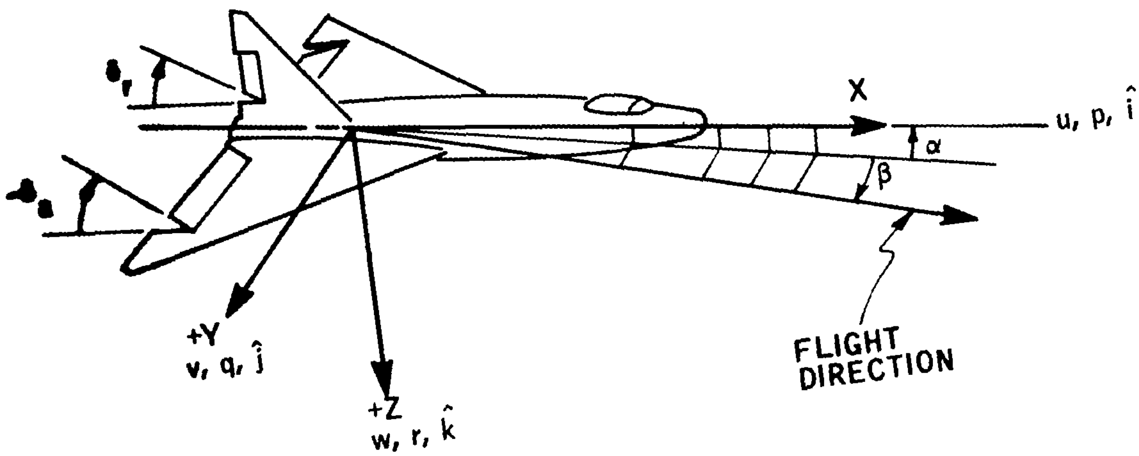


Figure F3. No Wind Flight Geometry

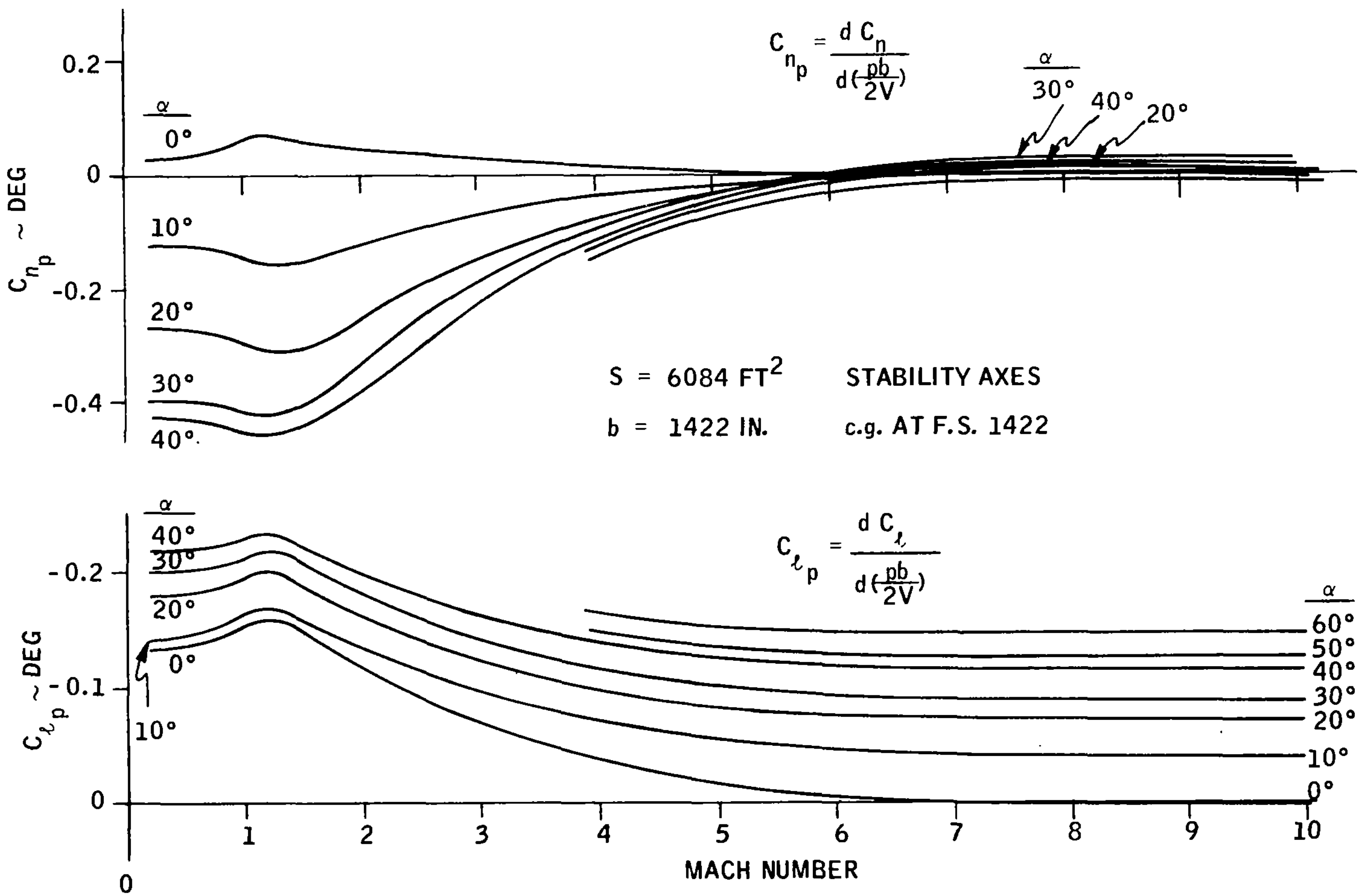


Figure F4. Damping in Roll (ref. 29)

