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Response of the Alliance 1 Proof-of-Concept Airplane Under Gust Loads

A. S. Naser, A. S. Pototzky, and C. V. Spain
Lockheed Martin Engineering and Sciences Company, Hampton, Virginia

March 2001

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ABSTRACT

This report presents work performed in support of NASA's Environmental Research Aircraft and Sensor Technology (ERAST) program. The primary purpose of this work was to develop and demonstrate a gust analysis method that accounts for the span-wise variation of gust velocity on unmanned aircraft characterized by high aspect ratios, low wing loading, high flexibility, and low airspeeds. The main focus of the work was therefore to perform a two-dimensional Power Spectrum Density (PSD) analysis of the Alliance 1 Proof-of-Concept Unmanned Aircraft. Suitable structural and aeroelastic Finite Element Models (FEM) were developed. One- and two-dimensional PSD gust analyses of the Alliance 1 were performed. For further validation and comparison, a two-dimensional PSD gust analysis was performed on a simple example problem, and a one-dimensional discrete gust analysis was performed on the Alliance 1. This report describes this process, shows the relevant comparisons between analytical methods, and discusses the physical meanings of the results.

INTRODUCTION

This report presents the work performed by Lockheed Martin's Langley Program Office in support of NASA's Environmental Research Aircraft and Sensor Technology (ERAST) program. The primary purpose of this work was to develop and demonstrate a gust analysis method that accounts for the span-wise variation of gust velocity. The evaluation of span-wise variation of gust velocity is important for these unmanned ERAST aircraft because they are characterized by high aspect ratios and low wing loading, are very flexible, and fly at low airspeeds. In the past, the gust response of these aircraft has been mainly investigated using the Pratt-Walker formula[1] that is derived from a discrete gust approach. However, the Pratt-Walker formula does not capture the effects of structural flexibility and the span-wise variation of gust velocity. The main focus of the work was therefore to perform a two-dimensional Power Spectrum Density (PSD) analysis of the Alliance 1 Proof-of-Concept Unmanned Aircraft. As of this writing, none of the aircraft described in this report have been constructed. They are concepts represented by analytical models.

The process first involved the development of suitable structural and aeroelastic Finite Element Models (FEM). This was followed by development of a one-dimensional PSD gust analysis, and then the two-dimensional PSD analysis of the Alliance 1. For further validation and comparison, two additional analyses were performed. A two-dimensional PSD gust analysis was performed on a simple MSC/NASTRAN[2] example problem. This served as a basis for comparison because an independent two-dimensional analysis had previously been performed on this analytical model. Finally, a one-dimensional discrete gust analysis was performed on the Alliance 1. This report describes this process, shows the relevant comparisons between analytical methods, and discusses the physical meanings of the results and comparisons.

1 FINITE ELEMENT MODELS OF THE ALLIANCE 1 PROOF-OF-CONCEPT UNMANNED AIRCRAFT STRUCTURE

1.1 Introduction

The Alliance 1 structural FEM used in this work was derived from a semi-span FEM originally developed by Scaled Composites Inc[3]. The Scaled Composites' FEM contained chord-wise grids on the lifting surfaces that were joined to the elastic axis grids by very stiff beam elements. By replacing the stiff beams with MSC/NASTRAN[4] rigid elements, the number of degrees-of-freedom was substantially reduced. In addition, the chord-wise incidence angle of the wing was eliminated as it was not needed for the linear aeroelastic model. Consequently, the plane of wing grid points has dihedral angle but no angle of incidence. On the horizontal and vertical tails, additional grids were introduced at 80% chord along the full span of these surfaces to represent the hinge lines of the control surfaces. The new semi-span model was compared to the Scaled Composites' FEM by checking the mass properties, natural frequencies, and mode shapes, which all matched. Later, in the gust analyses, the mass was changed to represent a desired fuel condition.

Figure 1.1 shows the resulting MSC/NASTRAN semi-span model which was used in the one-dimensional PSD gust analysis. A corresponding full-span model possessing identical stiffness and mass properties was used in the two-dimensional PSD gust analysis. The FEM input files are included in the appendices and are referred to as appropriate throughout the report.

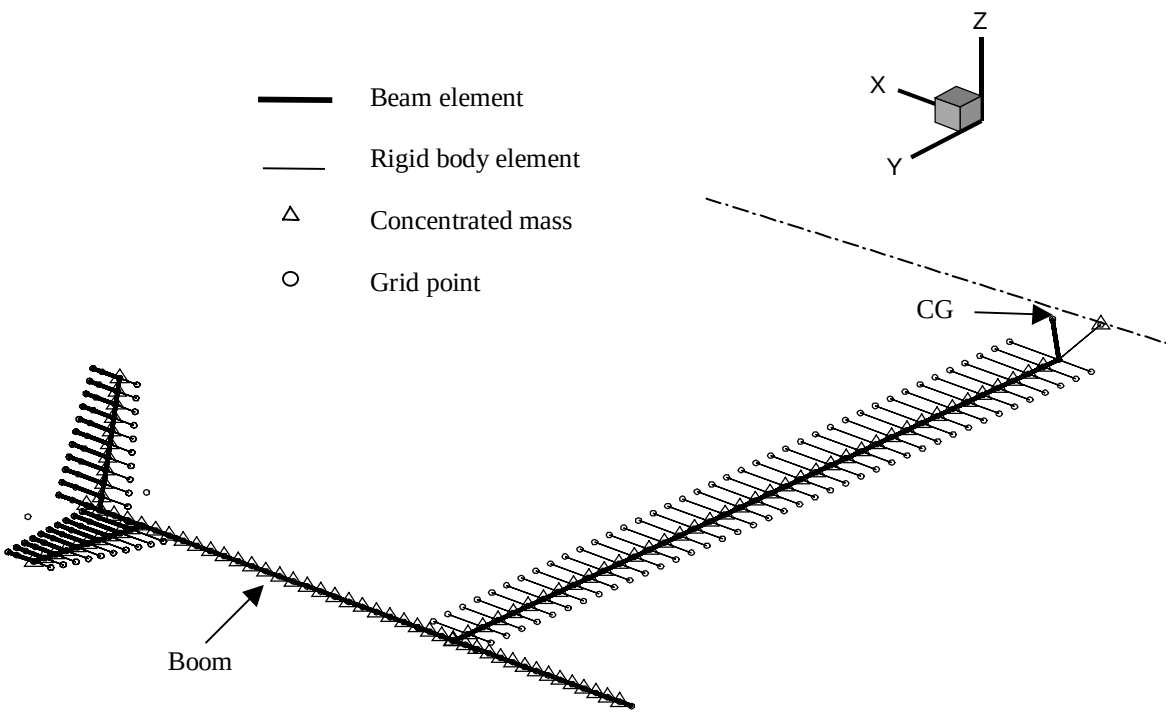


Figure 1.1: Semi-span structural FEM of the Alliance 1 Aircraft showing beam elements, rigid body elements, grid points and concentrated masses.

The stiffness properties are contained in beam elements (heavy lines in Figure 1.1) which run along the elastic axis of the wings, booms, horizontal tails and vertical tails. Very stiff beam elements also connect

the tail elastic axes with grid points at 80% chord and at the trailing edges. All of the model mass is contained in the concentrated masses which are offset from the grids that lie along the elastic axes. Rigid body elements connect the grid points at the leading and trailing edges of the wing, and leading edges of the tails. The purpose of the grids connected to the main structure by the rigid body elements is to provide mode shape displacements so that motion can be splined onto the aerodynamic surfaces.

In order to aid the model verification process, a number of grid points were added to the horizontal and vertical tails. On each tail surface, coincident grids were positioned on the existing grid locations at the leading edge, elastic axis, and trailing edge. However, the displacements of these extra grids are presented in the local tail coordinate systems.

1.2 Aeroelastic Models

As with the structural model, the aeroelastic model started with a semi-span model originally provided by Scaled Composites Inc. In the present work, both semi-span and full-span aeroelastic models were developed, with the full-span containing a left half which is symmetric to the right half, but identical in terms of properties. Following are descriptions of the coordinate systems and aerodynamic paneling for the semi-span aeroelastic model.

1.2.1 Coordinate Systems:

Coordinate systems used for structural modeling and aerodynamic paneling include:

a) Basic coordinate system (coordinate system 0) which is used to define locations of all structural grid points. The origin for this coordinate system is on the fuselage centerline ahead of the airplane with the x-axis directed aft and the y-axis out the right side. The basic coordinate system also serves as a Cartesian aerodynamic coordinate system. Aerodynamic flow is in the positive x direction and the x axis of every aerodynamic element is parallel to the flow.

b) Reference axis system for stability derivatives (coordinate system 12) has its origin at grid 101 on the airplane centerline with x-axis directed forward and z-axis downward.

c) Local coordinate systems which place their (x, y) axes in the plane of the horizontal and vertical tail surfaces (coordinate system 5 for horizontal tail and 6 for the vertical tail).

d) Coordinate systems whose y-axes define the hinge lines of the aerodynamic panels that constitute the control surfaces on the vertical and horizontal tails.

e) Element coordinate systems for aerodynamic macro elements (CAERO1 entry of Reference 1) which govern the sequence numbering of the doublet lattice aerodynamic boxes. There are a total of 6 coordinate systems of this type, with two on the right-side wing (origins at grids 101 and 118), two on the non-movable sections of the horizontal and vertical tails (with origins at grids 1301 and 1411 respectively), and two on the control surfaces of the horizontal and vertical tails (grids 2501 and 2611 respectively).

1.3 Aerodynamic Paneling

Figure 1.2 shows the structural grids and aerodynamic panels used in the semi-span model. The main wing was divided into inboard and outboard panels, with the break occurring at a span station of 223.5

inches. The horizontal and vertical tails each are modeled with two panel elements. In both cases, the first panel extends from the leading edge of the lifting surface up to the hinge line, and the second panel continues from the hinge line to the surface trailing edge.

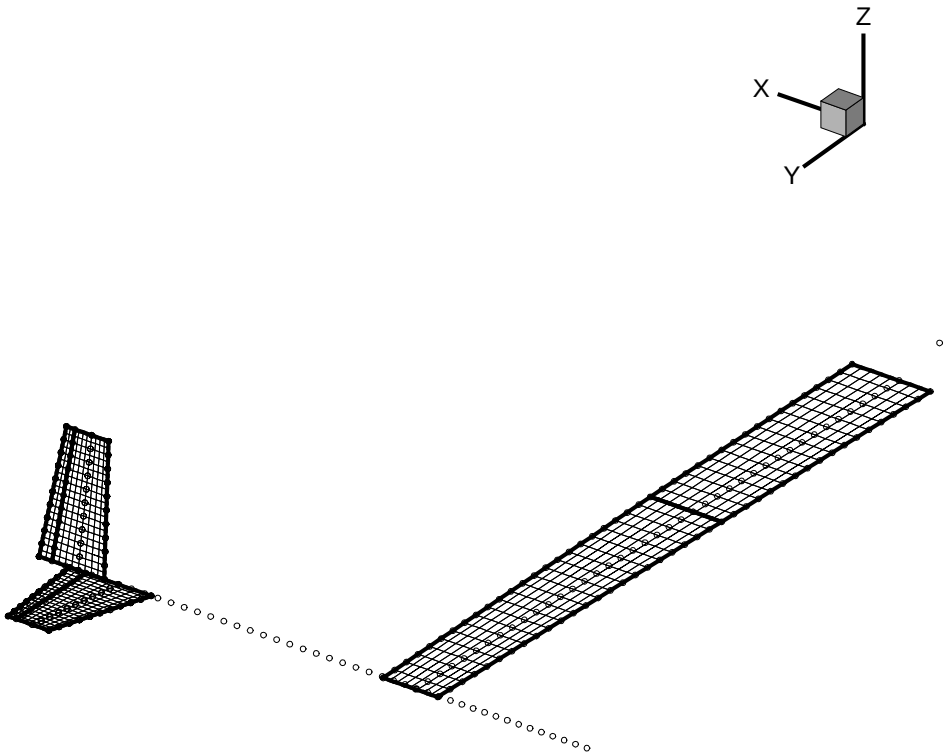


Figure 1.2: Semi-span aeroelastic FEM showing structural grids and aerodynamic panels and boxes.

Figure 1.3 gives an overview of the full-span aerodynamic model, and Figure 1.4 shows the aerodynamic box number pattern. The inboard wing panels have 8 chord-wise boxes and 17 span-wise boxes, while the outboard wing panels have 8 chord-wise boxes and 23 span-wise boxes. The panel box identification labels begin with 10001 for the right inboard wing and 20001 for the right outboard wing and so on. For the right side horizontal tail, the first panel begins at the leading edge and has 8 chord-wise boxes up to the hinge line of the control surface at 80% chord. The box labels begin with label 30001. The control surface aerodynamic panel has 2 chord-wise boxes and begins with label 31001. Both horizontal tail aerodynamic panels have 20 span-wise boxes. On the right side vertical tail box 40001 begins at the tip leading edge and extends to the 80% chord hinge line. This panel has 8 chord-wise boxes and 20 span-wise boxes. The panel extending from the hinge line to the trailing edge has 2 chord-wise boxes, 20 span-wise boxes and begins with label 41001. The left side aerodynamic panels and boxes have a similar numbering scheme as shown in the figure.

The modal displacements of aerodynamic boxes are related to displacements of the structural grids by a surface splining technique. Doublet Lattice aerodynamic modeling does not allow for angle of incidence, camber or twist in lifting surface panel definition. Therefore, the present model does not include such geometry. While these effects are disregarded in lifting surface flutter methods, they could, in the real world, affect aeroelastic trim and gust loading.

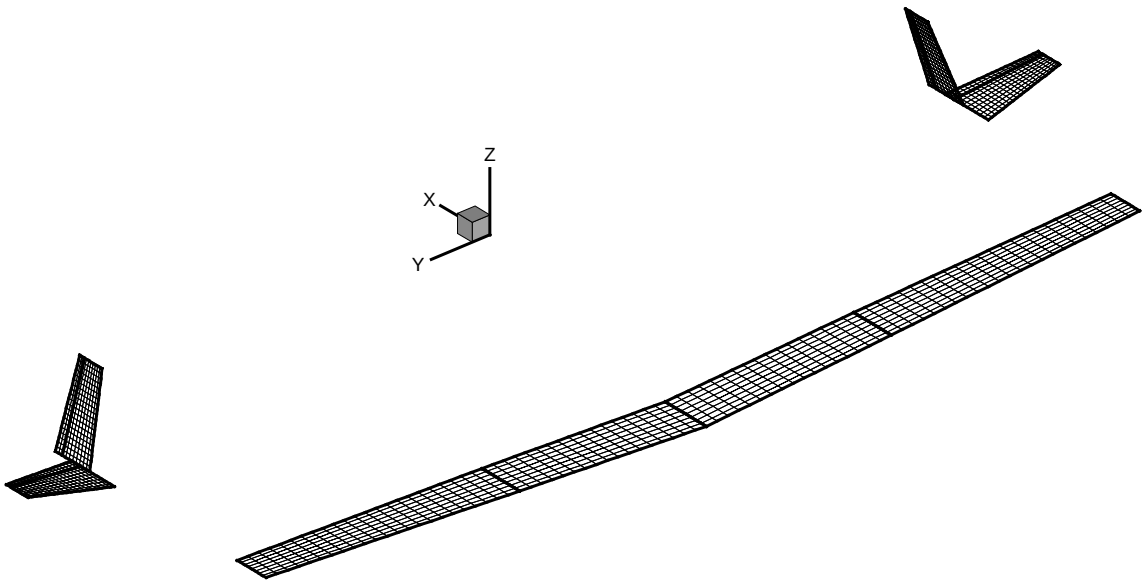


Figure 1.3: Overview of full-span aerodynamic model.

1.4 Verification of Semi-Span Aeroelastic Model

In order to demonstrate that the model was well conditioned and that it would be free from flutter at conditions of interest for gust analysis, trim and flutter analyses were conducted as described further below. Appendix A contains the input FEM file for trim, and Appendix B for flutter. Table 1-1 gives the weight, center of gravity (CG) location, and first 10 symmetric modal frequencies for the semi-span model used in the verification process. Symmetric modal frequencies (for the semi-span model) were produced by applying symmetric boundary conditions at the wing root.

A flutter solution was obtained using the PK method. The input conditions were at Mach 0.0, sea-level, velocity variation from 176 in./sec. to 7040 in./sec., and use of the 10 lowest-frequency symmetric modes. Inspection of the aerodynamic panel displacements in the rigid body pitch mode confirmed proper surface spline interpolation from the structural to the aerodynamic grid points. The model is flutter free for the configuration and conditions analyzed. The MSC/NASTRAN output file containing detailed modal data and flutter results can be produced by the input file in Appendix B. The differential pressure coefficient for the right wing and right horizontal tail at trim conditions are shown in figures 1.5 and 1.6, respectively.

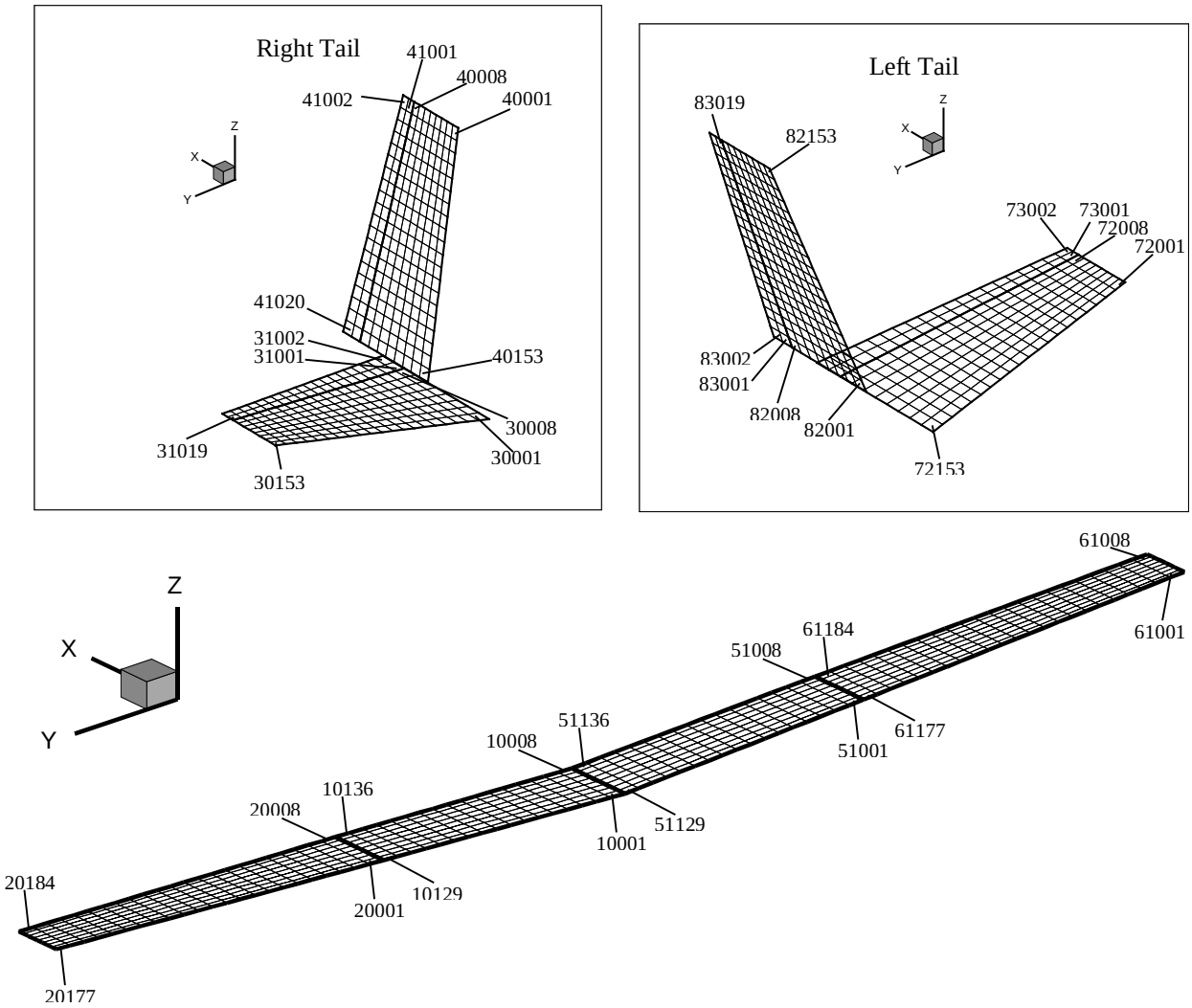


Figure 1.4: Full-span aerodynamic FEM showing aerodynamic panels and box number pattern.

Table 1-1: Summary of weight, CG and frequencies for verification model.

Weight	X-CG	Y-CG	Z-CG
1255 lb.	160.366 in.	219.461 in.	74.855 in
Frequencies (Hertz)			
0.38			
0.81			
1.19			
1.77			
2.18			
3.94			
5.29			

Note: CG is with respect to the origin of basic coordinate system. Inertias are with respect to CG.

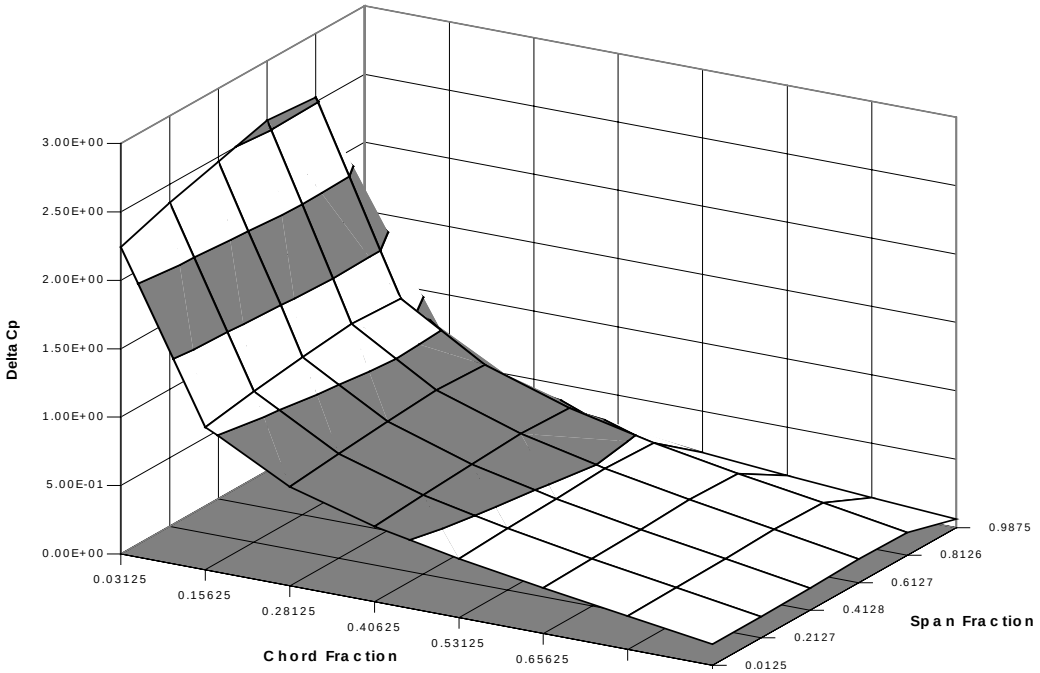


Figure 1.5: Differential pressure coefficients for the right wing at trim condition.

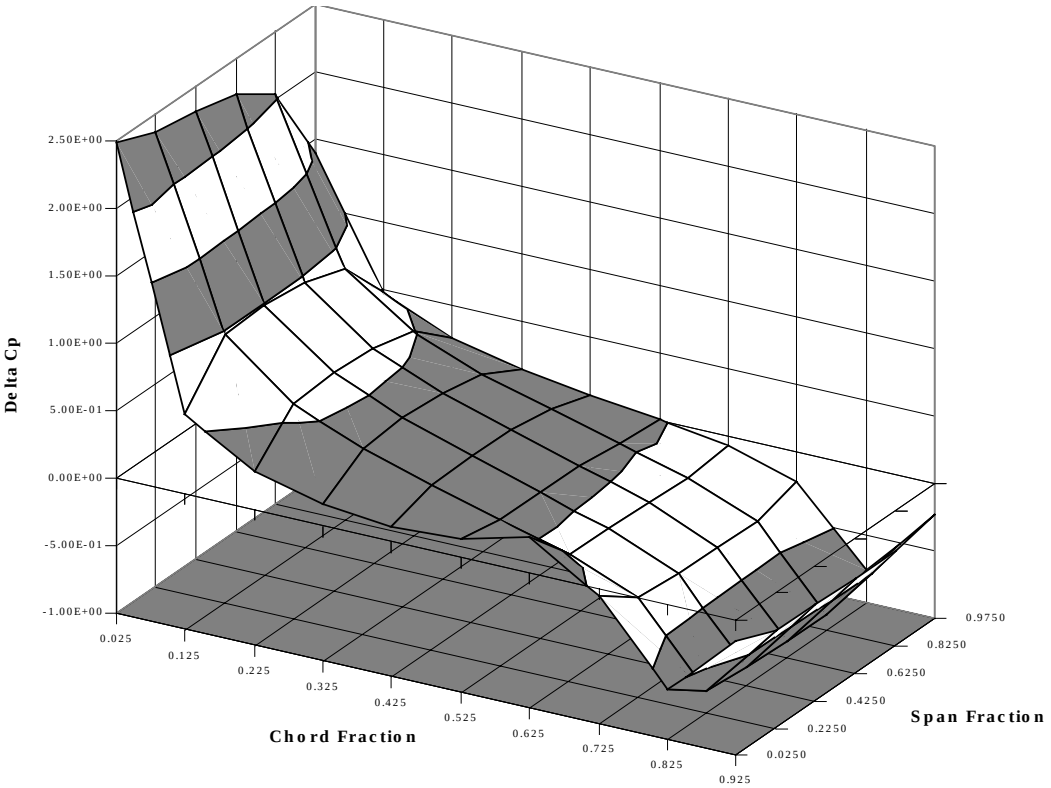


Figure 1.6: Differential pressure coefficients for the right horizontal tail at trim condition.

2 ONE-DIMENSIONAL VON KARMAN PSD GUST ANALYSIS

The purpose of this phase of the work was to perform dynamic analysis of the semi-span Alliance 1 aircraft subjected to a one-dimensional random gust load. The power spectral density (PSD) of the gust load is represented by the von Karman model[5]. The finite element program MSC/NASTRAN[4] was used for the entire analysis. The input data requirements were generated for a single set of flight conditions. Symmetry conditions were imposed on grid points located on the plane of symmetry and 32 normal modes spanning a frequency band up to 60 Hertz were included in the analysis. PSD of different response quantities such as accelerations, moments and torques at critical grid points of the structures are generated and plotted for a range of frequencies that covers the elastic modes of vibration. The semi-span finite element model is shown in Figure 2.1 with some of the critical grid points labeled for identification. Appendix C contains the complete MSC/NASTRAN data deck.

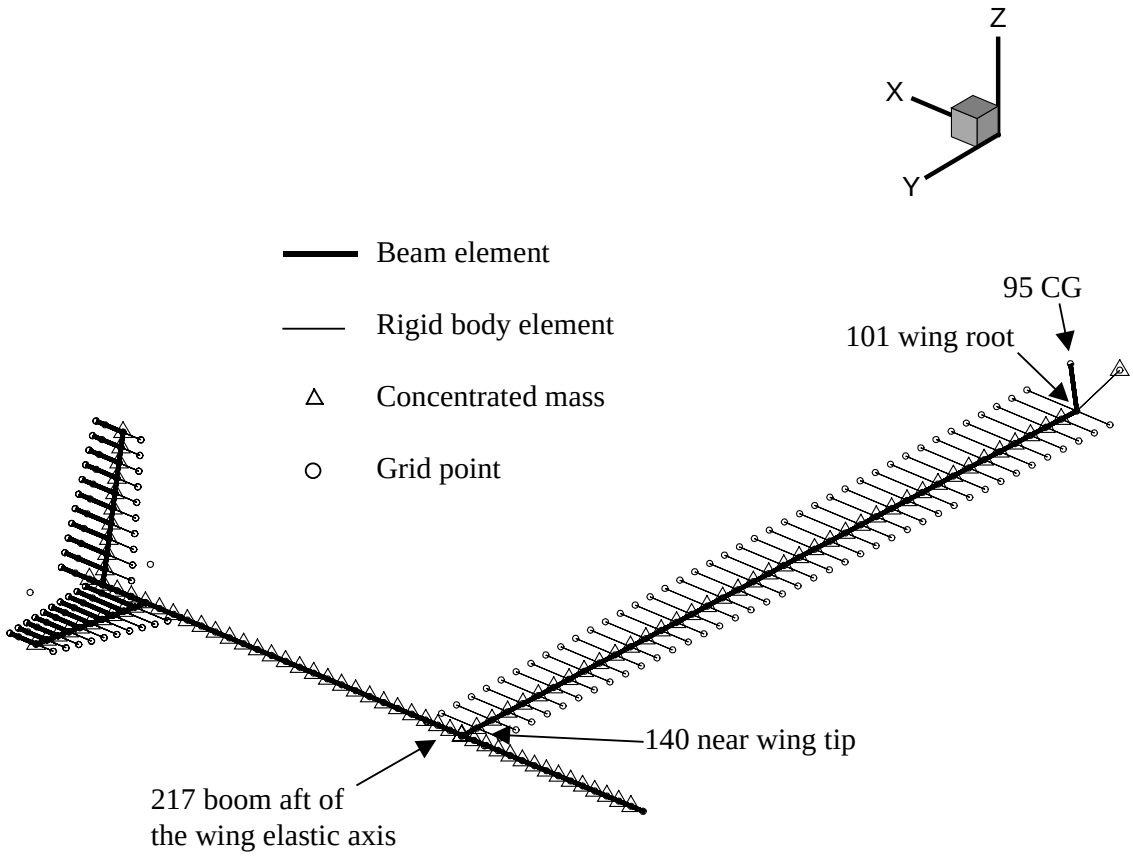


Figure 2.1: Semi-span structural FEM of the Alliance 1 Aircraft showing critical grid points.

2.1 Flight Conditions

The MSC NASTRAN Finite-Element model of the aeroelastic semi-span Alliance 1 Proof of Concept aircraft model was described in Section 1. Data records required to support a random dynamic loads analysis using the von Karman gust spectrum[5] were inserted into the MSC/NASTRAN Bulk Data deck. Analyses were conducted at the following flight conditions:

Altitude:	1000.0 ft
True Air Speed:	98.3 ft/sec
Dynamic pressure:	0.077444 psi
Mach Number:	0.09
Fuel Loading Condition:	333.9 lb. (total full model fuel weight)

2.2 Response Quantities Investigated

The PSD of the loads and accelerations at different grid points of interest were investigated. Loads were calculated at grid points 101(wing root), 140 (on the wing elastic axis near the tail boom), and 217 (on the tail boom just aft the wing elastic axis). The loads investigated are:

- Plane 1 bending moment, M1, which is the moment about the element's vertical axis (wing or boom in-plane bending moment).
- Plane 2 bending moment, M2, which is the moment about the element's horizontal axis (vertical bending moment).
- Plane 1 shear force, V1, which is the web shear force in the direction of the element's horizontal axis (in-plane shear).
- Plane 2 shear force, V2, which is the web shear force in the direction of element's vertical axis (vertical shear).
- Total web torque T.

The PSDs of accelerations were calculated at grid points 95 (the center of gravity of the corresponding full airplane), 140, and 217. The accelerations investigated are:

- Transnational acceleration in the global x-direction, A1, which is in the direction of the flow.
- Transnational acceleration in the global z-direction, A2, which is in the vertical direction.
- Rotational acceleration about the span-wise axis, A5, which is the pitching acceleration.

2.3 MSC/NASTRAN Input and Output

The desired total fuel weight was entered into the data deck distributed among 7 grid points. A normal modes analysis (Solution 103) was performed to obtain the new weight and center-of-gravity (CG) location and to determine the number of modes within a frequency band of 60 Hertz for symmetric boundary conditions on the vehicle centerline. The imposed boundary conditions permit vehicle fore-and-aft motion, vertical translation, and pitch rotation for the plane-of-symmetry grids. Since one of the desired output quantities is the acceleration at the center of gravity of the airplane (CG), an additional grid point was added to the model at the new CG position. This grid was given the identification label of 95 and connected to Grid 101 on the vehicle centerline with a relatively stiff beam element (see Figure 2.1).

The von Karman PSD of the gust is defined on the TABRNDG Bulk data deck input record. User input requirements were:

L (Scale of turbulence):	1000.0 ft
WG (Root-mean-square gust velocity):	1.0 in/sec

Additional input cards required to support the analysis were:

DAREA	Defines scale factors for dynamic loads set
FREQ1	Defines frequencies used in solution of frequency response problems
GUST	Defines a stationary vertical gust
RANDPS	Defines load set PSD factors
RLOAD1	Defines form of the frequency-dependent dynamic load
TABLED1	Defines frequency band for generation of dynamic loads
PARAM	inputs required included:
LMODE	Specifies the number of lowest normal mode to include
MACH	MACH number used to compute aerodynamic matrices
Q	Specifies the dynamic pressure

To obtain a listing of the von Karman spectrum an extra point was defined using the EPOINT Bulk Data entry in conjunction with DMIG. This procedure, which is described in the MSC/NASTRAN Aeroelastic User's Guide[4], positions an extra point into an unused region of the stiffness matrix which provides a way to calculate the spectrum of the input gust. The PSD of the von Karman gust is shown in Figure 2.2. This plot is generated from EPOINT 9990. It is worth mentioning that while the equation in the MSC/NASTRAN Aeroelastic User's Guide[2] for the von Karman equation is incorrect, the actual analysis in the code is correct.

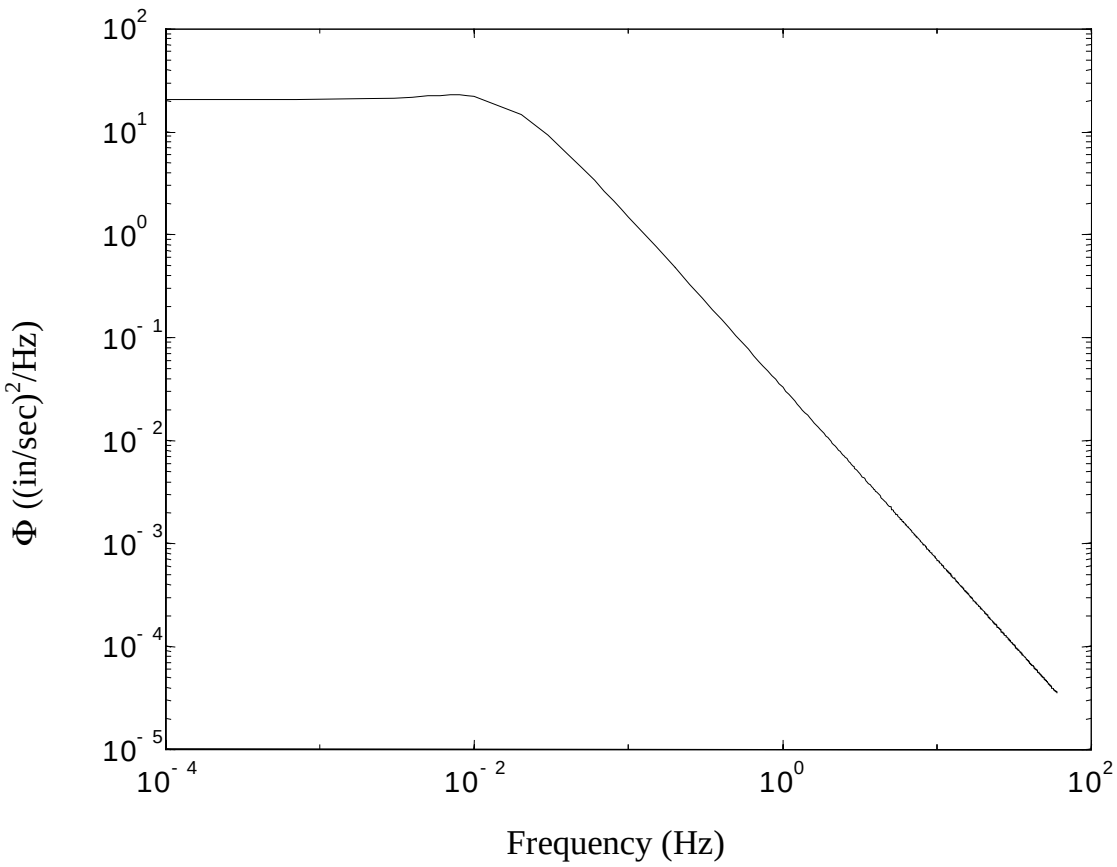


Figure 2.2: Power spectral density function of the von Karman gust.

2.4 Results and Discussion of the One-Dimensional Analysis

A summery of the weight and the location of the CG of the semi-span model with respect to the basic coordinate system is given in Table 2-1.

Table 2-2 shows the lowest 32 natural frequencies of the structure for a for symmetric boundary conditions on the vehicle plane of symmetry. The first 3 modes are rigid body modes (plunge, pitch, and fore-aft.). The elastic mode shapes are plotted in Figure 2.3.

Table 2-1: Weight summaries for the half-span model with respect to the basic coordinate system.

Weight (lb)	X-C.G. (in)	Y-C.G. (in)	Z-C.G. (in)
1047.7	160.9	207.2	77.1

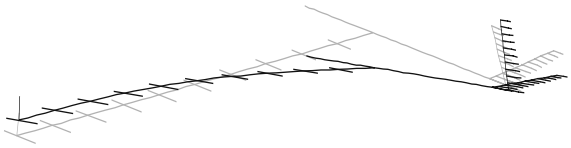
Table 2-2: Natural frequencies of the modes included in the one-dimensional PSD gust analysis.

Mode #	Frequency (Hz)	Mode #	Frequency (Hz)	Mode #	Frequency (Hz)	Mode #	Frequency (Hz)
1	0.000	9	4.117	17	15.340	25	38.740
2	0.000	10	6.115	18	16.717	26	40.058
3	0.000	11	6.749	19	21.315	27	43.874
4	0.380	12	8.314	20	23.917	28	44.948
5	0.813	13	9.271	21	26.451	29	50.464
6	1.290	14	10.870	22	31.500	30	51.756
7	2.036	15	12.840	23	31.927	31	55.838
8	2.201	16	14.599	24	36.936	32	59.570

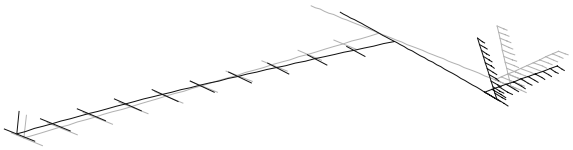
The excitation frequencies used in the frequency response solution ranged from 0.001 Hz to 60.0 Hz in three bands specified on FREQ1 data records. Figure 2.2 shows the Power Spectral Density of the von Karman gust over this total frequency band.

PSD of the bending moment in the vertical plane, M_1, for grid point 101 is plotted in Figure 2.4. PSD of M_2, V_1, V_2, and T for the same grid point are shown in Figure 2.5-Figure 2.8, respectively. The largest response for bending moment, M_2, occurs at a frequency of about 0.4 Hz, which is the frequency of the first bending mode. A smaller peak of M_2 response occurs at a frequency of 2 Hz. It can be seen from figure 6 that this frequency is the natural frequency of the second bending mode of the wing. Higher modes do not appear to influence the bending moment response. Moment M_1 has a large and sharp peak at about 2 Hz with multiple smaller peaks at lower frequencies. The PSD of the torque at this point has peaks at 0.8 Hz and 1.3 Hz, which are the natural frequencies of the first two torsional modes of the wing.

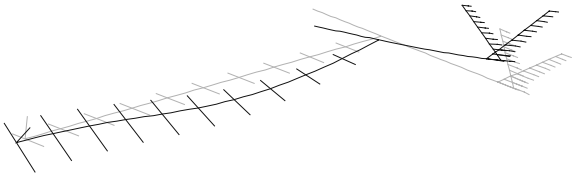
Results similar to Figure 2.5-Figure 2.8 are shown in Figure 2.9-Figure 2.13 for grid point 140. Results are also shown in Figure 2.14-Figure 2.18 for grid point 217. The peaks of the different loads for each of the points studied vary depending on the location and type of quantity studied.



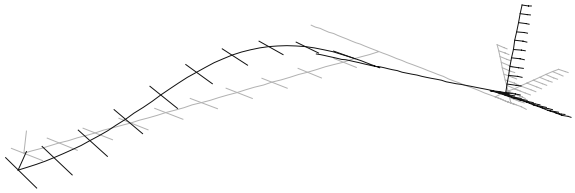
Mode shape no. 4 at 0.380 Hz



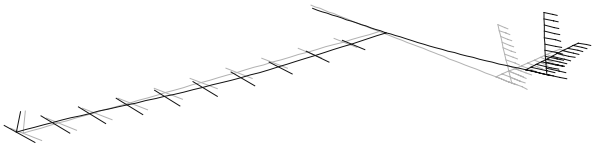
Mode shape no. 5 at 0.813 Hz



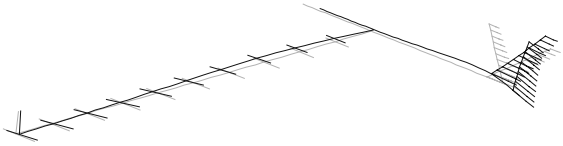
Mode shape no. 6 at 1.290 Hz



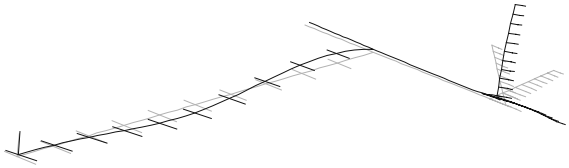
Mode shape no. 7 at 2.036 Hz



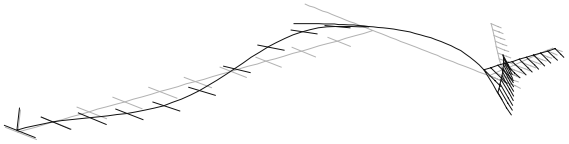
Mode shape no. 8 at 2.201 Hz



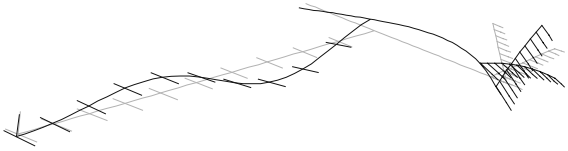
Mode shape no. 9 at 4.117 Hz



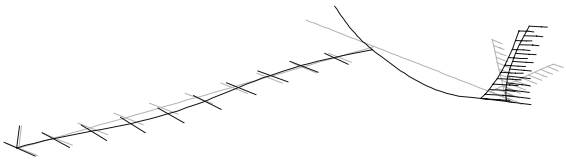
Mode shape no. 10 at 6.115 Hz



Mode shape no. 11 at 6.749 Hz

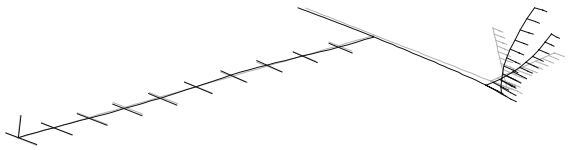


Mode shape no. 12 at 8.314 Hz

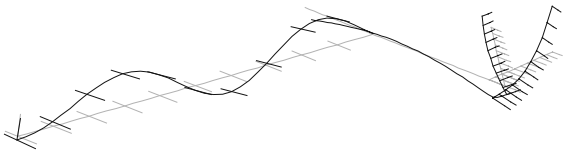


Mode shape no. 13 at 9.271 Hz

Figure 2.3: Flexible mode shapes for one-dimensional gust analysis.

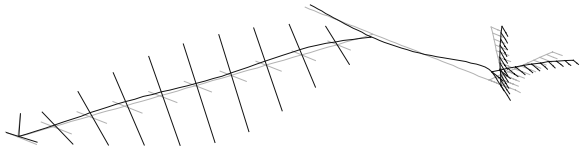


Mode shape no. 14 at 10.870 Hz

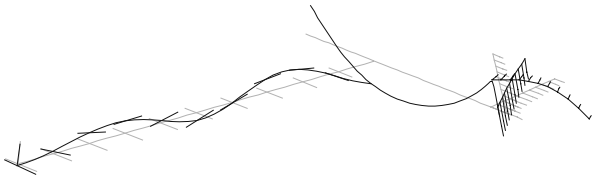


Mode shape no. 15 at 12.840Hz

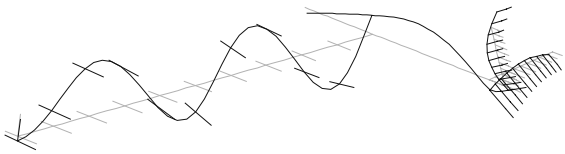
Mode shape no. 16 at 14.599 Hz



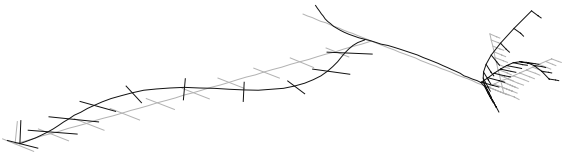
Mode shape no. 17 at 15.340 Hz



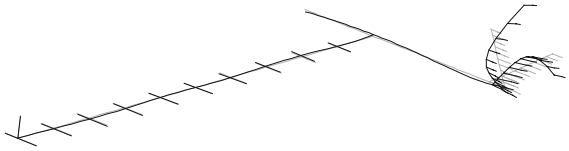
Mode shape no. 18 at 16.717 Hz



Mode shape no. 19 at 21.315 Hz

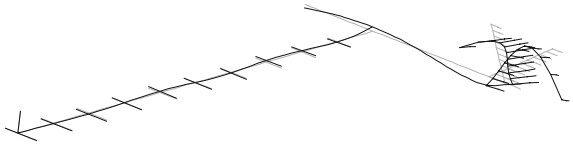


Mode shape no. 20 at 23.917 Hz



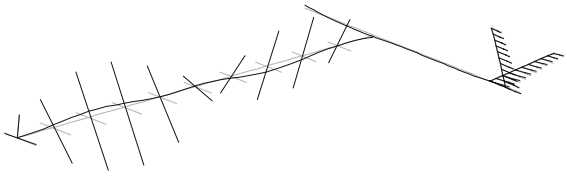
Mode shape no. 21 at 26.451 Hz

Mode shape no. 22 at 31.500 Hz



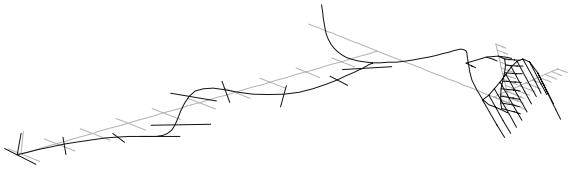
Mode shape no. 23 at 31.927 Hz

Figure 2.3: Flexible mode shapes for one-dimensional gust analysis (continued).

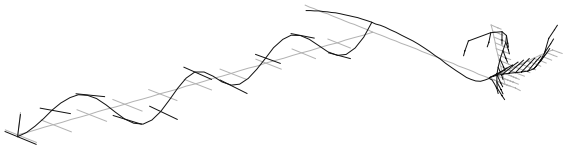


Mode shape no. 24 at 36.936 Hz

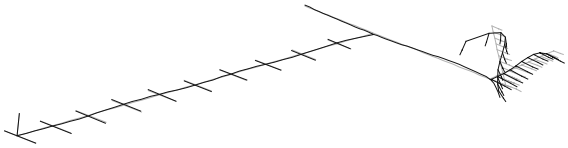
Mode shape no. 25 at 38.740 Hz



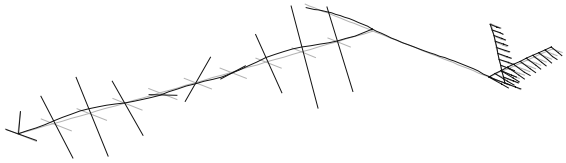
Mode shape no. 26 at 40.058 Hz



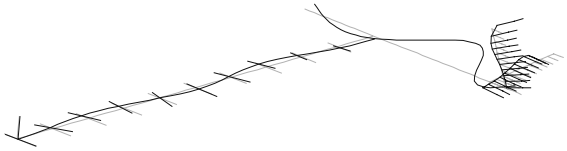
Mode shape no. 27 at 43.874 Hz



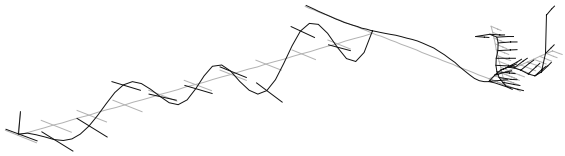
Mode shape no. 28 at 44.948 Hz



Mode shape no. 29 at 50.464 Hz



Mode shape no. 30 at 51.756 Hz



Mode shape no. 31 at 55.838 Hz

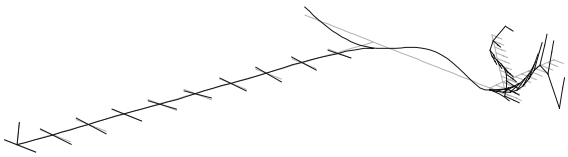


Figure 31: Mode shape no. 32 at 59.570 Hz

Figure 2.3: Flexible mode shapes for one-dimensional gust analysis (concluded).

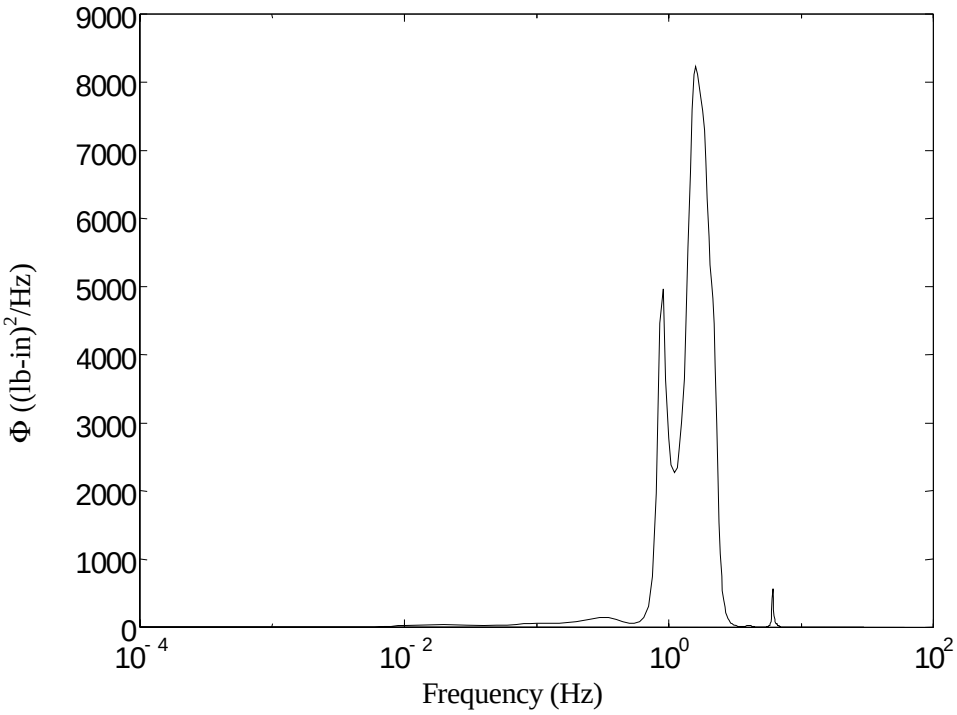


Figure 2.4: Power spectral density of M_1 at grid point 101.

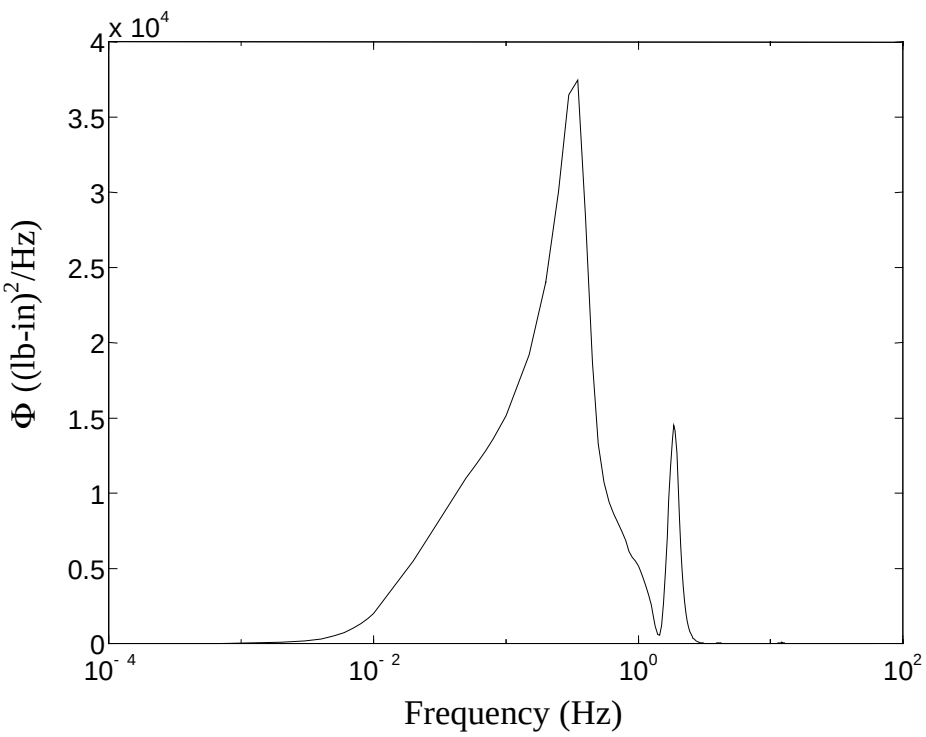


Figure 2.5: Power spectral density of M_2 at grid point 101.

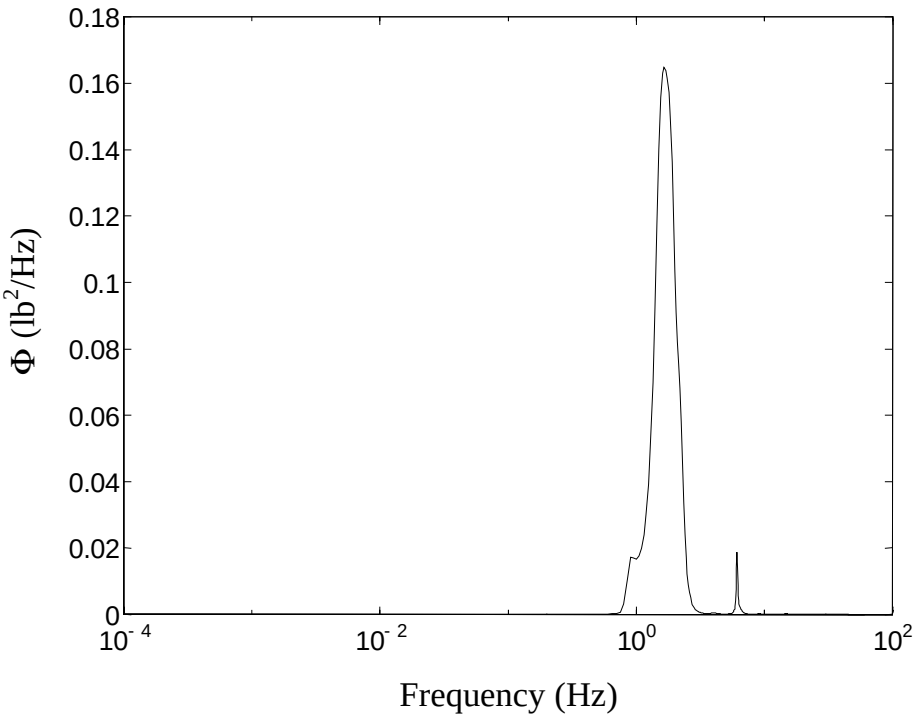


Figure 2.6: Power spectral density of V_1 at grid point 101.

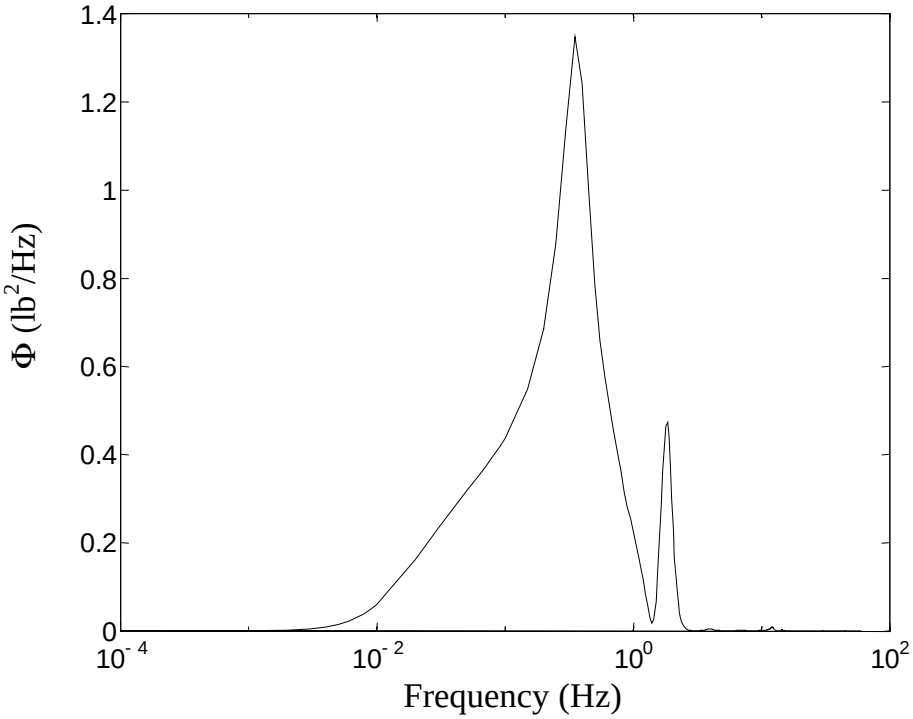


Figure 2.7: Power spectral density of V_2 at grid point 101.

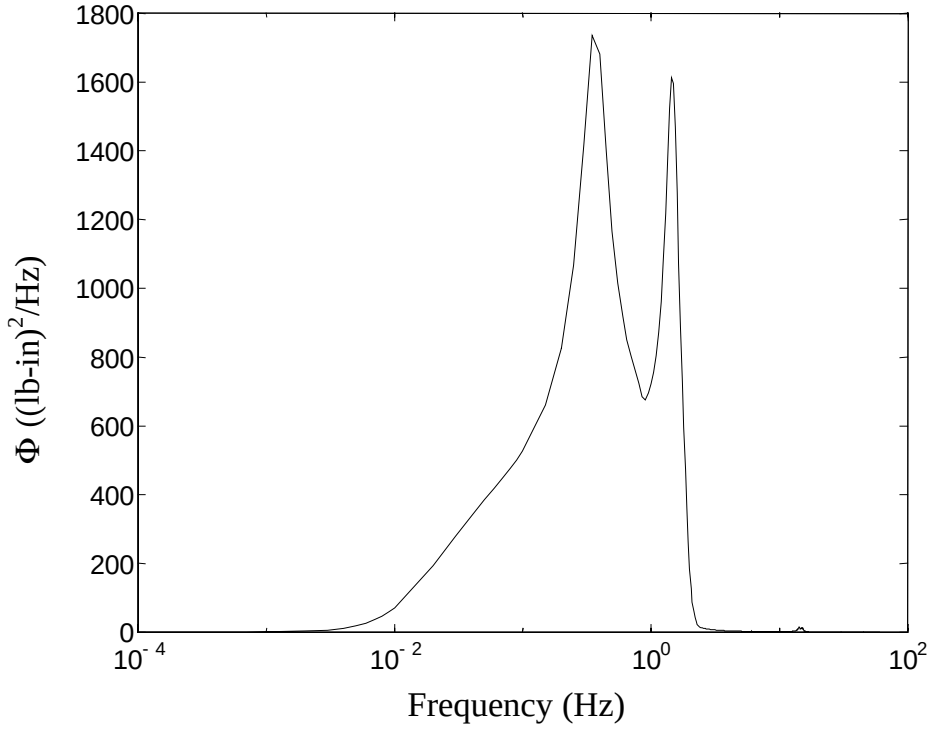


Figure 2.8: Power spectral density of T at grid point 101

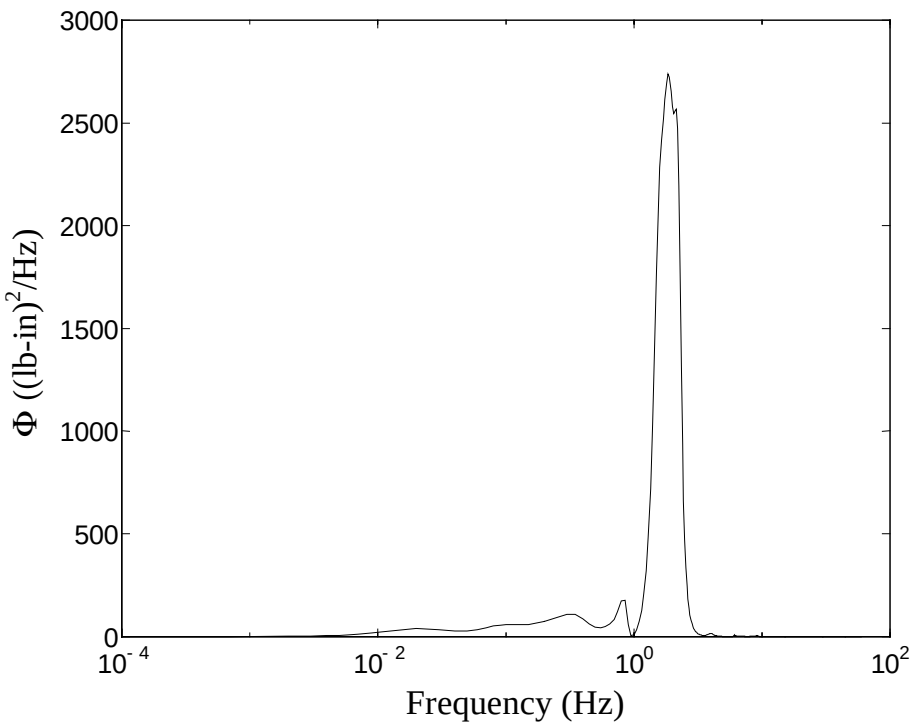


Figure 2.9: Power spectral density of M_1 at grid point 140.

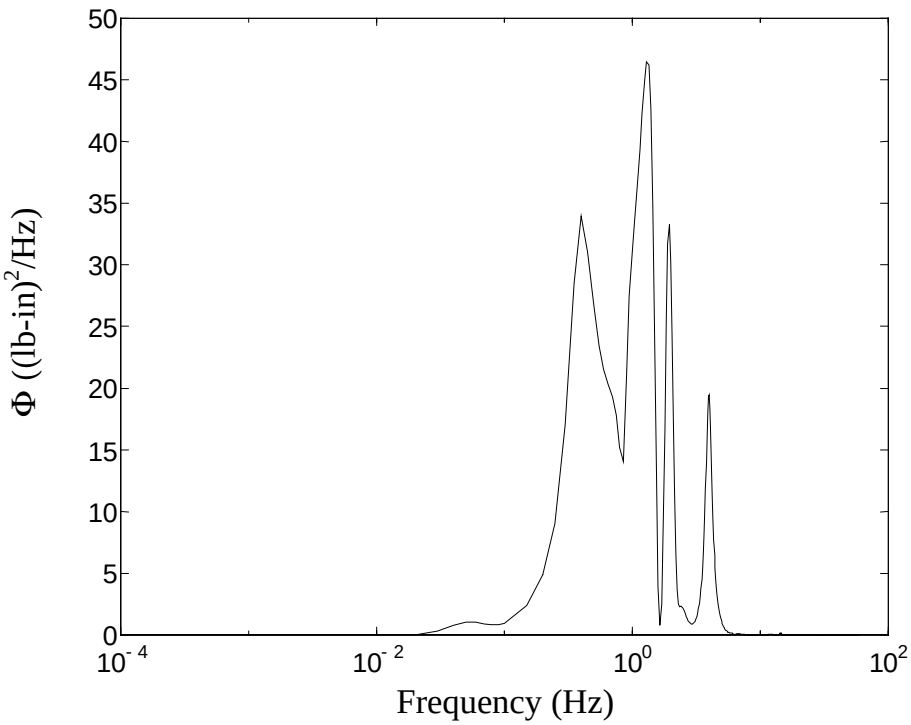


Figure 2.10: Power spectral density of M_2 at grid point 140.

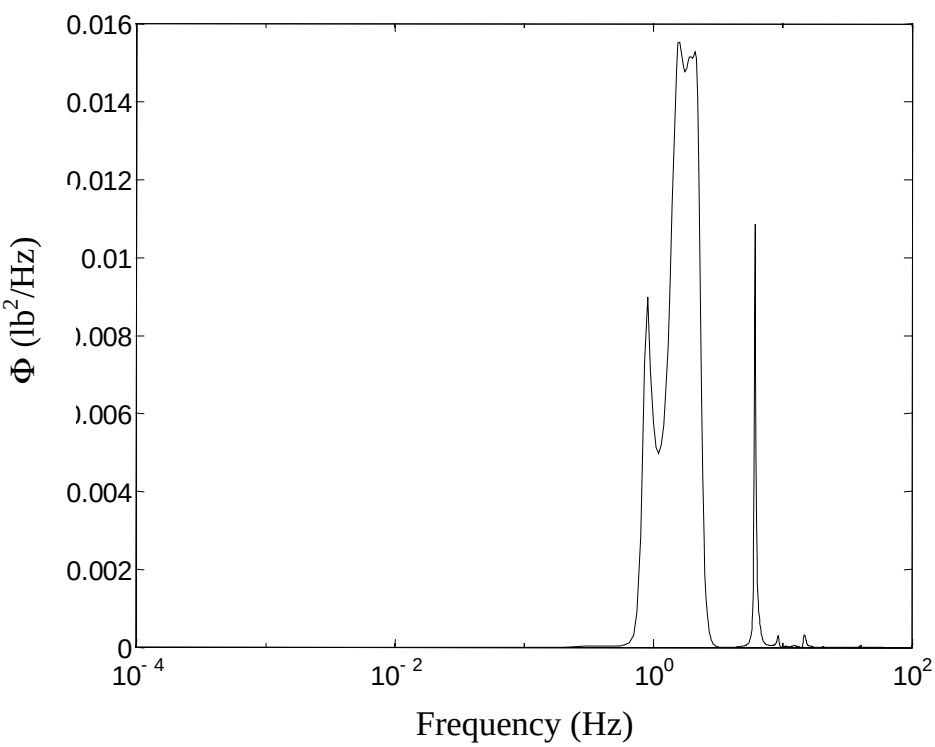


Figure 2.11: Power spectral density of V_1 at grid point 140.

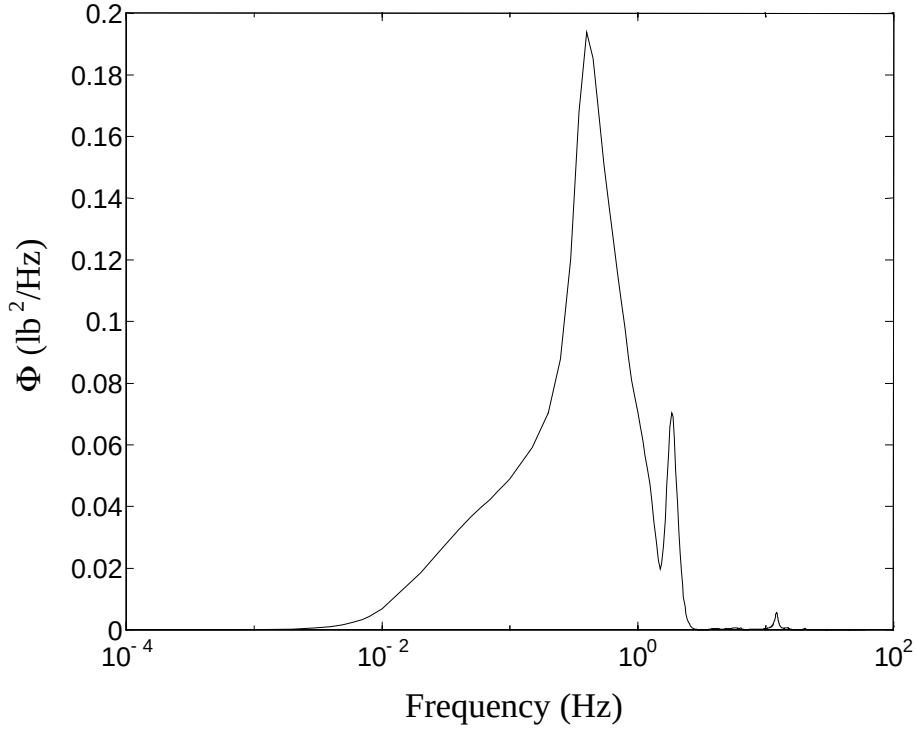


Figure 2.12: Power spectral density of V_2 at grid point 140.

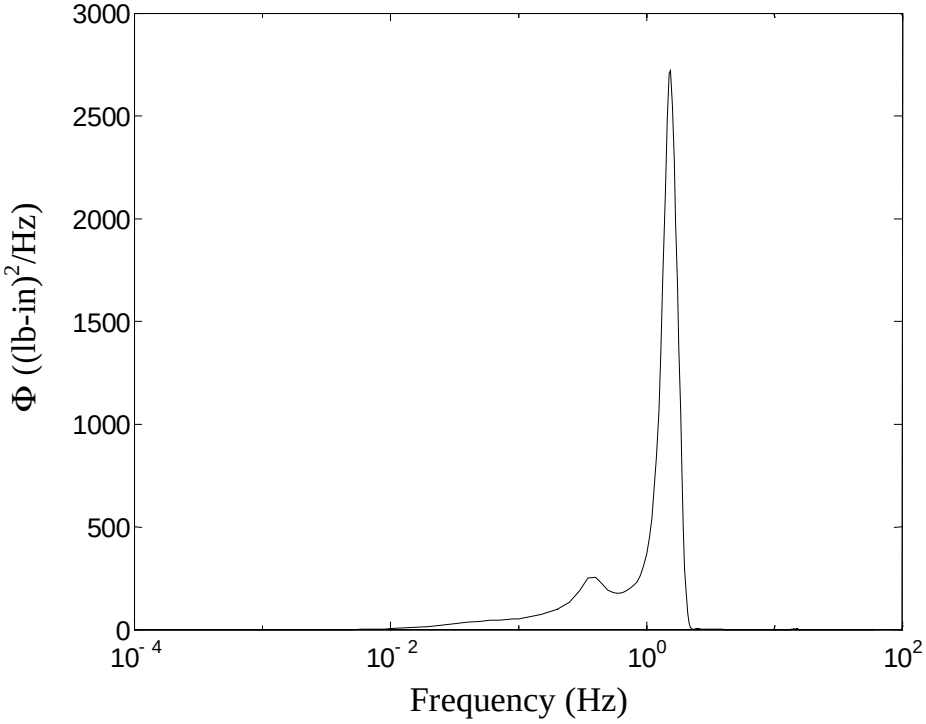


Figure 2.13: Power spectral density of T at grid point 140.

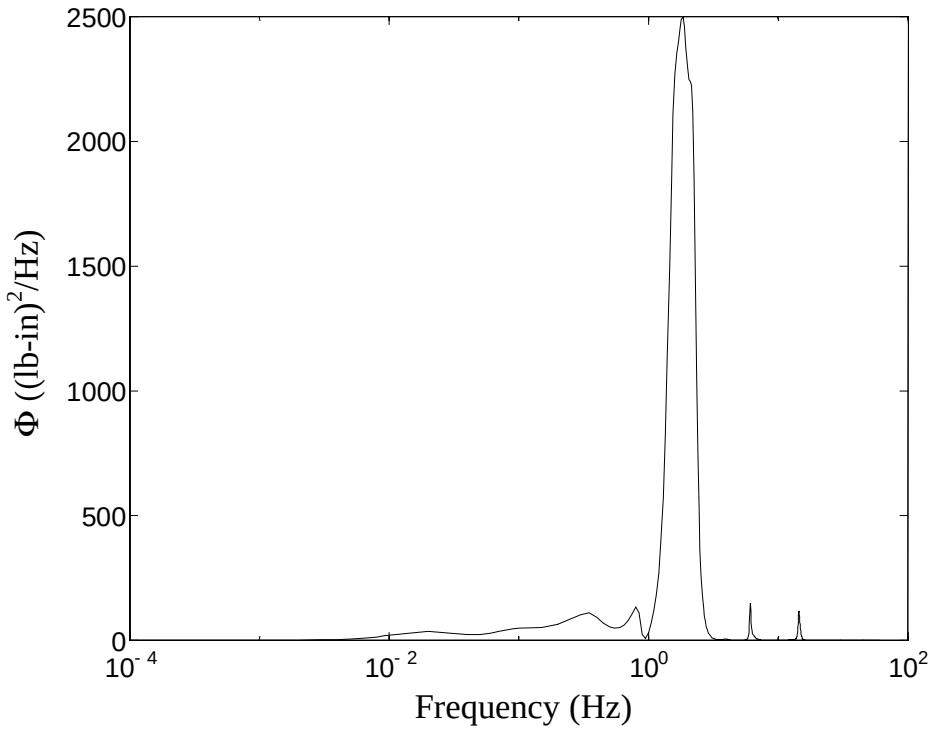


Figure 2.14: Power spectral density of M_1 at grid point 217.

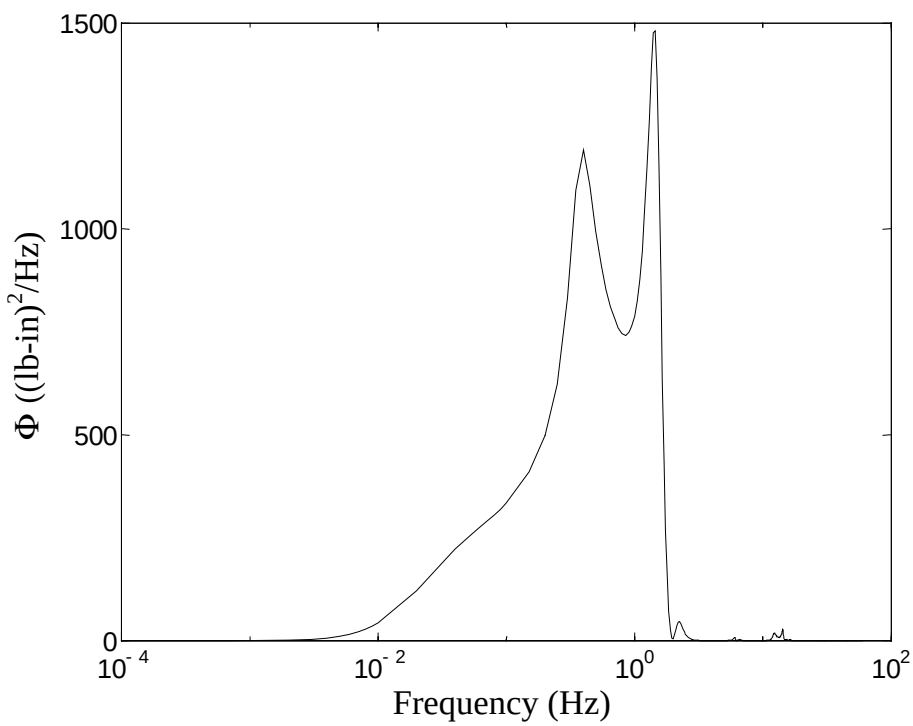


Figure 2.15: Power spectral density of M_2 at grid point 217.

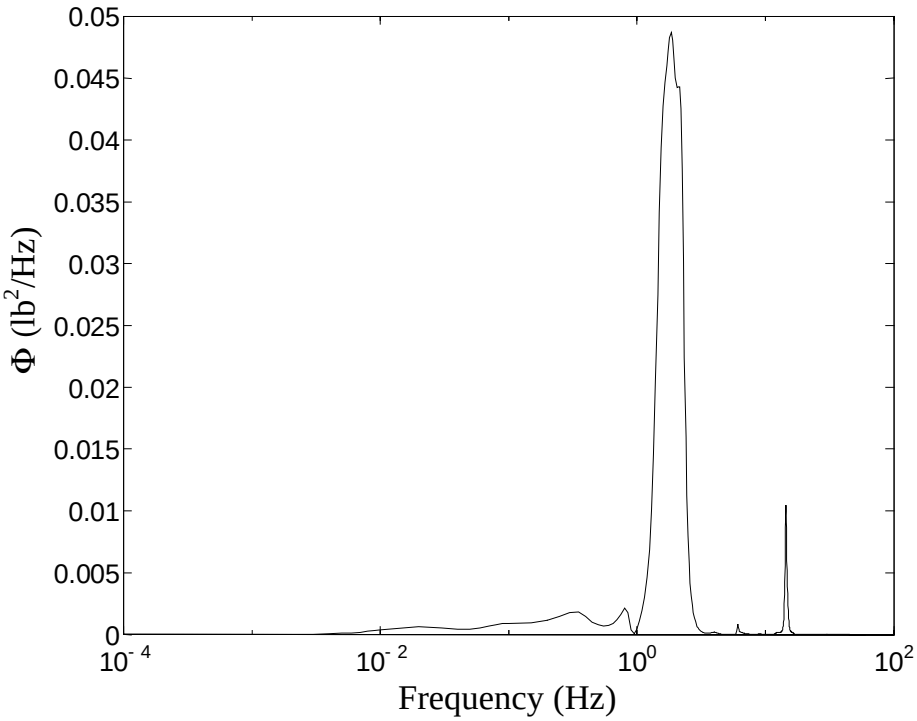


Figure 2.16: Power spectral density of V_1 at grid point 217.

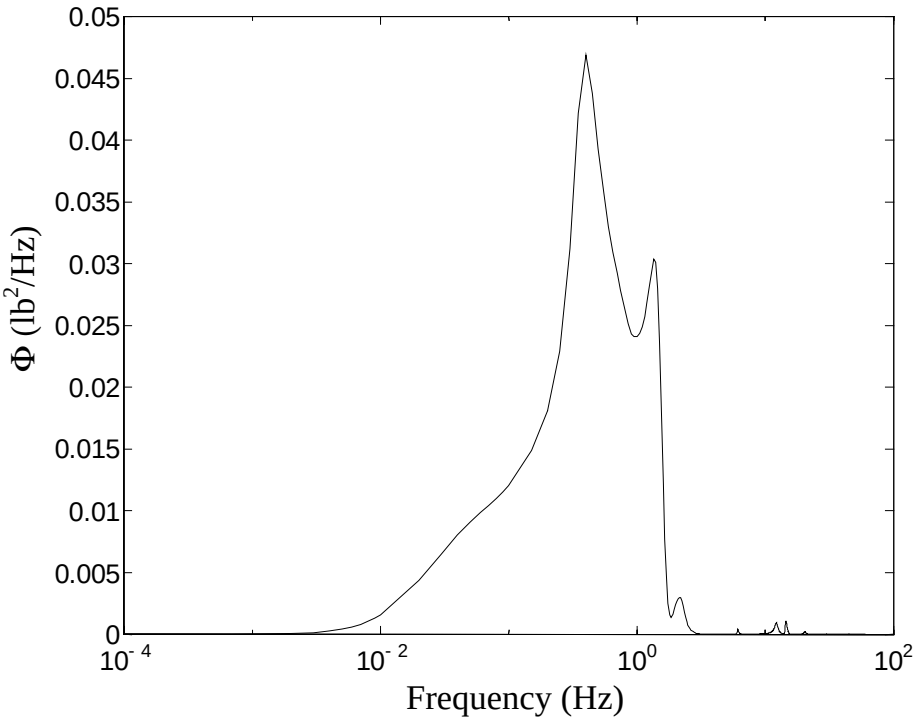


Figure 2.17: Power spectral density of V_2 at grid point 217.

The PSDs of the acceleration components of the center of gravity in the flow direction, A_1, the vertical direction, A_3, and about the pitching axis, A_5, are shown in Figure 2.19-Figure 2.21, respectively. As expected, the highest acceleration magnitude is in the vertical direction. Additionally, the translational accelerations A_1 and A_3, are affected by both bending and twisting modes. This is mainly because the center of gravity is offset horizontally from the elastic axis of the wing. The angular acceleration, A_5, on the other hand, peaks mainly at the natural frequencies of the torsional modes. Similarly, accelerations A_1, A_3, and A_5 for point 140 are shown in Figure 2.22-Figure 2.24, and for point 217 in Figure 2.25-Figure 2.27.

Additional requested output quantities were the root mean square value ($\overline{A}$) of the responses and the expected rate of zero crossings with positive slope (N_o). These statistical quantities are important for failure and fatigue analyses. These quantities are summarized in Table 2-3.

In order to ascertain that the solutions were converged with respect to the frequency range analyzed and the number of modes used in the analysis, the number of modes used was increased from 20 to 32 with no significant changes in loads. This includes the response RMS values shown in Table 2-3. Also, note that in Figure 2.4-Figure 2.18, no significant loads exist above 20 Hertz, whereas flexible modes and excitation loads exist at frequencies three times greater.

Table 2-3: Summery of the probability parameters for response quantities.

Point number	Type of response	$\overline{A}$	N_0 (Hz)
101	M_1	92.91 (lb-in)	1.94
	M_2	153.4 (lb-in)	1.473
	V_1	0.375 (lb)	2.450
	V_2	0.952 (lb)	2.217
	T	44.29 (lb-in)	2.316
140	M_1	51.10 (lb-in)	1.988
	M_2	8.080 (lb-in)	2.528
	V_1	0.149 (lb)	4.154
	V_2	0.419 (lb)	3.220
	T	41.03 (lb-in)	1.962
217	M_1	50.22 (lb-in)	3.346
	M_2	40.12 (lb-in)	2.800
	V_1	0.234 (lb)	5.850
	V_2	0.219 (lb)	3.681
	T	6.103 (lb-in)	4.661

Where, $\overline{A}$ = Root Mean Square value of the response.

N_0 = Expected number of zero crossings with positive slope per unit time

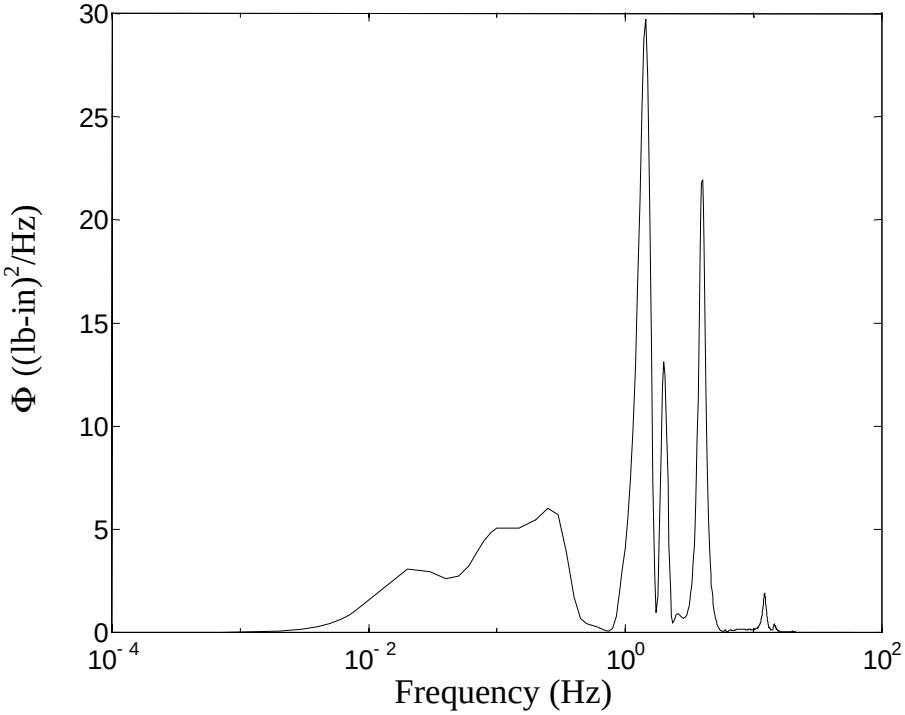


Figure 2.18: Power spectral density of T at grid point 217.

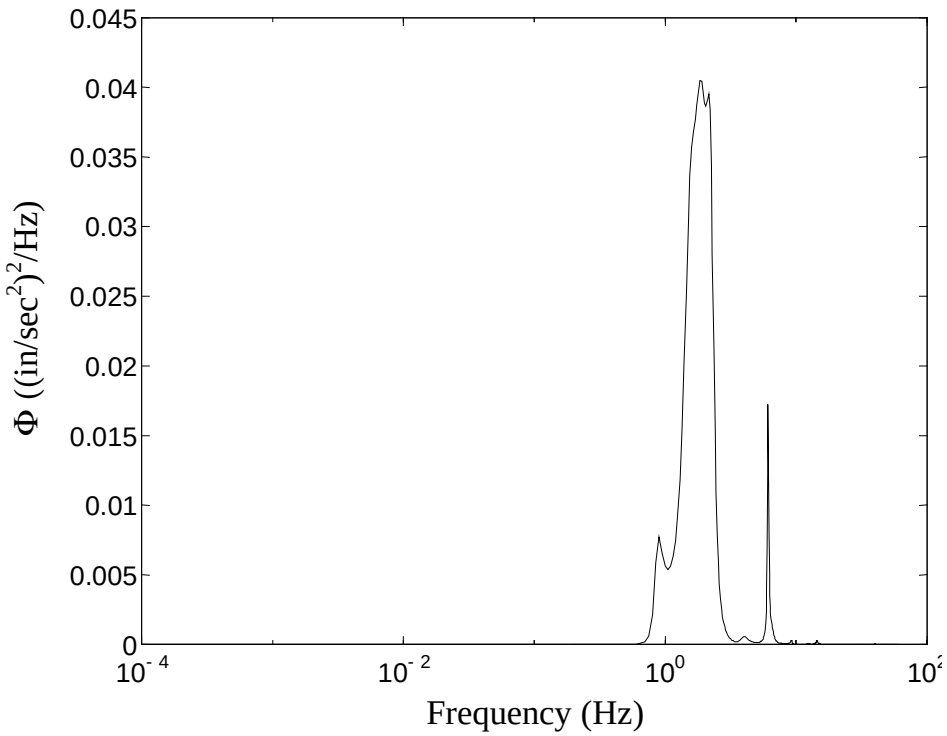


Figure 2.19: Power spectral density of acceleration A_1 for the center of gravity.

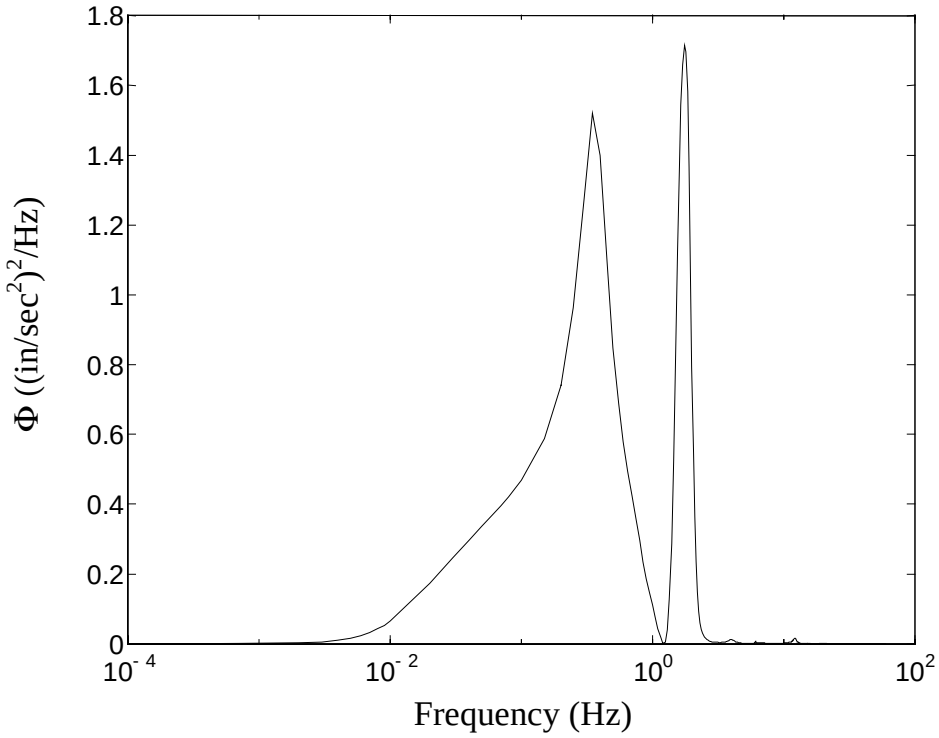


Figure 2.20: Power spectral the acceleration A_3 for the center of gravity.

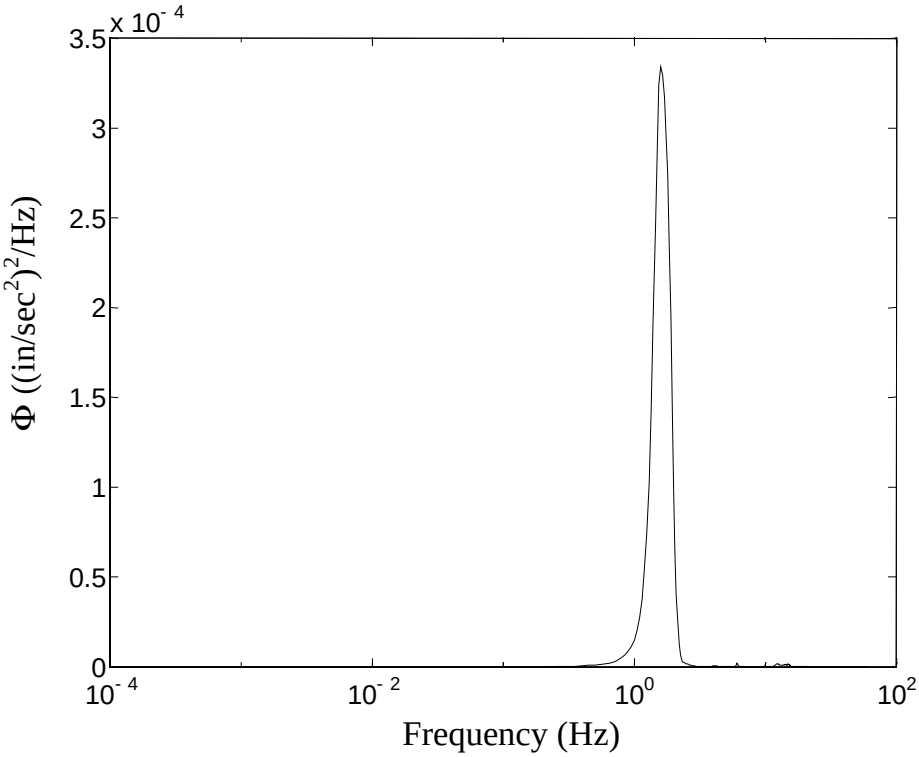


Figure 2.21: Power spectral the angular acceleration, A_5, for the center of gravity.

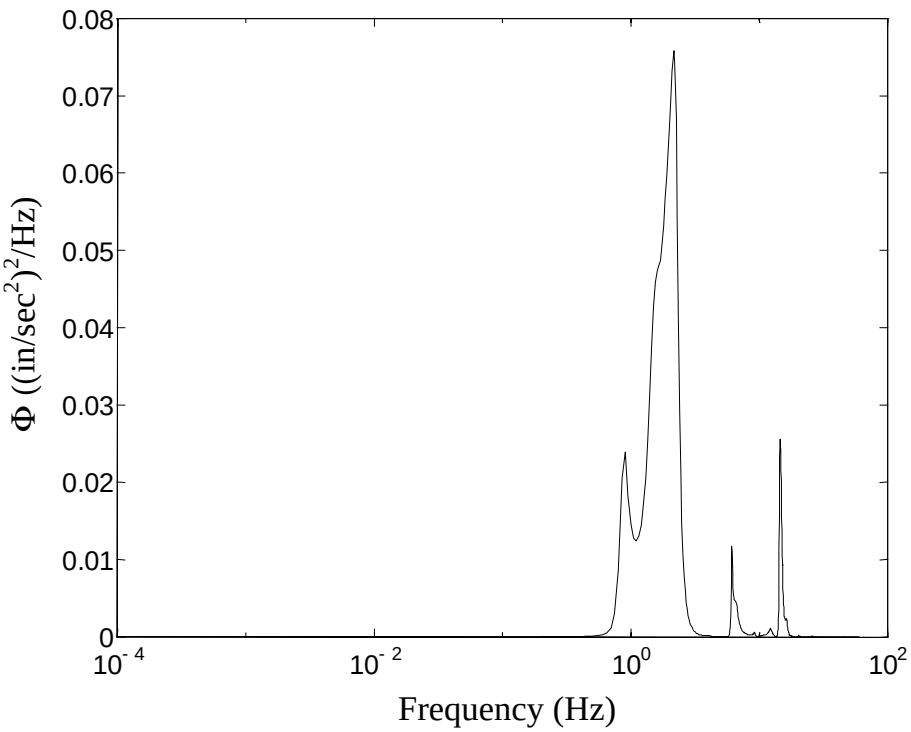


Figure 2.22: Power spectral density of the acceleration A_1 for point 140.