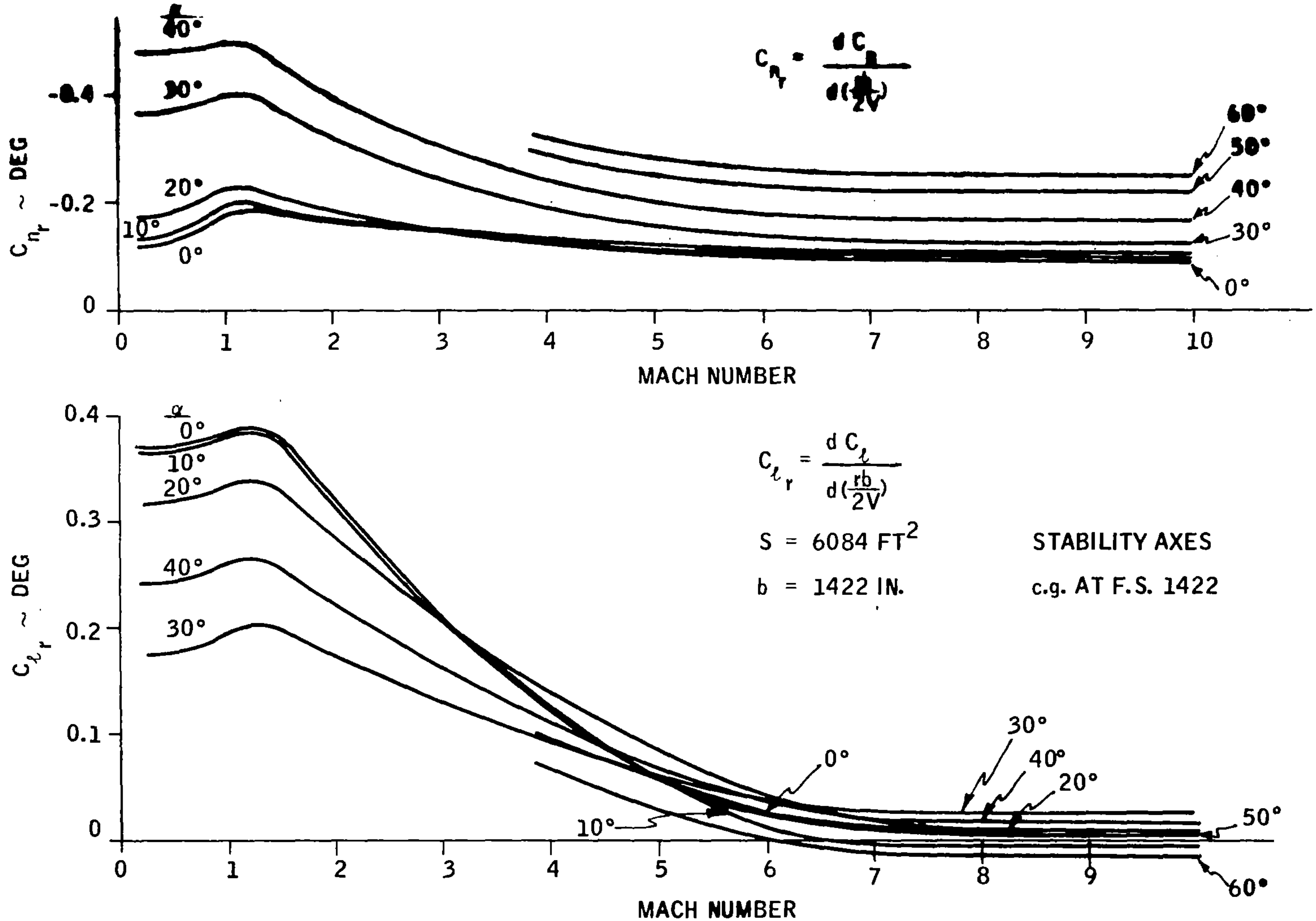


Figure F5. Damping in Yaw (ref. 29)

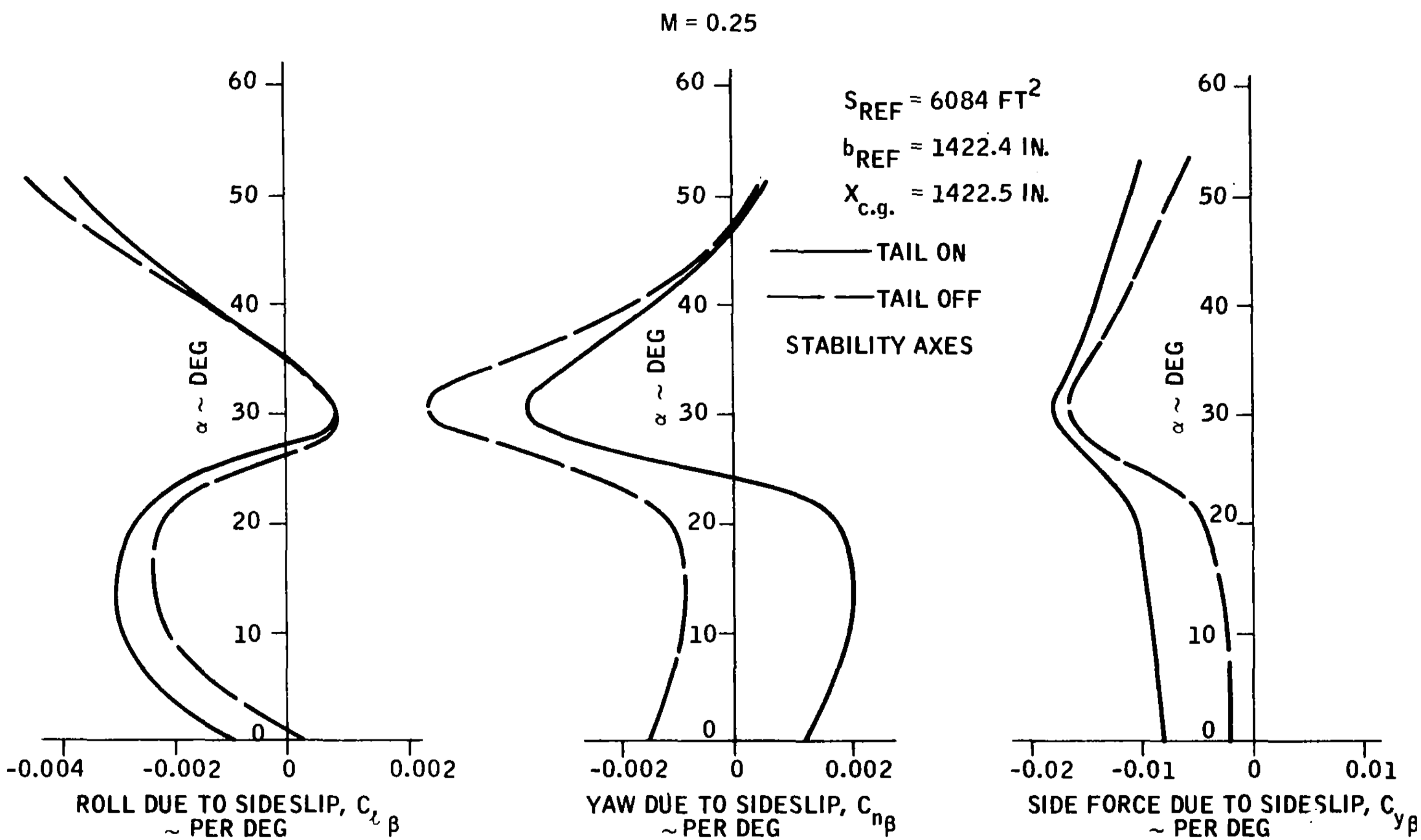


Figure F6. Sideslip Derivatives (ref. 30)

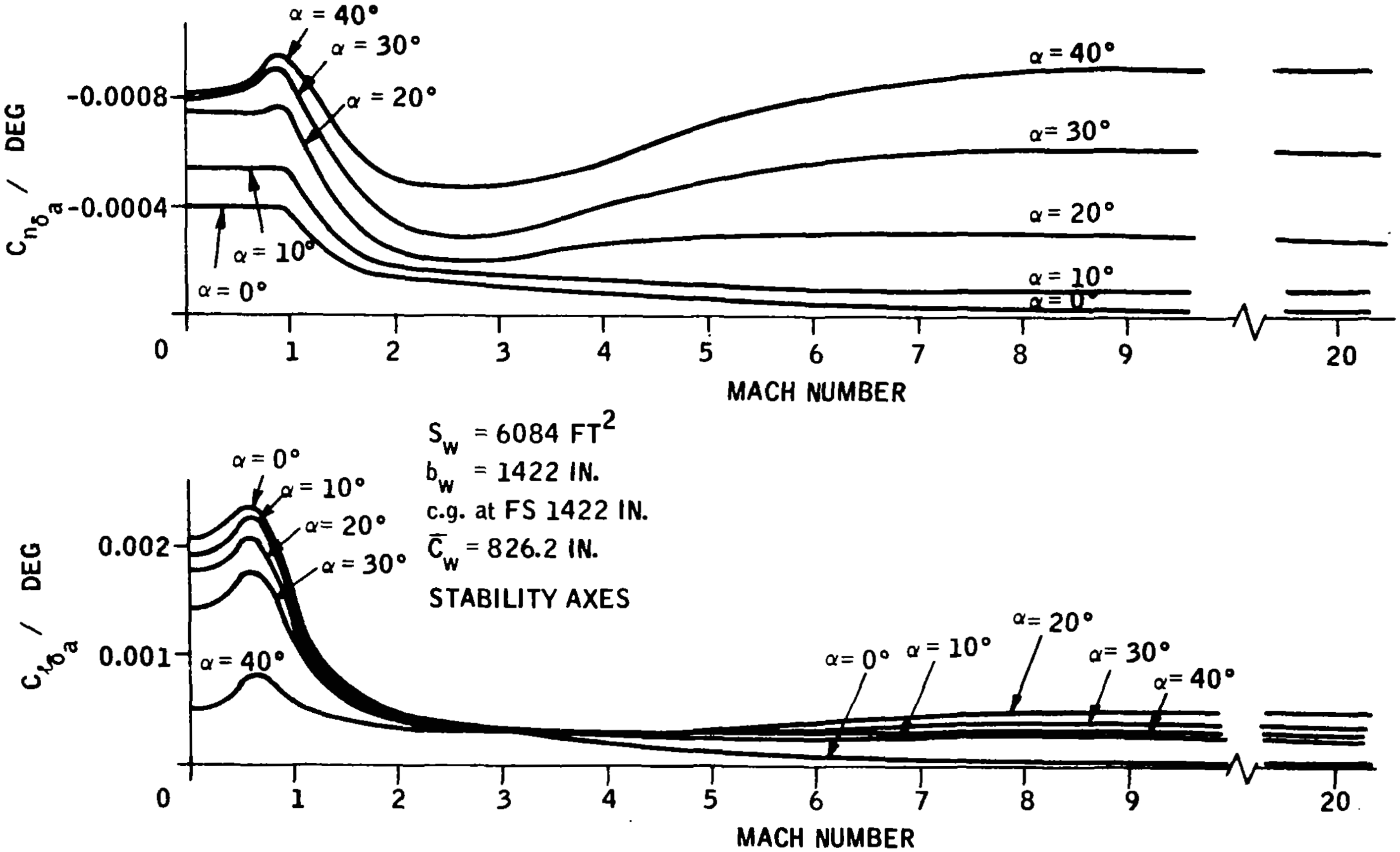


Figure F7. Aileron Power (ref. 31)

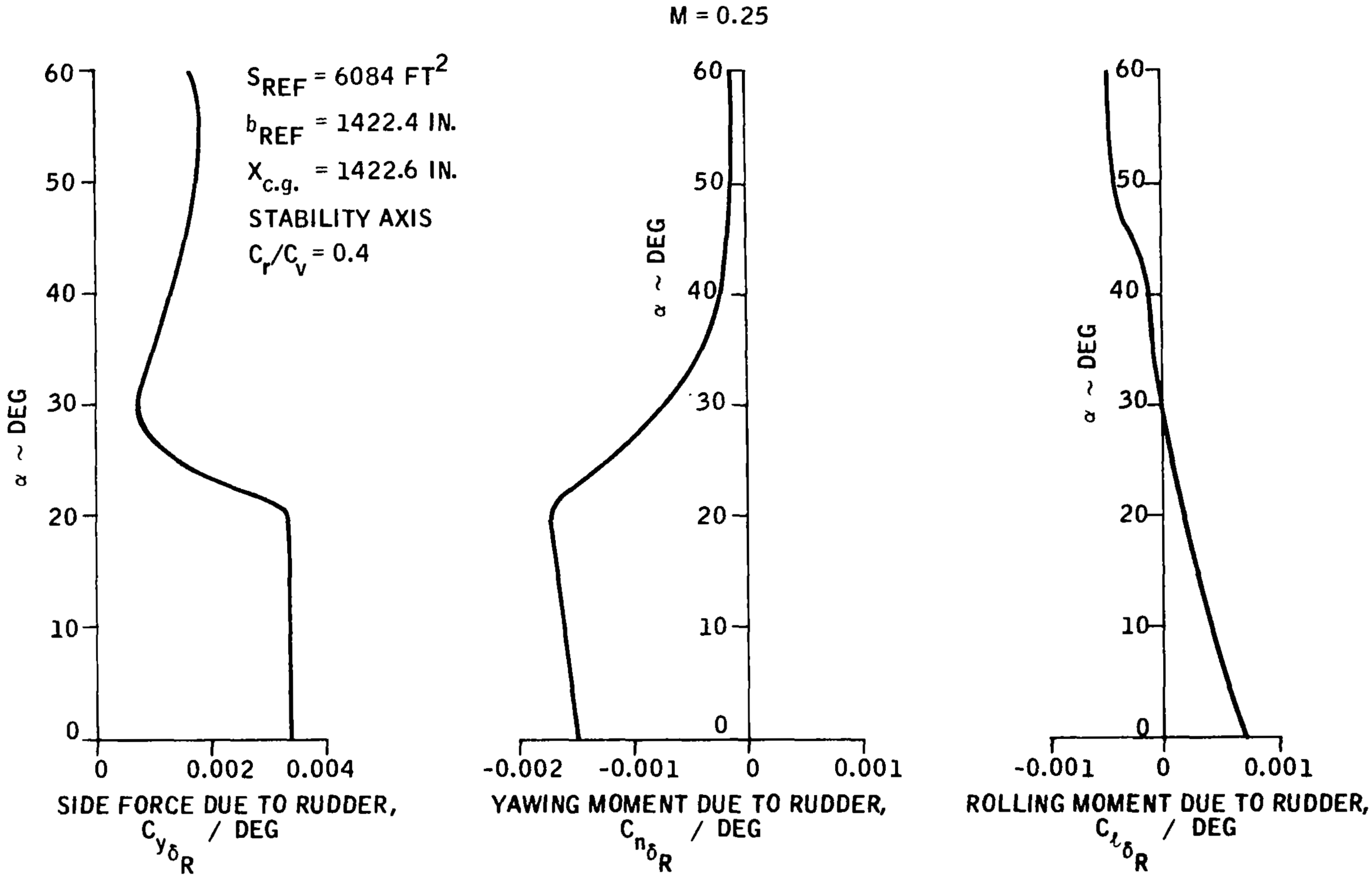


Figure F8. Rudder Power (ref. 30)