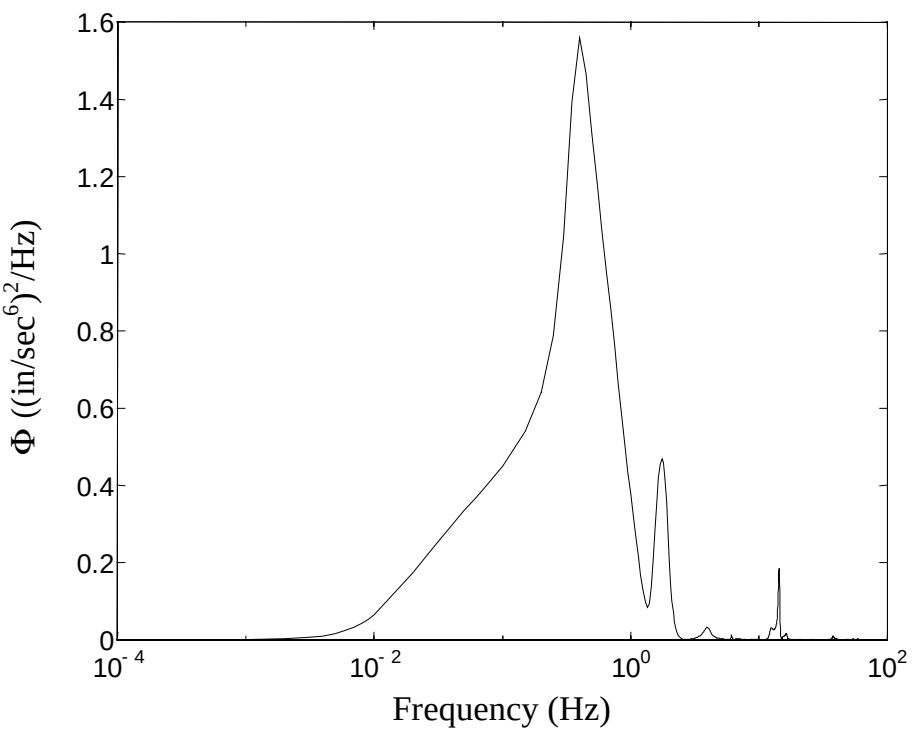


Figure 2.23: Power spectral density of the acceleration A_3 for point 140.

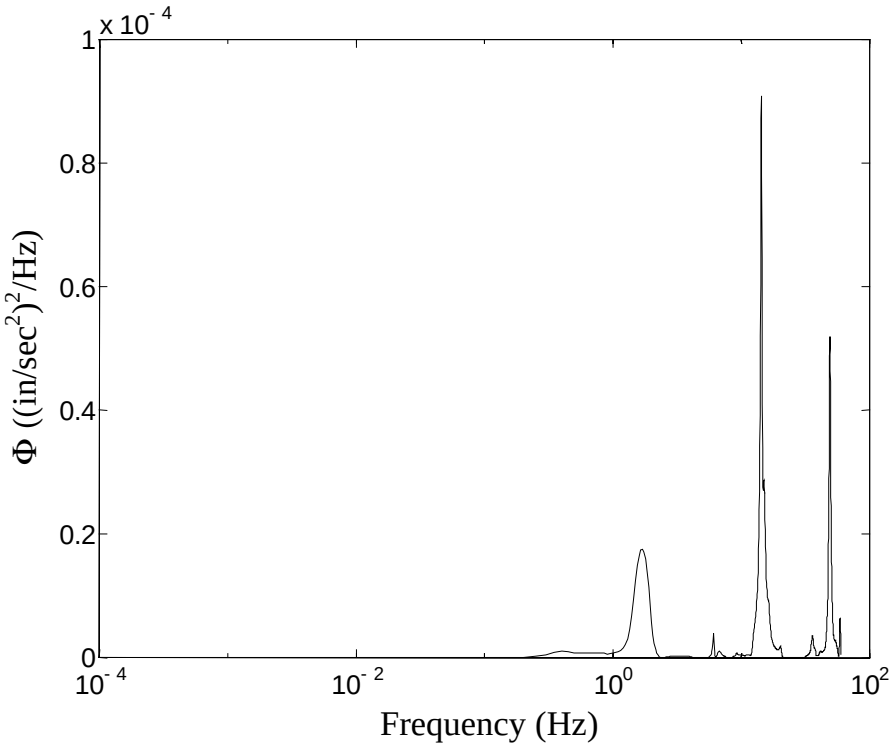


Figure 2.24: Power spectral density of the angular acceleration, A_5, for point 140.

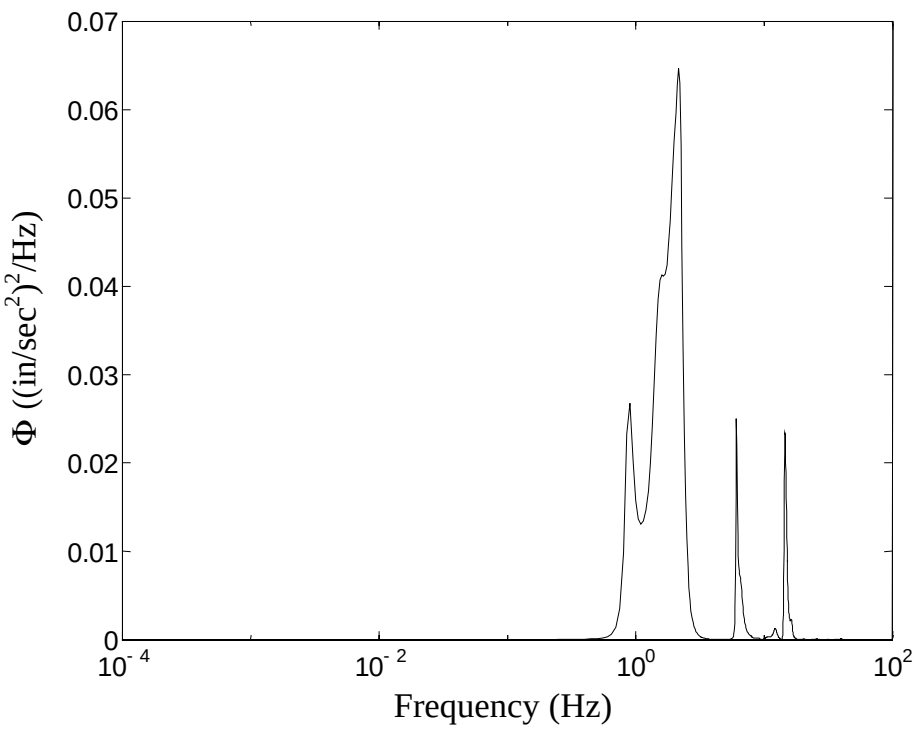


Figure 2.25: Power spectral density of the acceleration A_1 for point 217.

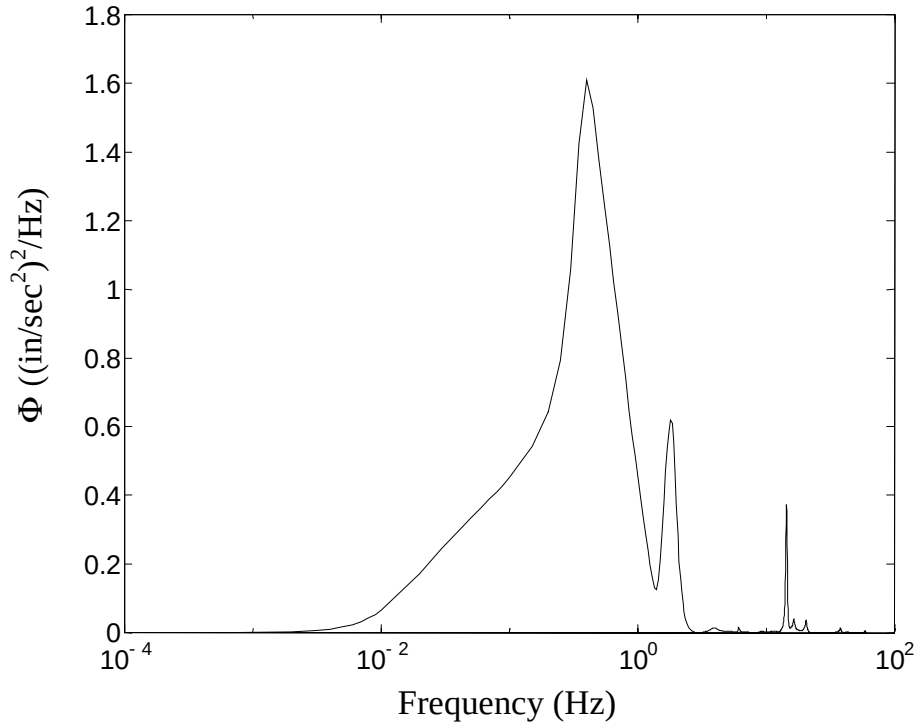


Figure 2.26: Power spectral density of the acceleration A_2 for point 217.

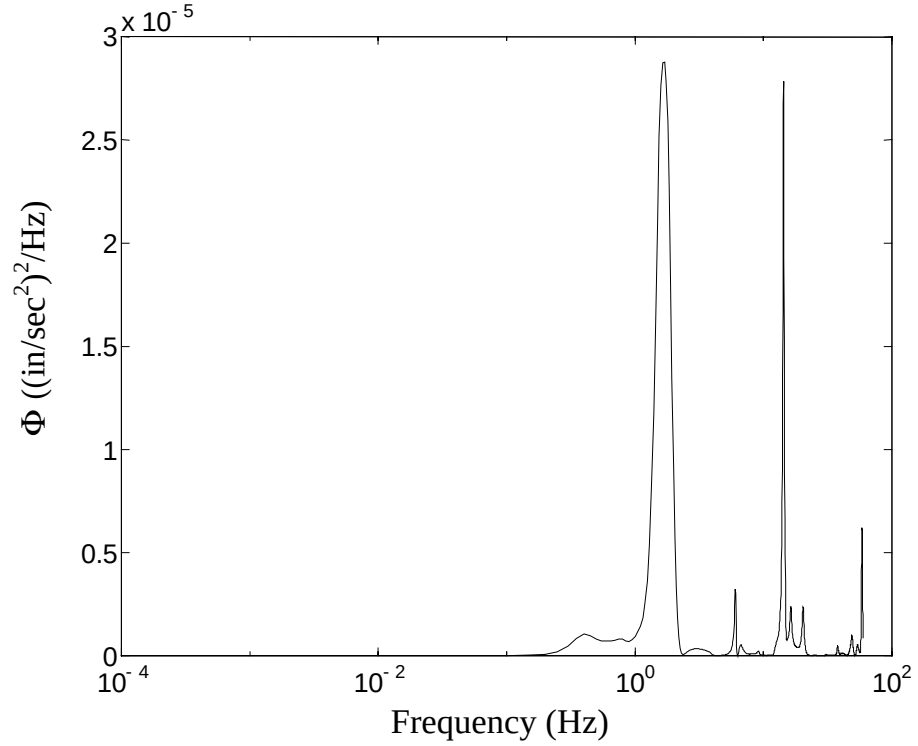


Figure 2.27: Power spectral density of the angular acceleration, A_1, for point 217.

3 TWO-DIMENSIONAL PSD GUST ANALYSIS

3.1 Introduction

This section deals with the two dimensional PSD gust analysis which was the central issue addressed in the entire study. All of the other work was done in order to develop and validate the two-dimensional process, or to correlate and compare the two-dimensional results with one-dimensional results. The gust load was represented by the cross spectral density between correlation strips spanning the airplane and parallel to the flight direction. The full-span structural and aeroelastic FEMs described in Section 1 were used for the analysis. As the capability of MSC/NASTRAN is limited to aerodynamic analysis under uniform (one dimensional) gust loads, Direct Matrix Abstraction Program (DMAP)[6] alters were introduced in the program to extract the frequency response functions (FRF) of the response from each of the correlation strips. One hundred and sixty (160) correlation strips were used, covering 1440 aerodynamic boxes. Programs written in MATLAB[7] were used to generate the cross spectral matrices and perform the post processing of the data generated by MSC/NASTRAN. The input data requirements were generated for a single set of flight conditions. Using no restraints (free-free boundary conditions), 64 normal modes spanning a frequency band up to 60 Hertz were computed and included in the analysis. PSD of different response quantities such as accelerations, moments and torques at critical grid points of the structures are generated and plotted for a range of frequencies that covers the elastic modes of vibration. The flight conditions and response quantities investigated are identical to those in the one-dimensional analysis.

3.2 MSC/NASTRAN Input and Output

The desired total fuel weight was entered into the data deck distributed among 14 grid stations. A normal modes analysis (Solution 103) was performed to obtain the weight and center-of-gravity (CG) location and to determine the number of modes within a frequency band of 60 Hertz. For the full-span case, the CG is at the centerline, and both symmetric and anti-symmetric mode shapes are involved. Appendix D contains complete listings of the MSC/NASTRAN files used in the two-dimensional analysis.

The lifting surfaces of the airplane were represented by 1440 aerodynamic boxes used for the doublet-lattice method. Each row of aerodynamic boxes in the chord-wise direction was used to represent a correlation strip for the two dimensional gust analysis. A DMAP alter was written to calculate the frequency response functions under unit aerodynamic loads acting on the correlation strips. The DMAP alter loops through the correlation strips which are identified by direct matrix input (DMI) cards. It was necessary to run each side of the airplane separately because the version of MSC/NASTRAN used restricted the maximum number of DMI cards to 100. The input cards required for the MSC/NASTRAN analysis include:

FREQ2	Defines frequencies used in solution of the frequency response problems.
MKAERO	Defines a set of Mach numbers and reduced frequencies to be used in the generation of the frequency response function.

PARAM inputs required included:

NSTRIPRM	Specifies the number of strips to be analyzed.
LMODE	Specifies the number of lowest normal mode to include.
MACH	MACH number used to compute aerodynamic matrices.
Q	Specifies the dynamic pressure.

In the absence of experimental estimates for the structural damping as a function of frequency, a modal structural damping of 0.02 was assumed over the entire analysis band of 60 Hz.

The desired set of analysis parameters is selected by the MSC/NASTRAN Case Control inputs. These inputs include:

FREQUENCY	Selects a set of desired solution frequencies (FREQ2).
METHOD	To select the eigenvalue extraction method (EIGR).
RANDOM	Selects the power spectral density factors (RANDPS) for the uniform case.
SDAMPING	Selects the desired modal damping (TABDMP1).

A SUPORT card was used to insure that the rigid-body modes have exactly zero frequencies.

XYPRINT specifications were required to create printouts of the FRFs from each strip. The output was chosen to be in the form of a "punch file". The MATLAB programs used in the post processing can, however, read "f06" files as well.

3.3 MATLAB Input and Output

MATLAB programs were written to generate the gust load cross-spectral matrices at each frequency, read the FRFs generated by MSC/NASTRAN, and calculate the power and cross-spectral densities of the responses. The input lists are contained in appendix E. The user needs to run only the program called "calc_response.m" with no input parameters. This program will call all the necessary programs to calculate the responses and their statistics. The cross-spectral density ϕ_{12} of the gust loads for two correlation strips is calculated according to reference 3 using the following equation:

$$\phi_{12}(\omega) = \frac{\sigma_w^2}{\sqrt{2\pi}} \frac{2^{2/3}}{\Gamma(1/3)} \frac{L}{V} \left(\frac{1}{1.339}\right)^{8/3} \left[\frac{8}{3}(1.339)^2 \frac{\sigma^{5/3}}{z^{5/6}} K_{5/6}(z) - \frac{\sigma^{11/3}}{z^{11/6}} K_{11/6}(z)\right] \tag{3.1}$$

where:

$$z = \frac{\sigma}{1.339}\sqrt{1+(1.339\nu)^2}\ , \tag{3.2}$$

$$\nu = \frac{\omega L}{V},$$

$$\sigma = \frac{s}{L},$$

s is the separation distance between the two strips,
L is the gust scale length,
σ_w is the rms value of the gust speed, and
K_i is the modified Bessel function of the second kind of order i.

The values of these variables are entered in a data file called "case_info.data". This file is read by the program "calc_response.m". Other information in the "case_info.data" file includes the name of the punch or "f06" file that has the FRF data, the number of frequency points used in the MSC/NASTRAN analysis,

the number of response quantities analyzed, and the number of correlation strips used in the analysis. A family of cross-spectral densities of the gust load is shown in Figure 3.1.

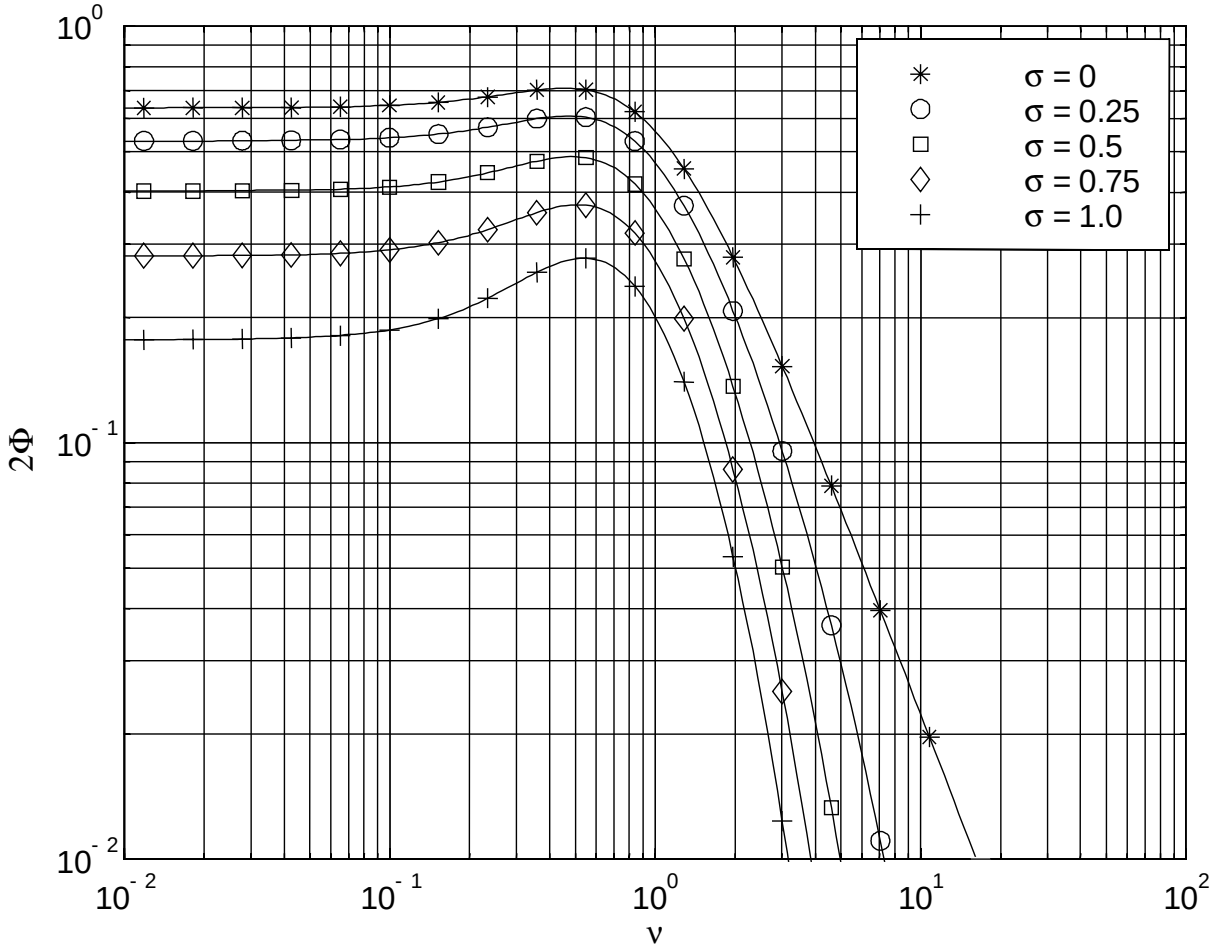


Figure 3.1: Non-dimensional gust cross-spectral spectral density for various non-dimensional separation distances.

The Matlab program "calc_resp.m" generates the following output quantities in order:

- The frequency vector,
- The auto power spectral matrix whose columns are the PSD vectors for each response quantity,
- A three-dimensional array for the cross-spectral matrices,
- The root-mean-square (RMS) values of the responses,
- The expected number of positive slope zero-crossings (N_o) of the responses.

The cross-spectral matrix of the response quantities is calculated in terms of the FRF matrix and the cross-spectral matrix of the gust load according to the following equation (reference 8):

$$[\phi_r(\omega)] = [H'(\omega)][\phi_g(\omega)][H(\omega)] \tag{4.2}$$

where ϕ_r is the cross-spectral matrix of the responses,

ϕ_g is the spectral-spectral matrix of the gust load,

H is the FRF matrix, and

H' is the complex conjugate transpose of *H*.

3.4 Verification of the Procedure

To verify the procedure used in the calculation of the non-uniform gust case, the procedure was first used to calculate the response to a uniform gust. This was done by setting the separation distances between all the strips to zero. This means that the cross-spectral density and the auto-spectral density is the same and is equal to the gust spectral density in the uniform gust case. The results of this procedure were compared to the results obtained directly from the MSC/NASTRAN uniform gust analysis. Both sets of results were identical. The figures plotted in this report for the uniform case were generated using this procedure. The results obtained directly from MSC/NASTRAN gust analysis were not plotted because they are an exact match of the results from the new procedure.

For further verification of the procedure used in this section, The present procedure was used to perform two-dimensional gust analysis on the jet transport wing used by Bisblinghoff, Ashley, and Halfman in reference 2, which is known in the literature as the BAH wing. The results of the present method are compared with the results reported by Crimaldi, Britt, and Rodden in reference 8.

3.4.1 Finite Element Model of the BAH Wing

The BAH full span wing was developed by modifying the half-span example in the MCS/NASTRAN example directory (reference 2) to produce a model similar to that used Crimaldi et al[9]. The right-hand wing in the example, which consisted of GENEL elements and concentrated masses, was mirrored into the left-hand side to produce the full-span wing (Figure 3.2). The GENEL elements are constrained so that the wing can only have roll, pitch, and plunge rigid body degrees of freedom. The fuselage weight was divided in half and carried by two very stiff beams 45 inches away from the center to each side. In addition, the connection point in the middle of the fuselage was broken into two co-incidental points connected by very stiff beams in order to generate the center moment from the beam stresses. This was done because structural loads cannot be recovered from GENEL elements. The structural model is shown in figure 1. The total span of the wing is 500 ft and the its total area is 162,500 in^2. The root chord is 100 inches and the chord at the three-quarter span is 131.2 inches. The total weight is 83,838 lb., of which 34,800 lb. is the fuselage weight.

For the aerodynamic model (Figure 3.3), the surface of the wing was divided into a lattice of 12X5 aerodynamic boxes for use with doublet-lattice method. Those boxes are splined with the grid points of the structural model. To calculate the frequency response function under non-uniform gust loads, eleven correlation strips were formed from the rows of aerodynamic boxes spanning the whole wing. The two rows of aerodynamic boxes in the middle of the wing are lumped into one correlation strip representing the fuselage. The aerodynamic model with the grid points for the splines is shown in Figure 3.3. The MSC/NASTRAN structural and aerodynamic input file can be found in Appendix F.

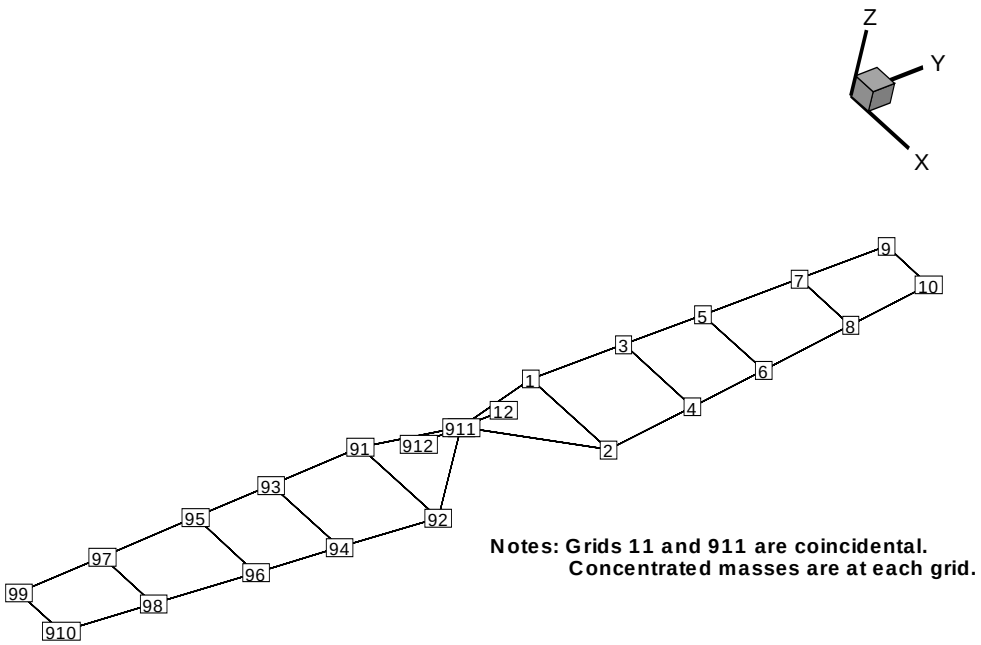


Figure 3.2: Structural model of the full-span BAH wing.

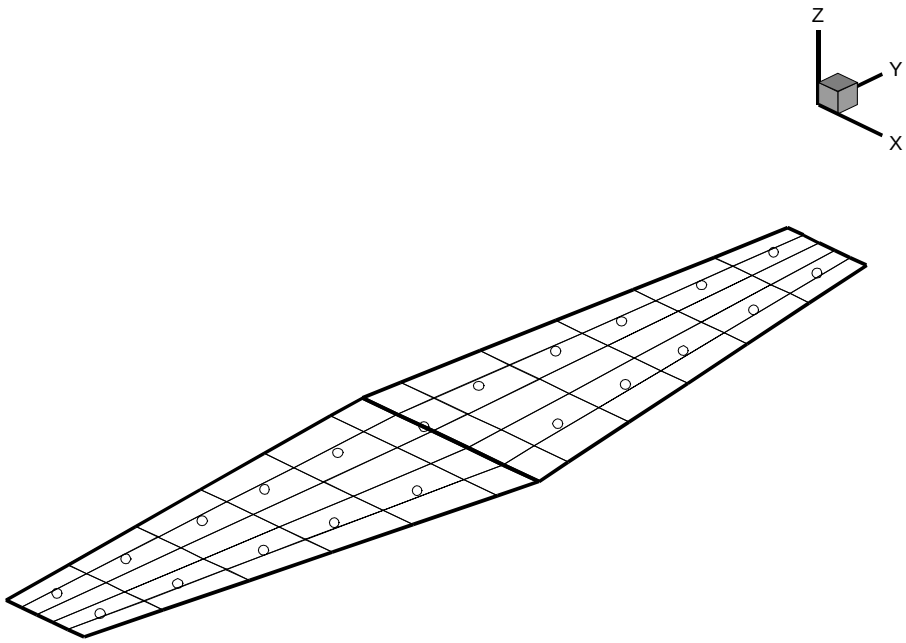


Figure 3.3: Aerodynamic model of the full-span BAH wing.

3.4.2 Results of the BAH Two-Dimensional Gust Analysis

Normal mode analysis was performed on the structural model to verify the free vibration characteristics of the wing. The first 13 mode shapes and natural frequencies, which are the ones included in the FRF analysis, are shown in Figure 3.4. These results are in exact agreement with the natural frequencies and mode shapes reported in reference 9.

The power spectral density (PSD) of the centerline acceleration for the uniform and non-uniform gust cases is shown in Figure 3.5. This figure is also an exact match to the results of reference 9. It is noted that the response to a non-uniform gust is higher than the response to uniform gust at high frequencies. At low frequencies, however, the uniform response is higher. The root mean square value $\overline{A}$ and the expected value of the positive slope zero-crossing rate (N_0) of the accelerations under uniform and non-uniform gust loads were also calculated. The results of the present method are compared to the results of reference 8 in Table 3-1 and Table 3-2 for the RMS and zero crossing rates, respectively.

PSD plots for the tip acceleration and the centerline bending moment are shown in Figure 3.6 and Figure 3.7, respectively. It is noticed from the comparison of the RMS values from the current study and reference 9 that while the centerline acceleration is exactly the same (within reasonable round off error), the results of the tip acceleration and the centerline moment are different. This can be explained by the fact that the centerline acceleration is the only quantity that is calculated for the same exact point in the two studies. The tip acceleration in reference 9 is calculated for the edge of the middle aerodynamic box at the end of the wing, whereas the tip acceleration calculated here is for grid point 10, which is removed a little from the edge of the aerodynamic box. Since the objective here is to validate present method, it was used in the same way as for the Alliance 1 airplane. The comparison of the results at points other than grid points is beyond the scope of the current task.

Table 3-1: Comparison of the RMS vlues of the responses of the BAH wing.

Response	Uniform		Non-uniform	
	Current	Reference 9	Current	Reference 9
Centerline acceleration	4.74 E-2	4.74 E-2	4.42 E-2	4.44 E-2
Tip acceleration	0.188	0.180	0.168	0.173
Centerline moment	2.61 E+5	2.32 E+5	2.30 E+5	2.04+E5

Table 3-2: Comparison of the zero crossing rates of the responses.

Response	Uniform		Non-uniform	
	Current	Reference 9	Current	Reference 9
Centerline acceleration	2.34	2.30	2.56	2.57
Tip acceleration	3.77	3.68	4.87	4.82
Centerline moment	2.05	2.02	2.06	1.99

The results for the center-line moments are calculated in the current study from the internal stresses of the structural elements, similar to the method used for the Alliance 1 airplane. This was the reason for the introduction of the stiff beam elements to connect the two coincidental grid points at the center of the wing. Calculating the moments (loads in general) for points or sections on elements other than real structural elements, as in the current example, requires the calculation of integral functions of the aerodynamic loads and inertial forces at that section. This is also beyond the scope of the current task.

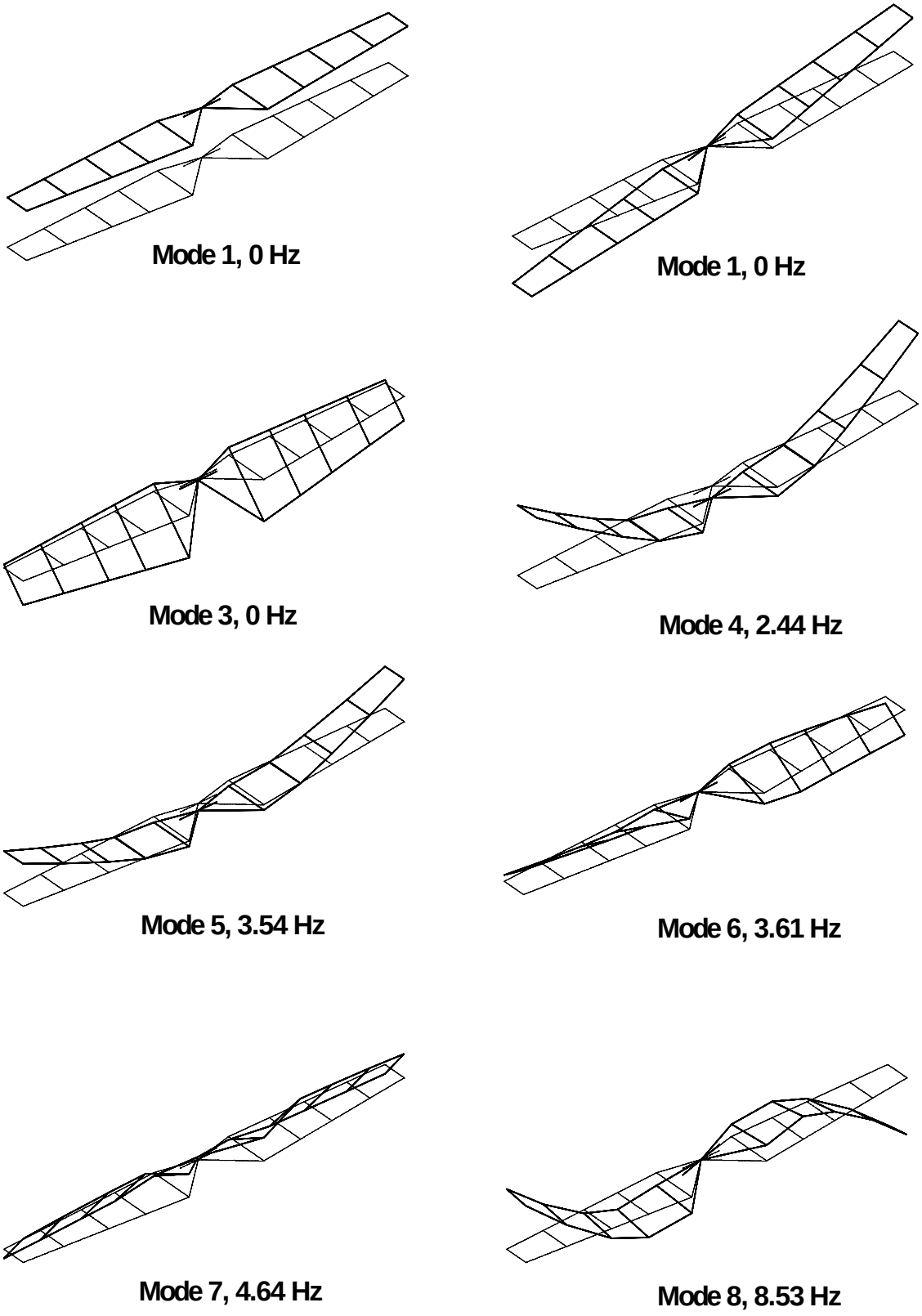


Figure 3.4: Mode shapes and natural frequencies of the BAH wing.

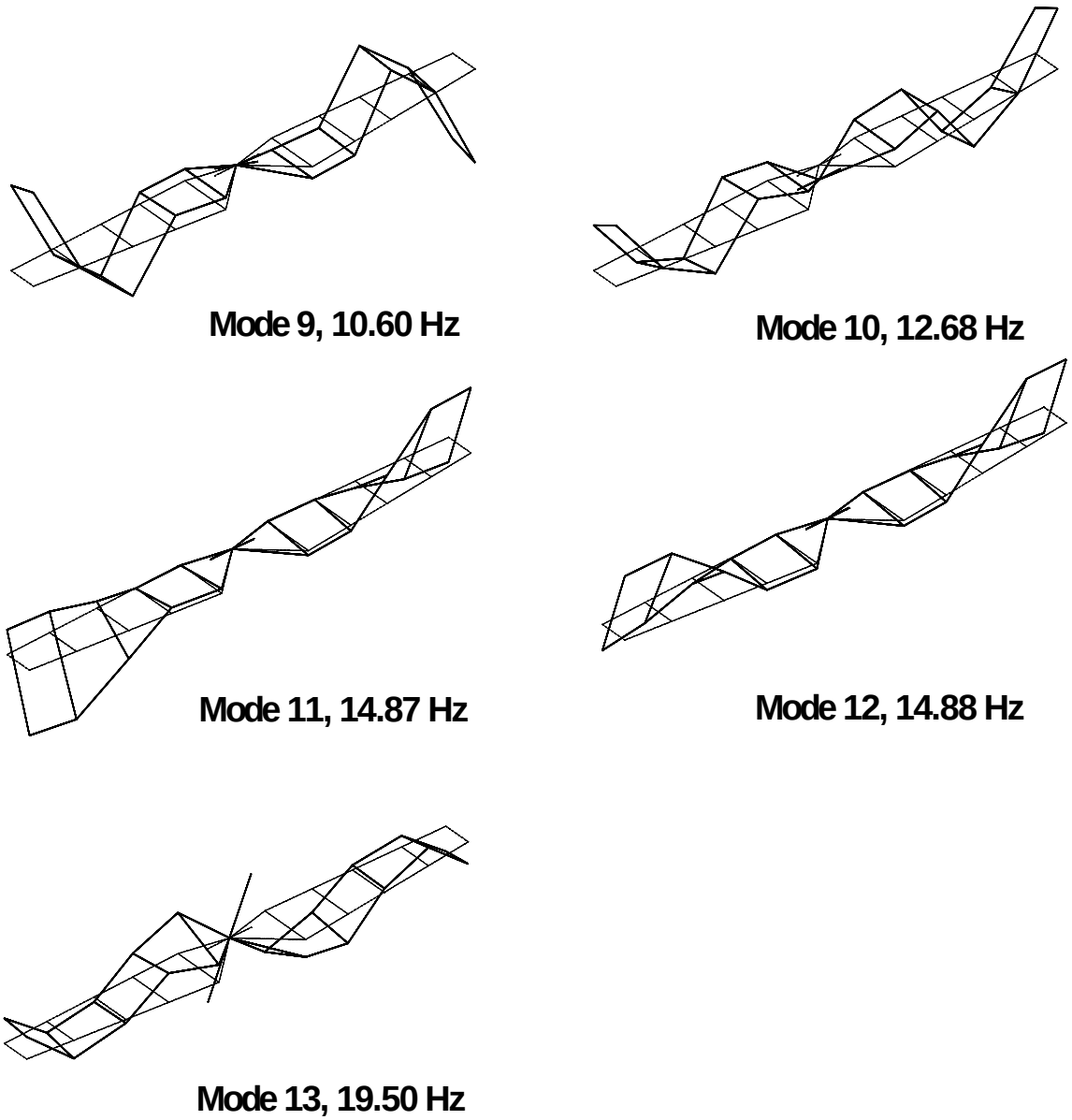


Figure 3.4: Mode shapes and natural frequencies of the BAH wing (concluded).

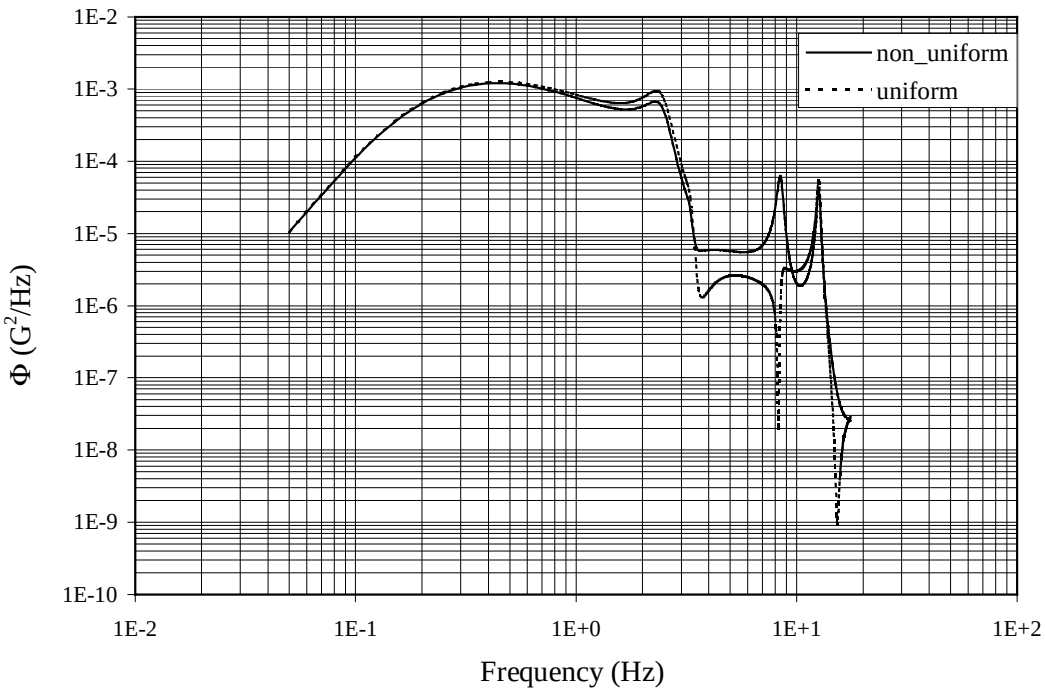


Figure 3.5: Power spectral density of the centerline acceleration of the BAH wing.

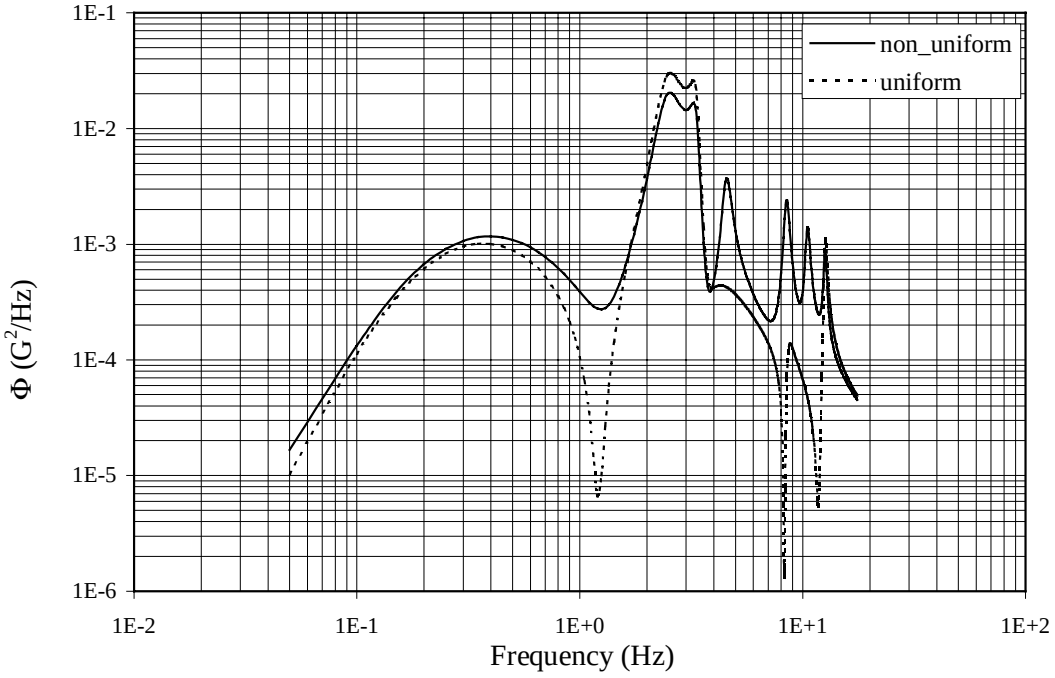


Figure 3.6: PSD of the acceleration of grid point 10 near the wing tip of the BAH wing.

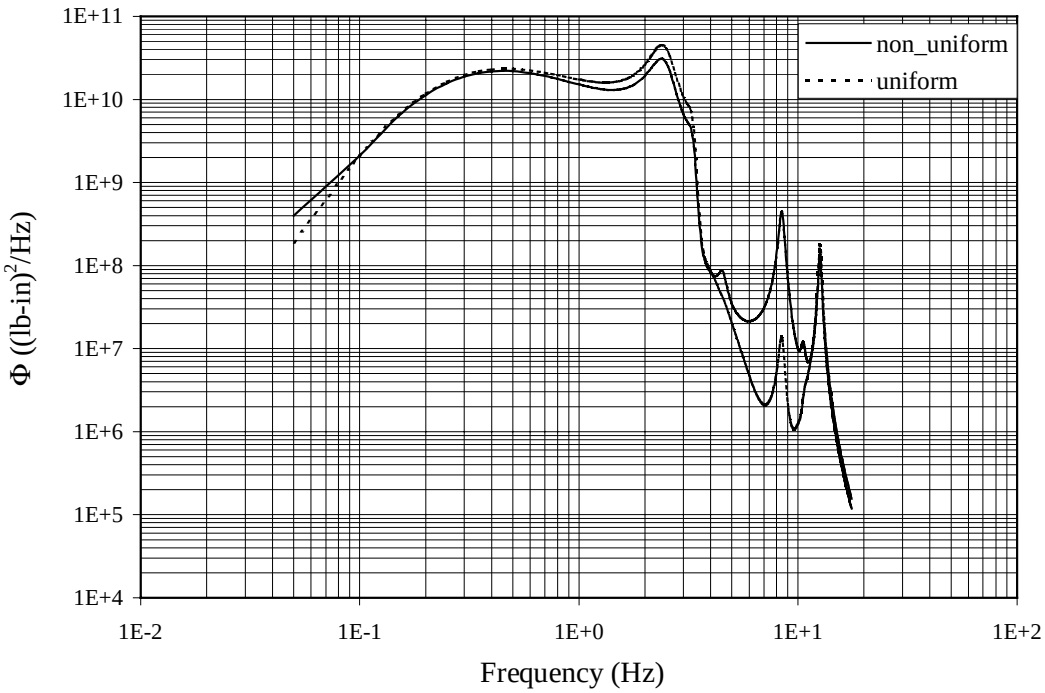


Figure 3.7: PSD of the centerline bending moment of the BAH wing.

3.5 Results and Discussion of the Two-Dimensional Analysis

A summery of the weight and the location of the CG with respect to the basic coordinate system is given in Table 3-3. Table 3-4 shows the lowest 64 natural frequencies of the structure. The first 6 modes are rigid-body modes. All rigid-body and elastic mode shapes are plotted in Figure 3.8. It should be noted that the anti-symmetric and symmetric mode shapes and frequencies start to converge at higher frequencies (mode 45 and above). This numerical behavior indicates degeneracy in the finite-element model. It is unreasonable to expect sufficient fidelity to accurately predict 64 mode shapes for such a model.

The excitation frequencies used in the frequency response solution ranged from 0.01 Hz to 50.0 Hz and were specified on FREQ2 data cards, which use a logarithmic distribution for the frequencies. Figure 3.1, shown earlier, presents the cross-power spectral density over this total frequency band for several separation distances. The roll-off frequency gets smaller as the separation distance increases.

Table 3-3: Weight summaries for the full-span model with respect to the basic coordinate system.

Weight (lb)	X-C.G (in)	Y-C.G (in)	Z-C.G (in)
2.094578E+03	160.95	0.0	77.09

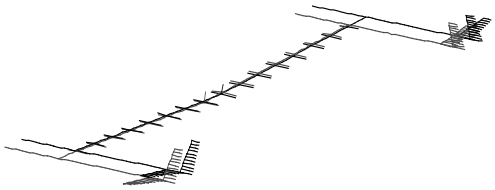
Table 3-4: Natural frequencies of the modes included in the dynamic response analysis.