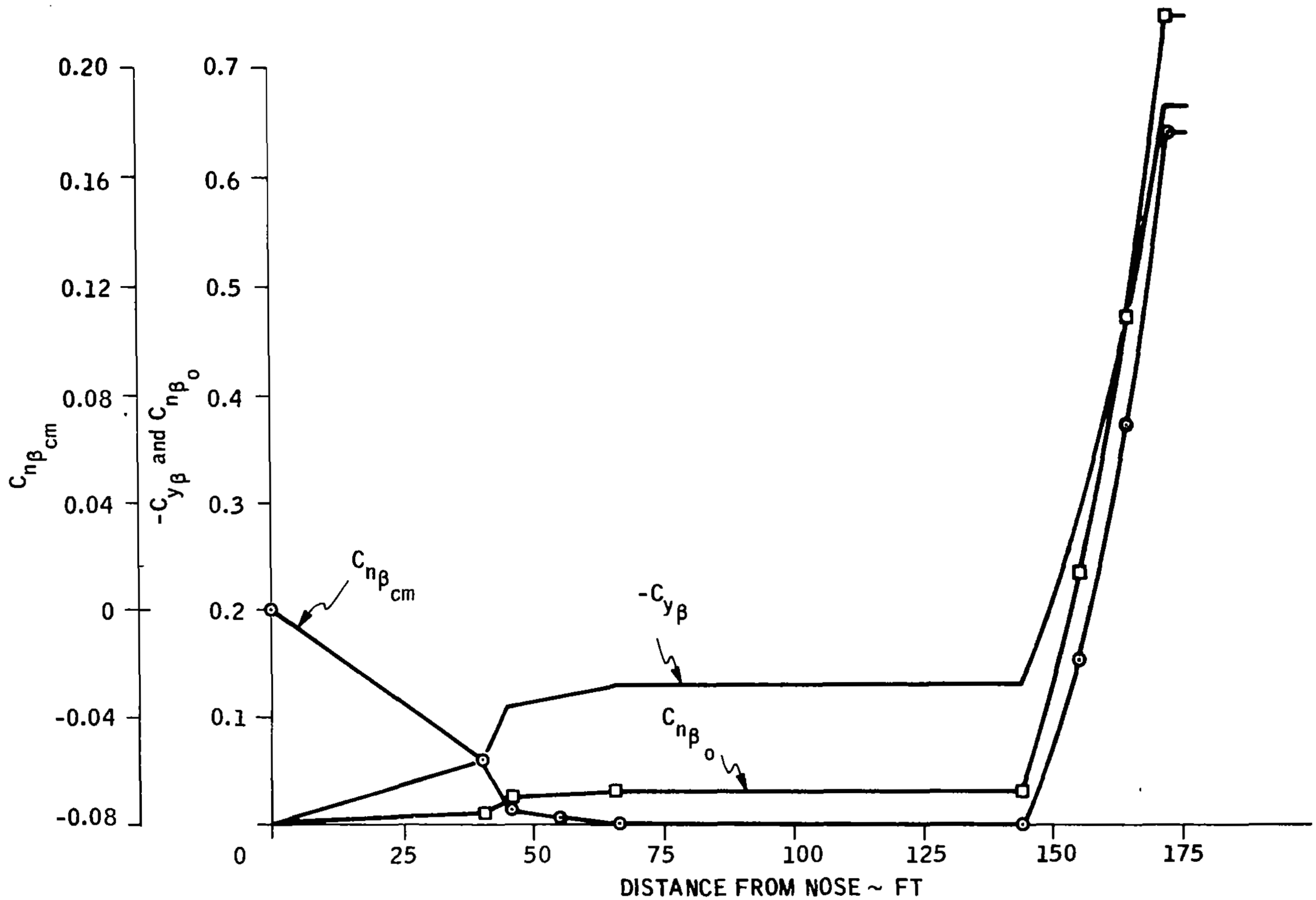


Figure F9. Side Gust Penetration

APPENDIX G
HIGH-ALTITUDE ABORT SIMULATION

This appendix discusses the simulation used to generate the high-altitude abort results of Section V.

The basis for the simulation is a 6-degree-of-freedom (6 DOF) hybrid simulation developed at Honeywell for performing entry simulations. This simulation includes data for the North American Rockwell (NR) 134D delta wing orbiter. The equations of motion are presented in Table G1. It is capable of simulating entry from orbiter to final approach, including navigation, guidance, and control. Closed-loop guidance was not used in this study. The high-altitude abort investigation of Section V required modifications to the entry simulation. Table G2 presents the thrust vectoring forces and control equations added to the basic entry simulation. This includes provisions for variable mass, center of gravity, inertias, and the effects of offset between the center of mass and the aerodynamic moment reference center.

The thrust vector control system (TVC) is presented in Figure 56. Figure 60 gives power levels (PL), angle-of-attack commands (α_c), and bank angle commands (ϕ_c) intended to duplicate the point mass trajectory obtained from NR. This abort trajectory initiated at 226,987 feet, at a velocity of 10,308 fps, with +6 deg of flight path angle. The commands are presented in Table G3 and are stored in the modified entry simulation.

Figure G1 shows the simulated mass properties variations with vehicle weight. The table at the top of the figure permits comparison with the source data. All of the tests began at the 650,000 pounds gross weight used by NR in generating the abort trajectory. The mass properties, as generated, are open to argument, since the cg's and inertias associated with 760,000 pounds gross weight were used at 650,000 pounds. This is an error, but the consequences are considered minor; they should not influence the conclusions of this report.

Table G1. Equations of Motion

BODY AXES LINEAR ACCELERATIONS

$$a_x = (F_x + F_{xE})/m$$

$$a_y = (F_y + F_{yE})/m$$

$$a_z = (F_z + F_{zE})/m$$

BODY AXES EQUATIONS OF MOTION

$$\dot{U} = a_x - (WQ - VR) + E_{11}g_x + E_{12}g_y + E_{13}g_z$$

$$\dot{V} = a_y - (UR - WP) + E_{21}g_x + E_{22}g_y + E_{23}g_z$$

$$\dot{W} = a_z - (VP - UQ) + E_{31}g_x + E_{32}g_y + E_{33}g_z$$

$$\dot{P}I_x = L + L_E + I_{xz}[\dot{R} + PQ] + QR[I_y - I_z]$$

$$\dot{Q}I_y = M + M_E + I_{xz}[R^2 - P^2] + RP[I_z - I_x]$$

$$\dot{R}I_z = N + N_E + I_{xz}[\dot{P} - QR] + PQ[I_x - I_y]$$

EULER PARAMETERS

$$\begin{pmatrix} \dot{\omega}_1 \\ \dot{\omega}_2 \\ \dot{\omega}_3 \\ \dot{\omega}_4 \end{pmatrix} = \begin{pmatrix} O & -P & -Q & -R \\ P & O & R & -Q \\ Q & -R & O & P \\ R & Q & -P & O \end{pmatrix} \begin{pmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \\ \omega_4 \end{pmatrix}$$

Table G1. Equations of Motion (Continued)