Mode #	Frequency (Hz)	Mode #	Frequency (Hz)	Mode #	Frequency (Hz)	Mode #	Frequency (Hz)
1	0.0000	17	4.1273	33	15.3397	49	38.7357
2	0.0000	18	5.1496	34	15.3545	50	38.7454
3	0.0000	19	6.1176	35	16.7184	51	40.0690
4	0.0000	20	6.7502	36	17.1604	52	40.4588
5	0.0000	21	7.0150	37	21.3164	53	43.8788
6	0.0000	22	8.3149	38	21.7041	54	43.9072
7	0.3804	23	8.3449	39	23.9172	55	44.9486
8	0.5778	24	9.0024	40	25.1920	56	44.9588
9	0.8129	25	9.2734	41	26.4514	57	50.4323
10	1.0502	26	10.8704	42	26.5199	58	50.4640
11	1.2899	27	10.9832	43	31.5077	59	51.7589
12	1.6263	28	12.0318	44	31.6183	60	52.3631
13	2.0371	29	12.8431	45	31.9269	61	55.8226
14	2.2012	30	13.8056	46	31.9337	62	55.8527
15	3.5555	31	14.6001	47	36.8595	63	59.5701
16	4.1178	32	14.8595	48	36.9357	64	59.5705

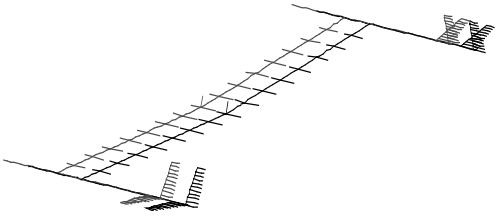
PSD of the bending moment in the vertical plane, M_1, for grid point 101 is plotted in Figure 3.9. PSD of M_2, V_1, V_2, and T for the same grid point are shown in Figure 3.10-Figure 3.13, respectively. The largest response for M_2 occurs at a frequency of about 0.4 Hz, which is the frequency of the first elastic mode. A large response of the bending moment at this frequency, especially when the PSD of the excitation is significant in that vicinity is expected. A smaller peak of M_2 response occurs at a frequency of 2 Hz which is the natural frequency of the second bending mode of the wing. Higher modes do not appear to influence the bending moment response. Moment M_1 has a large and sharp peak at about 2 Hz with multiple smaller peaks at lower frequencies. This small peaks can be attributed to the coupling between the responses in planes 1 and 2. The PSD of the torque at this point has peaks at 0.4 Hz, which is the frequency of the first elastic mode, and 1.6 Hz, which are the natural frequency of the torsional mode of the wing. It is generally noticed from all these figures that the non-uniform response is higher than the uniform at low frequencies and smaller at high frequencies. This can be attributed to the fact that the high magnitude influence for the cross power spectral density of the loads is concentrated in the lower frequency range for non-uniform case and decreases at higher frequencies.

Results similar to Figure 3.9-Figure 3.13 are shown in Figure 3.14-Figure 3.18 for a grid point 140 (on the right wing elastic axis at a span fraction of 97.50%). Another set of results is also shown in Figure 3.19-Figure 3.23 for grid point 217 (at the right wing tip boom 0.373 inches forward of intersection of the wing elastic axis and the tip boom). The peaks of the different loads for each of the points studied vary depending on the location and type of response examined.

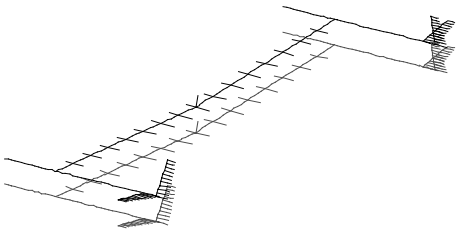
The variation along the span of the root-mean-square (RMS) values of the bending moment M_2 and vertical shear force V_2 are presented in Figure 3.24 and Figure 3.25, respectively. The RMS values of M_2 under non-uniform gust is higher than that under uniform gust. The difference in these values is greater in the mid-span region. The RMS values of the shear force V_2, on the other hand, are closer to each other near mid-span, with the response to a non-uniform gust being greater for some region and smaller in another.



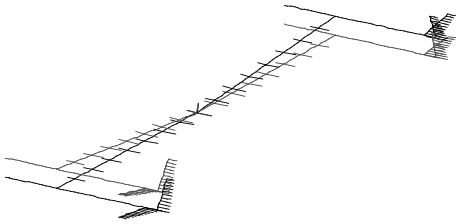
Mode shape no. 1 at 0.0 Hz



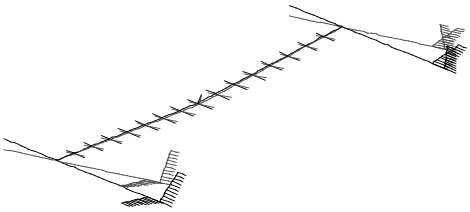
Mode shape no. 2 at 0.0 Hz



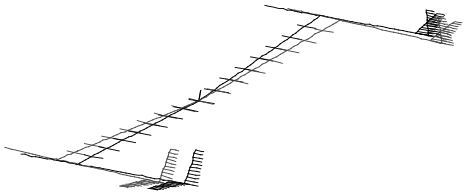
Mode shape no. 3 at 0.0 Hz



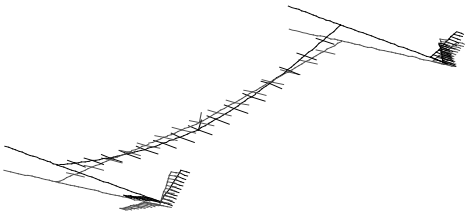
Mode shape no. 4 at 0.0 Hz



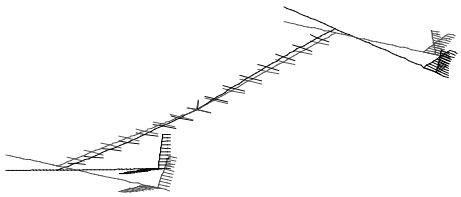
Mode shape no. 5 at 0.0 Hz



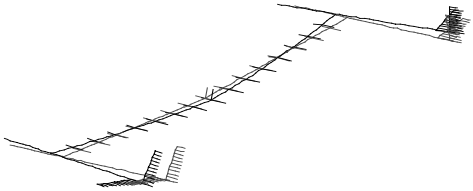
Mode shape no. 6 at 0.0 Hz



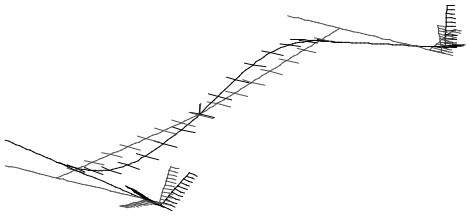
Mode shape no. 7 at 0.3804 Hz



Mode shape no. 8 at 0.5778 Hz

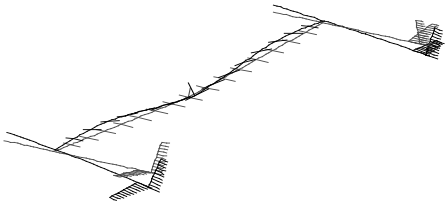


Mode shape no. 9 at 0.8129 Hz

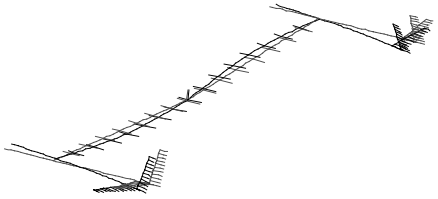


Mode shape no. 10 at 1.050 Hz

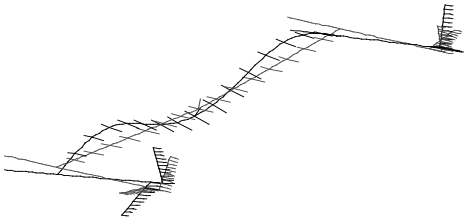
Figure 3.8: Mode shapes and natural frequencies for the two-dimensional gust analysis.



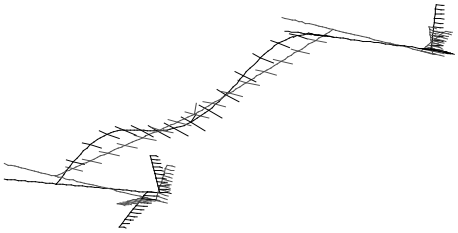
Mode shape no. 11 at 1.290 Hz



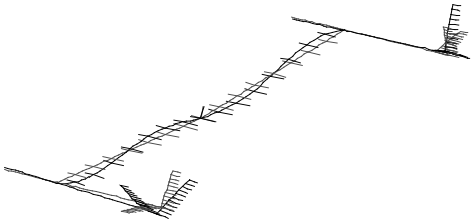
Mode shape no. 12 at 1.626 Hz



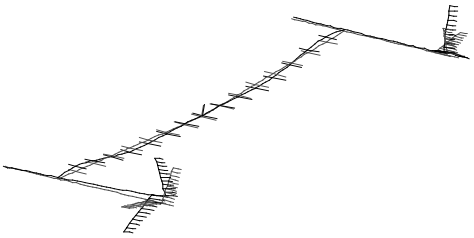
Mode shape no. 13 at 2.037 Hz



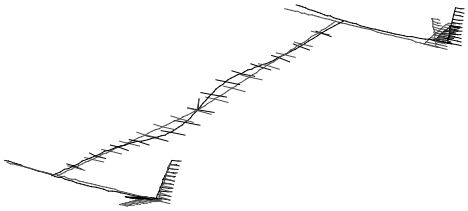
Mode shape no. 14 at 2.201 Hz



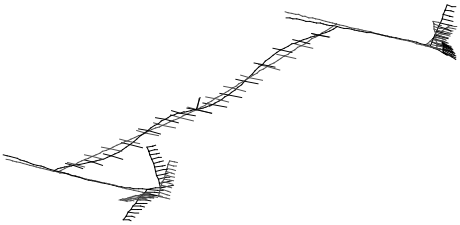
Mode shape no. 15 at 3.556 Hz



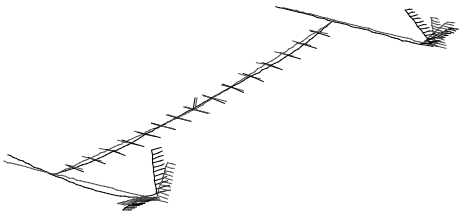
Mode shape no. 16 at 4.118 Hz



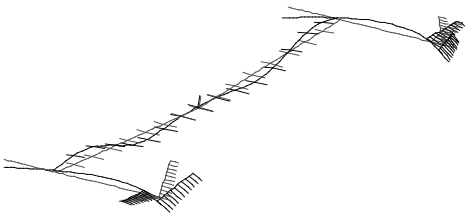
Mode shape no. 17 at 4.127 Hz



Mode shape no. 18 at 4.150 Hz

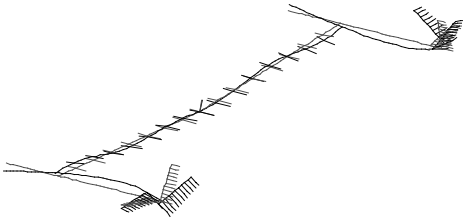


Mode shape no. 19 at 6.118 Hz

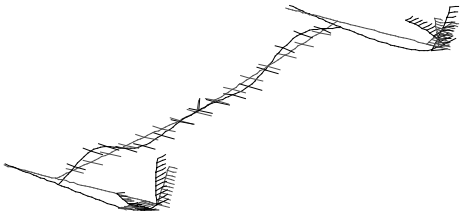


Mode shape no. 20 at 6.750 Hz

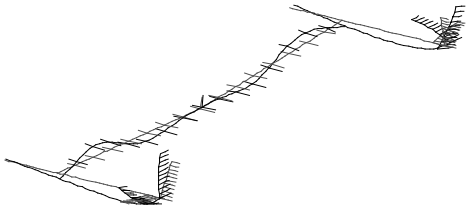
Figure 3.8: Mode shapes and natural frequencies for the two-dimensional gust analysis (continued).



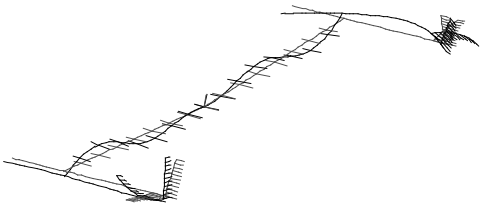
Mode shape no. 21 at 7.015 Hz



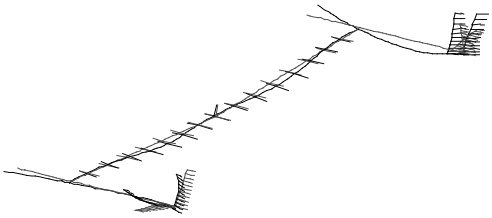
Mode shape no. 22 at 8.315 Hz



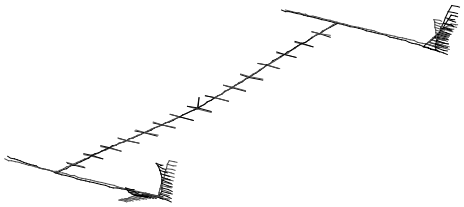
Mode shape no. 23 at 8.345 Hz



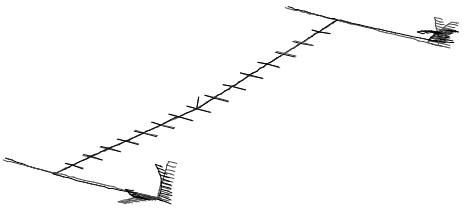
Mode shape no. 24 at 9.002 Hz



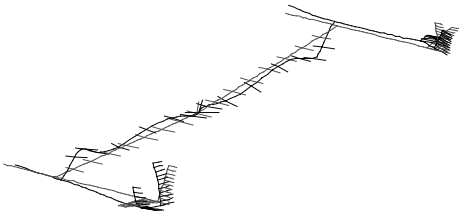
Mode shape no. 25 at 9.273 Hz



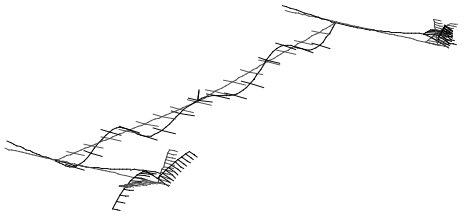
Mode shape no. 26 at 10.87 Hz



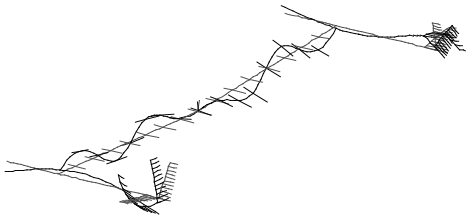
Mode shape no. 27 at 10.98 Hz



Mode shape no. 28 at 12.03 Hz

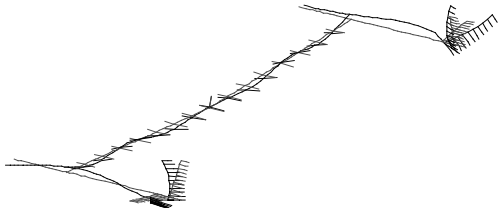


Mode shape no. 29 at 12.84 Hz

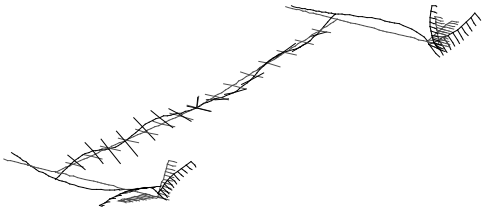


Mode shape no. 30 at 13.81 Hz

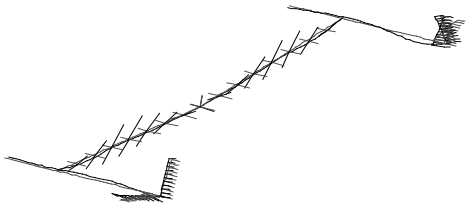
Figure 3.8: Mode shapes and natural frequencies for the two-dimensional gust analysis (continued).



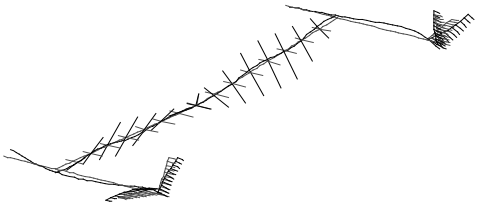
Mode shape no. 31 at 14.60 Hz



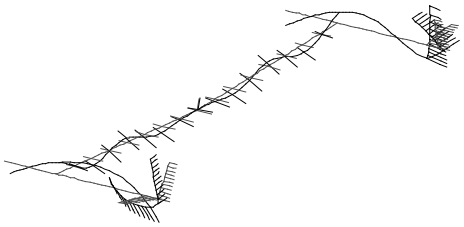
Mode shape no. 32 at 14.86 Hz



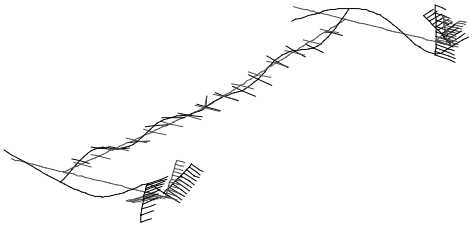
Mode shape no. 33 at 15.34 Hz



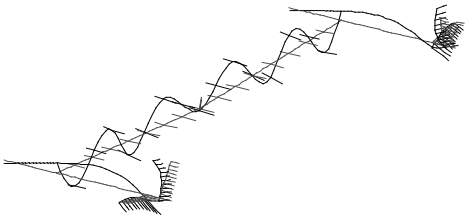
Mode shape no. 34 at 15.35 Hz



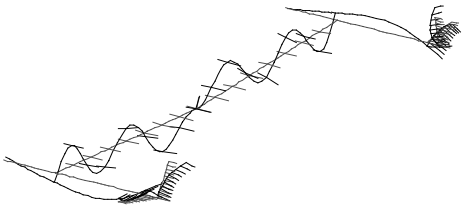
Mode shape no. 35 at 16.72 Hz



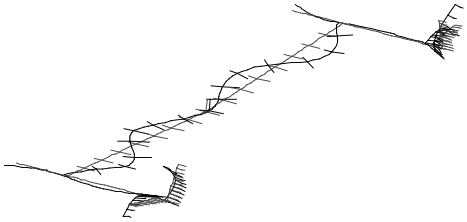
Mode shape no. 36 at 17.16 Hz



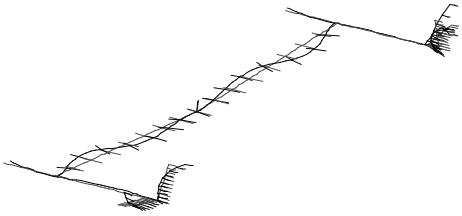
Mode shape no. 37 at 21.32 Hz



Mode shape no. 38 at 21.70 Hz

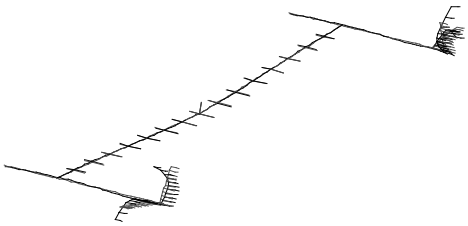


Mode shape no. 39 at 23.92 Hz

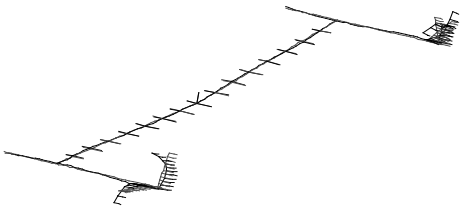


Mode shape no. 40 at 25.19 Hz

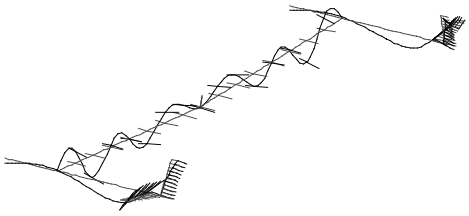
Figure 3.8: Mode shapes and natural frequencies for the two-dimensional gust analysis (continued).



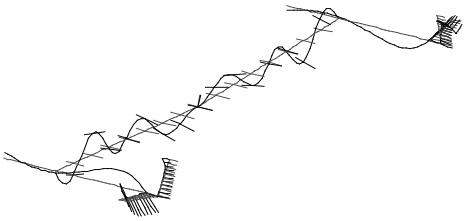
Mode shape no. 41 at 26.45 Hz



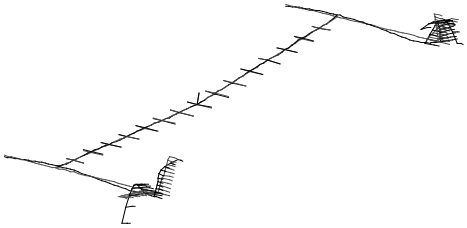
Mode shape no. 42 at 26.52 Hz



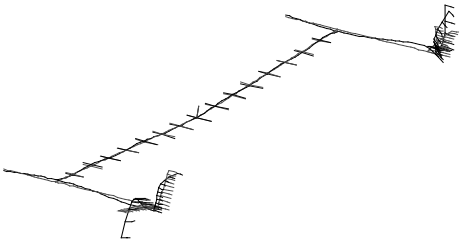
Mode shape no. 43 at 31.51 Hz



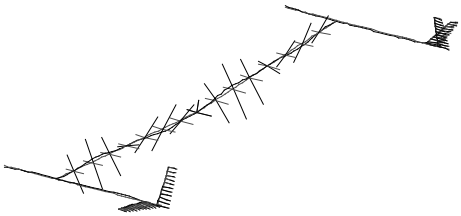
Mode shape no. 44 at 31.62 Hz



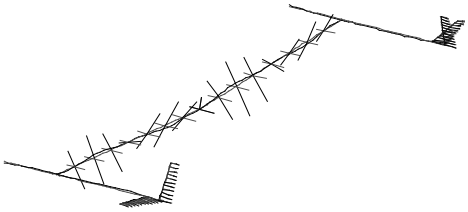
Mode shape no. 45 at 31.93 Hz



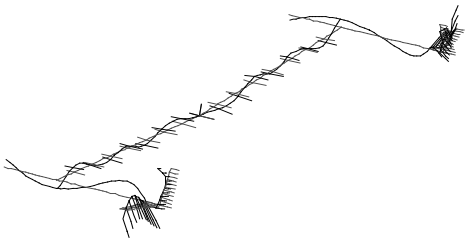
Mode shape no. 46 at 31.93 Hz



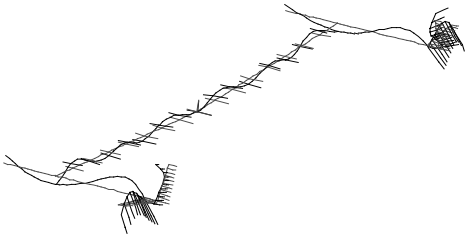
Mode shape no. 47 at 36.86 Hz



Mode shape no. 48 at 36.94 Hz

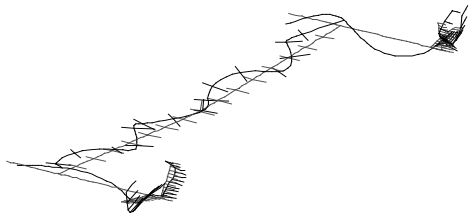


Mode shape no. 49 at 38.74 Hz

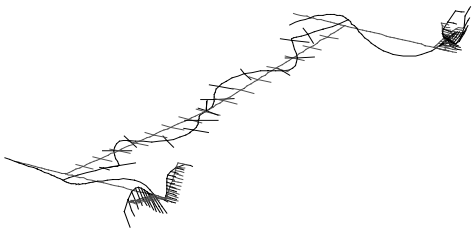


Mode shape no. 50 at 38.74 Hz

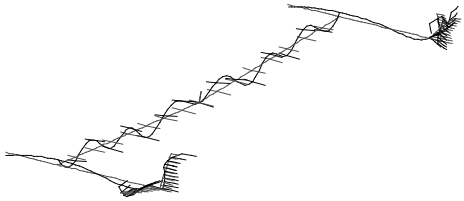
Figure 3.8: Mode shapes and natural frequencies for the two-dimensional gust analysis (continued).



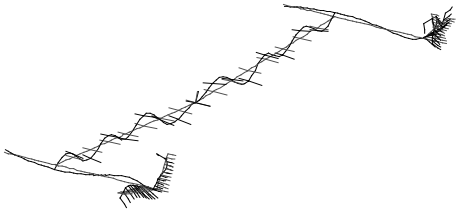
Mode shape no. 51 at 40.07 Hz



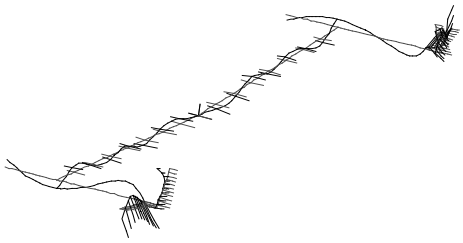
Mode shape no. 52 at 40.46 Hz



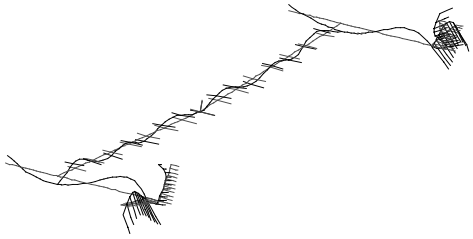
Mode shape no. 53 at 43.88 Hz



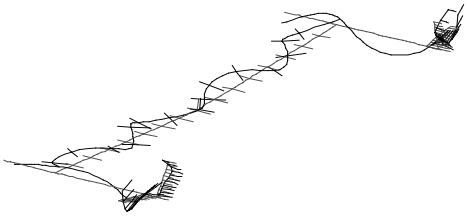
Mode shape no. 54 at 43.91 Hz



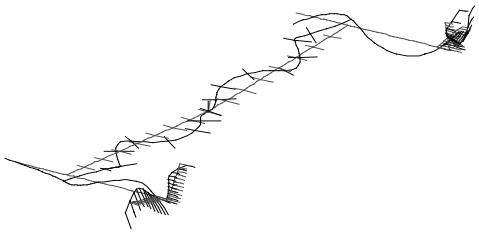
Mode shape no. 55 at 44.95 Hz



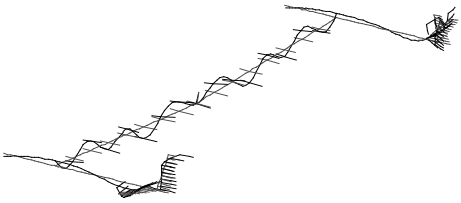
Mode shape no. 56 at 44.96 Hz



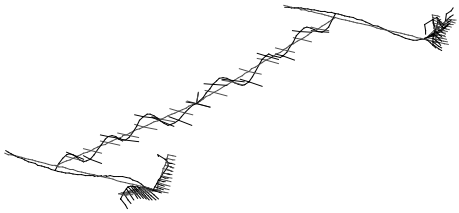
Mode shape no. 57 at 50.43 Hz



Mode shape no. 58 at 50.46 Hz

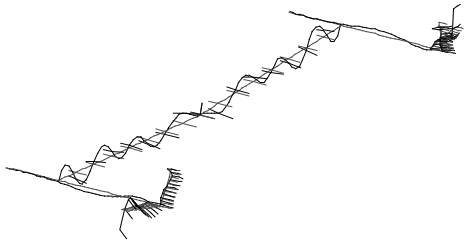


Mode shape no. 59 at 51.76 Hz

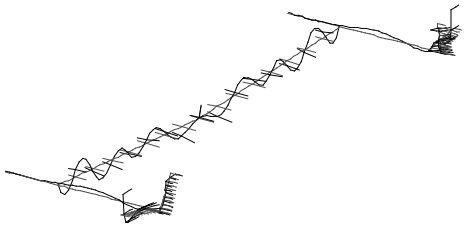


Mode shape no. 60 at 52.36 Hz

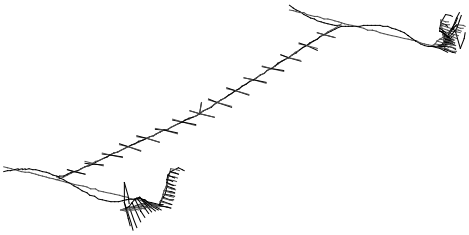
Figure 3.8: Mode shapes and natural frequencies for the two-dimensional gust analysis (continued).



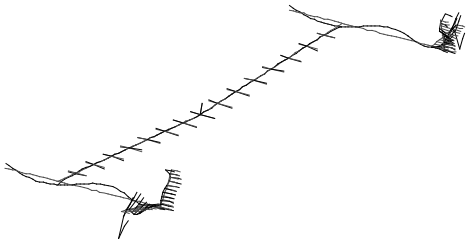
Mode shape no. 61 at 55.82 Hz



Mode shape no. 62 at 55.85 Hz



Mode shape no. 63 at 59.57 Hz



Mode shape no. 64 at 59.57 Hz

Figure 3.8: Mode shapes and natural frequencies for the two-dimensional gust analysis (concluded).

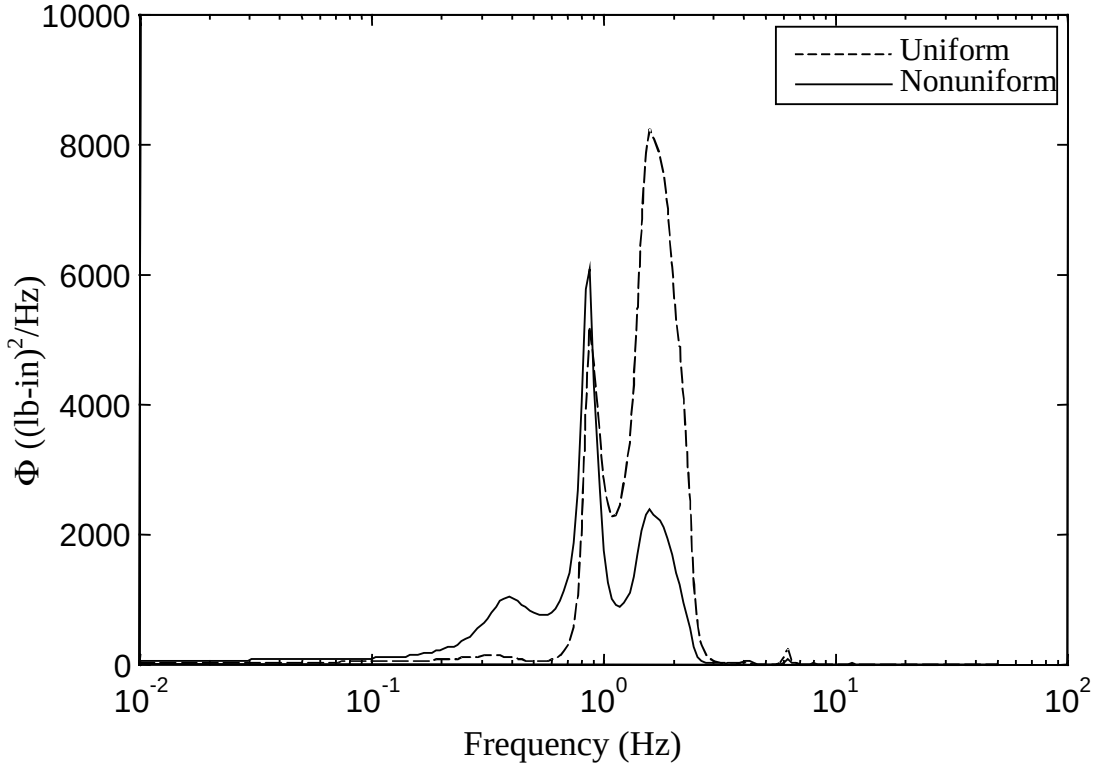


Figure 3.9: Power spectral density of M_1 at grid point 101.

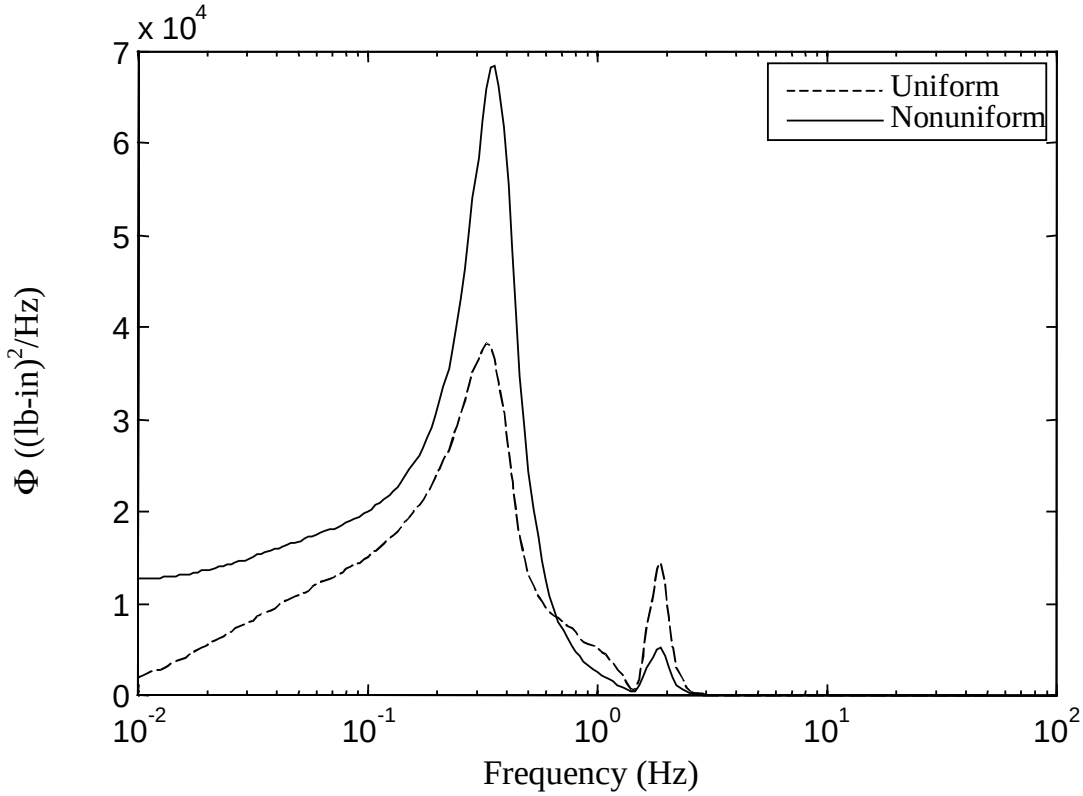


Figure 3.10: Power Spectral density of M_2 at grid point 101.

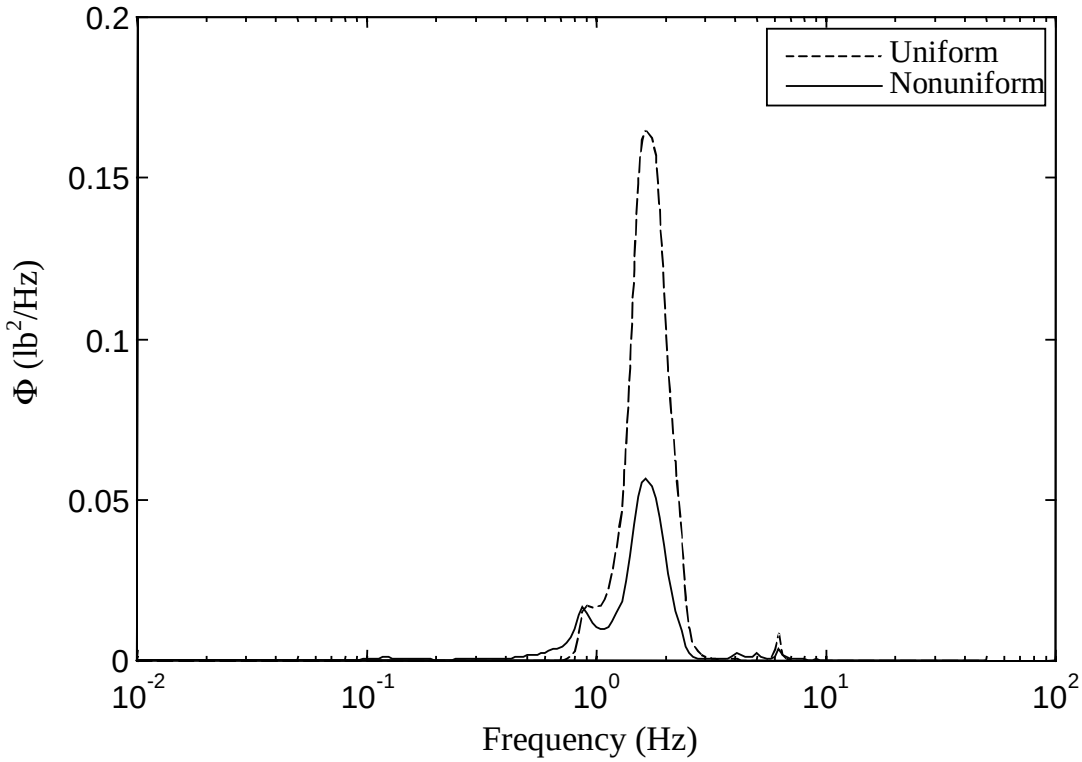


Figure 3.11: Power Spectral density of V_1 at grid point 101.

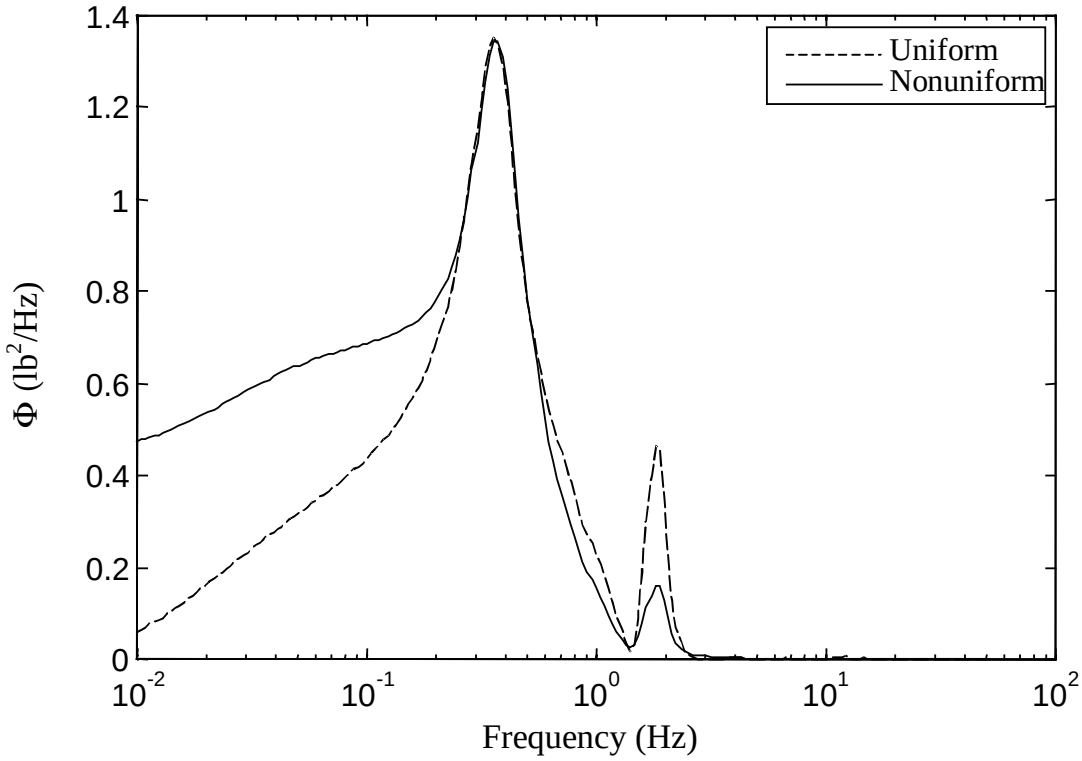


Figure 3.12: Power Spectral density of V_2 at grid point 101.

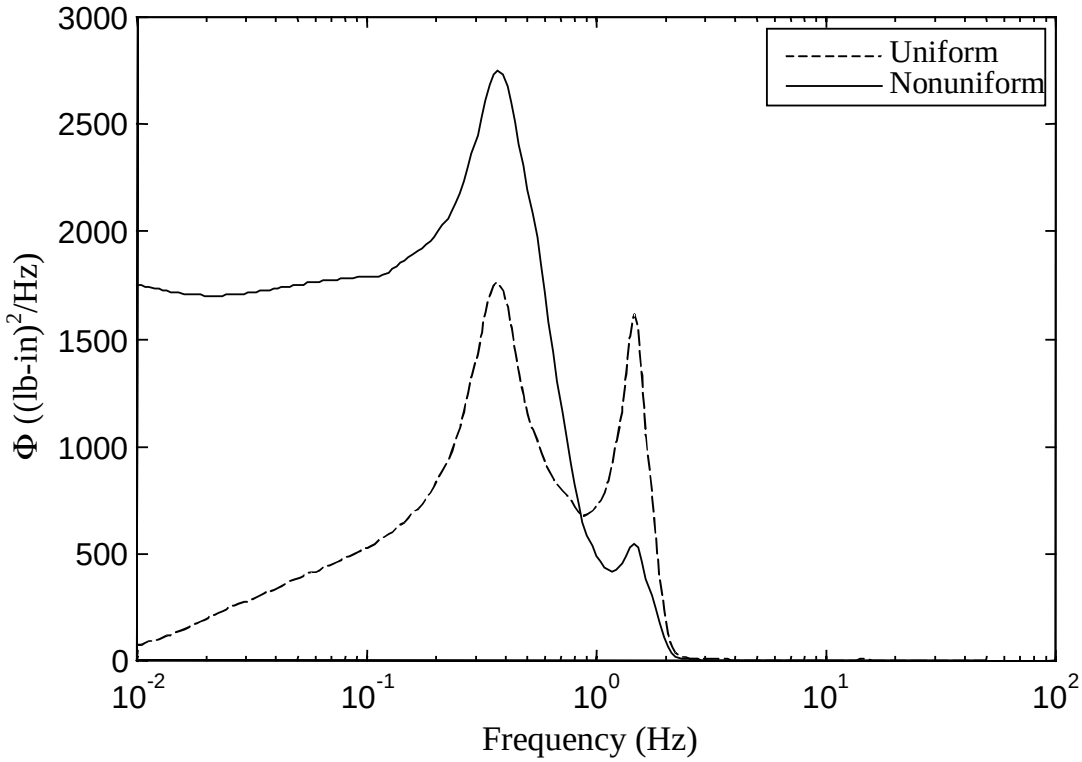


Figure 3.13: Power Spectral density of T at grid point 101.

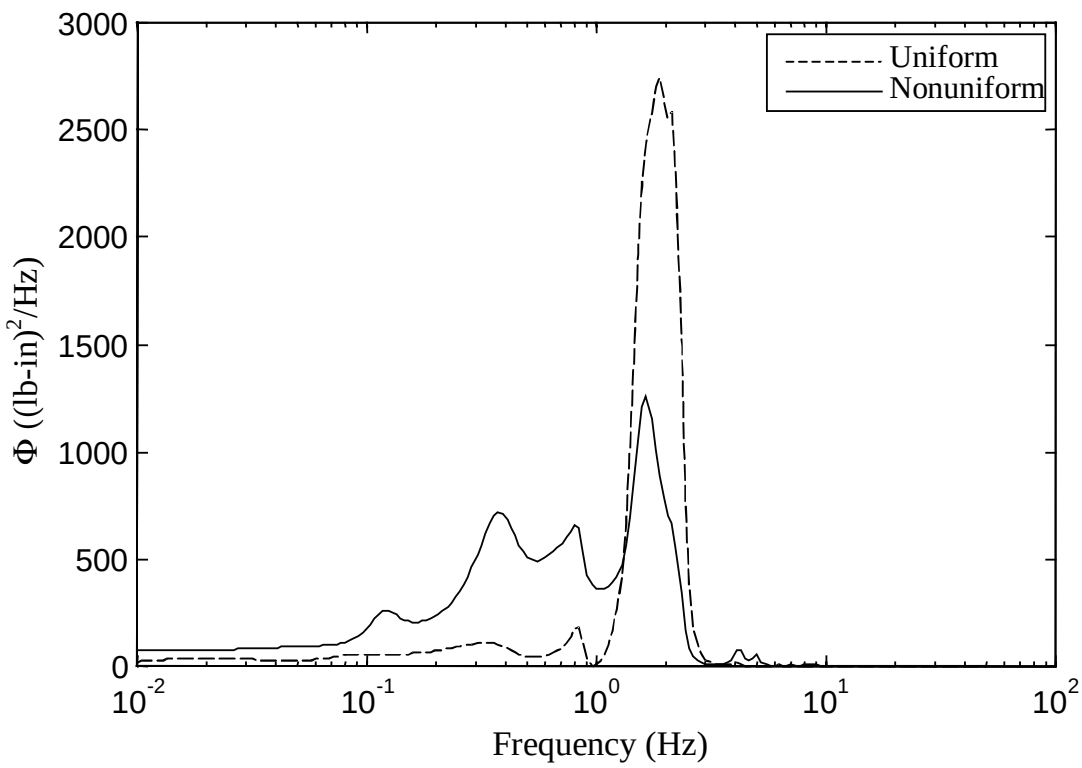


Figure 3.14: Power Spectral density of M_1 at grid point 140.

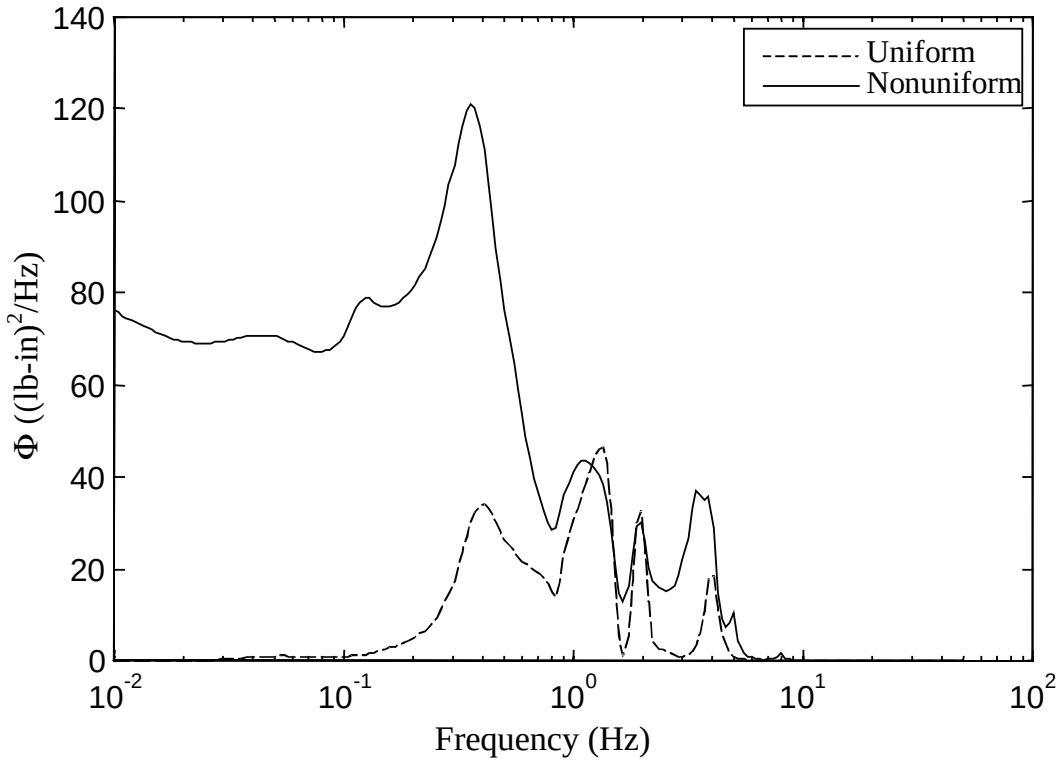


Figure 3.15: Power Spectral density of M_2 at grid point 140.