DIRECTION COSINES BETWEEN INERTIAL AND BODY AXES

$$E_{11} = \omega_1^2 + \omega_2^2 + \omega_3^2 + \omega_4^2$$

$$E_{12} = 2(\omega_2\omega_3 - \omega_1\omega_4)$$

$$E_{13} = 2(\omega_2\omega_4 - \omega_1\omega_3)$$

$$E_{21} = 2(\omega_2\omega_3 - \omega_1\omega_4)$$

$$E_{22} = \omega_1^2 - \omega_2^2 + \omega_3^2 - \omega_4^2$$

$$E_{23} = 2(\omega_3\omega_4 + \omega_1\omega_2)$$

$$E_{31} = 2(\omega_2\omega_4 + \omega_1\omega_3)$$

$$E_{32} = 2(\omega_3\omega_4 - \omega_1\omega_2)$$

$$E_{33} = \omega_1^2 - \omega_2^2 - \omega_3^2 + \omega_4^2$$

RELATION BETWEEN INERTIAL ($\dot{X}$, $\dot{Y}$, $\dot{Z}$) AND BODY VELOCITIES (U, V, W)

$$\begin{pmatrix} \dot{X} \\ \dot{Y} \\ \dot{Z} \end{pmatrix} = \begin{pmatrix} E_{11} & E_{21} & E_{31} \\ E_{12} & E_{22} & E_{32} \\ E_{13} & E_{23} & E_{33} \end{pmatrix} \begin{pmatrix} U \\ V \\ W \end{pmatrix}$$

GRAVITY COMPONENTS IN AN INERTIAL FRAME

$$r = (X^2 + Y^2 + Z^2)^{1/2}$$

$$g' = g_o r_o^2 / r^2$$

$$g_x = -g' \left(\frac{X}{r}\right), \quad g_y = g' \left(\frac{Y}{r}\right), \quad g_z = g' \left(\frac{Z}{r}\right)$$

Table G1. Equations of Motion (Continued)

VEHICLE VELOCITY IN A LOCAL VERTICAL REFERENCE FRAME

$$\begin{bmatrix} \dot{X}_e \\ \dot{Y}_e \\ \dot{Z}_e \end{bmatrix} = \begin{bmatrix} \mathrm{SinLCosB} & -\mathrm{SinLSinB} & -\mathrm{CosL} \\ \mathrm{SinB} & \mathrm{CosB} & 0 \\ \mathrm{CosLCosB} & -\mathrm{CosLSinB} & \mathrm{SinL} \end{bmatrix} \begin{bmatrix} \dot{X} - \omega_E Y \\ \dot{Y} - \omega_E X \\ \dot{Z} \end{bmatrix}$$

ALTITUDE RATE, HEADING, AND FLIGHT PATH ANGLE

$$\dot{h} = -\dot{Z}_e$$

$$\chi = \tan^{-1}\left[\frac{\dot{Y}_e}{\dot{X}_e}\right]$$

$$\gamma = \tan^{-1}\left[\frac{\dot{h}}{\left(\dot{X}_e^{\,2} + \dot{Y}_e^{\,2} + \dot{Z}_e^{\,2}\right)^{1/2}}\right]$$

RELATIVE VELOCITIES

$$\begin{pmatrix} U_a \\ V_a \\ W_a \end{pmatrix} = \begin{pmatrix} U \\ V \\ W \end{pmatrix} - \begin{pmatrix} U \\ V \\ W \end{pmatrix}_{gusts} + \begin{pmatrix} E_{12} & -E_{11} & -- \\ E_{22} & -E_{21} & -- \\ E_{32} & -E_{31} & -- \end{pmatrix} \begin{pmatrix} X \\ Y \\ 0 \end{pmatrix} \omega_E$$

Table G1. Equations of Motion (Concluded)

AIRSPEED, MACH NUMBER, α, AND β

$$V_t = \sqrt{(U_a^2 + V_a^2 + W_a^2)}$$

$$M = V_{t/a}$$

$$\alpha = \tan^{-1}\left[\frac{W_a}{U_a}\right]$$

$$\beta = \tan^{-1}\left[\frac{V_a}{\sqrt{U_a^2 + W_a^2}}\right]$$

$$\dot{\alpha} = (U_a\dot{W} - W_a\dot{U})/(U_a^2 + W_a^2)$$

$$\dot{\beta} = \frac{[(U_a^2 + W_a^2)\,\dot{V} - V_a\,(U_a\dot{U} + W_a\dot{W})]}{\sqrt{U_a^2 + W_a^2\,(U_a^2 + V_a^2 + W_a^2)}}$$

Table G2. TVC Equations Added to Entry 6 DOF Simulation

ENGINE THRUSTS (See Figure 60 for Power Level Program)

$FE1 = PL1[477{,}000 - (A_e)P_{ATMOS}]$. If $PL1 < 0.5$, $FE1 = 0$

$FE2 = PL2[477{,}000 - (A_e)P_{ATMOS}]$. If $PL2 < 0.5$, $FE2 = 0$

P_{ATMOS} = atmospheric pressure, lbs/ft^2

$A_e = 50\ ft^2$, the effective nozzle exit area retracted

β command for unsymmetric thrust:

IF $|PL1 - PL2| > 0.1$, $\beta_c = \beta_{c_o}\ SIGN(PL1 - PL2)$

PROPELLANT BURNED BY MAIN ENGINES

$WPRO = 400{,}000 - \int 1{,}043\ (PL1 + PL2)dt$

Vehicle Weight = 225,000 + WPRO + (250,000 - 225,000)

If WPRO = 0, go to orbit maneuver burn

MASS PROPERTIES, MAIN ENGINE BURN

$$x_{CG} = x_{CG_{BO}} + \left(x_{CG_{FULL}} - x_{CG_{BO}}\right)\left(\frac{WPRO}{400{,}000}\right)$$

$$z_{CG} = z_{CG_{BO}} + \left(z_{CG_{FULL}} - z_{CG_{BO}}\right)\left(\frac{WPRO}{400{,}000}\right)$$

$$I_x = I_{x_{BO}} + \left(I_{x_{FULL}} - I_{x_{BO}}\right)\left(\frac{WPRO}{400{,}000}\right)$$

$$I_y = I_{y_{BO}} + \left(I_{y_{FULL}} - I_{y_{BO}}\right)\left(\frac{WPRO}{400{,}000}\right)$$

Table G2. TVC Equations Added to Entry 6 DOF Simulation (Continued)

$$I_z = I_{z_{BO}} + \left(I_{z_{FULL}} - I_{z_{BO}}\right)\left(\frac{WPRO}{400,000}\right)$$

$$I_{xz} = I_{xz_{BO}} + \left(I_{xz_{FULL}} - I_{xz_{BO}}\right)\left(\frac{WPRO}{400,000}\right)$$

See Figure G3 for constants.