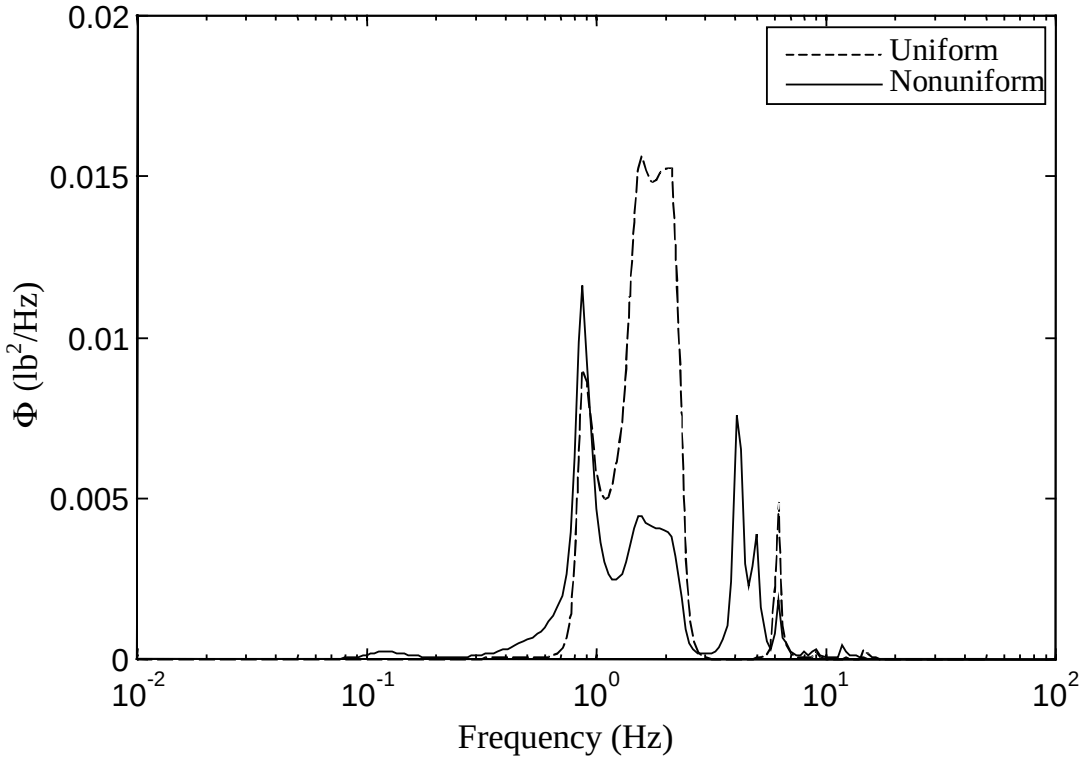


Figure 3.16: Power Spectral density of V_1 at grid point 140.

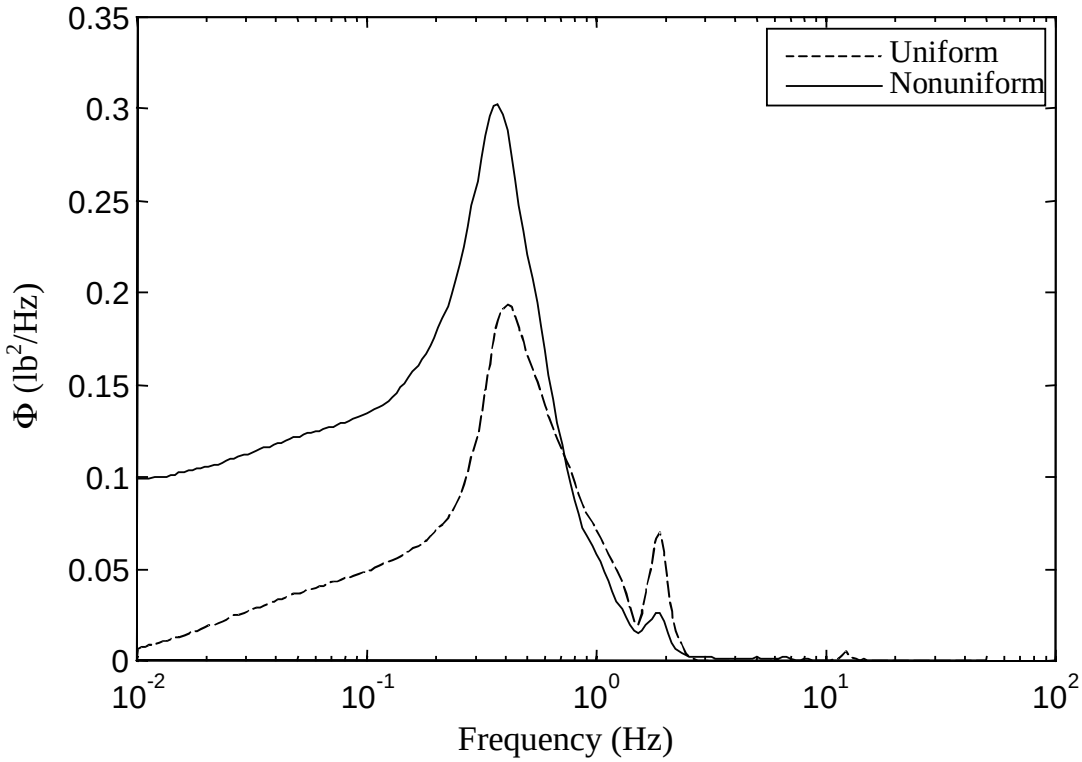


Figure 3.17: Power Spectral density of V_2 at grid point 140.

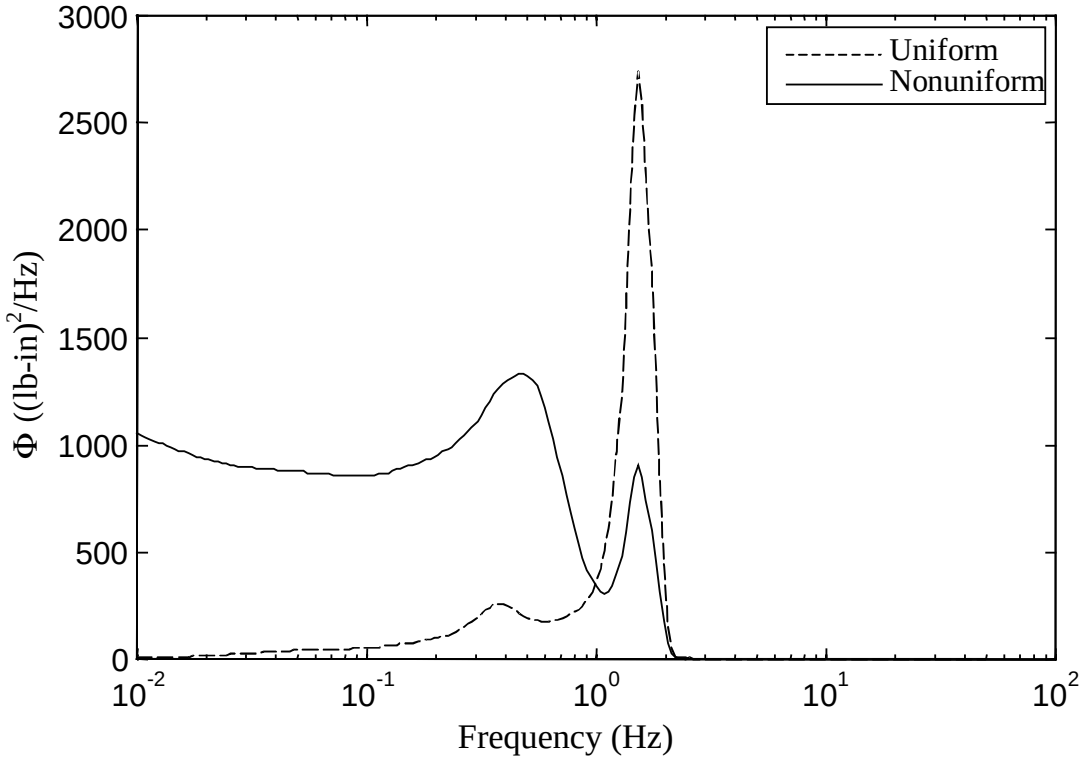


Figure 3.18: Power Spectral density of T at grid point 140.

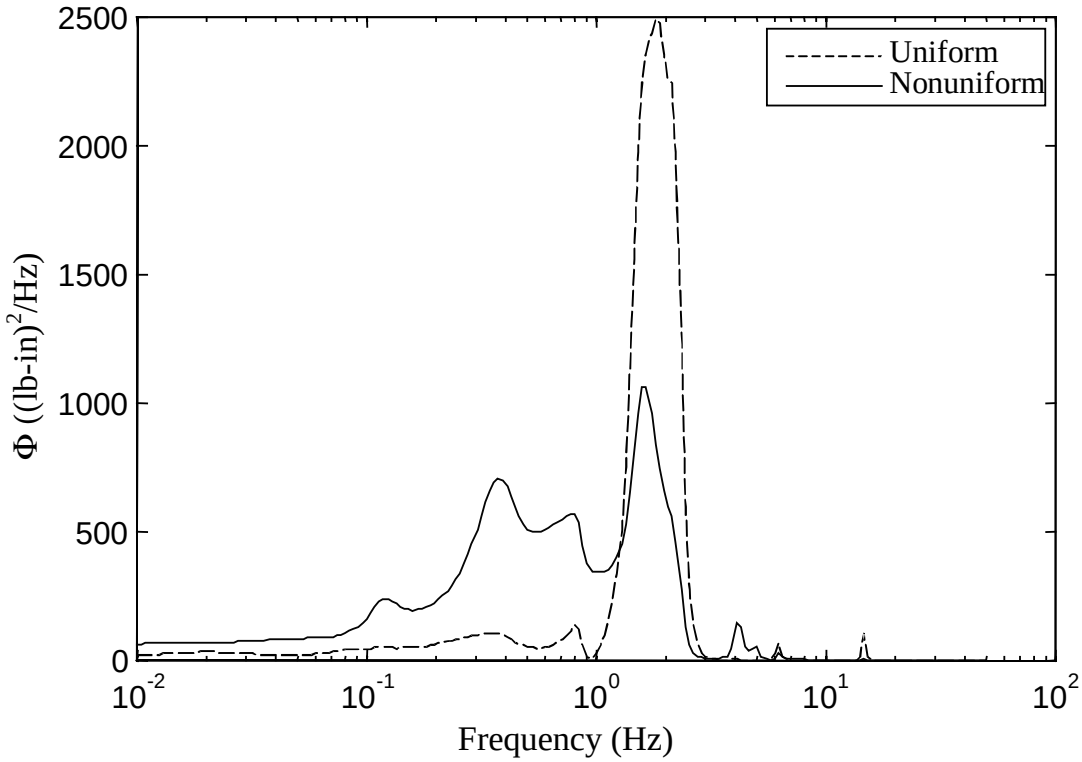


Figure 3.19: Power Spectral density of M_1 at grid point 217.

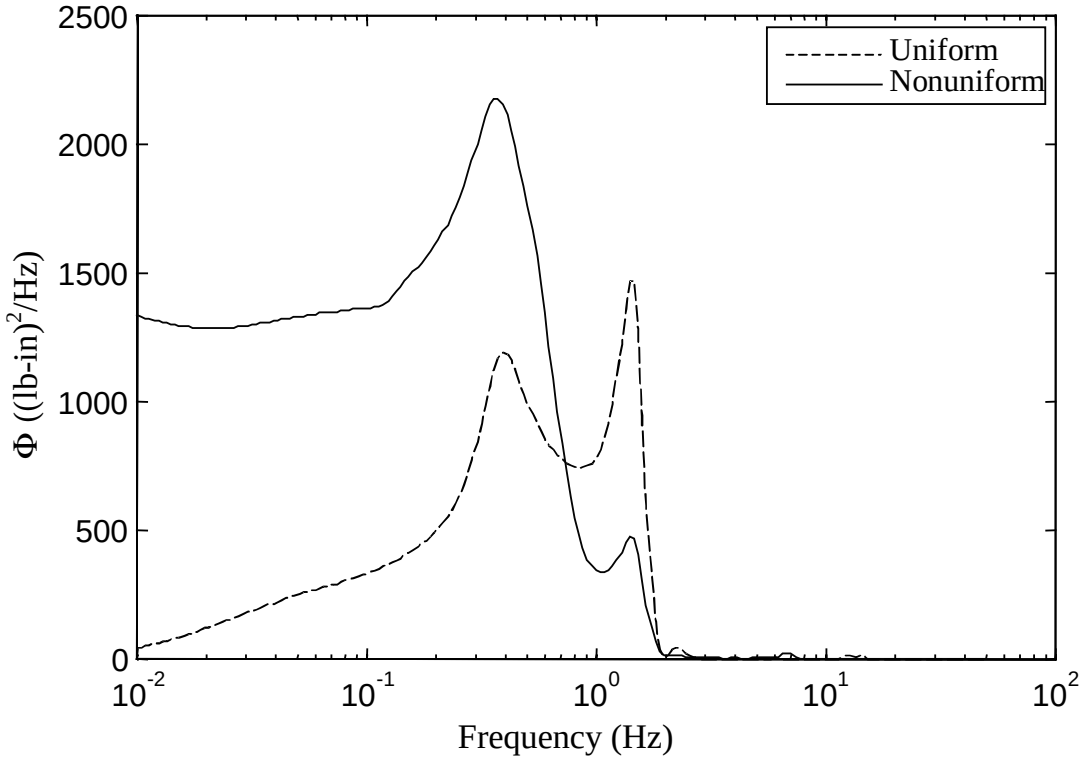


Figure 3.20: Power Spectral density of M_2 at grid point 217.

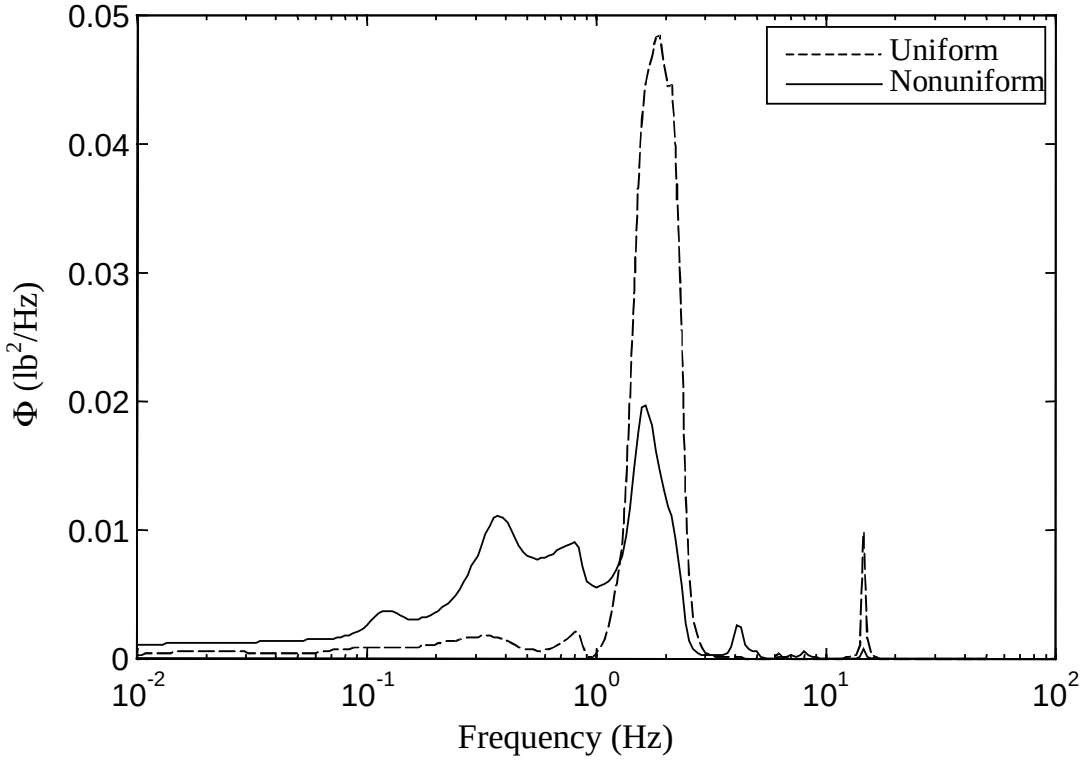


Figure 3.21: Power Spectral density of V_1 at grid point 217.

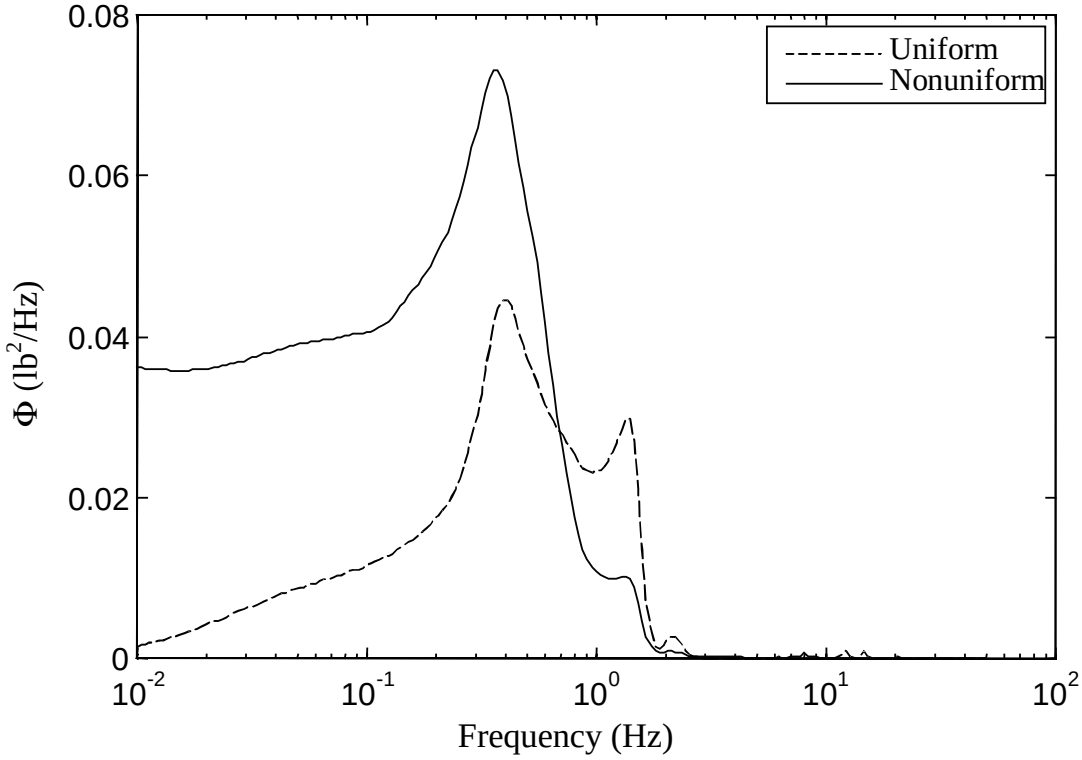


Figure 3.22: Power Spectral density of V_2 at grid point 217.

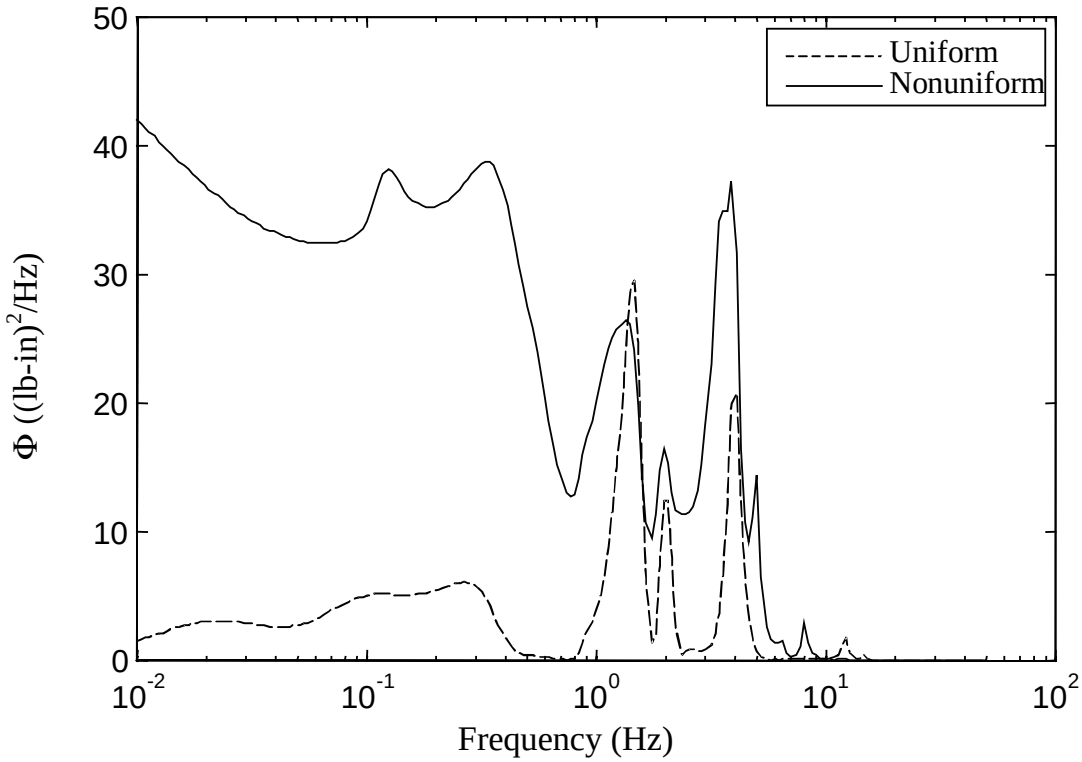


Figure 3.23: Power Spectral density of T at grid point 217.

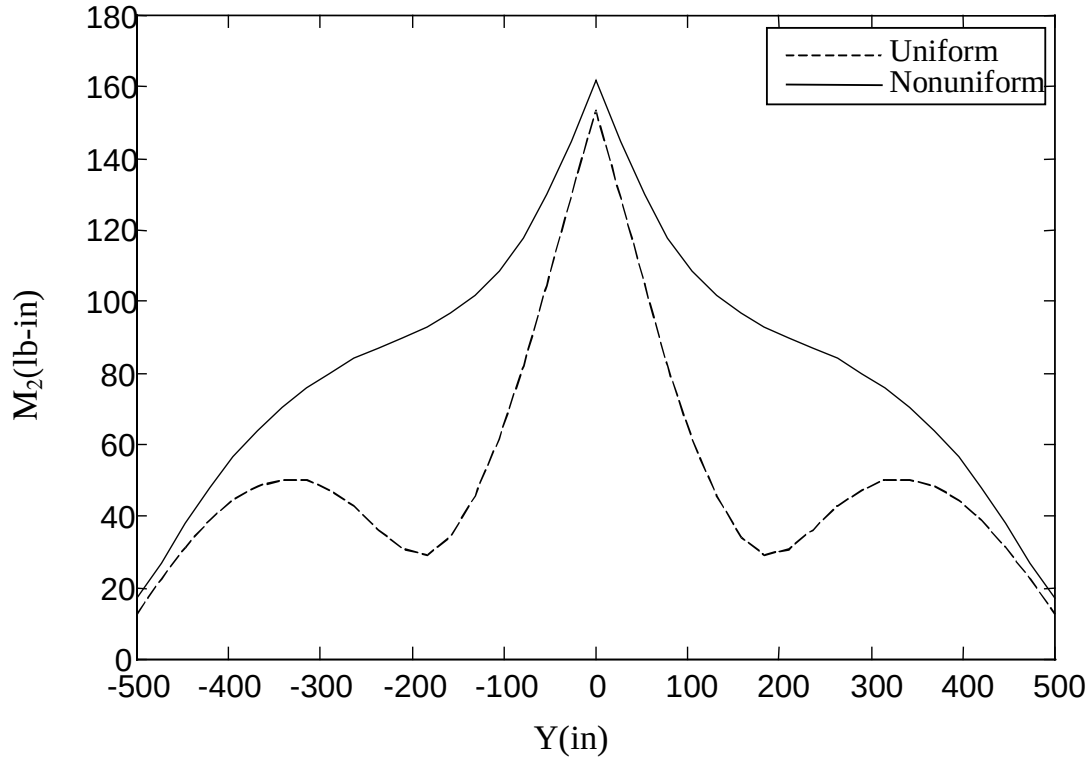


Figure 3.24: Span-wise variation of the RMS value of moment M_2.

The PSDs of the acceleration components of the center of gravity (point 95) in the flow direction, A_1, the vertical direction, A_3, and about the pitching axis, A_5, are shown in Figure 3.26-Figure 3.28, respectively. As expected, the highest acceleration magnitude is in the vertical direction. Additionally, the translational accelerations A_1 and A_3, are affected by both bending and twisting modes. This is mainly because the center if gravity is removed from the elastic axis of the wing. The angular acceleration, A_5, on the other hand peaks mainly at the natural frequencies of the torsion modes. Accelerations A_1, A_2, and A_5 for point 140 are shown in Figure 3.29-Figure 3.31, and for point 217 in Figure 3.32-Figure 3.34.

Additional output quantities were the root-mean-square value of the responses and the expected number of zero crossings with positive slope per unit time. Table 3-5 presents a comparison of these quantities for the non-uniform and uniform gusts.

In order to ascertain that the solutions were converged with respect to the frequency range analyzed and the number of modes used in the analysis, the number of modes used was increased from 50 to 64 with no significant changes in loads. This includes the response RMS values shown in Table 3-5. Also, note that in Figure 3.9-Figure 3.23, no significant loads exist above 20 Hertz in spite of the fact that flexible modes and excitation loads exist at frequencies three times greater. Another point to be addressed here is the size of the aerodynamic model. The current model has 1440 aerodynamic boxes with 160 strips. This case was also studied using a smaller model of 720 aerodynamic boxes and 80 correlation strips. The results from the smaller model were significantly different from those of the larger model, with difference in excess of 20% for some response quantities, especially in the lower frequency range.

Table 3-5: Summery of the probability parameters for response quantities.

Point number	Response	$\overline{A}$		N_0 (Hz)	
		Non uniform	Uniform	Non uniform	Uniform
101	M_1	61.918 lb-in	92.823 lb-in	2.1117	1.9112
	M_2	161.66 lb-in	153.57 lb-in	0.9794	1.4782
	V_1	0.2324 lb	0.3745 lb	2.8910	2.3761
	V2	0.8749 lb	0.9530 lb	1.5689	2.2180
	T	45.284 lb-in	44.291 lb-in	1.0717	2.2135
140	M_1	39.964 lb-in	51.174 lb-in	2.1109	1.9871
	M_2	12.805 lb-in	8.0928 lb-in	2.5697	2.4661
	V_1	0.1263 lb	0.1475 lb	4.8235	4.0010
	V2	0.4477 lb	0.4190 lb	1.9287	3.2141
	T	38.245 lb-in	41.039 lb-in	1.1334	1.9075
217	M_1	38.491 lb-in	50.282 lb-in	2.4539	3.4127
	M_2	40.182 lb-in	40.108 lb-in	1.6933	2.7075
	V_1	0.1660 lb	0.2351 lb	3.6163	6.0001
	V2	0.2200 lb	0.2150 lb	2.1295	3.3317
	T	10.645 lb-in	6.1148 lb-in	3.3283	4.6871

Where, $\overline{A}$ = Root Mean Square value of the response.
N_0 = Expected number of zero crossings with positive slope per unit time

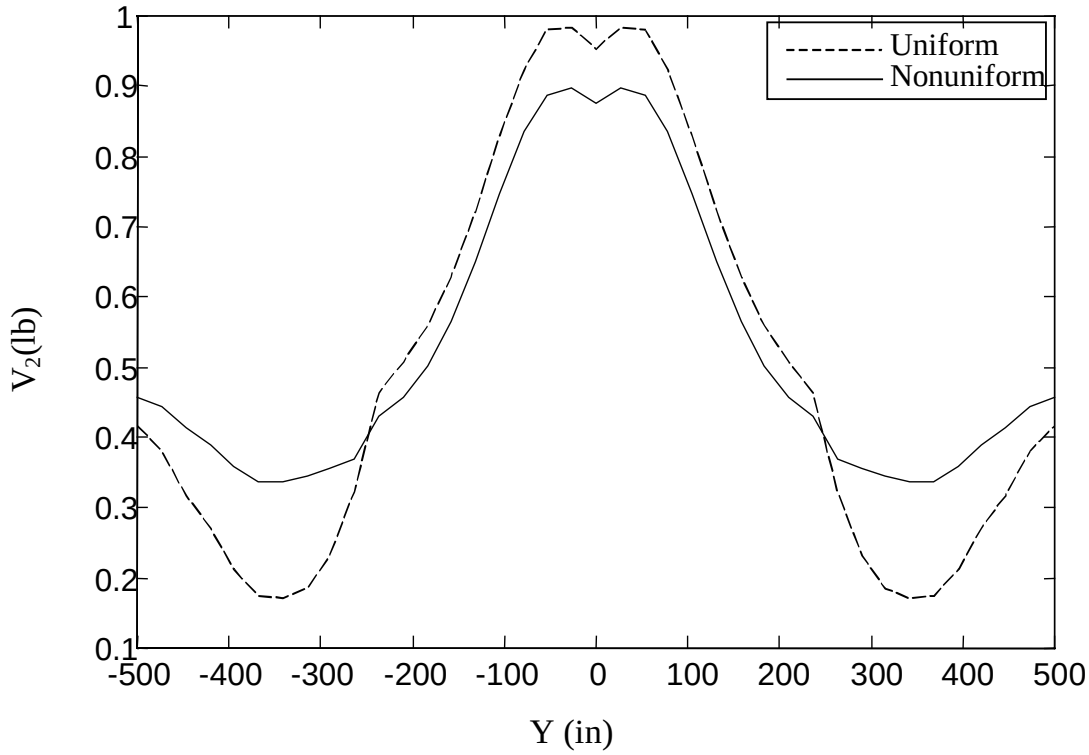


Figure 3.25: Span-wise variation of the RMS value of shear force V_2.

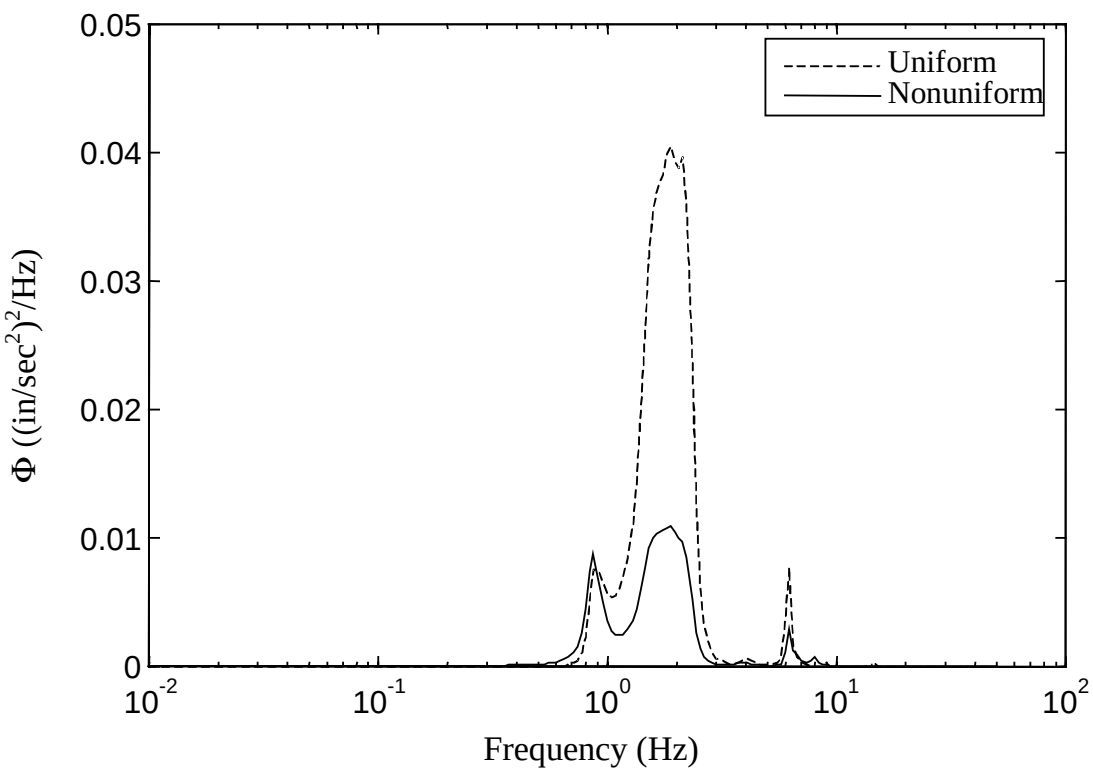


Figure 3.26: Power spectral density of the acceleration A_1 for the center of gravity.

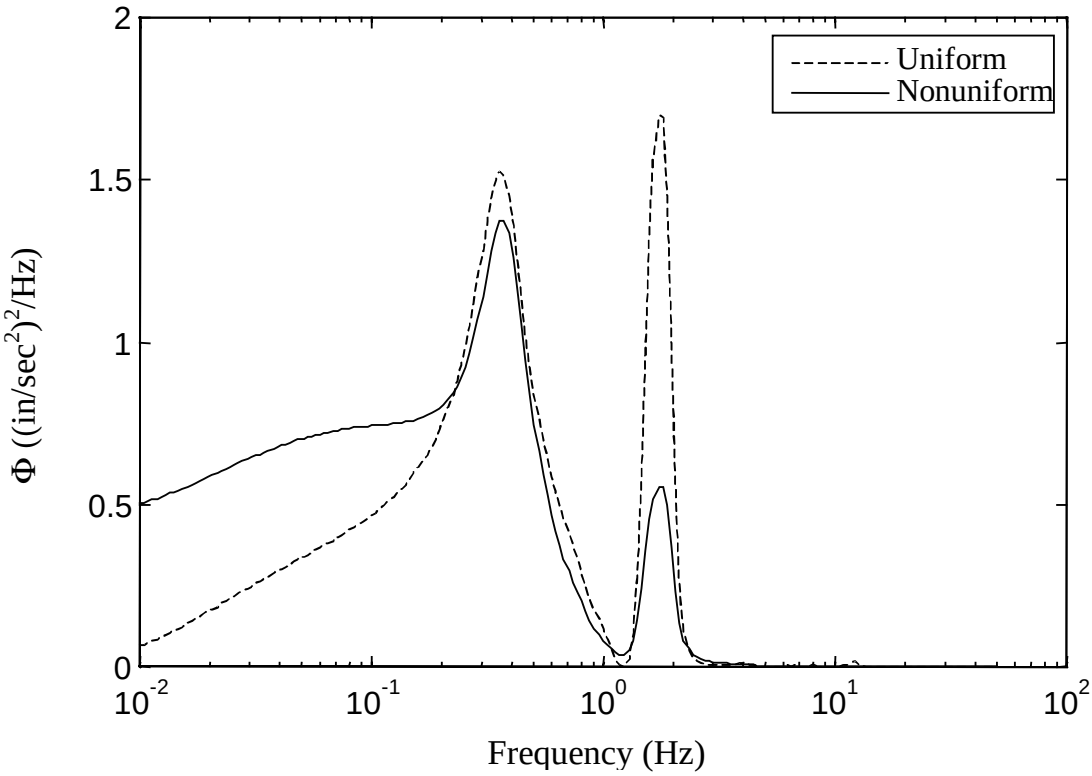


Figure 3.27: Power spectral density of the acceleration A_2 for the center of gravity.

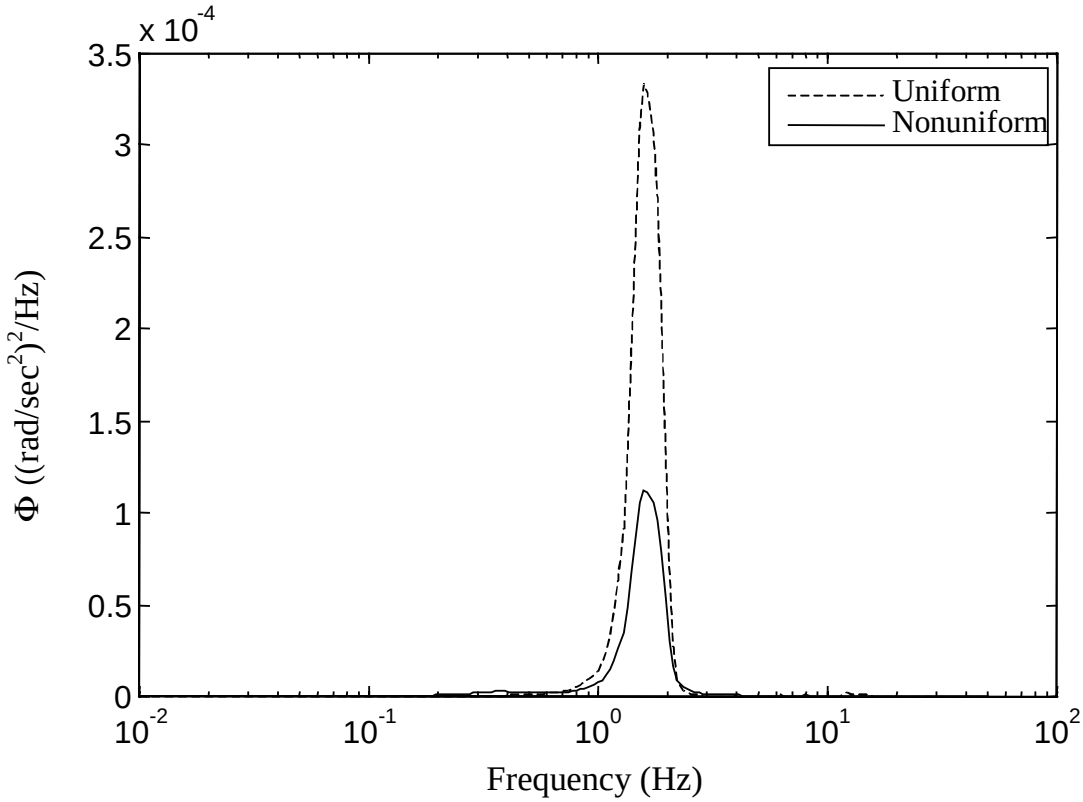


Figure 3.28: Power spectral density of the angular acceleration A_5 of the center of gravity.

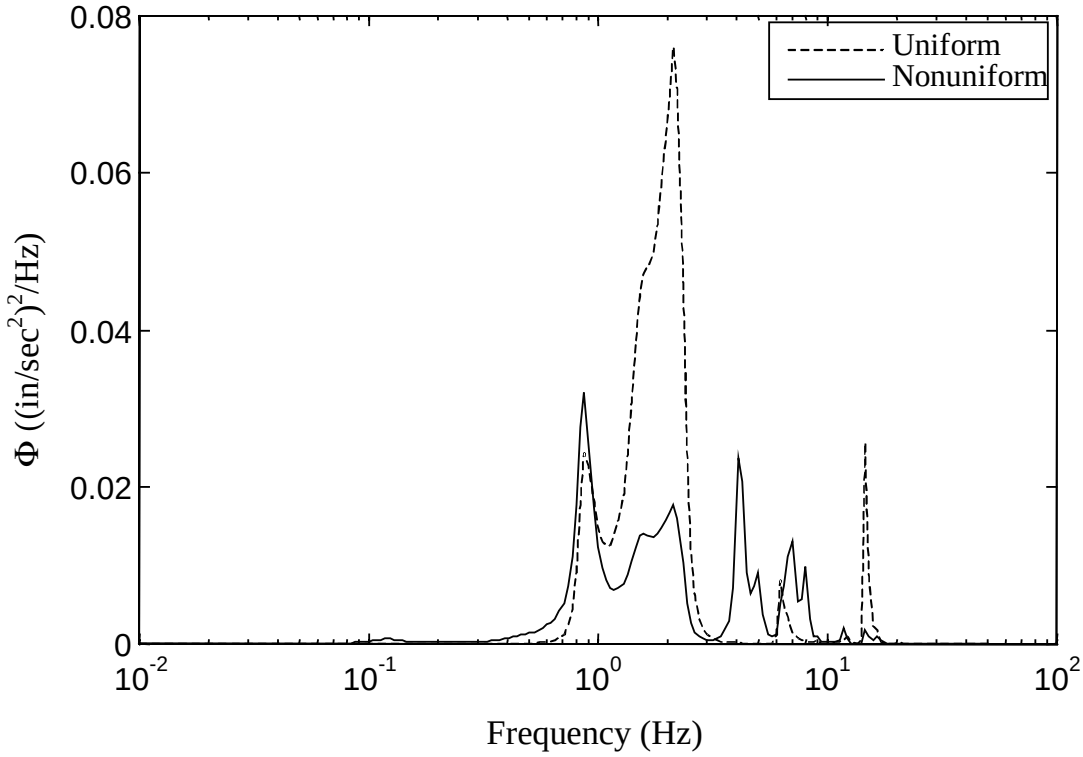


Figure 3.29: Power spectral density of the acceleration A_1 for grid point 140.

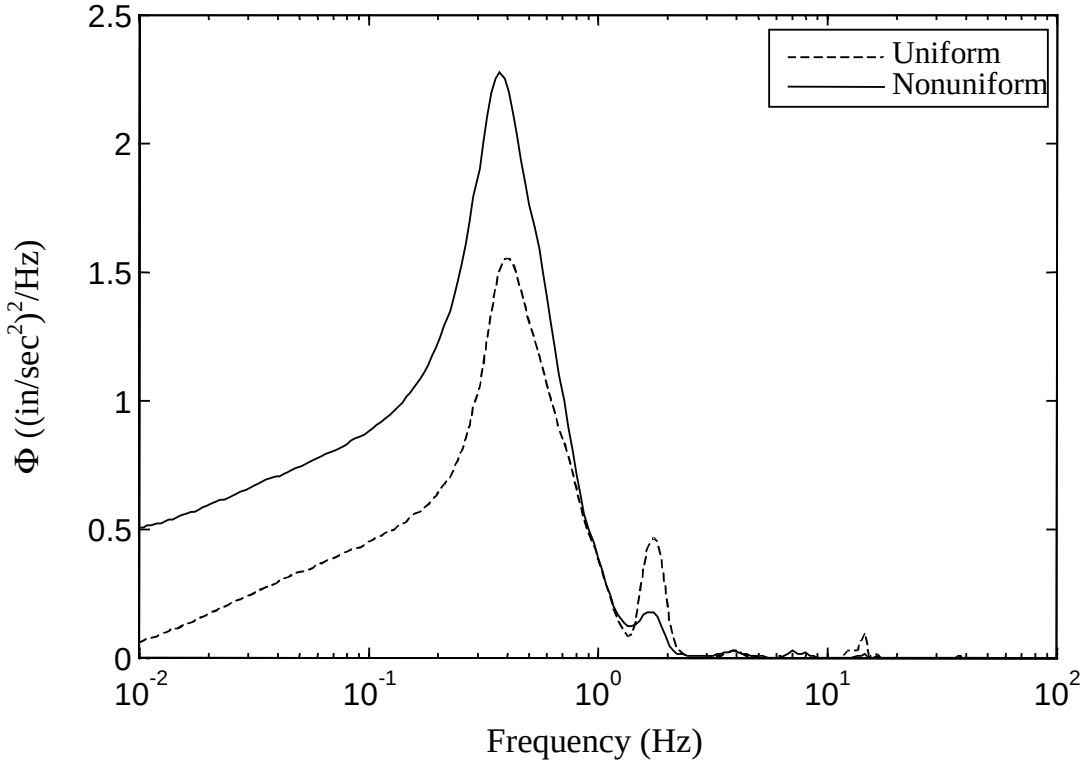


Figure 3.30: Power spectral density of the acceleration A_3 for grid point 140.

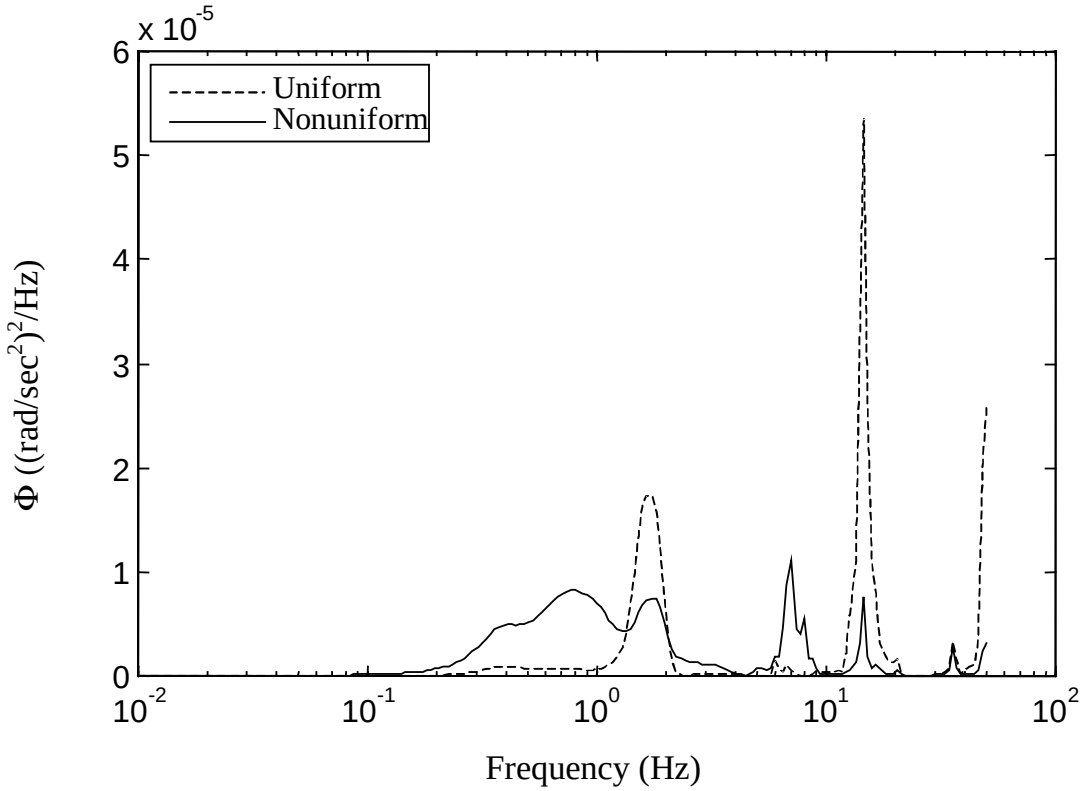


Figure 3.31: Power spectral density of the angular acceleration A_5 for grid point 140.

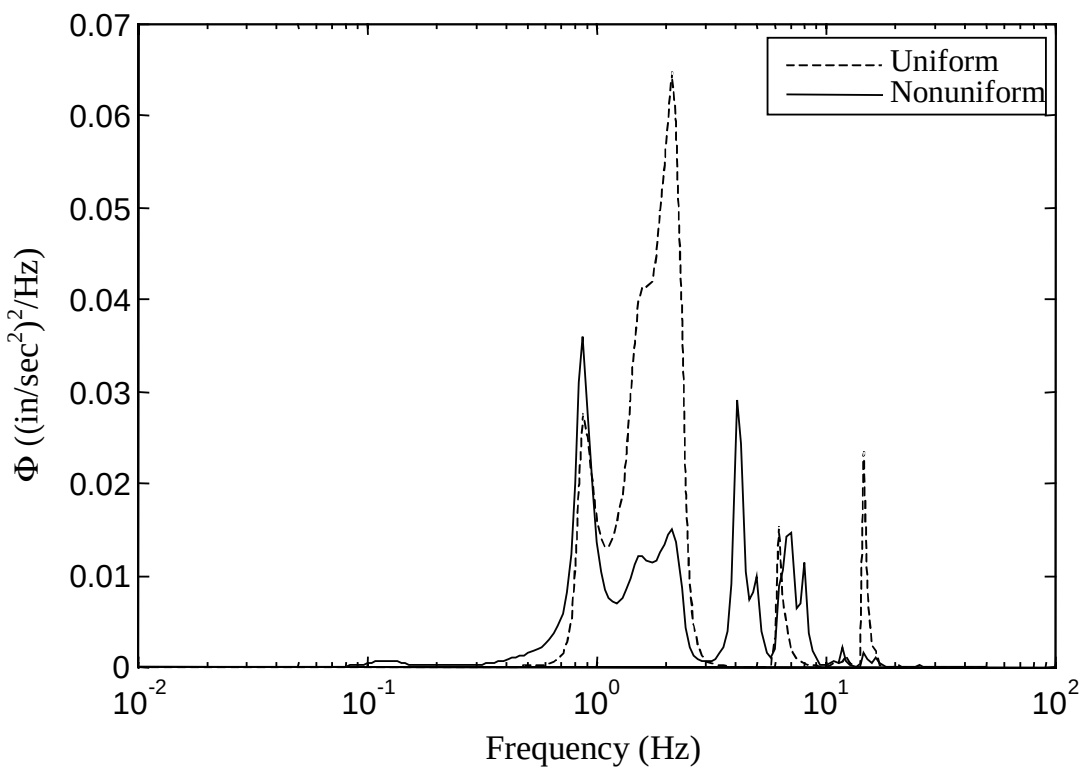


Figure 3.32: Power spectral density of the acceleration A_1 for grid point 217.

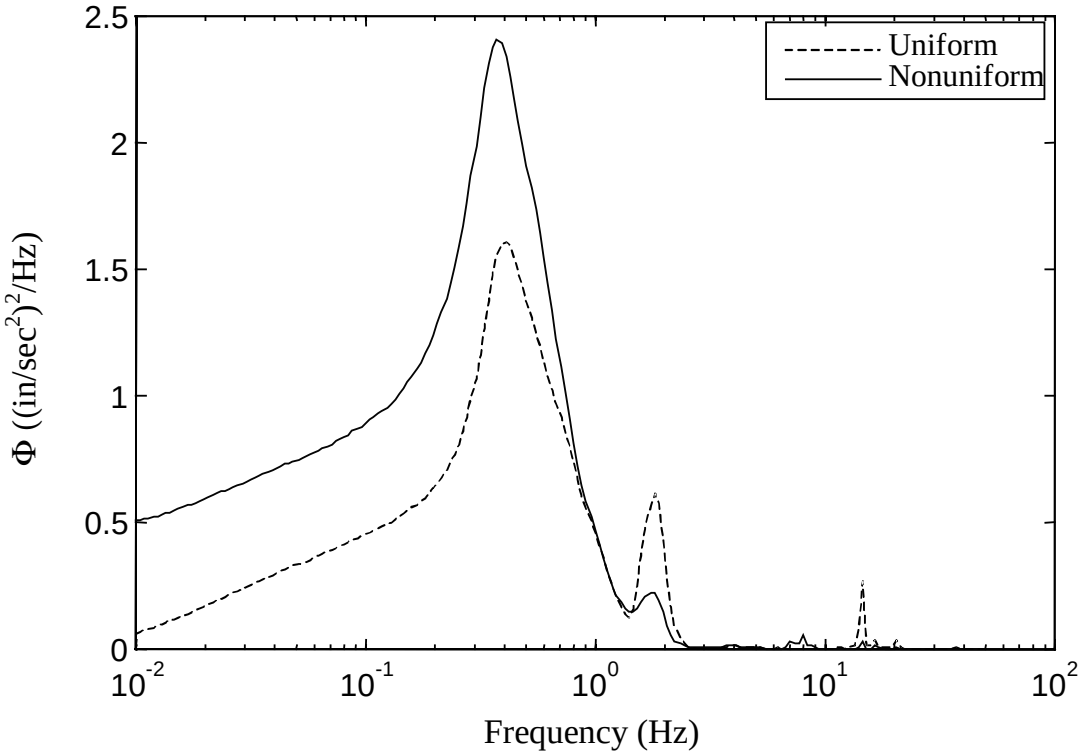


Figure 3.33: Power spectral density of the acceleration A_3 for grid point 217.

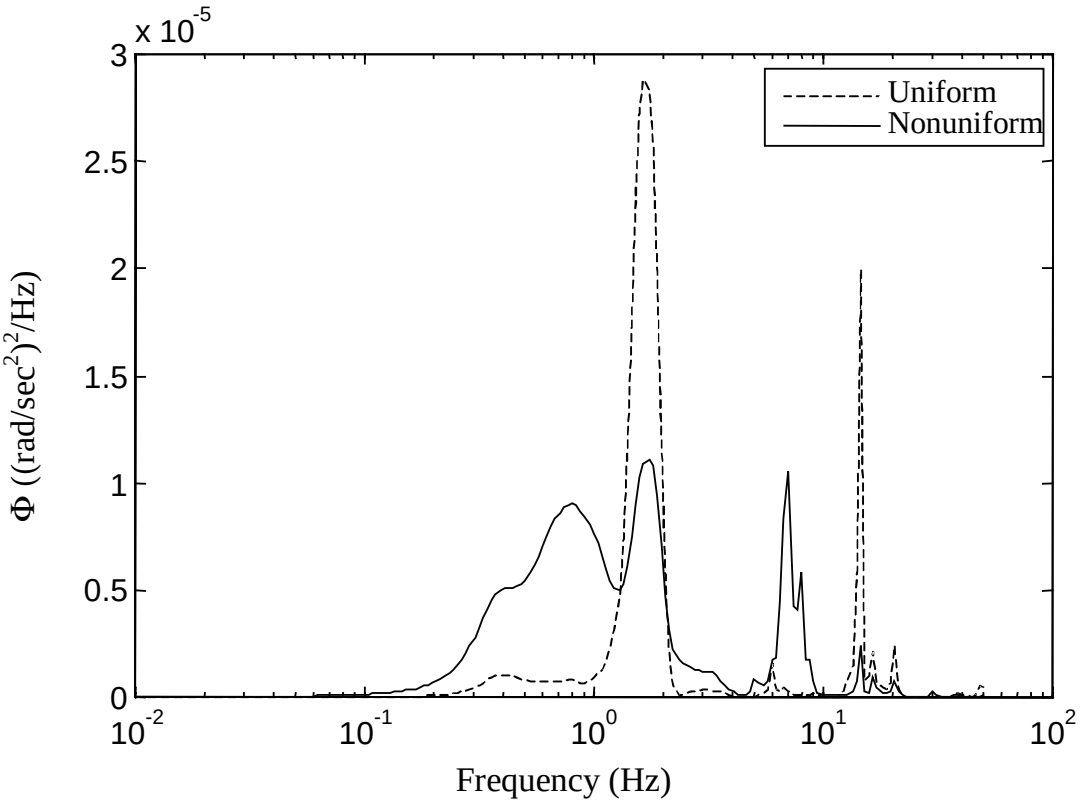


Figure 3.34: Power spectral density of the angular acceleration A_5 for grid point 21.

4 DISCRETE GUST ANALYSIS

4.1 Introduction

In this chapter we perform a tuned discrete gust analysis on the semi-span Alliance 1 aeroelastic/finite element model using MSC/NASTRAN's Discrete Gust Response Analysis (Reference 2) capability. The tuned discrete gust analysis presented here is based on the current (year 2000) analysis requirements of the Federal Aviation Administration Regulation (Part 25.341) airworthiness standards for transport airplanes. Due to the nature of the aircraft analyzed however, the family of gust gradient lengths used differs from that prescribed for transport aircraft.

The FAA standards have changed over last few years. In the past, a single discrete gust analysis was conducted with a gust gradient length of

$$H=12.5\bar{c} \tag{4.1}$$

where $\bar{c}$ is the mean aerodynamic chord, and only from that analysis where the peak loads and the correlated loads assessed. Because the single calculation did not give the maximum design load, a tuned discrete gust approach was adopted. The new requirement has two alleviating factors included in load computations. The first is for high altitude aircraft that spend little time at gust-prone low altitudes and the other is a $H^{1/6}$ factor which has an attenuating effect on the higher frequency modes.

Wing loading for the Alliance 1 is approximately 5 lbs/ft^2, which is less than 1/20th of a typical transport aircraft. Typical internal structural loads due to discrete gusts for this type of light aircraft tend to be much less than for commercial transports because the mass is more evenly distributed along the wing span and they are lifted or plunged vertically during uniform discrete gust encounters with little inertia resistance. Conversely, accelerations in response to discrete gusts tend to be larger than for heavier transports.

Table 4-1: Rigid body and flexible natural frequencies of all modes used in Discrete Gust Response Analysis.

Mode no.	Frequency hertz	Mode no.	Frequency hertz	Mode no.	Frequency hertz	Mode no.	Frequency hertz
1	0	9	4.117058	17	15.33962	25	38.73983
2	0	10	6.115234	18	16.71737	26	40.05799
3	0	11	6.749472	19	21.31522	27	43.87366
4	0.380363	12	8.314463	20	23.91713	28	44.94824
5	0.8129176	13	9.271044	21	26.45134	29	50.46395
6	1.289616	14	10.87025	22	31.49955	30	51.7564
7	2.036124	15	12.84028	23	31.92673	31	55.83799
8	2.201072	16	14.59939	24	36.93553	32	59.57046

The basic model for this analysis is the same semi-span finite element model described in Section 2. The model was structurally constrained to reflect symmetrical motions at the aircraft's centerline. The lowest frequency 32 modes, including three rigid-body modes and 29 flexible modes up to 60 Hertz, were used and are listed in Table 4-1. Mode shapes can be viewed in plots presented in Figure 2.3. The doublet-lattice method was used to compute the unsteady aerodynamics and the box layout used is also the same as in reference Section 1.

The parameters for the single flight condition used in the analysis are listed in Table 4-2. The fuel load, vehicle weight, and pitch inertia conditions specified in the Table are for the full-span aircraft. The weight and pitch inertia was computed from the finite element model. The gust velocity used in the analysis was taken from Reference 1. Some of the dimensions of the Alliance 1 vehicle are given in Table 4-3 and are for the full-span vehicle. The MSC/NASTRAN input file used for the discrete gust response analysis is listed in Appendix H. This file contains the structural and mass element definitions for the half-span finite element model. Since it is an aeroelastic model, the file listing also provides the geometry definitions for doublet lattice unsteady aerodynamics. Because the analysis requires a Fourier transform method to compute time response of the loads and accelerations, the frequency increment and time steps are listed in the Appendix in the FREQ and TSTEP entries. The discrete gust loading is rather complicated, requiring multiple TLOAD2 entries to build a particular excitation waveform for each gust gradient analysis. The TLOAD2 entry is a fairly general waveform generator, but for the purposes of this analysis, it provides unit steps and cosine waveforms. To generate one gust excitation load, multiple TLOAD2 entries are combined with a DLOAD entry to form a 1/2 -cosine/2 waveform shape. To reduce the number of input files, several TLOAD2 and DLOAD sets are listed. Each set represents a different gradient gust case. All the different gradient gust lengths cases are necessary to complete the tuned discrete gust analysis.

Table 4-2: Vehicle flight condition and inertial characteristics.

Altitude	1000.0 ft.
True Air Speed	98.3 ft/sec
Dynamic Pressure	.077444 psi
Mach Number	0.09
Gust Velocity, U_{de}	36.7 ft./sec.
Vehicle Flight Weight	2095.478 lbs.
Pitch Inertia	109,779.4 lbs-ft^2
Fuel Weight	333.9 lbs.

Table 4-3: Vehicle dimensions, areas and ratios.

Wing Reference Area	439 ft.^{2}
Wing Span	87.6 ft.
Length	34.4 ft.
Reference chord, $\bar{c}$	4.25 ft.
Aspect Ratio	24.3
Root Chord	5 ft.
Tip Chord	3.48 ft.

4.2 Analysis Procedure

The discrete gust analysis used in SC/NASTRAN is summarized in Figure 4.1, which shows two input paths to generate the gust load time response. The top path generates the prescribed 1-cosine excitation waveform with a peak gust velocity of U_{de}. The gust velocity waveform is attenuated by the $H^{1/6}$ factor and converted to a gust angle of attack when it is divided by the vehicle's forward velocity. F_g has a computed value of nearly one having no effect on this analysis. The final step of the top path is the Fourier transform of the excitation time response into the frequency domain to form an excitation

frequency response function. In the bottom path, the frequency domain equations of motion representing the aeroelastic states and the gust penetration aerodynamics and structural load output coefficients are combined to form the frequency response functions of load output to an arbitrary gust input. Before the unsteady aerodynamics in the aeroelastic equations of motion can be used in the gust analysis, they must first be converted to functions of the real frequencies instead of reduced frequencies. Then the aerodynamics must be interpolated to the gust analysis frequency points (these are the input frequency points listed by FREQ entry). The two paths are combined to form a final product that is a function of frequency. The final product is the load frequency response to the 1-cosine excitation. Each of the load frequency response functions is inverse Fourier transformed to obtain the time history responses of the loads.

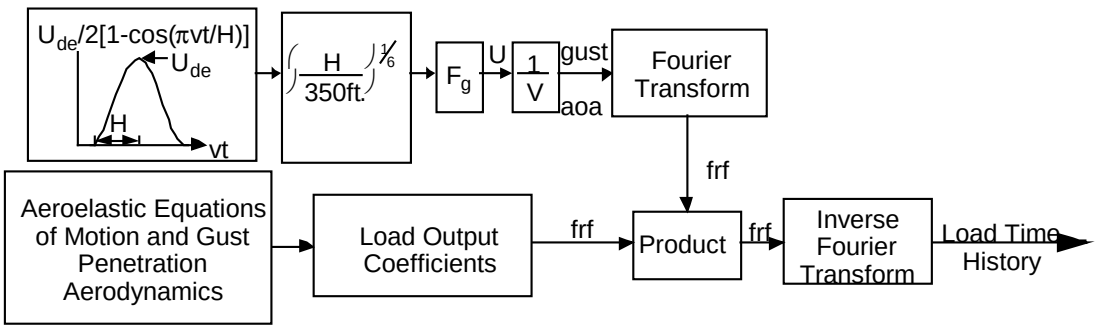


Figure 4.1: Analysis flow in MSC/NASTRAN for discrete gust response computations.

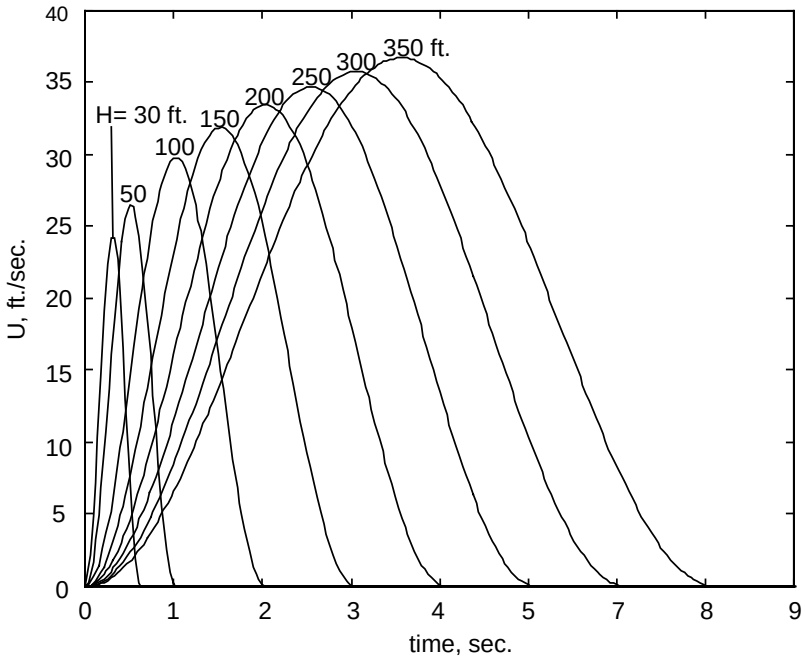


Figure 4.2: The 1 - cosine discrete gust velocities at various gradient lengths.

Since the MSC/NASTRAN Discrete Gust Response Analysis currently does not have subcase capability to analyze all the different gust gradient lengths for one tuned discrete gust analysis run, it is necessary to run one analysis for each gust gradient length. The velocity waveform plots shown in Figure 4.2 are the velocities computed at point U in the top path of Figure 4.1. The set shown is provided as an example and

is not the one used for this study, but it does show a typical set that would be used to complete a tuned discrete gust analysis of a transport. In order to investigate the maximum structural responses in a light-weight vehicle like the Alliance 1, a special set of gradient lengths was selected which included shorter lengths than for a transport.

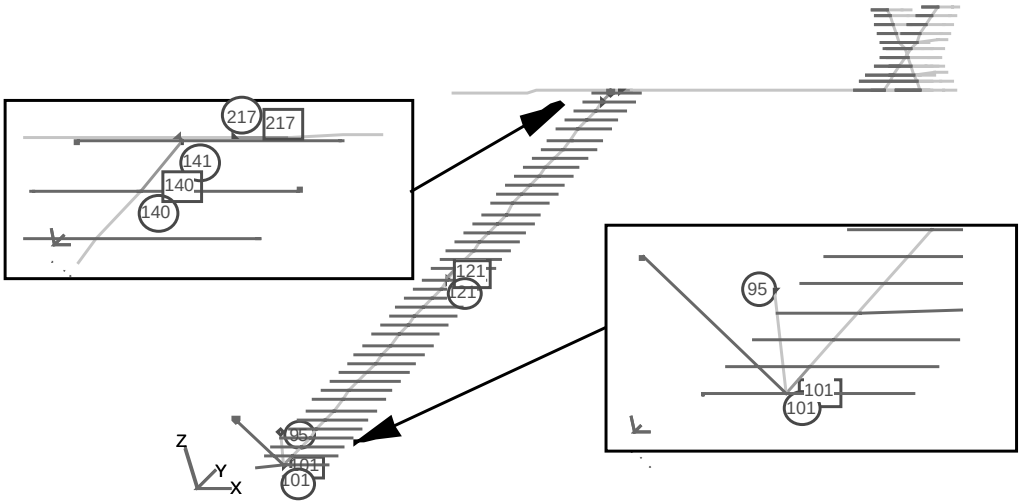


Figure 4.3: Element and node response locations on the half span finite element model of Alliance 1 aircraft.

4.3 Discrete Gust Response Analysis Output Quantities and Locations

For gust load certification purposes, loads and accelerations at many thousands of locations are typically output from a discrete gust response analysis to find the points where critical load conditions can occur on the aircraft. For purposes of this analysis, five points were selected for outputting load and acceleration time history responses. These locations are shown in Figure 4.3 and can be distinguished as nodes or element locations by circles or rectangles around their respective node or element numbers. Many of the locations output both nodal accelerations and element forces. The five location are: node 95 at the CG., node 101 at the centerline and element 101 at wing root, element and node 121 at mid span, element and node 140 at the wing tip, and element and node 217 on the boom just aft of the wing elastic axis. At each of the node locations, in-plane, vertical, and local pitch accelerations are output by MC/NASTRAN. For each bar element location, MSC/NASTRAN outputs in-plane and vertical shear forces, bending moments and torsion moments.

4.4 Results and Discussion

Although all the results mentioned above are generated by the MSC/NASTRAN deck in Appendix H, only a selection of the results will be presented in the this report. The wing root location had the largest gust loads. Figures 4.4-4.6 show both the vertical and in-plane components of load. For this location, nearly all the load time responses are shown.

Traditionally, vertical bending moment, vertical shear force, and torsion moment along the wing are computed, since the force created by the gust acts in the vertical direction. The in-plane loads generally are much smaller and regarded as being inconsequential. In this aircraft design, where the wing has a high aspect ratio and the spar consists of round-tube composite construction, the in-plane components of loads are smaller but not inconsequential as compared to the vertical component. In the figures, all the

gust gradient lengths load responses are given as a family of curves. Only one gradient length gives the maximum (or minimum) load for each family of load plots. Table 4-4 lists the gradient lengths used in this tuned gust study and also their respective frequencies. Figure 4.7-Figure 4.9 show a family of the vertical acceleration response curves at the vehicle's wing root, wing mid span, and wing tip locations respectively.

Table 4-4: Gust gradient lengths and corresponding frequencies used in the tuned gust analysis.

H, ft.	f, hz	H, ft.	f, hz	H, ft.	f, hz
6.64	7.4	39.8	1.23	85.0	.578
13.3	3.7	46.5	1.06	106.	.463
19.9	2.47	53.1	.925	142.	.346
26.6	1.85	60.7	.809	212.	.231
33.2	1.48	70.8	.694	425.	.116

It is interesting to note that the acceleration responses are the largest at mid-span, but if we look at the vehicle in terms of the its mass distribution, of the three output locations, mid-span has the least mass. This is expected because the lightest mass areas usually respond with the highest accelerations.

Generally, the response points of highest magnitude are of interest. Figure 4.10-Figure 4.13 show the maximum load and the absolute value of the minimum load for each of the gradient lengths at a given location.

An interesting aspect of this tuned gust analysis is that for all the locations and load types examined, gust gradient lengths of less than 30 feet were needed in order to find the maximum absolute responses. The necessity of using these shorter gradient lengths is significant, since the Federal Aviation Administration Regulation Part 25.341 specifies an analysis range to be between 30 feet to 350 feet. Because the Alliance 1 is very light and exhibits very low natural frequencies, the standard analysis starting point of 30 feet gust gradient length was not low enough. Maximum and minimum accelerations are shown in Figure 4.14-Figure 4.16 . The mid-wing station is shown to attain the highest vertical accelerations of 2.4 g's at a gust gradient length of 13 feet. The frequency of this gradient length is approximately 3 Hertz and it seem to interact with second and third bending modes near 2 to 4 hertz.

The second and third bending modes show little motion at the wing tip and aircraft centerline, indicating the large mass concentrations at those locations.

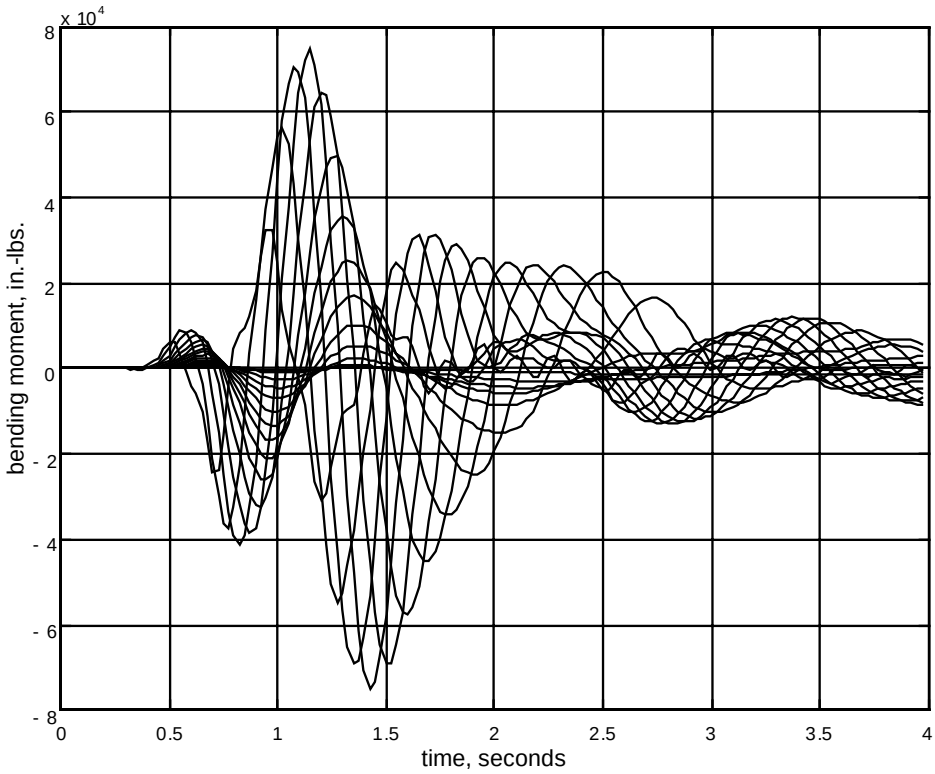


Figure 4.4: Tuned gust responses of in-plane wing root bending moment.

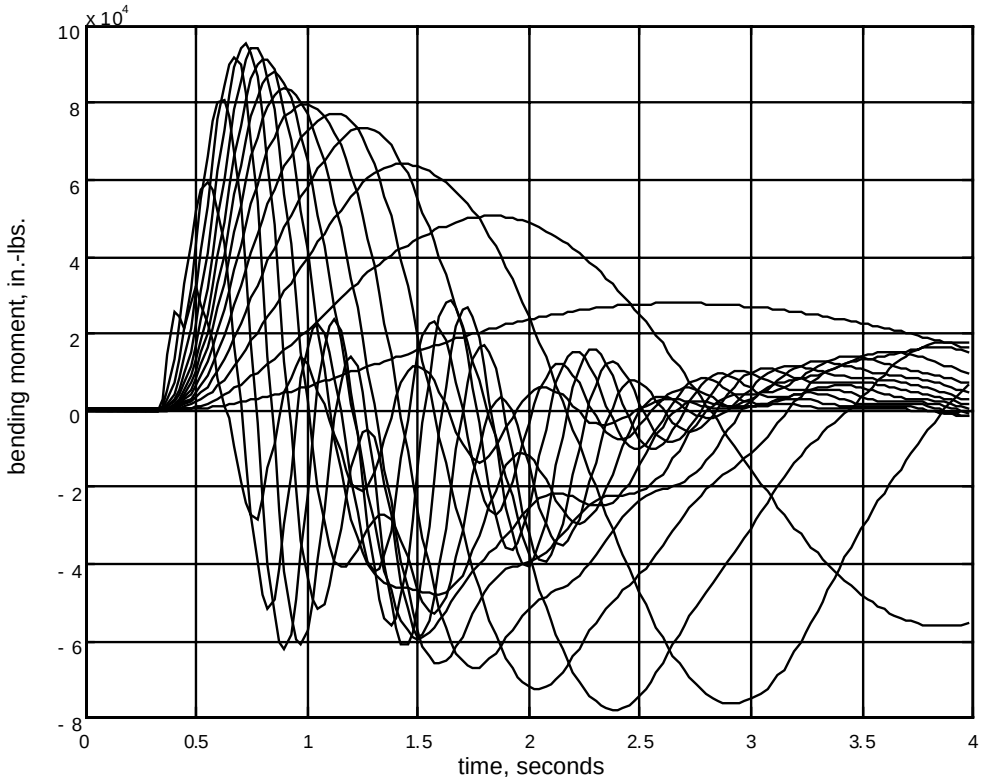


Figure 4.5: Tuned gust responses of vertical wing root bending moment.

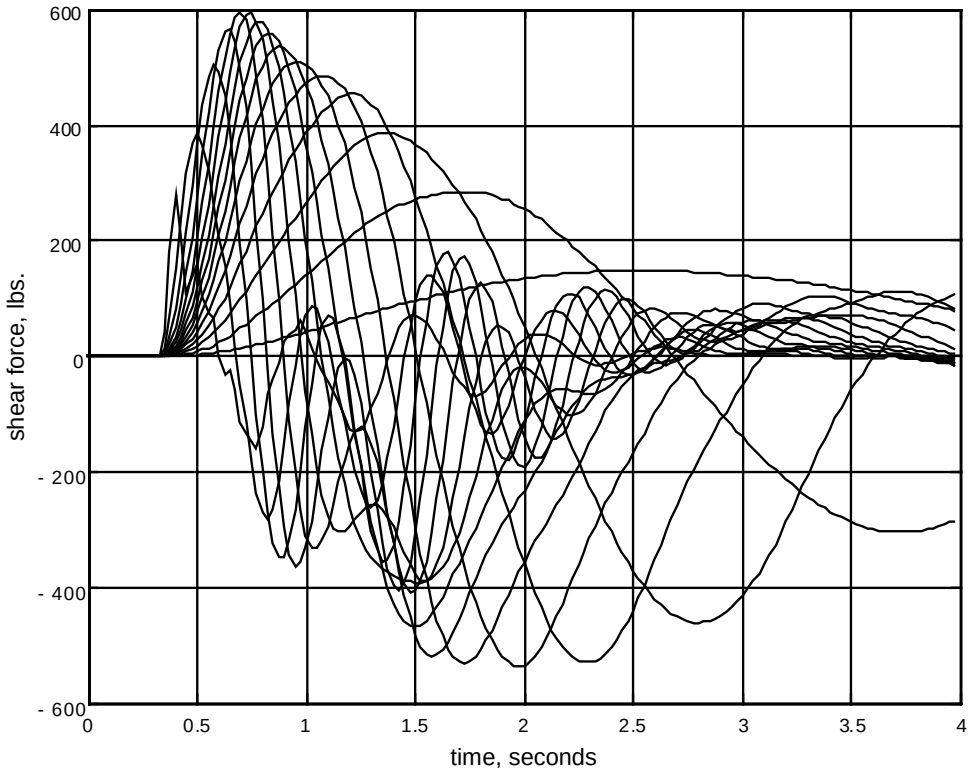


Figure 4.6: Tuned gust responses of vertical wing root shear force.

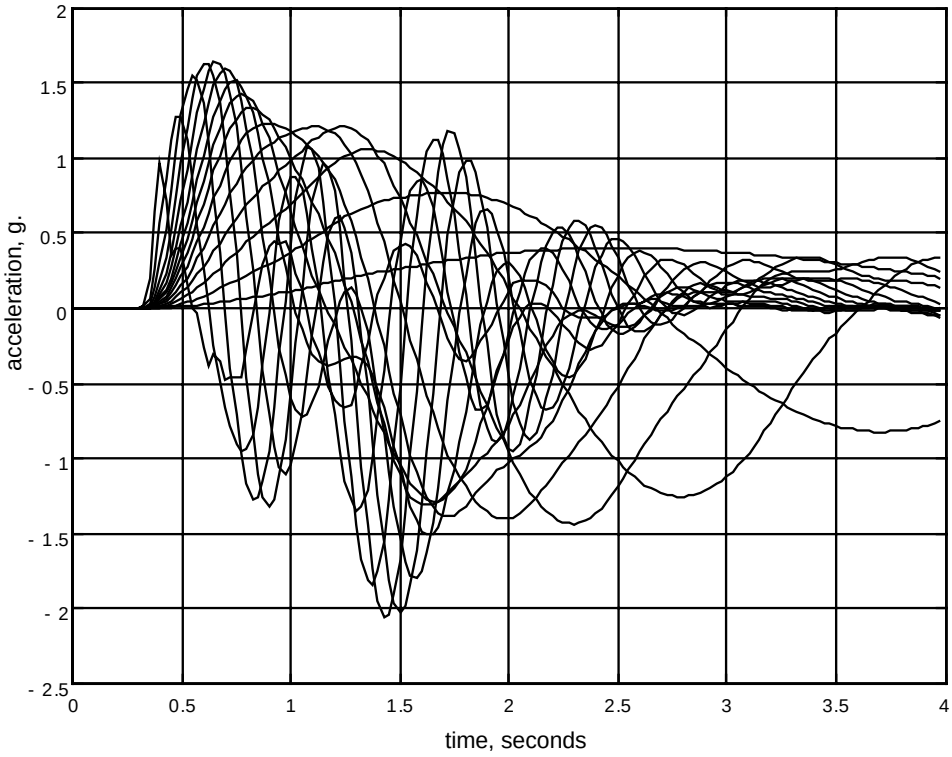


Figure 4.7: Tuned gust responses of vertical wing root acceleration.

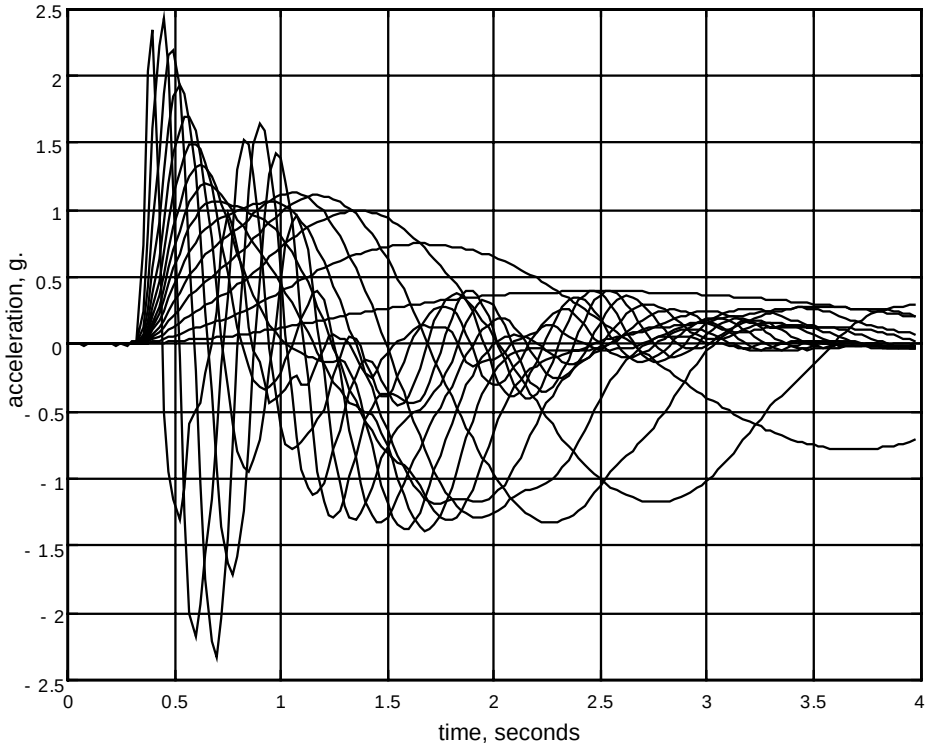


Figure 4.8: Tuned gust responses of vertical mid wing acceleration.

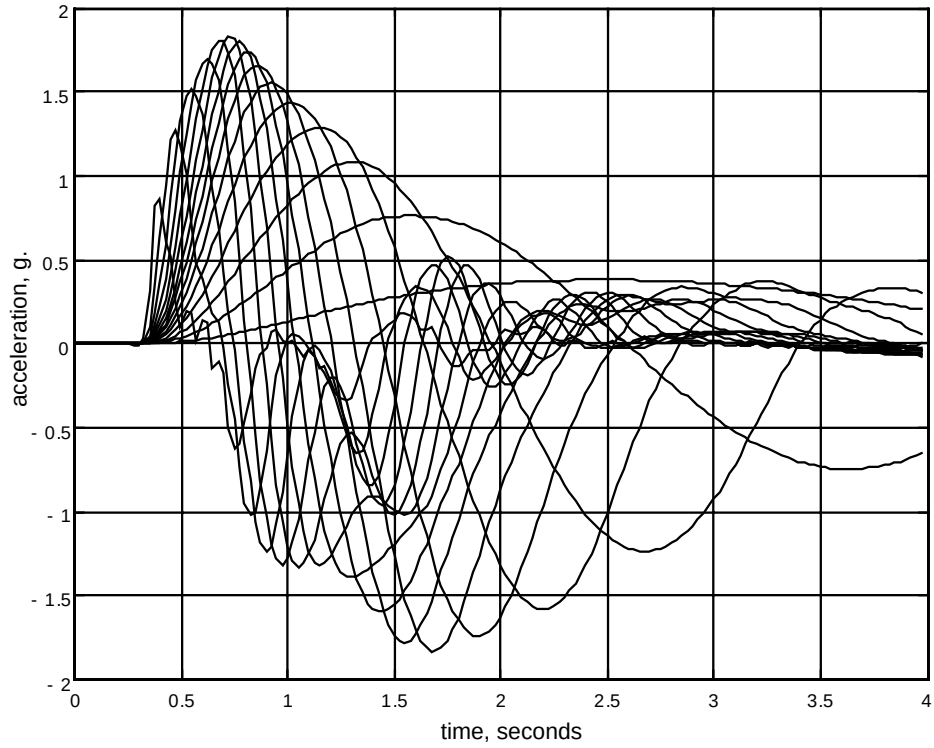


Figure 4.9: Tuned gust responses of vertical wing tip acceleration.

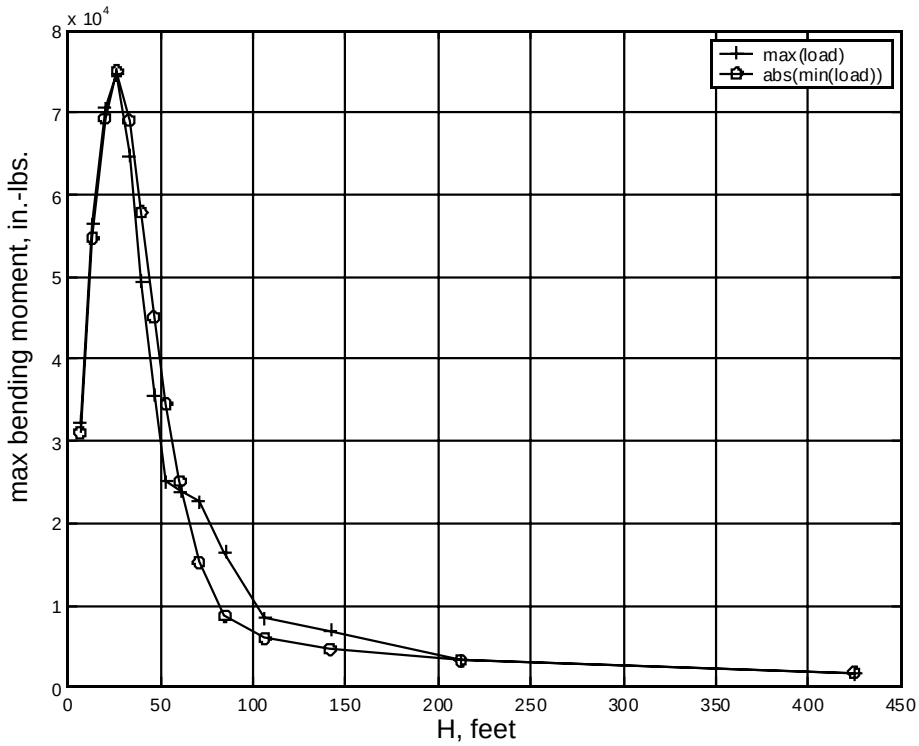


Figure 4.10: Maximum in-plane wing root bending moment.

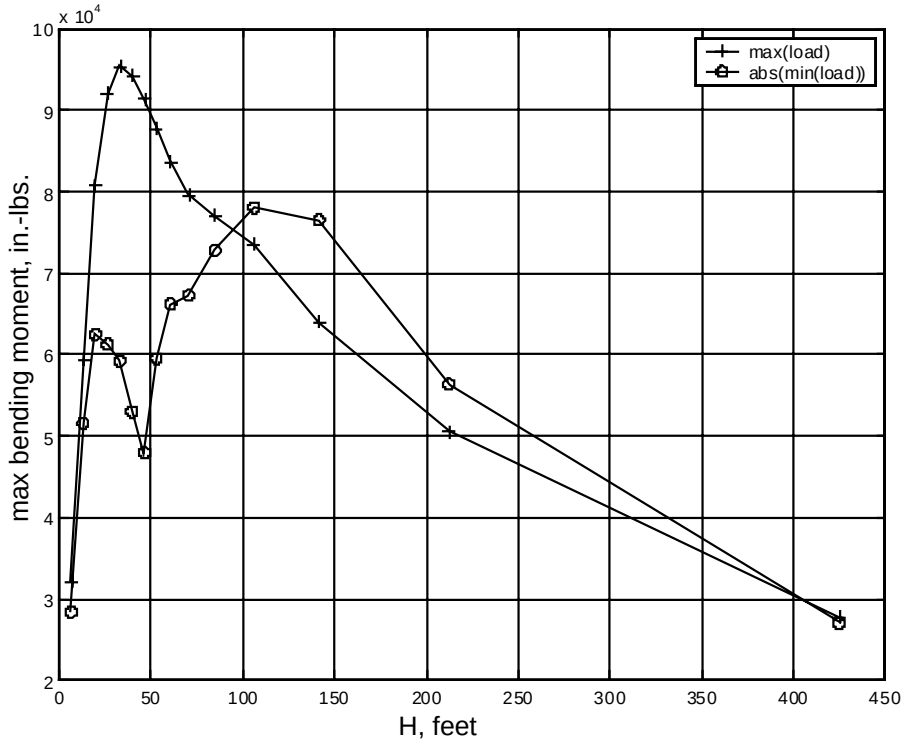


Figure 4.11: Maximum vertical wing root bending moment.

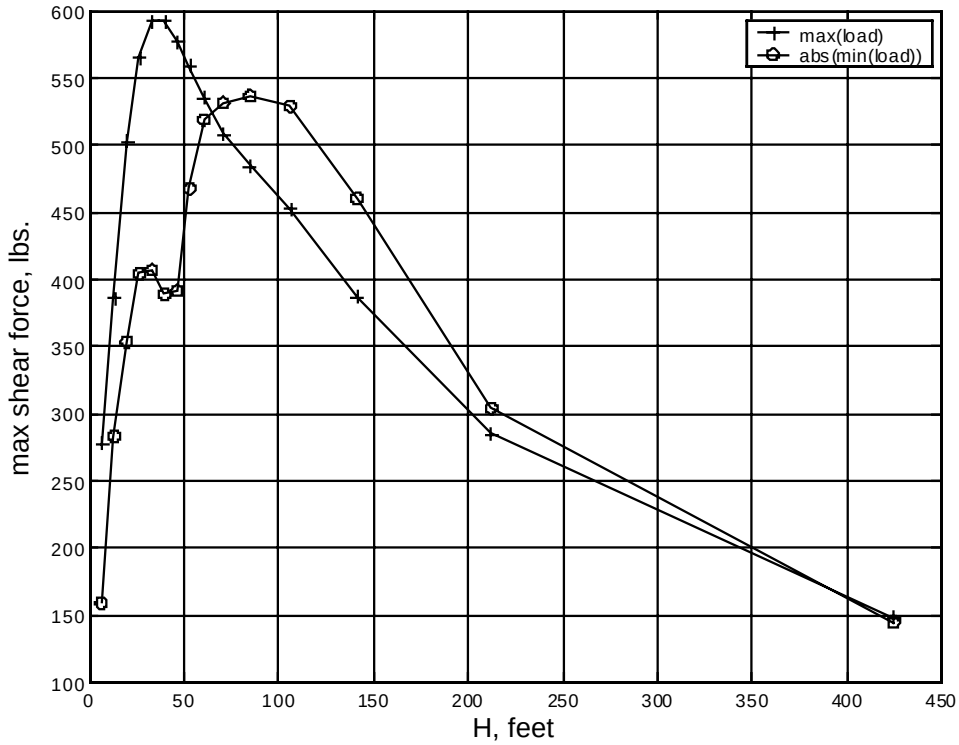


Figure 4.12: Maximum vertical wing root shear force.

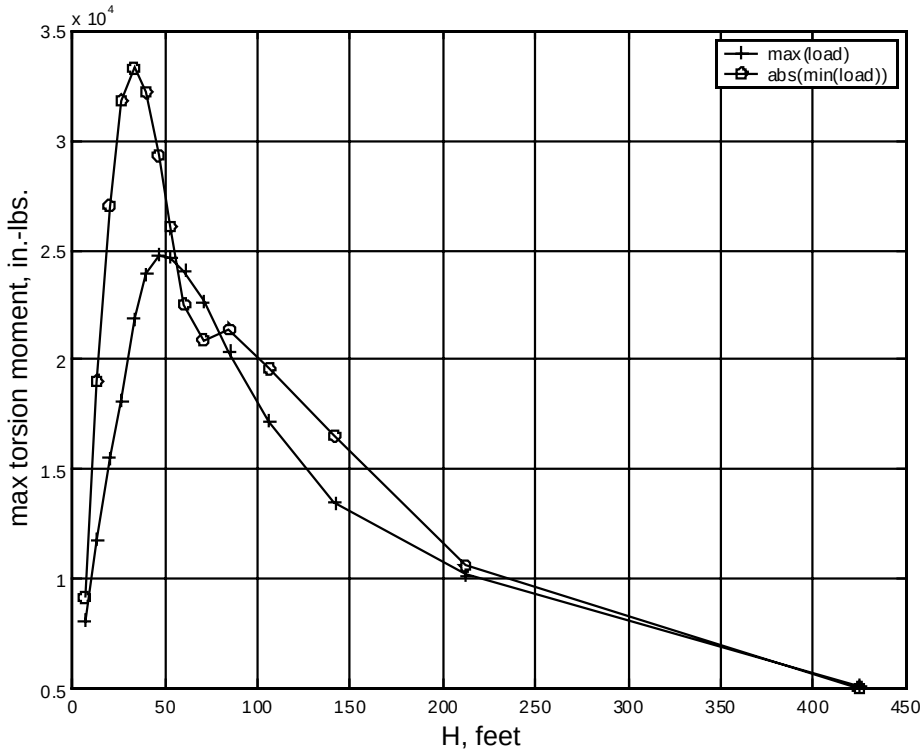


Figure 4.13: Maximum wing root torsion moment.