ORBIT MANEUVER BURN

$$x_{FORCE} = 30,000 \text{ lb}$$

$$\beta_c = 0$$

Weight of OM propellant, WOM = 25,000 - 63t

If WOM = 0, then 0 = FXE = FYE = FZE = LE = ME = NE

MASS PROPERTIES, ORBIT MANEUVER PROPELLANT BURN

$$x_{CG} = x_{CG_{ENT}} + \left(x_{CG_{BO}} - x_{CG_{ENT}}\right)\left(\frac{WOM}{25,000}\right)$$

$$z_{CG} = z_{CG_{ENT}} + \left(z_{CG_{BO}} - z_{CG_{ENT}}\right)\left(\frac{WOM}{25,000}\right)$$

$$I_x = I_{x_{ENT}} + \left(I_{x_{BO}} - I_{x_{ENT}}\right)\left(\frac{WOM}{25,000}\right)$$

$$I_y = I_{y_{ENT}} + \left(I_{y_{BO}} - I_{y_{ENT}}\right)\left(\frac{WOM}{25,000}\right)$$

$$I_z = I_{z_{ENT}} + \left(I_{z_{BO}} - I_{z_{ENT}}\right)\left(\frac{WOM}{25,000}\right)$$

$$I_{xz} = I_{xz_{ENT}} + \left(I_{xz_{BO}} - I_{xz_{ENT}}\right)\left(\frac{WOM}{25,000}\right)$$

Table G2. TVC Equations Added to Entry 6 DOF Simulation (Concluded)

ENGINE FORCES AND MOMENTS, BODY AXES

$$FXE = FE1 + FE2 + x_{FORCE}$$

$$FYE = (FE1)\delta_{1z} + (FE2)\delta_{2z}$$

$$FZE = -(FE1)\delta_{1y} - (FE2)\delta_{2y}$$

$$LE = FE1[\delta_{1y}(Y_{CG} - Y\delta_1) - \delta_{1z}(z_{CG} - z_{\delta_1})]$$

$$+ FE2[\delta_{2y}(Y_{CG} - Y_{\delta_2}) - \delta_{2z}(z_{CG} - z_{\delta_2})]$$

$$ME = FE1[\delta_{1y}(x_{CG} - x_{\delta_1}) + (z_{CG} - z_{\delta_1})]$$

$$+ FE2[\delta_{2y}(x_{CG} - x_{\delta_2}) + (z_{CG} - z_{\delta_2})]$$

$$NE = FE1[\delta_{1z}(x_{CG} - x_{\delta_1}) + (y_{CG} - y_{\delta_1})]$$

$$+ FE2[\delta_{2z}(x_{CG} - x_{\delta_1}) + (y_{CG} - y_{\delta_2})]$$

y_{CG} is zero. Gimbal position coordinates are converted to feet. In inches, they are:

$x_{\delta_1} = 2200$ $\quad$ $x_{\delta_2} = 2200$

$y_{\delta_1} = -68$ $\quad$ $y_{\delta_2} = +68$

$z_{\delta_1} = +490$ $\quad$ $z_{\delta_2} = +490$

AERODYNAMIC MOMENTS CORRECTED FOR CG OFFSET FROM REFERENCE MOMENT CENTER

$$x_{RMC} = (1422 + 211)/12$$

$$C_{NORM} = C_{LIFT} \cos\alpha + C_{DRAG} \sin\alpha$$

$$C_{m_{CG}} = C_{m_{RMC}} + C_N(x_{CG} - x_{RMC})/\bar{c}$$

$$C_{n_{CG}} = C_{n_{RMC}} + C_y(x_{CG} - x_{RMC})/b$$

Table G3. Test Sequences to Check Out TVC and SAS

TVC Test Sequence				
Time	Pl1	PL2	α_C	ϕ_C
0	1.0	1.0	50.0	0
5.0				0
5.1				70.0
20.0				70.0
20.1				0
35.0			50.0	
35.1			30.0	
45.0		1.0		
45.1		0		
75.0			30.0	
75.1			11.0	
85.0	1.0			
85.1	0			

SAS Alpha Command Sequence	
Time	α_C
0	11.0
10.0	11.0
10.1	30.0
30.0	30.0
30.0	50.0
50.0	50.0
50.1	11.0
1000.0	11.0

$0 = PL1 = PL2 = \phi_C$

NR 134D AUGUST 1970 MASS PROPERTIES (NO PAYLOAD)

CONDITION	WEIGHT	C.G. STATION x	C.G. STATION z	INERTIAS x 10^{-6} I_x	I_y	I_z	I_{xz}
LIFTOFF	760,000	1578.1	484.6	5.74	22.9	26.3	1.04
BURNOUT	250,587	1692.8	486.5	3.49	15.0	16.1	1.21
ENTRY	214,861	1648.8	473.9	3.36	13.3	14.6	0.96

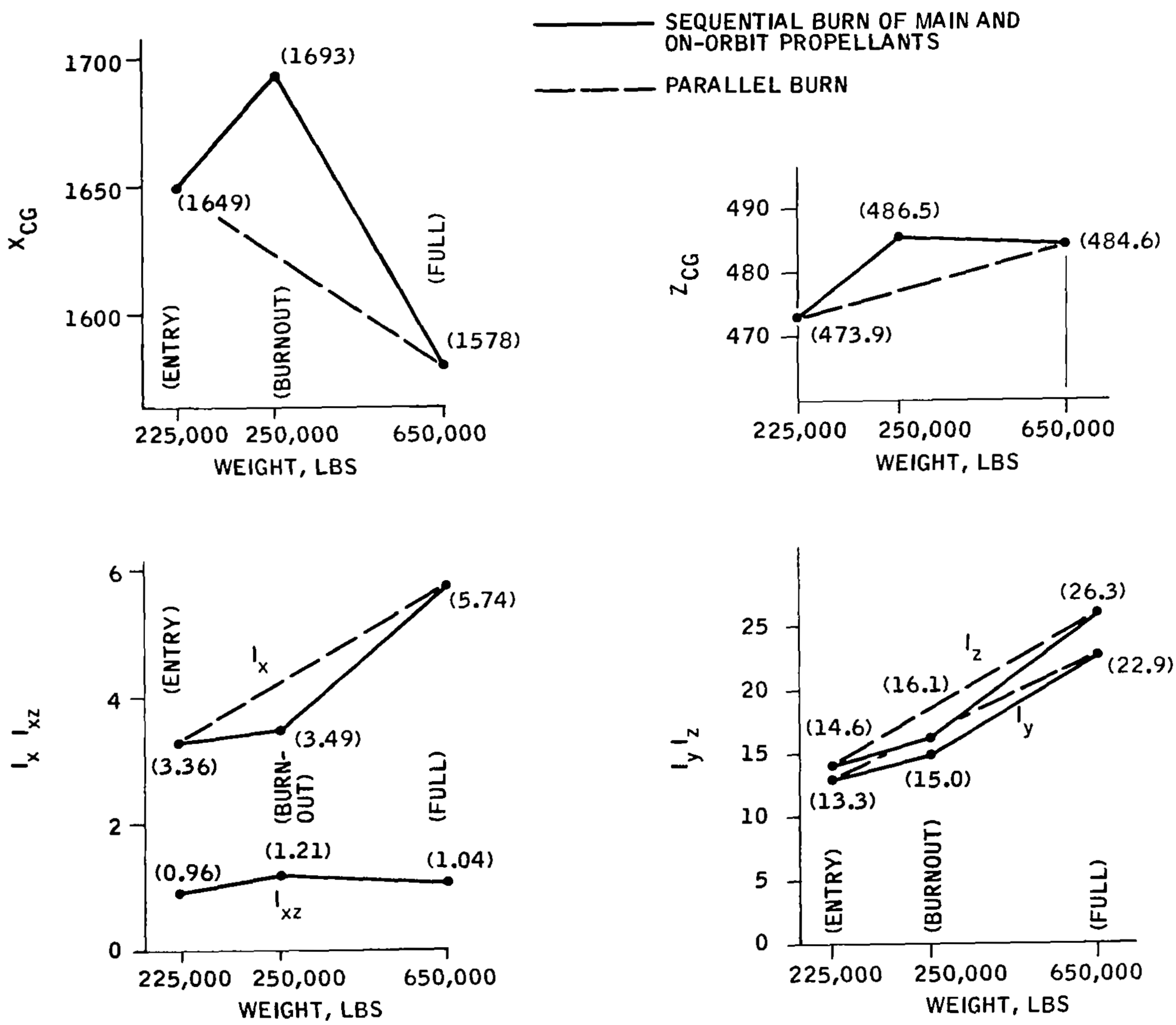


Figure G1. Mass Properties Variations with Vehicle Weight

APPENDIX H
SYMBOLS AND NOTATION

Reference: Thelander, J. A., "Aircraft Motion Analysis", Air Force Technical Documentary Report FDL-TDR-64-70, March 1965