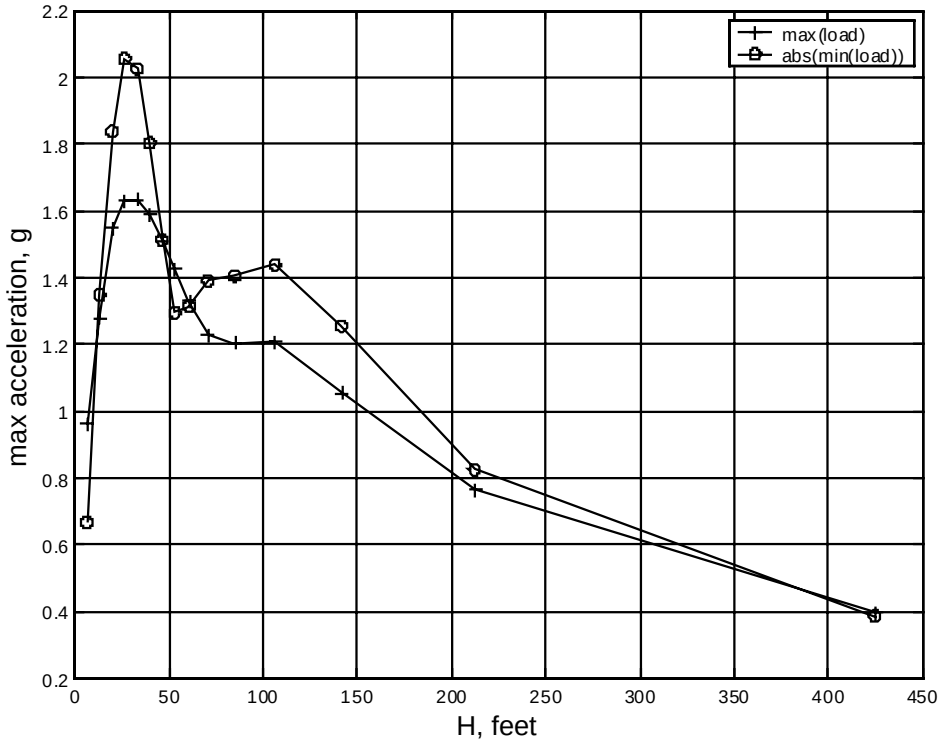


Figure 4.14: Maximum vertical wing root acceleration.

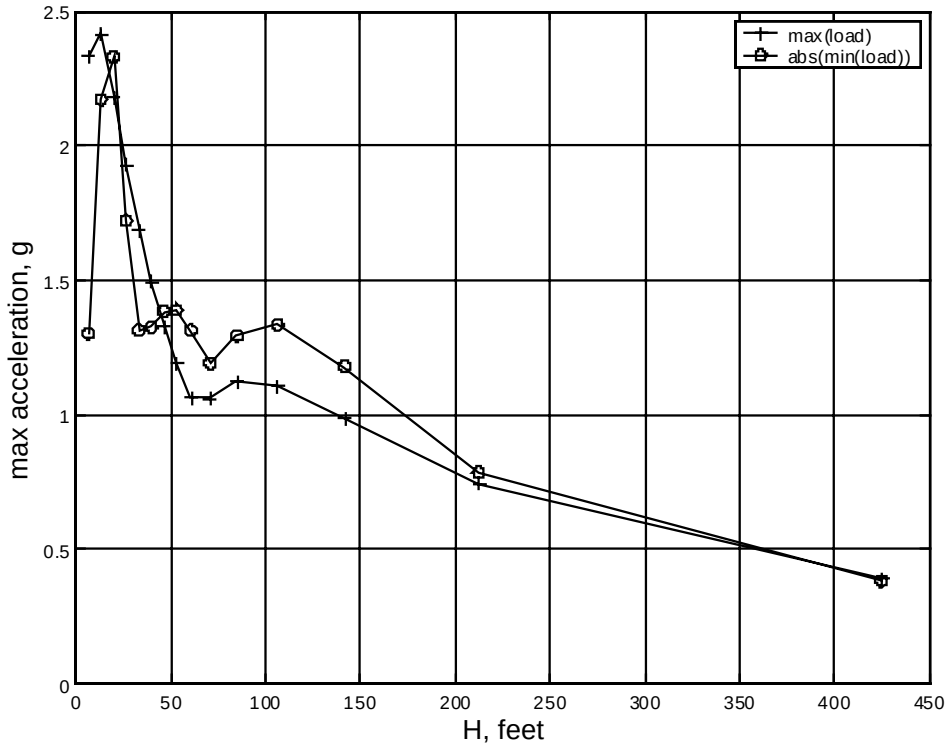


Figure 4.15: Maximum vertical mid wing acceleration.

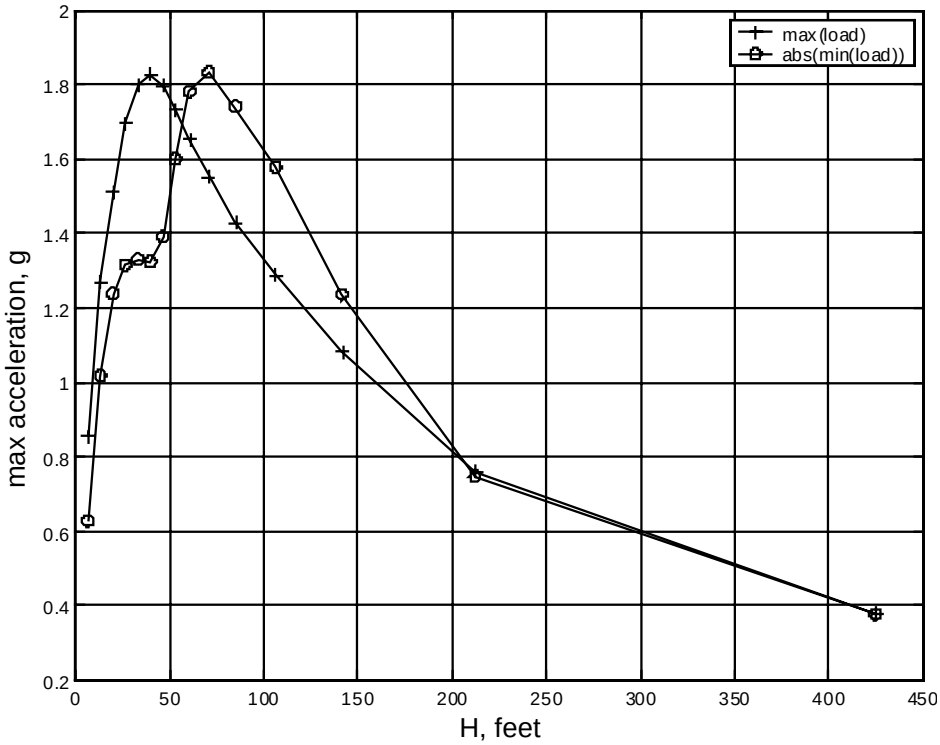


Figure 4.16: Maximum vertical wing tip acceleration.

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7. Using Matlab, Version 5, The Math Works Inc., 1997.

8. Crimaldi, J. P., Britt, R T., and Rodden, W. P.: "Response of the USAF/NORTHROP B-2 Aircraft to Nonuniform Spanwise Atmospheric Turbulence," AIAA/ASME/ASCE/AHS/ASC 32nd Structures, Structural Dynamics and Materials Conference, Baltimore, MD, April 8-10,1991, pp.1728-1741. AIAA-91-1048-CP.

9. Crimaldi, J. P., Britt, R. T., and Rodden, W. P.: "Nonuniform Spanwise Gust Response Study (U)", Report Number CDRL A02B, 1990.

APPENDIX A

MSC/NASTRAN file used in the trim analysis of the semi-span model

```
$   TO EXECUTE THIS FILE USE THE FOLLOWING:
$   NASTRAN STATIC04 SCRATCH=YES MEM=8MW NEWS=NO
$
$ SOL 103  $  NORMAL MODES
SOL 144  $  STATIC AEROELASTICITY
$ SOL 145 $   FLUTTER SOLUTION
$ DIAG = 8,15   $   Matrix and Table trailers
TIME 20.00    $  time in minutes
$
CEND
TITLE = SYMMETRIC TRIM * MACH=0 * VEL=1000 IN/SEC AT SEA LEVEL
$ TITLE = SYMM. FREE-FREE FLUTTER * SEMISPAN MODEL * FULL FUEL
SUBTITLE = CHORDWISE GRIDS * SURFACE SPLINES
LABEL = SPC D.O.F. 1 AT GRID 101 * NO VERTICAL TAIL
$ METHOD = 1
$ FMETHOD = 30   $  ID of FLUTTER Bulk Data entry
ECHO = UNSORT
$  ECHO = NONE
$  MODE SHAPE OUTPUT REQUESTED FOR VELOCITY=880 IN/SEC (FLFACT 4)
TRIM = 1  $ TRIM VARIABLE CONSTRAINTS
DISPLACEMENT = ALL
APRES = ALL  $  PRINT AERO. PRESSURES (ONLY IN SOL 144)
AEROF = ALL  $  AERO. LOADS ON AERO. CONTROL POINTS (NOT IN SOL 145)
SPC = 1  $  BOUNDARY CONDITION CONSTRAINTS
SPCFORCES = ALL  $  CONSTRAINT VECTOR OUTPUT
$
BEGIN BULK
$
$   LENGTH UNITS ARE INCHES, MASS UNITS ARE POUNDS
$
PARAM, POST, -2   $  IDEAS POST-PROCESSING
SUPORT, 101, 35   $   DEFINE REACTION D.O.F. FOR FREE BODY
$
PARAM, OPPHIPA, 1  $ OUTPUT MODES AT ALL D.O.F. INCLUDING AERO D.O.F.
$
PARAM, LMODES, 10   $   USE THE 10 LOWEST NORMAL MODES
PARAM, VREF, 12.0  $  USE VELOCITY UNITS OF FEET/SECOND
PARAM, AUNITS, 0.002588   $  ALLOWS ACCELERATION UNITS IN G'S IN TRIM ENTRY
$
$ changes "weight" input data to "mass" data
PARAM,WTMASS,0.002588
$
$ requests mass properties summary
PARAM,GRDPNT,0
$
$  DEFINE LOCAL COORDINATE SYSTEMS FOR HORIZONTAL AND VERTICAL TAILS
SPC1, 1, 123456, 30, 40   $   GRIDS 30 AND 40 ONLY USED FOR ORIENTATION
GRID, 30, 0, 379.75, 521.5678, 100.0   $   DEFINES DIRECTION OF Z-AXIS (H-TAIL)
GRID, 40, 0, 410.39, 587.3362, 100.0   $   DEFINES DIRECTION OF Z-AXIS (V-TAIL)
$
$  COORDINATE SYSTEM 12 IS A REFERENCE AXIS SYSTEM FOR STABILITY DERIVATIVES
CORD2R        12       0 156.51    0.0   48.98   156.51   0.0     40.0  +CO12
+CO12      140.0  0.0     48.98
$    LOCAL COORD. SYSTEM FOR HORIZONTAL TAIL
CORD1R, 5, 301, 30, 2301   $   Z-AXIS NORMAL TO PLANE OF HORIZ. TAIL
$    LOCAL COORD. SYSTEM FOR VERTICAL TAIL
CORD1R, 6, 401, 40, 2401   $   Z-AXIS NORMAL TO PLANE OF VERT. TAIL
$
```

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$  LOCAL COORDINATE SYSTEM TO DEFINE Y-AXIS OF RIGHT H-TAIL HINGE LINE
CORD2R        13       0 404.480 525.50  77.360  404.480521.5678 100.0  +CO13
+CO13      450.0531.888378.46955
$  LOCAL COORDINATE SYSTEM TO DEFINE Y-AXIS OF RIGHT V-TAIL HINGE LINE
CORD2R        14       0 433.14  496.50 157.190  433.140614.1537 200.0  +CO14
+CO14      500.0497.3168154.9451
$
CORD2C         1       0      0.      0.      0.      0.      0.      1.+FEMAPC1
+FEMAPC1      1.      0.      1.
CORD2S         2       0      0.      0.      0.      0.      0.      1.+FEMAPC2
+FEMAPC2      1.      0.      1.
$
$   SELECT THE DESIRED BOUNDARY CONDITIONS
$ Fixed Root
$ SPC            1     101  123456      0.
$
$ Symmetric BC
$  FOR AERO. STABILITY, CONSTRAIN D.O.F. 1 (X-DIRECTION)
SPC            1     101 1246         0.
$ SPC            1     101  246         0.
$
$ Antisymmetric BC
$ SPC            1     101  135         0.
$
$ ************************************************************
$    BEGIN AERODYNAMIC FLUTTER CARDS
$ ************************************************************
$
$    *******************************************************
$      SECTION FOR STATIC AEROELASTIC ANALYSIS
$    *******************************************************
$
$ CONSTRAINTS FOR AERODYNAMIC TRIM VARIABLES
$  MACH=0.0 , VELOCITY=1000.0 IN/SEC , SEA-LEVEL
TRIM       1     0.0     0.05734 PITCH    0.0    URDD3  -1.0            +TR01
+TR01    URDD5   0.0
$
AESTAT     70    ANGLEA
AESTAT     71    PITCH
AESTAT     73    URDD3
AESTAT     74    URDD5
$
AEROS     0       12     54.03   1236.0  31608.0   1       0
$
AESURF     80    HTAIL    13      90
AELIST     90    31001    THRU    31040
$ AESURF     81    VTAIL    14      91
$ AELIST     91    41001    THRU    41040
$
$    *********************************************************
$      END OF SECTION FOR STATIC AEROELASTIC ANALYSIS
$    *********************************************************
$
$ VALUE OF FIELD 6 (SYMXZ) IS 1 FOR SYM CASE, -1 FOR ASYM,  0 FOR FIXED
$       2       3       4       5       6       7       8       9       1
$   AERO. DENSITY UNITS: LB-SEC**2/IN**4 (SEA-LEVEL)
AERO    0       0       54.03   1.145-7 1       0
$
$ Inboard Wing   (RIGHT SIDE)
CAERO1  10001   1       0       17      8                       1       +CA101
+CA101  132.83  0.0     48.98   59.2    134.33  223.5   60.77   54.03
$
$GRID   101     0       156.51    0.00   48.98
```

```
$ (156.51-132.83)/59.2=0.40 chord
$
$ Outboard Wing   (RIGHT SIDE)
CAERO1  20001   1       0       23      8                       1       +CA102
+CA102  134.33  223.5   60.77   54.03    138.03  525.5   76.79    41.28
$
$GRID   118     0       155.94  223.50   60.77
$ (155.94-134.33)/54.03=0.40 chord
$
$   RIGHT-SIDE HORIZONTAL TAIL - Corrected a touch (tip Z)
$   THE H-TAIL PANEL SPANS THE AREA FROM THE LEADING EDGE TO THE HINGE LINE
CAERO1  30001   1       0       20      8                       1       +CA103
+CA103  355.08  525.5   77.36   49.40   366.04  620.5   93.92   24.704
$
$   RIGHT-SIDE CONTROL SURFACE PANEL ON HORIZONTAL TAIL
CAERO1  31001      1      0      20       2                       1      +CA103A
+CA103A 404.480 525.50  77.360  12.35   390.744 620.50  93.920  6.176
$
$GRID   301     0       379.75  525.50   77.36
$ (379.75-355.08)/61.75=0.40 chord
$
$   RIGHT-SIDE VERTICAL TAIL - Corrected a bunch (Both x's and both chord lengths)
$ CAERO1  40001   1       0       16      8                       1       +CA104
$ +CA104  390.67  525.5   77.5    49.3    407.54  496.5   157.19  32.00
$
$  REDEFINE POINTS 1 AND 4 FOR VERTICAL TAIL (SWAP POINTS 1 AND 4)
CAERO1  40001   1       0       20      8                       1       +CA104
+CA104  407.54  496.5   157.19  25.60   390.67  525.5   77.5    39.44
$
$  RIGHT-SIDE CONTROL SURFACE PANEL ON VERTICAL TAIL
CAERO1  41001      1       0      20       2                       1     +CA104A
+CA104A 433.140  496.50  157.190  6.40   430.110 525.50  77.50   9.86
$
$GRID   401     0       410.39  525.50  77.50
$ (410.39-390.67)/49.30=0.40 chord
$
$                       DENS    MACH    VEL     INTERP  MODES   PK TOL (0.001 default)
FLUTTER 30      PK      1       2       4       L       10
FLFACT  1       1.0
FLFACT  2       0.0
$
$ FLFACT  4       200.0   THRU    10000.   20
$  FOR PK METHOD, 'FLFACT 4' IS A VELOCITY TABLE (UNITS IN/SEC)
FLFACT  4       176.0   528.0   -880.0  1320.0  1760.0  2640.0  3520.0  +FL01
+FL01   4400.0  5280.0  4500.0  7040.0
$
$       2       3       4       5       6       7       8       9       1
$
MKAERO1 0.0                                                             +MK1
+MK1    .0001    .01    .05     .1      .2      .5      1.0     4.0
$
PAERO1  1
$
$  TEST USAGE OF SURFACE SPLINES ON ALL LIFTING SURFACES
$   SPLINE1 = 100   RIGHT-SIDE INBOARD WING
$   SPLINE1 = 200   RIGHT-SIDE OUTBOARD WING
$   SPLINE1 = 300   RIGHT-SIDE HORIZONTAL TAIL WITHOUT CONTROL SURFACE
$   SPLINE1 = 305   RIGHT-SIDE CONTROL SURFACE ON HORIZONTAL TAIL
$   SPLINE1 = 400   RIGHT-SIDE VERTICAL TAIL WITHOUT CONTROL SURFACE
$   SPLINE1 = 405   RIGHT-SIDE CONTROL SURFACE ON VERTICAL TAIL
$
SPLINE1 100     10001   10001   10136   100
SPLINE1 200     20001   20001   20184   200
```

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$
SPLINE1 300     30001   30001   30160   300
SPLINE1 400     40001   40001   40160   400
$
SPLINE1 305     31001   31001   31040   305
SPLINE1 405     41001   41001   41040   405
$
$   GRIDS UTILIZED FOR RIGHT SIDE INBOARD WING SURFACE SPLINES
SET1         100     101     102     103     104     105     106     107+IW01
+IW01        108     109     110     111     112     113     114     115+IW02
+IW02        116     117     118    1101    1102    1103    1104    1105+IW03
+IW03       1106    1107    1108    1109    1110    1111    1112    1113+IW04
+IW04       1114    1115    1116    1117    1118    2101    2102    2103+IW05
+IW05       2104    2105    2106    2107    2108    2109    2110    2111+IW06
+IW06       2112    2113    2114    2115    2116    2117    2118
$   GRIDS UTILIZED FOR RIGHT SIDE OUTBOARD WING SURFACE SPLINES
SET1         200     118     119     120     121     122     123     124+OW01
+OW01        125     126     127     128     129     130     131     132+OW02
+OW02        133     134     135     136     137     138     139     140+OW03
+OW03        141    1118    1119    1120    1121    1122    1123    1124+OW04
+OW04       1125    1126    1127    1128    1129    1130    1131    1132+OW05
+OW05       1133    1134    1135    1136    1137    1138    1139    1140+OW06
+OW06       1141    2118    2119    2120    2121    2122    2123    2124+OW07
+OW07       2125    2126    2127    2128    2129    2130    2131    2132+OW08
+OW08       2133    2134    2135    2136    2137    2138    2139    2140+OW09
+OW09       2141
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON H-TAIL
SET1         300     301     302     303     304     305     306     307+HT01
+HT01        308     309     310     311    1301    1302    1303    1304+HT02
+HT02       1305    1306    1307    1308    1309    1310    1311    2501+HT03
+HT03       2502    2503    2504    2505    2506    2507    2508    2509+HT04
+HT04       2510    2511
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON H-TAIL CONTROL SURFACE
SET1         305    2501    2502    2503    2504    2505    2506    2507+HC01
+HC01       2508    2509    2510    2511    2301    2302    2303    2304+HC02
+HC02       2305    2306    2307    2308    2309    2310    2311
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON V-TAIL
SET1         400     401     402     403     404     405     406     407+VT01
+VT01        408     409     410     411    1401    1402    1403    1404+VT02
+VT02       1405    1406    1407    1408    1409    1410    1411    2601+VT03
+VT03       2602    2603    2604    2605    2606    2607    2608    2609+VT04
+VT04       2610    2611
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON V-TAIL CONTROL SURFACE
SET1         405    2601    2602    2603    2604    2605    2606    2607+VC01
+VC01       2608    2609    2610    2611    2401    2402    2403    2404+VC02
+VC02       2405    2406    2407    2408    2409    2410    2411
$
$ *****  END OF AERODYNAMIC FLUTTER INPUTS  *****
$
EIGR           1    MGIV                              10
$
$ EIGRL          1                      10       0
$
$   BEAM PROPERTIES FOR RIGHT WING ELASTIC AXIS
PBEAM        101       1   1000.   1021.   247.3      0.   174.3      0.
PBEAM        102       1   1000.   1005.   227.7      0.   171.5      0.
PBEAM        103       1   1000.   989.3   208.8      0.   168.7      0.
PBEAM        104       1   1000.    974.   190.5      0.    166.      0.
PBEAM        105       1   1000.   958.7    173.      0.   163.3      0.
PBEAM        106       1   1000.   943.7   156.2      0.   160.6      0.
PBEAM        107       1   1000.   928.8   140.2      0.   157.9      0.
PBEAM        108       1   1000.    914.   124.8      0.   155.3      0.
PBEAM        109       1   1000.   899.4   110.3      0.   152.7      0.
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PBEAM        110       1   1000.    885.   96.95      0.   150.1      0.
PBEAM        111       1   1000.   870.7   92.06      0.   147.6      0.
PBEAM        112       1   1000.   856.6   86.48      0.   145.1      0.
PBEAM        113       1   1000.   842.6   79.99      0.   142.6      0.
PBEAM        114       1   1000.   828.8   75.44      0.   140.1      0.
PBEAM        115       1   1000.   815.2   71.21      0.   137.7      0.
PBEAM        116       1   1000.   801.6   68.65      0.   135.3      0.
PBEAM        117       1   1000.   788.3   67.96      0.    133.      0.
PBEAM        118       1   1000.   769.7   66.91      0.   129.7      0.
PBEAM        119       1   1000.   746.1   65.52      0.   125.5      0.
PBEAM        120       1   1000.   723.1   64.11      0.   121.4      0.
PBEAM        121       1   1000.   700.5   62.75      0.   117.4      0.
PBEAM        122       1   1000.   678.4   61.39      0.   113.5      0.
PBEAM        123       1   1000.   656.7   60.02      0.   109.7      0.
PBEAM        124       1   1000.   635.5   58.67      0.    106.      0.
PBEAM        125       1   1000.   614.8   57.33      0.   102.3      0.
PBEAM        126       1   1000.   594.6   56.01      0.   98.78      0.
PBEAM        127       1   1000.   574.8    54.7      0.    95.3      0.
PBEAM        128       1   1000.   555.4    53.4      0.   91.91      0.
PBEAM        129       1   1000.   536.5   52.12      0.    88.6      0.
PBEAM        130       1   1000.    518.   50.86      0.   85.37      0.
PBEAM        131       1   1000.   499.9   49.61      0.   82.22      0.
PBEAM        132       1   1000.   482.3   48.37      0.   79.15      0.
PBEAM        133       1   1000.   465.1   47.15      0.   76.15      0.
PBEAM        134       1   1000.   448.3   45.95      0.   73.23      0.
PBEAM        135       1   1000.   431.9   44.76      0.   70.39      0.
PBEAM        136       1   1000.   415.9   43.58      0.   67.62      0.
PBEAM        137       1   1000.   400.3   42.42      0.   64.93      0.
PBEAM        138       1   1000.   385.1   41.27      0.    62.3      0.
PBEAM        139       1   1000.   370.3   40.14      0.   59.75      0.
PBEAM        140       1   1000.   355.9   39.03      0.   57.27      0.
$   BEAM PROPERTIES FOR RIGHT WING TIP BOOM
PBEAM        201       2   1000.   83.46   90.29      0.   238.6      0.
PBEAM        202       2   1000.   132.9   146.5      0.   238.6      0.
PBEAM        203       2   1000.   182.3   202.8      0.   238.6      0.
PBEAM        204       2   1000.   231.8   259.1      0.   238.6      0.
PBEAM        205       2   1000.   281.2   315.3      0.   238.6      0.
PBEAM        206       2   1000.   330.7   371.6      0.   238.6      0.
PBEAM        207       2   1000.   380.1   427.8      0.   238.6      0.
PBEAM        208       2   1000.   429.5   484.1      0.   238.6      0.
PBEAM        209       2   1000.    479.   540.4      0.   238.6      0.
PBEAM        210       2   1000.   528.4   596.6      0.   238.6      0.
PBEAM        211       2   1000.   577.8   652.9      0.   238.6      0.
PBEAM        212       2   1000.   627.3   709.1      0.   238.6      0.
PBEAM        213       2   1000.   676.7   765.4      0.   238.6      0.
PBEAM        214       2   1000.   726.2   821.7      0.   238.6      0.
PBEAM        215       2   1000.   704.4   793.9      0.   238.6      0.
PBEAM        216       2   1000.   682.7   766.2      0.   238.6      0.
PBEAM        217       2   1000.    661.   738.4      0.   238.6      0.
PBEAM        218       2   1000.   639.3   710.7      0.   238.6      0.
PBEAM        219       2   1000.    597.   659.8      0.   221.1      0.
PBEAM        220       2   1000.   556.2   610.7      0.   204.5      0.
PBEAM        221       2   1000.   516.7   563.3      0.   188.8      0.
PBEAM        222       2   1000.   478.6   517.7      0.   173.9      0.
PBEAM        223       2   1000.   441.9   473.7      0.   159.8      0.
PBEAM        224       2   1000.   406.6   431.5      0.   146.5      0.
PBEAM        225       2   1000.   372.6   391.1      0.    134.      0.
PBEAM        226       2   1000.    340.   352.3      0.   122.1      0.
PBEAM        227       2   1000.   308.8   315.3      0.    111.      0.
PBEAM        228       2   1000.   278.9   279.9      0.   100.6      0.
PBEAM        229       2   1000.   253.6   249.5      0.   113.6      0.
PBEAM        230       2   1000.   226.1   217.3      0.   102.3      0.
PBEAM        231       2   1000.    200.   186.8      0.   91.71      0.
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PBEAM        232       2   1000.   177.6   160.2      0.   98.27      0.
PBEAM        233       2   1000.   153.9   132.9      0.   87.36      0.
PBEAM        234       2   1000.   131.7   107.3      0.   77.29      0.
PBEAM        235       2   1000.   112.4   85.01      0.   79.37      0.
PBEAM        236       2   1000.   94.08   64.02      0.   79.38      0.
PBEAM        237       2   1000.    75.6   43.23      0.   69.04      0.
PBEAM        238       2   1000.   59.53    25.2      0.    67.1      0.
PBEAM        239       2   1000.   44.55   8.614      0.   63.92      0.
PBEAM        240       2   1000.    30.7   8.007      0.   59.78      0.
PBEAM        241       2   1000.   14.37   3.655      0.   27.47      0.
PBEAM        242       2   1000.   3.024   3.024      0.    22.9      0.
PBEAM        301       3   1000.   1047.   54.91      0.    179.      0.
$   BEAM PROPERTIES FOR RIGHT SIDE HORIZONTAL TAIL
PBEAM        302       3   1000.   894.1    41.7      0.   151.7      0.
PBEAM        303       3   1000.   756.8   30.83      0.   127.4      0.
PBEAM        304       3   1000.   634.3   22.05      0.   105.8      0.
PBEAM        305       3   1000.   525.8   15.11      0.   86.74      0.
PBEAM        306       3   1000.   430.5   9.772      0.   70.15      0.
PBEAM        307       3   1000.   347.4   5.823      0.   55.82      0.
PBEAM        308       3   1000.   275.8   3.046      0.   43.59      0.
PBEAM        309       3   1000.   214.8   1.241      0.   33.28      0.
PBEAM        310       3   1000.   163.5  0.2188      0.   24.75      0.
$   BEAM PROPERTIES FOR RIGHT SIDE VERTICAL TAIL
PBEAM        401       4   1000.   542.6   24.42      0.   73.63      0.
PBEAM        402       4   1000.   486.7   18.52      0.   66.03      0.
PBEAM        403       4   1000.   434.7   13.68      0.   58.98      0.
PBEAM        404       4   1000.   386.6   9.785      0.   52.45      0.
PBEAM        405       4   1000.   342.1   6.712      0.   46.42      0.
PBEAM        406       4   1000.   301.3    4.35      0.   40.87      0.
PBEAM        407       4   1000.   263.8   2.599      0.   35.79      0.
PBEAM        408       4   1000.   229.5   1.365      0.   31.14      0.
PBEAM        409       4   1000.   198.4  0.5584      0.   26.91      0.
PBEAM        410       4   1000.   170.2 0.09922      0.   23.09      0.
$
$ FEMAP Material 1 : Generic - WING AND CHORDWISE SPINES
MAT1           11000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - BOOM
MAT1           21000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - HORIZONTAL
MAT1           31000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - VERTICAL
MAT1           41000000.1000000.     0.3      0.      0.      0.
$
$   GRID 100 REPRESENTS PROPULSION SYSTEM
RBE2         504     101  123456     100
$  CONNECTIONS TO WING-TIP BOOM, HORIZONTAL AND VERTICAL TAILS
$
RBE2         501     141  123456     216
RBE2         502     238  123456     301
RBE2         503     240  123456     401
$
GRID         100       0   125.8     0.0    86.1       0
$
$  GRIDS FOR RIGHT WING BEAM
$
GRID         101       0  156.51    0.00   48.98       0
GRID         102       0  156.48   13.15   49.67       0
GRID         103       0  156.45   26.29   50.37       0
GRID         104       0  156.41   39.44   51.06       0
GRID         105       0  156.38   52.59   51.75       0
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GRID          106       0  156.34   65.74   52.45       0
GRID          107       0  156.31   78.88   53.14       0
GRID          108       0  156.28   92.03   53.83       0
GRID          109       0  156.24  105.18   54.53       0
GRID          110       0  156.21  118.32   55.22       0
GRID          111       0  156.18  131.47   55.91       0
GRID          112       0  156.14  144.62   56.61       0
GRID          113       0  156.11  157.76   57.30       0
GRID          114       0  156.08  170.91   57.99       0
GRID          115       0  156.04  184.06   58.69       0
GRID          116       0  156.01  197.21   59.38       0
GRID          117       0  155.98  210.35   60.07       0
GRID          118       0  155.94  223.50   60.77       0
GRID          119       0  155.88  236.63   61.46       0
GRID          120       0  155.82  249.76   62.16       0
GRID          121       0  155.76  262.89   62.86       0
GRID          122       0  155.70  276.02   63.55       0
GRID          123       0  155.64  289.15   64.25       0
GRID          124       0  155.58  302.28   64.95       0
GRID          125       0  155.52  315.41   65.64       0
GRID          126       0  155.46  328.54   66.34       0
GRID          127       0  155.39  341.67   67.04       0
GRID          128       0  155.33  354.80   67.73       0
GRID          129       0  155.27  367.93   68.43       0
GRID          130       0  155.21  381.07   69.13       0
GRID          131       0  155.15  394.20   69.82       0
GRID          132       0  155.09  407.33   70.52       0
GRID          133       0  155.03  420.46   71.22       0
GRID          134       0  154.97  433.59   71.91       0
GRID          135       0  154.91  446.72   72.61       0
GRID          136       0  154.85  459.85   73.31       0
GRID          137       0  154.79  472.98   74.00       0
GRID          138       0  154.72  486.11   74.70       0
GRID          139       0  154.66  499.24   75.40       0
GRID          140       0  154.60  512.37   76.09       0
GRID          141       0  154.54  525.50   76.79       0
$
$ RIGHT SIDE WING SURFACE LEADING-EDGE GRID POINTS
$
GRID         1101       0  132.83    0.00   48.98       0
GRID         1102       0  132.92   13.15   49.67       0
GRID         1103       0  133.01   26.29   50.37       0
GRID         1104       0  133.10   39.44   51.06       0
GRID         1105       0  133.18   52.59   51.75       0
GRID         1106       0  133.27   65.74   52.45       0
GRID         1107       0  133.36   78.88   53.14       0
GRID         1108       0  133.45   92.03   53.83       0
GRID         1109       0  133.54  105.18   54.53       0
GRID         1110       0  133.63  118.32   55.22       0
GRID         1111       0  133.71  131.47   55.91       0
GRID         1112       0  133.80  144.62   56.61       0
GRID         1113       0  133.89  157.76   57.30       0
GRID         1114       0  133.98  170.91   57.99       0
GRID         1115       0  134.07  184.06   58.69       0
GRID         1116       0  134.16  197.21   59.38       0
GRID         1117       0  134.24  210.35   60.07       0
GRID         1118       0  134.33  223.50   60.77       0
GRID         1119       0  134.49  236.63   61.46       0
GRID         1120       0  134.65  249.76   62.16       0
GRID         1121       0  134.81  262.89   62.86       0
GRID         1122       0  134.97  276.02   63.55       0
GRID         1123       0  135.14  289.15   64.25       0
GRID         1124       0  135.30  302.28   64.95       0
```

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GRID        1125       0  135.46  315.41   65.64       0
GRID        1126       0  135.62  328.54   66.34       0
GRID        1127       0  135.78  341.67   67.04       0
GRID        1128       0  135.94  354.80   67.73       0
GRID        1129       0  136.10  367.93   68.43       0
GRID        1130       0  136.26  381.07   69.13       0
GRID        1131       0  136.42  394.20   69.82       0
GRID        1132       0  136.58  407.33   70.52       0
GRID        1133       0  136.74  420.46   71.22       0
GRID        1134       0  136.90  433.59   71.91       0
GRID        1135       0  137.06  446.72   72.61       0
GRID        1136       0  137.22  459.85   73.31       0
GRID        1137       0  137.38  472.98   74.00       0
GRID        1138       0  137.55  486.11   74.70       0
GRID        1139       0  137.71  499.24   75.40       0
GRID        1140       0  137.87  512.37   76.09       0
GRID        1141       0  138.03  525.50   76.79       0
$
$ RIGHT SIDE WING SURFACE TRAILING-EDGE GRID POINTS
$
GRID        2101       0  192.03    0.00   48.98       0
GRID        2102       0  191.82   13.15   49.67       0
GRID        2103       0  191.60   26.29   50.37       0
GRID        2104       0  191.39   39.44   51.06       0
GRID        2105       0  191.17   52.59   51.75       0
GRID        2106       0  190.95   65.74   52.45       0
GRID        2107       0  190.74   78.88   53.14       0
GRID        2108       0  190.52   92.03   53.83       0
GRID        2109       0  190.30  105.18   54.53       0
GRID        2110       0  190.09  118.32   55.22       0
GRID        2111       0  189.87  131.47   55.91       0
GRID        2112       0  189.66  144.62   56.61       0
GRID        2113       0  189.44  157.76   57.30       0
GRID        2114       0  189.22  170.91   57.99       0
GRID        2115       0  189.01  184.06   58.69       0
GRID        2116       0  188.79  197.21   59.38       0
GRID        2117       0  188.58  210.35   60.07       0
GRID        2118       0  188.36  223.50   60.77       0
GRID        2119       0  187.97  236.63   61.46       0
GRID        2120       0  187.57  249.76   62.16       0
GRID        2121       0  187.18  262.89   62.86       0
GRID        2122       0  186.79  276.02   63.55       0
GRID        2123       0  186.39  289.15   64.25       0
GRID        2124       0  186.00  302.28   64.95       0
GRID        2125       0  185.61  315.41   65.64       0
GRID        2126       0  185.21  328.54   66.34       0
GRID        2127       0  184.82  341.67   67.04       0
GRID        2128       0  184.43  354.80   67.73       0
GRID        2129       0  184.03  367.93   68.43       0
GRID        2130       0  183.64  381.07   69.13       0
GRID        2131       0  183.25  394.20   69.82       0
GRID        2132       0  182.85  407.33   70.52       0
GRID        2133       0  182.46  420.46   71.22       0
GRID        2134       0  182.07  433.59   71.91       0
GRID        2135       0  181.67  446.72   72.61       0
GRID        2136       0  181.28  459.85   73.31       0
GRID        2137       0  180.89  472.98   74.00       0
GRID        2138       0  180.49  486.11   74.70       0
GRID        2139       0  180.10  499.24   75.40       0
GRID        2140       0  179.71  512.37   76.09       0
GRID        2141       0  179.31  525.50   76.79       0
$
$  RIGHT WING * LEADING AND TRAILING EDGE GRIDS ARE DEPENDENT ON MAIN BEAM
```