The above reference provided the bulk of the notations used in this report as well as the equations of motion given in Appendix B. Additional symbols are due primarily to powered flight with thrust vector control systems.

a = speed of sound, ft/sec

A_e = effective nozzle area of main engine, ft^2, used to compute engine thrust: $A_\ell = \left(F_{VAC} - F_{SL}\right)/P_{SL}$

a_{cg} = lateral acceleration at c.g., equations decoupled from pitch

ACPS = attitude control propulsion system (acronym)

a_x, a_y, a_{cg} = linear c.g. accelerations along body x, y, and z axis, respectively

a_z = normal acceleration at station x_a

b = wing span, or reference length for lateral aerodynamic moment coefficients

B = inertial longitude; $B = \tan^{-1}\left(\frac{-X}{Y}\right)$

C = basic symbol for aerodynamic force and moment coefficients

$\bar{c}$ = wing mean aerodynamic chord

C_{D_α}, C_{L_M}, C_{n_β}, C_{m_α}, etc. = nondimensional stability derivatives with reference to stability axes

C_ℓ, C_m, C_n = rolling, pitching, and yawing moment coefficients, respectively

$$C_\ell = \frac{L}{qSb},\ C_m = \frac{M}{qSc},\ C_n = \frac{N}{qSb}$$

C_L, C_D = life and drag force coefficients, respectively, (stability axes)

C_N, C_A = normal and axial force coefficients, respectively (body axes)

C_x, C_y, C_z = longitudinal, side-force, and normal-force coefficients, respectively (body axes)

D = aerodynamic drag - the aerodynamic force in the plane of symmetry along the projection of the relative wind on the plane of symmetry. Drag is positive in the negative X (downstream) direction

DWO = Delta Wing Orbiter (acronym)

DWT = Dog-Wag-Tail (acronym)

ECS = Entry Control System (acronym)

F_{Ei} = thrust of ith engine, lbs: $(T = \Sigma F_{Ei})$

F_{VAC}, F_{SL} = engine thrust in vacuum and at sea level, respectively

F_x, F_y, F_z = total force components along body axes

$$F_x = X_g + X + F_{xe}$$

$$F_y = Y_g + Y + F_{ye}$$

$$F_z = Z_g + Z + F_{ze}$$

F_{xe}, F_{ye}, F_{ze} = engine force components along body axes

g = gravitational acceleration constant

h = altitude, feet

H = heading; more often denoted by ψ

I_{sp} = engine specific impulse, lbs thrust/lb/sec propellant consumed

I_E = moment of inertia of one engine about hinge line

I_x, I_y, I_z = moments of inertia about X-, Y-, and Z-axes, respectively

Ixz = product of inertia with respect to X- and Z-axes

K = control system gain (G sometimes used in FORTRAN)

ℓ = reference length for aerodynamic moment coefficients

L = aerodynamic lift - the aerodynamic force in the plane of symmetry perpendicular to the projection of the relative wind on the plane of symmetry. Life is positive in the negative Z (upward) sense.

L = inertial latitude, positive North

L_E, M_E, N_E = engine rolling, pitching, and yawing moments about X, Y, and Z axes, respectively

L, M, N = aerodynamic rolling, pitching, and yawing moments about X-, Y-, and Z-axes

$L_{(\ )}, M_{(\ )}, N_{(\ )}$ = basic symbols for dimensional moment derivatives; subscript denotes variable of differentiation, e.g., $L_\beta = \partial L/\partial\beta$, $M_\alpha = \partial M/\partial\alpha$

m = mass

M = Mach number

m_E = mass of one engine

N = normal force; force component along negative Z axis

P = atmospheric pressure, lbs/ft^2 (P_{SL} = 2116 PSF)

PL = power level of propulsion engine; a value of 1.0 denotes 100% of normal power level

p, q, r = small-disturbance angular velocity components about X-, Y-, and Z-axes, respectively

P, Q, R = rolling, pitching, and yawing velocity components (angular) about X-, Y-, and Z-axes, respectively

q = dynamic pressure

$$q = \frac{\rho V^2}{2}$$

rmc = reference moment center for aerodynamic data, normally used as a subscript

S = wing area or reference area for aerodynamic coefficients

SAS = stability augmentation system (acronym)

t = time

T = total direct thrust force = ΣF_{Ei}

TVC = thrust vector control (acronym)

TWD = Tail wag dog

u, v, w = small-disturbance linear velocity components along X-, Y-, and Z-axes, respectively

U, V, W = linear velocity components along X-, Y-, and Z-axes, respectively

U_A, V_A, W_A = vehicle velocity components with respect to the air mass along X-, Y-, and Z-axes, respectively:

$$U_A = U - U_w$$

$$V_A = V - V_w$$

$$W_A = W - W_w$$

U_w, V_w, W_w = wind velocity components along X-, Y-, and Z-axes, respectively

V = total linear velocity of vehicle c.g.

V_N = velocity normal to the reference trajectory

V_t = total velocity with respect to the relative wind, $[U_A^2 + V_A^2 + W_A^2]^{1/2}$, the true airspeed

$\dot{W}$ = weight, lb.

W = wind vector, or horizontal component

W_x, W_y, W_z = wind components with respect to launch local vertical (the boost study assumed $W_z = 0$)

X, Y, Z = inertial position coordinates

x, y, z = lengths measured from mass properties axes. The MSFC launch vehicle axes center at the booster nose on its C_L. x positive aft, y to right, and z up. This is viewing the combination with orbiter on top, its belly to the belly of the booster, which is upside down

x_{E_i}, y_{E_i}, z_{E_i} = ith gimballed engine mass center coordinates

x_{CG}, y_{CG}, z_{CG} = C.G. coordinates

x_{δ_i}, y_{δ_i}, z_{δ_i} = ith gimballed engine hinge line coordinates

X, Y, Z = aerodynamic force components along X-, Y-, and Z-axes, respectively

X( ), Y( ), Z( ) = basic symbols for dimensional force derivative; subscript denotes variable of differentiation. For example,

$$Xu = \frac{\partial X}{\partial u} \; ; \; X\delta_e = \frac{\partial X}{\partial \delta_e} \; ; \; Xw = \frac{\partial X}{\partial w}$$

Xg, Yg, Zg = gravity force components along X-, Y-, and Z-axes. The boost analysis in this report uses:

$$\left.\begin{aligned} Xg &= -\,mg \sin \Theta \\ Yg &= mg \cos \Theta \sin \Phi \\ Zg &= mg \cos \Theta \cos \Phi \end{aligned}\right\} \Theta = \gamma_R + \theta$$

α = angle of attack; $\tan \alpha = W_A / U_A$

β = sideslip angle; $\sin \beta = V_A / V_t$

δi_y, δi_z = ith engine gimbal rotations about gimbal pitch and yaw hinges; the notation implies control moments predominantly about body y and z axes

δ_x, δ_y, δ_z = TVC system parameters, denoting rotational commands about the X-, Y-, and Z-axes to be distributed to the δi_y and δi_z

δ_{xp}, δ_p = typical control system gains, denoting $\partial \delta x / \partial p$ and $\partial \delta a / \partial p$, respectively

ζ = damping ratio

γ = flight-path angle, the angle between the velocity vector and the plane of the horizon

γ_R = flight-path angle of boost reference trajectory

δ_a, δ_e, δ_r = deflection of ailerons, elevator, and rudder, respectively

ρ = air density

Ψ, Θ, Φ = orientation angles of vehicle body axes in yaw, pitch, roll sequence

χ = heading of inertial velocity vector in local vertical frame

ϕ, θ, ψ = perturbations of vehicle axes orientation angles Φ, Θ, Ψ, respectively. In the small-disturbance approximation $\phi = \int p\,dt$, $\theta = \int q\,dt$, $\psi = \int r\,dt$, respectively

ω = frequency, rad/sec

ω_E = earth's rotation rate, rad/sec

General Notes:

1. All angles and angular velocities are in radian measure.
2. Fundamental units are used throughout, i.e., slugs, feet, seconds.
3. Throughout this table, the symbol q denotes dynamic pressure when multiplied by the wing area (qS).
4. The subscripts o denote steady-state reference condition for small-disturbance analyses, c command, j jet, respectively.

Subscripts

o	steady-state value
c	command
j	reaction jet
e	local vertical coordinates

a total velocity or component with respect to air mass

w wind velocity

E rocket engine

REFERENCES

1. Anonymous, "Guidance, Navigation, and Control System: Flight Control Analysis," Honeywell Document 21602-1.3.3.7.3, Circa December 1970.

2. Ellison, D. E., et al, "USAF Stability and Control Datcom", McDonnell Douglas Corp., Air Force Flight Dynamics Laboratory, 1970.

3. Anonymous, "Study of Automatic and Manual Terminal Guidance and Control Systems for Space Shuttle Vehicles," First through Fifth Monthly Progress Reports to NASA ARC under Contract NASA2-5804 by Sperry Flight Systems Division; April, May, --- 10 August 1970.

4. Smith, Herbert E., Jr., and Walter, Parry M., "Project Apollo Manned Simulation of a Straight Wing Orbiter Unpowered Approach and Landing", MSC-IN-EG-70-34, NASA MSC, 30 September 1970.

5. Vaughan, William W., "Interlevel and Intralevel Correlations of Wind Components for Six Geographical Locations," NASA TN D-561, December 1960.

6. Skelton, G. B., et al., "Final Technical Report: Design of a Load-Relief Control System," Honeywell report 12013 FR1 for NASA MSFC, Contract NAS8-20155, St. Paul, Minnesota, 9 May 1966.

7. Harvey, C. A., et al., "Application of Optimal Control Theory to Launch Vehicles," Honeywell report 12073-FR1 for NASA MSFC Contract NAS8-21063, 1968.

8. Harris, Robert D., "Analysis and Design of Space Vehicle Flight Control Systems, Volume XIV -- Load Relief," NASA CR-833, August 1967.

9. Edinger, L. D., "Saturn V/Voyager Load Relief Study," NASA CR-61956, March 1968.

10. Anon., "NAS8-25181 Reference Data Package," supplied by MSFC.

11. Etheridge, Orval, "Preliminary Reference Trajectories of the MSFC In-house Space Shuttle," MSFC S and E-Aero-GT-5-70, February 4, 1970.

12. Hoernor, S. F., Fluid-Dynamic Drag, published by the author, 1965.

13. Staff of NASA Flight Research Center, "Preliminary Flying Qualities Specifications for Space Shuttle Vehicles," January 28, 1970.

14. Stein, G. and A. H. Henke, "A Design Procedure and Handling-Quality Criteria for Lateral-Directional Flight Control Systems," AFFDL-TR-70-152, October 1970.

15. Anon, "Study of Automatic and Manual Terminal Guidance and Control Systems for Space Shuttle Vehicles," First through Eighth Monthly Progress Reports to NASA ARC under Contract NASA2-5804 by Sperry Flight Systems Division; April, May, ---, 10 November 1970.

16. Schofield, B. L., Richardson, D. F., and Hoag, P. C., "Terminal Area Energy Management, Approach and Landing Investigation for Maneuvering Reentry Vehicles Using F-111A and NB-52B Aircraft," Technology Doc. No. 70-2, Air Force Flight Test Center, June 1970.

17. Smith, Herbert E., Jr., and Walter, Parry M., "Project Apollo Manned Simulation of a Straight Wing Orbiter Unpowered Approach and Landing", MSC-IN-EG-70-34, NASA MSC, 30 September 1970.

18. McAnnally, R.C., "Preliminary Reference Trajectories of the MSFC Inhouse Space Shuttle," MSFC, February 4, 1970.

19. Thelander, J.A., FDL-TDR-64-70, "Aircraft Motion Analysis," March 1965 (AD617 354)

20. Nelson, F.R., Koerner, W., and Trudel, R.E., BUAER Report AE-61-4II, Dynamics of the Airframe, September 1952.

21. Edinger, L.D., Hughes, T.W., and Pluimer, M.J., "Data Base Report for Saturn/Voyager Load Relief Study," NASA MSFC Contract NAS8-21171, 30 January 1968.

22. Rheinfurth, Mario H., "Control-Feedback Stability Analysis," Report No. DA-TR-2-60, Army Ballistic Agency, Redstone Arsenal, Alabama, January 11, 1960; AD 232447.

23. Miles, John W., The Potential Theory of Unsteady Supersonic Flow, Cambridge University Press, 1959.

24. Thomson, William Tyrrell, Introduction to Space Dynamics, John Wiley and Sons, Inc., 1962.

25. Anon., "NAS8-25181, Reference Data Package," supplied by MSFC.

26. Anon., "Simplified Flight Loads Analysis Program," Boeing publication circulation 1964.

27. Space Shuttle Aerodynamics Group, "NR Space Shuttle Program Aerodynamics Design Data Book: Volume 1, Straight-Wing Orbiter," Report 2. 1. 5-13000-00, SD 70-414, Space Division, North American Rockwell, August 1970.

28. Graham, K. D., "Kinematic Model for Fire Control," MR10757, August 7, 1969.

29. Sokolosky, O. M., "SSV Aerodynamic Rotary Derivatives for the Delta Wing Orbiter (Aero Design Data Book II-DB 2. 1. 5-13000-10)," NAR, August 31, 1970.

30. Ehlers, H. L., "Aero Data for 134D Vehicle."

31. Anon., "Aileron Effectiveness in Roll," NAR 11 August 1970.

32. Wyllie, C., "Unpowered Orbiter Touchdown State Limits," Honeywell Internal Memorandum, 29 January 1971

NASA-Langley, 1971 —— 31