```
$
RBE2        1201     101  123456    1101    2101
RBE2        1202     102  123456    1102    2102
RBE2        1203     103  123456    1103    2103
RBE2        1204     104  123456    1104    2104
RBE2        1205     105  123456    1105    2105
RBE2        1206     106  123456    1106    2106
RBE2        1207     107  123456    1107    2107
RBE2        1208     108  123456    1108    2108
RBE2        1209     109  123456    1109    2109
RBE2        1210     110  123456    1110    2110
RBE2        1211     111  123456    1111    2111
RBE2        1212     112  123456    1112    2112
RBE2        1213     113  123456    1113    2113
RBE2        1214     114  123456    1114    2114
RBE2        1215     115  123456    1115    2115
RBE2        1216     116  123456    1116    2116
RBE2        1217     117  123456    1117    2117
RBE2        1218     118  123456    1118    2118
RBE2        1219     119  123456    1119    2119
RBE2        1220     120  123456    1120    2120
RBE2        1221     121  123456    1121    2121
RBE2        1222     122  123456    1122    2122
RBE2        1223     123  123456    1123    2123
RBE2        1224     124  123456    1124    2124
RBE2        1225     125  123456    1125    2125
RBE2        1226     126  123456    1126    2126
RBE2        1227     127  123456    1127    2127
RBE2        1228     128  123456    1128    2128
RBE2        1229     129  123456    1129    2129
RBE2        1230     130  123456    1130    2130
RBE2        1231     131  123456    1131    2131
RBE2        1232     132  123456    1132    2132
RBE2        1233     133  123456    1133    2133
RBE2        1234     134  123456    1134    2134
RBE2        1235     135  123456    1135    2135
RBE2        1236     136  123456    1136    2136
RBE2        1237     137  123456    1137    2137
RBE2        1238     138  123456    1138    2138
RBE2        1239     139  123456    1139    2139
RBE2        1240     140  123456    1140    2140
RBE2        1241     141  123456    1141    2141
$
$  GRIDS FOR RIGHT SIDE WING-TIP BOOM
$
GRID         201       0     25.   525.5    77.5       0
GRID         202       0 33.6111   525.5    77.5       0
GRID         203       0 42.2222   525.5    77.5       0
GRID         204       0 50.8333   525.5    77.5       0
GRID         205       0 59.4444   525.5    77.5       0
GRID         206       0 68.0556   525.5    77.5       0
GRID         207       0 76.6667   525.5    77.5       0
GRID         208       0 85.2778   525.5    77.5       0
GRID         209       0 93.8889   525.5    77.5       0
GRID         210       0   102.5   525.5    77.5       0
GRID         211       0 111.111   525.5    77.5       0
GRID         212       0 119.722   525.5    77.5       0
GRID         213       0 128.333   525.5    77.5       0
GRID         214       0 136.944   525.5    77.5       0
GRID         215       0 145.556   525.5    77.5       0
GRID         216       0 154.167   525.5    77.5       0
GRID         217       0 162.778   525.5    77.5       0
GRID         218       0 171.389   525.5    77.5       0
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GRID         219       0    180.   525.5    77.5       0
GRID         220       0    190.   525.5    77.5       0
GRID         221       0    200.   525.5    77.5       0
GRID         222       0    210.   525.5    77.5       0
GRID         223       0    220.   525.5    77.5       0
GRID         224       0    230.   525.5    77.5       0
GRID         225       0    240.   525.5    77.5       0
GRID         226       0    250.   525.5    77.5       0
GRID         227       0    260.   525.5    77.5       0
GRID         228       0    270.   525.5    77.5       0
GRID         229       0    280.   525.5    77.5       0
GRID         230       0    290.   525.5    77.5       0
GRID         231       0    300.   525.5    77.5       0
GRID         232       0    310.   525.5    77.5       0
GRID         233       0    320.   525.5    77.5       0
GRID         234       0    330.   525.5    77.5       0
GRID         235       0    340.   525.5    77.5       0
GRID         236       0    350.   525.5    77.5       0
GRID         237       0    360.   525.5    77.5       0
GRID         238       0    370.   525.5    77.5       0
GRID         239       0    380.   525.5    77.5       0
GRID         240       0    390.   525.5    77.5       0
GRID         241       0    400.   525.5    77.5       0
GRID         242       0    410.   525.5    77.5       0
GRID         243       0    420.   525.5    77.5       0
$
$   ***********************************************
$      RIGHT SIDE HORIZONTAL TAIL DEFINITION
$   ***********************************************
$  GRIDS FOR RIGHT SIDE HORIZONTAL TAIL BEAM
$
GRID         301       0  379.75  525.50   77.36       0
GRID         302       0  379.61  535.00   79.01       0
GRID         303       0  379.47  544.50   80.67       0
GRID         304       0  379.34  554.00   82.33       0
GRID         305       0  379.20  563.50   83.98       0
GRID         306       0  379.06  573.00   85.64       0
GRID         307       0  378.92  582.50   87.30       0
GRID         308       0  378.79  592.00   88.95       0
GRID         309       0  378.65  601.50   90.61       0
GRID         310       0  378.51  611.00   92.27       0
GRID         311       0  378.37  620.50   93.92       0
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL MAIN BEAM
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 5
GRID         331       0  379.75  525.50   77.36       5
GRID         332       0  379.61  535.00   79.01       5
GRID         333       0  379.47  544.50   80.67       5
GRID         334       0  379.34  554.00   82.33       5
GRID         335       0  379.20  563.50   83.98       5
GRID         336       0  379.06  573.00   85.64       5
GRID         337       0  378.92  582.50   87.30       5
GRID         338       0  378.79  592.00   88.95       5
GRID         339       0  378.65  601.50   90.61       5
GRID         340       0  378.51  611.00   92.27       5
GRID         341       0  378.37  620.50   93.92       5
$   DUPLICATE GRIDS ON H-TAIL ARE DEPENDENT ON ELASTIC AXIS BEAM
RBE2         521     301  123456     331
RBE2         522     302  123456     332
RBE2         523     303  123456     333
RBE2         524     304  123456     334
RBE2         525     305  123456     335
RBE2         526     306  123456     336
RBE2         527     307  123456     337
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RBE2         528     308  123456     338
RBE2         529     309  123456     339
RBE2         530     310  123456     340
RBE2         531     311  123456     341
$
$  RIGHT SIDE HORIZONTAL TAIL LEADING EDGE
$
GRID        1301       0  355.08  525.50   77.36       0
GRID        1302       0  356.17  535.00   79.01       0
GRID        1303       0  357.27  544.50   80.67       0
GRID        1304       0  358.36  554.00   82.33       0
GRID        1305       0  359.46  563.50   83.98       0
GRID        1306       0  360.56  573.00   85.64       0
GRID        1307       0  361.65  582.50   87.30       0
GRID        1308       0  362.75  592.00   88.95       0
GRID        1309       0  363.85  601.50   90.61       0
GRID        1310       0  364.94  611.00   92.27       0
GRID        1311       0  366.04  620.50   93.92       0
$
$  DISPLACEMENT OF H-TAIL L.E. IS DEPENDENT ON ELASTIC AXIS
RBE2        1251     301  123456    1301
RBE2        1252     302  123456    1302
RBE2        1253     303  123456    1303
RBE2        1254     304  123456    1304
RBE2        1255     305  123456    1305
RBE2        1256     306  123456    1306
RBE2        1257     307  123456    1307
RBE2        1258     308  123456    1308
RBE2        1259     309  123456    1309
RBE2        1260     310  123456    1310
RBE2        1261     311  123456    1311
$
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL LEADING EDGE
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 5
GRID        1331       0  355.08  525.50   77.36       5
GRID        1332       0  356.17  535.00   79.01       5
GRID        1333       0  357.27  544.50   80.67       5
GRID        1334       0  358.36  554.00   82.33       5
GRID        1335       0  359.46  563.50   83.98       5
GRID        1336       0  360.56  573.00   85.64       5
GRID        1337       0  361.65  582.50   87.30       5
GRID        1338       0  362.75  592.00   88.95       5
GRID        1339       0  363.85  601.50   90.61       5
GRID        1340       0  364.94  611.00   92.27       5
GRID        1341       0  366.04  620.50   93.92       5
$  DUPLICATE GRIDS ON H-TAIL LEADING EDGE ARE DEPENDENT ON ELASTIC AXIS
RBE2         541     301  123456    1331
RBE2         542     302  123456    1332
RBE2         543     303  123456    1333
RBE2         544     304  123456    1334
RBE2         545     305  123456    1335
RBE2         546     306  123456    1336
RBE2         547     307  123456    1337
RBE2         548     308  123456    1338
RBE2         549     309  123456    1339
RBE2         550     310  123456    1340
RBE2         551     311  123456    1341
$
$  RIGHT SIDE HORIZONTAL TAIL TRAILING EDGE
$
GRID        2301       0  416.83  525.50   77.36       0
GRID        2302       0  414.84  535.00   79.01       0
GRID        2303       0  412.85  544.50   80.67       0
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GRID        2304       0  410.86  554.00   82.33       0
GRID        2305       0  408.87  563.50   83.98       0
GRID        2306       0  406.88  573.00   85.64       0
GRID        2307       0  404.88  582.50   87.30       0
GRID        2308       0  402.89  592.00   88.95       0
GRID        2309       0  400.90  601.50   90.61       0
GRID        2310       0  398.91  611.00   92.27       0
GRID        2311       0  396.92  620.50   93.92       0
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL TRAILING EDGE
$  THE OUTPUT FOR THESE GRIDS WILL BE IN COORD. SYST. 5
GRID        2331       0  416.83  525.50   77.36       5
GRID        2332       0  414.84  535.00   79.01       5
GRID        2333       0  412.85  544.50   80.67       5
GRID        2334       0  410.86  554.00   82.33       5
GRID        2335       0  408.87  563.50   83.98       5
GRID        2336       0  406.88  573.00   85.64       5
GRID        2337       0  404.88  582.50   87.30       5
GRID        2338       0  402.89  592.00   88.95       5
GRID        2339       0  400.90  601.50   90.61       5
GRID        2340       0  398.91  611.00   92.27       5
GRID        2341       0  396.92  620.50   93.92       5
$  DUPLICATE H-TAIL T.E. GRIDS ARE DEPENDENT ON ORIGINAL T.E. GRIDS
RBE2         561    2301  123456    2331
RBE2         562    2302  123456    2332
RBE2         563    2303  123456    2333
RBE2         564    2304  123456    2334
RBE2         565    2305  123456    2335
RBE2         566    2306  123456    2336
RBE2         567    2307  123456    2337
RBE2         568    2308  123456    2338
RBE2         569    2309  123456    2339
RBE2         570    2310  123456    2340
RBE2         571    2311  123456    2341
$
$  GRIDS AT 80% CHORD HINGE-LINE OF RIGHT SIDE HORIZONTAL TAIL
GRID        2501       0 404.480 525.500  77.360       0
GRID        2502       0 403.106 535.000  79.010       0
GRID        2503       0 401.734 544.500  80.670       0
GRID        2504       0 400.360 554.000  82.330       0
GRID        2505       0 398.988 563.500  83.980       0
GRID        2506       0 397.616 573.000  85.640       0
GRID        2507       0 396.234 582.500  87.300       0
GRID        2508       0 394.862 592.000  88.950       0
GRID        2509       0 393.490 601.500  90.610       0
GRID        2510       0 392.116 611.000  92.270       0
GRID        2511       0 390.744 620.500  93.920       0
$
$    ****************************************************
$    END OF RIGHT SIDE HORIZONTAL TAIL DEFINITION
$    ****************************************************
$
$    ****************************************************
$    RIGHT SIDE VERTICAL TAIL DEFINITION
$    ****************************************************
$
$  GRIDS FOR RIGHT SIDE VERTICAL TAIL BEAM
GRID         401       0  410.39  525.50   77.50       0
GRID         402       0  411.39  522.60   85.47       0
GRID         403       0  412.38  519.70   93.44       0
GRID         404       0  413.38  516.80  101.41       0
GRID         405       0  414.37  513.90  109.38       0
GRID         406       0  415.37  511.00  117.34       0
GRID         407       0  416.36  508.10  125.31       0
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GRID         408       0  417.36  505.20  133.28       0
GRID         409       0  418.35  502.30  141.25       0
GRID         410       0  419.35  499.40  149.22       0
GRID         411       0  420.34  496.50  157.19       0
$   THIS GROUP OF GRIDS GENERATES OUTPUT IN COORD. SYSTEM 6
$   THE Z-AXIS FOR COORD. SYS. 5 IS NORMAL TO PLANE OF V-TAIL
GRID         431       0  410.39  525.50   77.50       6
GRID         432       0  411.39  522.60   85.47       6
GRID         433       0  412.38  519.70   93.44       6
GRID         434       0  413.38  516.80  101.41       6
GRID         435       0  414.37  513.90  109.38       6
GRID         436       0  415.37  511.00  117.34       6
GRID         437       0  416.36  508.10  125.31       6
GRID         438       0  417.36  505.20  133.28       6
GRID         439       0  418.35  502.30  141.25       6
GRID         440       0  419.35  499.40  149.22       6
GRID         441       0  420.34  496.50  157.19       6
$  DUPLICATE GRIDS OF MAIN V-TAIL ARE DEPENDENT ON ELASTIC AXIS GRIDS
RBE2         581     401  123456     431
RBE2         582     402  123456     432
RBE2         583     403  123456     433
RBE2         584     404  123456     434
RBE2         585     405  123456     435
RBE2         586     406  123456     436
RBE2         587     407  123456     437
RBE2         588     408  123456     438
RBE2         589     409  123456     439
RBE2         590     410  123456     440
RBE2         591     411  123456     441
$
$  RIGHT SIDE VERTICAL TAIL LEADING EDGE
$
GRID        1401       0  390.67  525.50   77.50       0
GRID        1402       0  392.36  522.60   85.47       0
GRID        1403       0  394.05  519.70   93.44       0
GRID        1404       0  395.73  516.80  101.41       0
GRID        1405       0  397.42  513.90  109.38       0
GRID        1406       0  399.11  511.00  117.34       0
GRID        1407       0  400.79  508.10  125.31       0
GRID        1408       0  402.48  505.20  133.28       0
GRID        1409       0  404.17  502.30  141.25       0
GRID        1410       0  405.85  499.40  149.22       0
GRID        1411       0  407.54  496.50  157.19       0
$
$  LEADING EDGE V-TAIL GRIDS ARE DEPENDENT ON ELASTIC AXIS
RBE2        1271     401  123456    1401
RBE2        1272     402  123456    1402
RBE2        1273     403  123456    1403
RBE2        1274     404  123456    1404
RBE2        1275     405  123456    1405
RBE2        1276     406  123456    1406
RBE2        1277     407  123456    1407
RBE2        1278     408  123456    1408
RBE2        1279     409  123456    1409
RBE2        1280     410  123456    1410
RBE2        1281     411  123456    1411
$
$  DUPLICATE GRIDS FOR VERTICAL TAIL LEADING EDGE
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 6
GRID        1431       0  390.67  525.50   77.50       6
GRID        1432       0  392.36  522.60   85.47       6
GRID        1433       0  394.05  519.70   93.44       6
GRID        1434       0  395.73  516.80  101.41       6
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GRID        1435       0  397.42  513.90  109.38       6
GRID        1436       0  399.11  511.00  117.34       6
GRID        1437       0  400.79  508.10  125.31       6
GRID        1438       0  402.48  505.20  133.28       6
GRID        1439       0  404.17  502.30  141.25       6
GRID        1440       0  405.85  499.40  149.22       6
GRID        1441       0  407.54  496.50  157.19       6
$  V-TAIL LEADING EDGE DUPLICATE GRIDS ARE DEPENDENT ON ELASTIC AXIS GRIDS
RBE2         601     401  123456    1431
RBE2         602     402  123456    1432
RBE2         603     403  123456    1433
RBE2         604     404  123456    1434
RBE2         605     405  123456    1435
RBE2         606     406  123456    1436
RBE2         607     407  123456    1437
RBE2         608     408  123456    1438
RBE2         609     409  123456    1439
RBE2         610     410  123456    1440
RBE2         611     411  123456    1441
$
$  RIGHT SIDE VERTICAL TAIL TRAILING EDGE
$
GRID        2401       0  439.97  525.50   77.50       0
GRID        2402       0  439.93  522.60   85.47       0
GRID        2403       0  439.89  519.70   93.44       0
GRID        2404       0  439.84  516.80  101.41       0
GRID        2405       0  439.80  513.90  109.38       0
GRID        2406       0  439.76  511.00  117.34       0
GRID        2407       0  439.71  508.10  125.31       0
GRID        2408       0  439.67  505.20  133.28       0
GRID        2409       0  439.63  502.30  141.25       0
GRID        2410       0  439.58  499.40  149.22       0
GRID        2411       0  439.54  496.50  157.19       0
$  DUPLICATE GRIDS FOR VERTICAL TAIL TRAILING EDGE
$  THE OUTPUT FOR THESE GRIDS WILL BE IN COORD. SYST. 6
GRID        2431       0  439.97  525.50   77.50       6
GRID        2432       0  439.93  522.60   85.47       6
GRID        2433       0  439.89  519.70   93.44       6
GRID        2434       0  439.84  516.80  101.41       6
GRID        2435       0  439.80  513.90  109.38       6
GRID        2436       0  439.76  511.00  117.34       6
GRID        2437       0  439.71  508.10  125.31       6
GRID        2438       0  439.67  505.20  133.28       6
GRID        2439       0  439.63  502.30  141.25       6
GRID        2440       0  439.58  499.40  149.22       6
GRID        2441       0  439.54  496.50  157.19       6
$  DUPLICATE V-TAIL T.E. GRIDS ARE DEPENDENT ON ORIGINAL GRIDS
RBE2         621    2401  123456    2431
RBE2         622    2402  123456    2432
RBE2         623    2403  123456    2433
RBE2         624    2404  123456    2434
RBE2         625    2405  123456    2435
RBE2         626    2406  123456    2436
RBE2         627    2407  123456    2437
RBE2         628    2408  123456    2438
RBE2         629    2409  123456    2439
RBE2         630    2410  123456    2440
RBE2         631    2411  123456    2441
$
$  GRIDS AT 80% CHORD HINGE-LINE OF RIGHT SIDE VERTICAL TAIL
GRID        2601       0 430.110 525.500  77.500       0
GRID        2602       0 430.416 522.600  85.470       0
GRID        2603       0 430.722 519.700  93.440       0
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GRID        2604       0 431.018 516.800 101.410       0
GRID        2605       0 431.324 513.900 109.380       0
GRID        2606       0 431.630 511.000 117.340       0
GRID        2607       0 431.926 508.100 125.310       0
GRID        2608       0 432.232 505.200 133.280       0
GRID        2609       0 432.538 502.300 141.250       0
GRID        2610       0 432.834 499.400 149.220       0
GRID        2611       0 433.140 496.500 157.190       0
$
$    ***************************************************
$      END OF RIGHT SIDE VERTICAL TAIL DEFINITION
$    ***************************************************
$
$   MAIN BEAMS FOR RIGHT WING
CBEAM        101     101     101     102     -1.      0.      0.
CBEAM        102     102     102     103     -1.      0.      0.
CBEAM        103     103     103     104     -1.      0.      0.
CBEAM        104     104     104     105     -1.      0.      0.
CBEAM        105     105     105     106     -1.      0.      0.
CBEAM        106     106     106     107     -1.      0.      0.
CBEAM        107     107     107     108     -1.      0.      0.
CBEAM        108     108     108     109     -1.      0.      0.
CBEAM        109     109     109     110     -1.      0.      0.
CBEAM        110     110     110     111     -1.      0.      0.
CBEAM        111     111     111     112     -1.      0.      0.
CBEAM        112     112     112     113     -1.      0.      0.
CBEAM        113     113     113     114     -1.      0.      0.
CBEAM        114     114     114     115     -1.      0.      0.
CBEAM        115     115     115     116     -1.      0.      0.
CBEAM        116     116     116     117     -1.      0.      0.
CBEAM        117     117     117     118     -1.      0.      0.
CBEAM        118     118     118     119     -1.      0.      0.
CBEAM        119     119     119     120     -1.      0.      0.
CBEAM        120     120     120     121     -1.      0.      0.
CBEAM        121     121     121     122     -1.      0.      0.
CBEAM        122     122     122     123     -1.      0.      0.
CBEAM        123     123     123     124     -1.      0.      0.
CBEAM        124     124     124     125     -1.      0.      0.
CBEAM        125     125     125     126     -1.      0.      0.
CBEAM        126     126     126     127     -1.      0.      0.
CBEAM        127     127     127     128     -1.      0.      0.
CBEAM        128     128     128     129     -1.      0.      0.
CBEAM        129     129     129     130     -1.      0.      0.
CBEAM        130     130     130     131     -1.      0.      0.
CBEAM        131     131     131     132     -1.      0.      0.
CBEAM        132     132     132     133     -1.      0.      0.
CBEAM        133     133     133     134     -1.      0.      0.
CBEAM        134     134     134     135     -1.      0.      0.
CBEAM        135     135     135     136     -1.      0.      0.
CBEAM        136     136     136     137     -1.      0.      0.
CBEAM        137     137     137     138     -1.      0.      0.
CBEAM        138     138     138     139     -1.      0.      0.
CBEAM        139     139     139     140     -1.      0.      0.
CBEAM        140     140     140     141     -1.      0.      0.
$   BEAMS FOR RIGHT WING TIP BOOM
CBEAM        201     201     201     202      0.      1.      0.
CBEAM        202     202     202     203      0.      1.      0.
CBEAM        203     203     203     204      0.      1.      0.
CBEAM        204     204     204     205      0.      1.      0.
CBEAM        205     205     205     206      0.      1.      0.
CBEAM        206     206     206     207      0.      1.      0.
CBEAM        207     207     207     208      0.      1.      0.
CBEAM        208     208     208     209      0.      1.      0.
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CBEAM        209     209     209     210      0.      1.      0.
CBEAM        210     210     210     211      0.      1.      0.
CBEAM        211     211     211     212      0.      1.      0.
CBEAM        212     212     212     213      0.      1.      0.
CBEAM        213     213     213     214      0.      1.      0.
CBEAM        214     214     214     215      0.      1.      0.
CBEAM        215     215     215     216      0.      1.      0.
CBEAM        216     216     216     217      0.      1.      0.
CBEAM        217     217     217     218      0.      1.      0.
CBEAM        218     218     218     219      0.      1.      0.
CBEAM        219     219     219     220      0.      1.      0.
CBEAM        220     220     220     221      0.      1.      0.
CBEAM        221     221     221     222      0.      1.      0.
CBEAM        222     222     222     223      0.      1.      0.
CBEAM        223     223     223     224      0.      1.      0.
CBEAM        224     224     224     225      0.      1.      0.
CBEAM        225     225     225     226      0.      1.      0.
CBEAM        226     226     226     227      0.      1.      0.
CBEAM        227     227     227     228      0.      1.      0.
CBEAM        228     228     228     229      0.      1.      0.
CBEAM        229     229     229     230      0.      1.      0.
CBEAM        230     230     230     231      0.      1.      0.
CBEAM        231     231     231     232      0.      1.      0.
CBEAM        232     232     232     233      0.      1.      0.
CBEAM        233     233     233     234      0.      1.      0.
CBEAM        234     234     234     235      0.      1.      0.
CBEAM        235     235     235     236      0.      1.      0.
CBEAM        236     236     236     237      0.      1.      0.
CBEAM        237     237     237     238      0.      1.      0.
CBEAM        238     238     238     239      0.      1.      0.
CBEAM        239     239     239     240      0.      1.      0.
CBEAM        240     240     240     241      0.      1.      0.
CBEAM        241     241     241     242      0.      1.      0.
CBEAM        242     242     242     243      0.      1.      0.
$   RIGHT SIDE HORIZONTAL TAIL BEAMS
CBEAM        301     301     301     302     -1.      0.      0.
CBEAM        302     302     302     303     -1.      0.      0.
CBEAM        303     303     303     304     -1.      0.      0.
CBEAM        304     304     304     305     -1.      0.      0.
CBEAM        305     305     305     306     -1.      0.      0.
CBEAM        306     306     306     307     -1.      0.      0.
CBEAM        307     307     307     308     -1.      0.      0.
CBEAM        308     308     308     309     -1.      0.      0.
CBEAM        309     309     309     310     -1.      0.      0.
CBEAM        310     310     310     311     -1.      0.      0.
$   RIGHT SIDE VERTICAL TAIL BEAMS
CBEAM        401     401     401     402      1.      0.      0.
CBEAM        402     402     402     403      1.      0.      0.
CBEAM        403     403     403     404      1.      0.      0.
CBEAM        404     404     404     405      1.      0.      0.
CBEAM        405     405     405     406      1.      0.      0.
CBEAM        406     406     406     407      1.      0.      0.
CBEAM        407     407     407     408      1.      0.      0.
CBEAM        408     408     408     409      1.      0.      0.
CBEAM        409     409     409     410      1.      0.      0.
CBEAM        410     410     410     411      1.      0.      0.
$
$ Fuselage Rigid Body Mass (50% for 1/2 symm model)
$
CONM2        601     100      -1   446.1  125.80    0.00    86.1       0 MASS601
+MASS601  2.64E5       0  8.90E5       0       0  6.95E5
$
$ *********************
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$ LUMPED MASSES FOR RIGHT-WING
$ *********************
$   RIGHT WING
CONM2        602     102      -1    7.91  157.54    6.57   49.16       0 MASS602
CONM2        603     103      -1    7.75  157.67   19.72   49.83       0 MASS603
CONM2        604     104      -1    7.60  157.80   32.87   50.50       0 MASS604
CONM2        605     105      -1    7.45  157.92   46.01   51.17       0 MASS605
CONM2        606     106      -1    7.30  158.05   59.16   51.84       0 MASS606
CONM2        607     107      -1    7.16  158.17   72.31   52.51       0 MASS607
CONM2        608     108      -1    7.03  158.30   85.46   53.17       0 MASS608
CONM2        609     109      -1    6.90  158.42   98.60   53.84       0 MASS609
CONM2        610     110      -1    6.77  158.54  111.75   54.51       0 MASS610
CONM2        611     111      -1    6.66  158.65  124.90   55.18       0 MASS611
CONM2        612     112      -1    6.57  158.71  138.04   55.86       0 MASS612
CONM2        613     113      -1    6.49  158.77  151.19   56.54       0 MASS613
CONM2        614     114      -1    6.41  158.82  164.34   57.22       0 MASS614
CONM2        615     115      -1    6.35  158.83  177.49   57.91       0 MASS615
CONM2        616     116      -1    6.30  158.82  190.63   58.60       0 MASS616
CONM2        617     117      -1    6.26  158.79  203.78   59.29       0 MASS617
CONM2        618     118      -1    6.24  158.74  216.93   59.99       0 MASS618
CONM2        619     119      -1    6.19  158.66  230.07   60.69       0 MASS619
$
+MASS602   114.0       0  2357.1       0       0  2471.1
+MASS603   111.7       0  2285.6       0       0  2397.2
+MASS604   109.4       0  2216.7       0       0  2326.1
+MASS605   107.3       0  2150.3       0       0  2257.6
+MASS606   105.2       0  2086.5       0       0  2191.6
+MASS607   103.2       0  2025.0       0       0  2128.2
+MASS608   101.2       0  1966.0       0       0  2067.2
+MASS609    99.4       0  1909.2       0       0  2008.6
+MASS610    97.6       0  1854.7       0       0  1952.3
+MASS611    95.9       0  1802.8       0       0  1898.7
+MASS612    94.6       0  1760.2       0       0  1854.9
+MASS613    93.4       0  1719.1       0       0  1812.6
+MASS614    92.3       0  1679.5       0       0  1771.8
+MASS615    91.5       0  1646.6       0       0  1738.0
+MASS616    90.7       0  1615.4       0       0  1706.1
+MASS617    90.2       0  1587.8       0       0  1678.0
+MASS618    89.8       0  1563.6       0       0  1653.4
+MASS619    88.9       0  1527.9       0       0  1616.9
$
$   ***************************************************************
$      BEGIN FUEL STATIONS
$   ***************************************************************
$
$ No Fuel
$
$CONM2        620     120      -1    6.14  158.56  243.20   61.53       0 MASS620
$CONM2        621     121      -1    6.10  158.46  256.33   62.23       0 MASS621
$CONM2        622     122      -1    6.05  158.36  269.46   62.93       0 MASS622
$CONM2        623     123      -1    6.00  158.26  282.59   63.63       0 MASS623
$CONM2        624     124      -1    5.95  158.16  295.72   64.33       0 MASS624
$CONM2        625     125      -1    5.91  158.06  308.85   65.03       0 MASS625
$CONM2        626     126      -1    5.86  157.96  321.98   65.73       0 MASS626
$
$ No Fuel
$
$+MASS620    88.3       0  1485.1       0       0  1573.4
$+MASS621    87.6       0  1443.1       0       0  1530.7
$+MASS622    86.9       0  1402.0       0       0  1488.9
$+MASS623    86.2       0  1361.5       0       0  1447.8
$+MASS624    85.5       0  1321.9       0       0  1407.5
$+MASS625    84.9       0  1283.1       0       0  1367.9
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$+MASS626    84.2       0  1245.0       0       0  1329.1
$
$ With Fuel
$
CONM2        620     120      -1   56.86  157.65  243.20   61.53       0 MASS620
CONM2        621     121      -1   55.70  157.57  256.33   62.23       0 MASS621
CONM2        622     122      -1   54.55  157.49  269.46   62.93       0 MASS622
CONM2        623     123      -1   53.41  157.41  282.59   63.63       0 MASS623
CONM2        624     124      -1   52.28  157.33  295.72   64.33       0 MASS624
CONM2        625     125      -1   51.17  157.25  308.85   65.03       0 MASS625
CONM2        626     126      -1   50.07  157.17  321.98   65.73       0 MASS626
$
$ With Fuel
$
+MASS620   816.9       0  8807.9       0       0  9165.0
+MASS621   800.2       0  8456.6       0       0  8805.8
+MASS622   783.7       0  8116.0       0       0  8457.4
+MASS623   767.3       0  7785.8       0       0  8119.6
+MASS624   751.2       0  7465.9       0       0  7792.1
+MASS625   735.2       0  7156.0       0       0  7474.7
+MASS626   719.4       0  6856.0       0       0  7167.2
$
$   ****************************************************************
$      END FUEL STATIONS
$   ****************************************************************
$
CONM2        627     127      -1    5.81  157.86  335.11   66.31       0 MASS627
CONM2        628     128      -1    5.76  157.76  348.24   67.01       0 MASS628
CONM2        629     129      -1    5.72  157.66  361.37   67.71       0 MASS629
CONM2        630     130      -1    5.67  157.56  374.50   68.42       0 MASS630
CONM2        631     131      -1    5.62  157.46  387.63   69.12       0 MASS631
CONM2        632     132      -1    5.58  157.37  400.76   69.82       0 MASS632
CONM2        633     133      -1    5.53  157.27  413.89   70.52       0 MASS633
CONM2        634     134      -1    5.48  157.17  427.02   71.23       0 MASS634
CONM2        635     135      -1    5.43  157.07  440.15   71.93       0 MASS635
CONM2        636     136      -1   12.39  155.86  453.28   72.81       0 MASS636
CONM2        637     137      -1    5.34  156.87  466.41   73.33       0 MASS637
CONM2        638     138      -1   12.29  155.76  479.54   74.19       0 MASS638
CONM2        639     139      -1    5.24  156.67  492.67   74.74       0 MASS639
CONM2        640     140      -1   12.20  155.67  505.80   75.58       0 MASS640
CONM2        641     141      -1    5.15  156.47  518.93   76.14       0 MASS641
$
+MASS627    83.5       0  1207.6       0       0  1291.1
+MASS628    82.8       0  1171.0       0       0  1253.8
+MASS629    82.1       0  1135.2       0       0  1217.3
+MASS630    81.5       0  1100.0       0       0  1181.5
+MASS631    80.8       0  1065.6       0       0  1146.4
+MASS632    80.1       0  1031.9       0       0  1112.0
+MASS633    79.4       0   999.0       0       0  1078.4
+MASS634    78.7       0   966.7       0       0  1045.4
+MASS635    78.1       0   935.1       0       0  1013.2
+MASS636    77.4       0   974.4       0       0   974.4
+MASS637    76.7       0   874.0       0       0   950.7
+MASS638    76.0       0   912.3       0       0   912.3
+MASS639    75.3       0   815.6       0       0   890.9
+MASS640    74.7       0   853.1       0       0   853.1
+MASS641    74.0       0   759.8       0       0   833.8
$
$   LUMPED MASSES ON RIGHT WING-TIP BOOM
CONM2        702     202      -1   11.25   33.61  525.50   77.50       0 MASS702
CONM2        703     203      -1   16.33   42.22  525.50   77.50       0 MASS703
CONM2        704     204      -1   16.41   50.83  525.50   77.50       0 MASS704
CONM2        705     205      -1   11.48   59.44  525.50   77.50       0 MASS705
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CONM2        706     206      -1    1.56   68.06  525.50   77.50        0 MASS706
CONM2        707     207      -1    1.64   76.67  525.50   77.50        0 MASS707
CONM2        708     208      -1    1.72   85.28  525.50   77.50        0 MASS708
CONM2        709     209      -1    1.79   93.89  525.50   77.50        0 MASS709
CONM2        710     210      -1    1.87  102.50  525.50   77.50        0 MASS710
CONM2        711     211      -1    1.95  111.11  525.50   77.50        0 MASS711
CONM2        712     212      -1    2.02  119.72  525.50   77.50        0 MASS712
CONM2        713     213      -1    2.10  128.33  525.50   77.50        0 MASS713
CONM2        714     214      -1    2.18  136.94  525.50   77.50        0 MASS714
CONM2        715     215      -1    2.25  145.56  525.50   77.50        0 MASS715
CONM2        716     216      -1    2.22  154.17  525.50   77.50        0 MASS716
CONM2        717     217      -1    2.18  162.78  525.50   77.50        0 MASS717
CONM2        718     218      -1    5.65  171.39  525.50   77.50        0 MASS718
CONM2        719     219      -1    2.11  180.00  525.50   77.50        0 MASS719
CONM2        720     220      -1    2.41  190.00  525.50   77.50        0 MASS720
CONM2        721     221      -1    2.35  200.00  525.50   77.50        0 MASS721
CONM2        722     222      -1    2.30  210.00  525.50   77.50        0 MASS722
CONM2        723     223      -1    2.24  220.00  525.50   77.50        0 MASS723
CONM2        724     224      -1    2.17  230.00  525.50   77.50        0 MASS724
CONM2        725     225      -1    2.11  240.00  525.50   77.50        0 MASS725
CONM2        726     226      -1    2.05  250.00  525.50   77.50        0 MASS726
CONM2        727     227      -1    1.98  260.00  525.50   77.50        0 MASS727
CONM2        728     228      -1    1.91  270.00  525.50   77.50        0 MASS728
CONM2        729     229      -1    1.84  280.00  525.50   77.50        0 MASS729
CONM2        730     230      -1    1.89  290.00  525.50   77.50        0 MASS730
CONM2        731     231      -1    1.81  300.00  525.50   77.50        0 MASS731
CONM2        732     232      -1    1.73  310.00  525.50   77.50        0 MASS732
CONM2        733     233      -1    1.76  320.00  525.50   77.50        0 MASS733
CONM2        734     234      -1    1.66  330.00  525.50   77.50        0 MASS734
CONM2        735     235      -1    1.56  340.00  525.50   77.50        0 MASS735
CONM2        736     236      -1    1.56  350.00  525.50   77.50        0 MASS736
CONM2        737     237      -1    1.54  360.00  525.50   77.50        0 MASS737
CONM2        738     238      -1    1.42  370.00  525.50   77.50        0 MASS738
CONM2        739     239      -1    1.37  380.00  525.50   77.50        0 MASS739
CONM2        740     240      -1    1.31  390.00  525.50   77.50        0 MASS740
CONM2        741     241      -1    1.29  400.00  525.50   77.50        0 MASS741
CONM2        742     242      -1    0.80  410.00  525.50   77.50        0 MASS742
CONM2        743     243      -1    0.71  420.00  525.50   77.50        0 MASS743
$
$
+MASS702   316.5       0   126.6       0       0   126.6
+MASS703   459.3       0   330.6       0       0   330.6
+MASS704   461.5       0   332.1       0       0   332.1
+MASS705   323.0       0   232.5       0       0   232.5
+MASS706    87.8       0    53.6       0       0    53.6
+MASS707    92.2       0    56.2       0       0    56.2
+MASS708    96.5       0    58.8       0       0    58.8
+MASS709   100.8       0    61.5       0       0    61.5
+MASS710   105.1       0    64.1       0       0    64.1
+MASS711   109.5       0    66.8       0       0    66.8
+MASS712   113.8       0    69.4       0       0    69.4
+MASS713   118.1       0    72.0       0       0    72.0
+MASS714   122.5       0    74.7       0       0    74.7
+MASS715   126.8       0    77.3       0       0    77.3
+MASS716   124.8       0    76.1       0       0    76.1
+MASS717   122.7       0    74.9       0       0    74.9
+MASS718   158.8       0   114.3       0       0   114.3
+MASS719   118.7       0    72.4       0       0    72.4
+MASS720   128.9       0    84.6       0       0    84.6
+MASS721   119.5       0    79.4       0       0    79.4
+MASS722   110.5       0    74.4       0       0    74.4
+MASS723   101.8       0    69.6       0       0    69.6
+MASS724    93.6       0    64.9       0       0    64.9
```

```
+MASS725    85.8       0    60.5       0       0    60.5
+MASS726    78.3       0    56.2       0       0    56.2
+MASS727    71.3       0    52.1       0       0    52.1
+MASS728    64.5       0    48.2       0       0    48.2
+MASS729    58.2       0    44.4       0       0    44.4
+MASS730    56.0       0    43.8       0       0    43.8
+MASS731    50.0       0    40.1       0       0    40.1
+MASS732    44.3       0    36.6       0       0    36.6
+MASS733    41.8       0    35.5       0       0    35.5
+MASS734    36.5       0    32.1       0       0    32.1
+MASS735    31.6       0    28.8       0       0    28.8
+MASS736    29.0       0    27.5       0       0    27.5
+MASS737    26.2       0    26.0       0       0    26.0
+MASS738    21.9       0    22.8       0       0    22.8
+MASS739    19.3       0    21.1       0       0    21.1
+MASS740    16.6       0    19.2       0       0    19.2
+MASS741    14.7       0    18.1       0       0    18.1
+MASS742     8.1       0    10.7       0       0    10.7
+MASS743     6.4       0     9.1       0       0     9.1
$   LUMPED MASSES FOR RIGHT SIDE HORIZONTAL TAIL
CONM2        802     302      -1    4.97  387.10  530.25   77.80       0 MASS802
CONM2        803     303      -1    4.73  386.66  539.75   79.47       0 MASS803
CONM2        804     304      -1    7.69  387.79  549.25   81.06       0 MASS804
CONM2        805     305      -1    4.26  385.75  558.75   82.82       0 MASS805
CONM2        806     306      -1    4.03  385.29  568.25   84.49       0 MASS806
CONM2        807     307      -1    7.00  387.18  577.75   86.04       0 MASS807
CONM2        808     308      -1    3.58  384.33  587.25   87.84       0 MASS808
CONM2        809     309      -1    3.35  383.83  596.75   89.51       0 MASS809
CONM2        810     310      -1    6.34  386.70  606.25   91.01       0 MASS810
CONM2        811     311      -1    2.92  382.81  615.75   92.87       0 MASS811
$
+MASS802    37.4       0  1504.7       0       0  1542.1
+MASS803    35.6       0  1289.2       0       0  1324.7
+MASS804    33.8       0  1149.5       0       0  1149.5
+MASS805    32.0       0   923.6       0       0   955.6
+MASS806    30.3       0   770.9       0       0   801.2
+MASS807    28.6       0   710.0       0       0   710.0
+MASS808    26.9       0   519.2       0       0   546.1
+MASS809    25.2       0   417.6       0       0   442.8
+MASS810    23.6       0   427.7       0       0   427.7
+MASS811    22.0       0   256.7       0       0   278.7
$   LUMPED MASSES FOR RIGHT SIDE VERTICAL TAIL
CONM2        902     402      -1    3.06  413.63  524.05   81.48       0 MASS902
CONM2        903     403      -1    2.91  414.65  521.15   89.45       0 MASS903
CONM2        904     404      -1    5.97  418.34  518.25   97.42       0 MASS904
CONM2        905     405      -1    2.63  416.67  515.35  105.39       0 MASS905
CONM2        906     406      -1    2.49  417.67  512.45  113.36       0 MASS906
CONM2        907     407      -1    2.36  418.66  509.55  121.33       0 MASS907
CONM2        908     408      -1    5.43  422.59  506.65  129.30       0 MASS908
CONM2        909     409      -1     2.1  420.61  503.75  137.27       0 MASS909
CONM2        910     410      -1    1.98  421.57  500.85  145.23       0 MASS910
CONM2        911     411      -1    1.86  422.50  497.95  153.20       0 MASS911
$
+MASS902    18.3       0   616.3       0       0   597.9
+MASS903    17.5       0   547.1       0       0   529.7
+MASS904    16.6       0   483.7       0       0   467.1
+MASS905    15.8       0   425.8       0       0   410.0
+MASS906    14.9       0   373.1       0       0   358.2
+MASS907    14.1       0   325.3       0       0   311.2
+MASS908    13.3       0   282.3       0       0   269.0
+MASS909    12.6       0   243.7       0       0   231.1
+MASS910    11.8       0   209.3       0       0   197.5
+MASS911    11.1       0   178.9       0       0   167.8
```

```
$
$
PBEAM       2301       1   100.    1000.  1000.       0.  1000.
PBEAM       2401       1   100.    1000.  1000.       0.  1000.
$
$   RIGHT SIDE BEAMS FROM H-TAIL MAIN BEAM TO HINGE LINE
CBEAM       2301    2301    301     2501     302
CBEAM       2302    2301    302     2502     301
CBEAM       2303    2301    303     2503     301
CBEAM       2304    2301    304     2504     301
CBEAM       2305    2301    305     2505     301
CBEAM       2306    2301    306     2506     301
CBEAM       2307    2301    307     2507     301
CBEAM       2308    2301    308     2508     301
CBEAM       2309    2301    309     2509     301
CBEAM       2310    2301    310     2510     301
CBEAM       2311    2301    311     2511     301
$
$   RIGHT SIDE BEAMS FROM H-TAIL HINGE LINE TO H-TAIL TRAILING EDGE
CBEAM       2321    2301    2501    2301    2502
CBEAM       2322    2301    2502    2302    2501
CBEAM       2323    2301    2503    2303    2501
CBEAM       2324    2301    2504    2304    2501
CBEAM       2325    2301    2505    2305    2501
CBEAM       2326    2301    2506    2306    2501
CBEAM       2327    2301    2507    2307    2501
CBEAM       2328    2301    2508    2308    2501
CBEAM       2329    2301    2509    2309    2501
CBEAM       2330    2301    2510    2310    2501
CBEAM       2331    2301    2511    2311    2501
$   RIGHT SIDE BEAMS FROM V-TAIL MAIN BEAM TO HINGE LINE
CBEAM       2401    2401    401     2601     402
CBEAM       2402    2401    402     2602     401
CBEAM       2403    2401    403     2603     401
CBEAM       2404    2401    404     2604     401
CBEAM       2405    2401    405     2605     401
CBEAM       2406    2401    406     2606     401
CBEAM       2407    2401    407     2607     401
CBEAM       2408    2401    408     2608     401
CBEAM       2409    2401    409     2609     401
CBEAM       2410    2401    410     2610     401
CBEAM       2411    2401    411     2611     401
$
$   RIGHT SIDE BEAMS FROM V-TAIL HINGE LINE TO V-TAIL TRAILING EDGE
CBEAM       2421    2401    2601    2401    2602
CBEAM       2422    2401    2602    2402    2601
CBEAM       2423    2401    2603    2403    2601
CBEAM       2424    2401    2604    2404    2601
CBEAM       2425    2401    2605    2405    2601
CBEAM       2426    2401    2606    2406    2601
CBEAM       2427    2401    2607    2407    2601
CBEAM       2428    2401    2608    2408    2601
CBEAM       2429    2401    2609    2409    2601
CBEAM       2430    2401    2610    2410    2601
CBEAM       2431    2401    2611    2411    2601
$
ENDDATA
```

APPENDIX B

MSC/NASTRAN file used in the flutter analysis of the semi-span model

```
$   TO EXECUTE THIS FILE USE THE FOLLOWING:
$   NASTRAN FL01 SCRATCH=YES MEM=8MW NEWS=NO
$
$ SOL 103  $  NORMAL MODES
$ SOL 144  $  STATIC AEROELASTICITY
SOL 145 $   FLUTTER SOLUTION
$ DIAG = 8,15   $   Matrix and Table trailers
TIME 30.00    $  time in minutes
$
CEND
$ TITLE = SYMMETRIC TRIM * MACH=0 * VEL=1000 IN/SEC AT SEA LEVEL
TITLE = SYMM. FREE-FREE FLUTTER * SEMISPAN MODEL * FULL FUEL
SUBTITLE = CHORDWISE GRIDS * SURFACE SPLINES
METHOD = 1
FMETHOD = 30   $  ID of FLUTTER Bulk Data entry
ECHO = UNSORT
$  ECHO = NONE
$  MODE SHAPE OUTPUT REQUESTED FOR VELOCITY=880 IN/SEC (FLFACT 4)
TRIM = 1  $ TRIM VARIABLE CONSTRAINTS
DISPLACEMENT = ALL
APRES = ALL  $  PRINT AERO. PRESSURES (ONLY IN SOL 144)
AEROF = ALL  $  AERO. LOADS ON AERO. CONTROL POINTS (NOT IN SOL 145)
SPC = 1  $  BOUNDARY CONDITION CONSTRAINTS
$
BEGIN BULK
$
$   LENGTH UNITS ARE INCHES, MASS UNITS ARE POUNDS
$
PARAM, POST, -2   $  IDEAS POST-PROCESSING
SUPORT, 101, 135   $   REACTIONS FOR RIGID BODY MOTION
$
PARAM, OPPHIPA, 1  $ OUTPUT MODES AT ALL D.O.F. INCLUDING AERO D.O.F.
$
PARAM, LMODES, 10   $   USE THE 10 LOWEST NORMAL MODES
$ PARAM, VREF, 20.2537  $  CONVERT FROM IN/SEC TO KNOTS
PARAM, VREF, 12.0  $  USE VELOCITY UNITS OF FEET/SECOND
PARAM, AUNITS, 0.002588   $  ALLOWS ACCELERATION UNITS IN G'S IN TRIM ENTRY
$
$ changes "weight" input data to "mass" data
PARAM,WTMASS,0.002588
$
$ requests mass properties summary
PARAM,GRDPNT,0
$
$  DEFINE LOCAL COORDINATE SYSTEMS FOR HORIZONTAL AND VERTICAL TAILS
SPC1, 1, 123456, 30, 40   $   GRIDS 30 AND 40 ONLY USED FOR ORIENTATION
GRID, 30, 0, 379.75, 521.5678, 100.0   $   DEFINES DIRECTION OF Z-AXIS (H-TAIL)
GRID, 40, 0, 410.39, 587.3362, 100.0   $   DEFINES DIRECTION OF Z-AXIS (V-TAIL)
$
$  COORDINATE SYSTEM 12 IS A REFERENCE AXIS SYSTEM FOR STABILITY DERIVATIVES
CORD2R        12       0 156.51    0.0   48.98   156.51   0.0     40.0  +CO12
+CO12      140.0  0.0     48.98
$    LOCAL COORD. SYSTEM FOR HORIZONTAL TAIL
CORD1R, 5, 301, 30, 2301   $   Z-AXIS NORMAL TO PLANE OF HORIZ. TAIL
$    LOCAL COORD. SYSTEM FOR VERTICAL TAIL
CORD1R, 6, 401, 40, 2401   $   Z-AXIS NORMAL TO PLANE OF VERT. TAIL
$
```

```
$  LOCAL COORDINATE SYSTEM TO DEFINE Y-AXIS OF RIGHT H-TAIL HINGE LINE
CORD2R        13       0 404.480 525.50  77.360  404.480521.5678 100.0  +CO13
+CO13      450.0531.888378.46955
$  LOCAL COORDINATE SYSTEM TO DEFINE Y-AXIS OF RIGHT V-TAIL HINGE LINE
CORD2R        14       0 433.14  496.50 157.190  433.140614.1537 200.0  +CO14
+CO14      500.0497.3168154.9451
$
CORD2C         1       0      0.      0.      0.      0.      0.      1.+FEMAPC1
+FEMAPC1      1.      0.      1.
CORD2S         2       0      0.      0.      0.      0.      0.      1.+FEMAPC2
+FEMAPC2      1.      0.      1.
$
$   SELECT THE DESIRED BOUNDARY CONDITIONS
$ Fixed Root
$ SPC            1     101  123456      0.
$
$ Symmetric BC
SPC            1     101  246         0.
$
$ Antisymmetric BC
$ SPC            1     101  135         0.
$
$    ********************************************************
$      SECTION FOR STATIC AEROELASTIC ANALYSIS
$    ********************************************************
$
$ CONSTRAINTS FOR AERODYNAMIC TRIM VARIABLES
$  MACH=0.0 , VELOCITY=1000.0 IN/SEC , SEA-LEVEL
$ SYMMETRIC B.C. FOR STATIC STABILITY ANALYSIS
$ SPC            1     101 1246         0.
$
TRIM       1     0.0     0.05734 PITCH    0.0    URDD3  -1.0            +TR01
+TR01    URDD5   0.0
$
AESTAT     70    ANGLEA
AESTAT     71    PITCH
AESTAT     73    URDD3
AESTAT     74    URDD5
$
AEROS     0       12     54.03   1236.0  31608.0   1       0
$
AESURF     80    HTAIL    13      90
AELIST     90    31001    THRU    31040
$ AESURF     81    VTAIL    14      91
$ AELIST     91    41001    THRU    41040
$
$    ********************************************************
$      END OF SECTION FOR STATIC AEROELASTIC ANALYSIS
$    ********************************************************
$
$ ********************************************************
$    BEGIN AERODYNAMIC FLUTTER CARDS
$ ********************************************************
$
$ VALUE OF FIELD 6 (SYMXZ) IS 1 FOR SYM CASE, -1 FOR ASYM,  0 FOR FIXED
$       2       3       4       5       6       7       8       9       1
$   AERO. DENSITY UNITS: LB-SEC**2/IN**4 (SEA-LEVEL)
AERO    0       0       54.03   1.145-7 1       0
$
$ Inboard Wing   (RIGHT SIDE)
CAERO1  10001   1       0       17      8                       1       +CA101
+CA101  132.83  0.0     48.98   59.2    134.33  223.5   60.77   54.03
$
```

```
$GRID   101     0       156.51    0.00   48.98
$ (156.51-132.83)/59.2=0.40 chord
$
$ Outboard Wing   (RIGHT SIDE)
CAERO1  20001   1       0       23      8                       1       +CA102
+CA102  134.33  223.5   60.77   54.03    138.03  525.5   76.79    41.28
$
$GRID   118     0       155.94  223.50   60.77
$ (155.94-134.33)/54.03=0.40 chord
$
$   RIGHT-SIDE HORIZONTAL TAIL - Corrected a touch (tip Z)
$   THE H-TAIL PANEL SPANS THE AREA FROM THE LEADING EDGE TO THE HINGE LINE
CAERO1  30001   1       0       20      8                       1       +CA103
+CA103  355.08  525.5   77.36   49.40   366.04  620.5   93.92   24.704
$
$   RIGHT-SIDE CONTROL SURFACE PANEL ON HORIZONTAL TAIL
CAERO1  31001      1      0      20       2                       1      +CA103A
+CA103A 404.480 525.50  77.360  12.35   390.744 620.50  93.920  6.176
$
$GRID   301     0       379.75  525.50   77.36
$ (379.75-355.08)/61.75=0.40 chord
$
$   RIGHT-SIDE VERTICAL TAIL - Corrected a bunch (Both x's and both chord lengths)
$ CAERO1  40001   1       0       16      8                       1       +CA104
$ +CA104  390.67  525.5   77.5    49.3    407.54  496.5   157.19  32.00
$
$  REDEFINE POINTS 1 AND 4 FOR VERTICAL TAIL (SWAP POINTS 1 AND 4)
CAERO1  40001   1       0       20      8                       1       +CA104
+CA104  407.54  496.5   157.19  25.60   390.67  525.5   77.5    39.44
$
$  RIGHT-SIDE CONTROL SURFACE PANEL ON VERTICAL TAIL
CAERO1  41001      1       0      20       2                       1     +CA104A
+CA104A 433.140  496.50  157.190  6.40   430.110 525.50  77.50   9.86
$
$GRID   401     0       410.39  525.50  77.50
$ (410.39-390.67)/49.30=0.40 chord
$
$                       DENS    MACH    VEL     INTERP  MODES   PK TOL (0.001 default)
FLUTTER 30      PK      1       2       4       L       10
FLFACT  1       1.0
FLFACT  2       0.0
$
$ FLFACT  4       200.0   THRU    10000.   20
$  FOR PK METHOD, 'FLFACT 4' IS A VELOCITY TABLE (UNITS IN/SEC)
$  A MINUS SIGN FOR A VELOCITY IS A REQUEST FOR EIGENVALUE OUTPUT
FLFACT  4       176.0   528.0   -880.0  1320.0  1760.0  2640.0  3520.0  +FL01
+FL01   4400.0  5280.0  6200.0  7040.0
$
$       2       3       4       5       6       7       8       9       1
$
MKAERO1 0.0                                                             +MK1
+MK1    .0001    .01    .05     .1      .2      .5      1.0     4.0
$
PAERO1  1
$
$  TEST USAGE OF SURFACE SPLINES ON ALL LIFTING SURFACES
$   SPLINE1 = 100   RIGHT-SIDE INBOARD WING
$   SPLINE1 = 200   RIGHT-SIDE OUTBOARD WING
$   SPLINE1 = 300   RIGHT-SIDE HORIZONTAL TAIL WITHOUT CONTROL SURFACE
$   SPLINE1 = 305   RIGHT-SIDE CONTROL SURFACE ON HORIZONTAL TAIL
$   SPLINE1 = 400   RIGHT-SIDE VERTICAL TAIL WITHOUT CONTROL SURFACE
$   SPLINE1 = 405   RIGHT-SIDE CONTROL SURFACE ON VERTICAL TAIL
$
```

```
SPLINE1 100     10001   10001   10136   100
SPLINE1 200     20001   20001   20184   200
$
SPLINE1 300     30001   30001   30160   300
SPLINE1 400     40001   40001   40160   400
$
SPLINE1 305     31001   31001   31040   305
SPLINE1 405     41001   41001   41040   405
$
$   GRIDS UTILIZED FOR RIGHT SIDE INBOARD WING SURFACE SPLINES
SET1         100     101     102     103     104     105     106     107+IW01
+IW01        108     109     110     111     112     113     114     115+IW02
+IW02        116     117     118    1101    1102    1103    1104    1105+IW03
+IW03       1106    1107    1108    1109    1110    1111    1112    1113+IW04
+IW04       1114    1115    1116    1117    1118    2101    2102    2103+IW05
+IW05       2104    2105    2106    2107    2108    2109    2110    2111+IW06
+IW06       2112    2113    2114    2115    2116    2117    2118
$   GRIDS UTILIZED FOR RIGHT SIDE OUTBOARD WING SURFACE SPLINES
SET1         200     118     119     120     121     122     123     124+OW01
+OW01        125     126     127     128     129     130     131     132+OW02
+OW02        133     134     135     136     137     138     139     140+OW03
+OW03        141    1118    1119    1120    1121    1122    1123    1124+OW04
+OW04       1125    1126    1127    1128    1129    1130    1131    1132+OW05
+OW05       1133    1134    1135    1136    1137    1138    1139    1140+OW06
+OW06       1141    2118    2119    2120    2121    2122    2123    2124+OW07
+OW07       2125    2126    2127    2128    2129    2130    2131    2132+OW08
+OW08       2133    2134    2135    2136    2137    2138    2139    2140+OW09
+OW09       2141
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON H-TAIL
SET1         300     301     302     303     304     305     306     307+HT01
+HT01        308     309     310     311    1301    1302    1303    1304+HT02
+HT02       1305    1306    1307    1308    1309    1310    1311    2501+HT03
+HT03       2502    2503    2504    2505    2506    2507    2508    2509+HT04
+HT04       2510    2511
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON H-TAIL CONTROL SURFACE
SET1         305    2501    2502    2503    2504    2505    2506    2507+HC01
+HC01       2508    2509    2510    2511    2301    2302    2303    2304+HC02
+HC02       2305    2306    2307    2308    2309    2310    2311
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON V-TAIL
SET1         400     401     402     403     404     405     406     407+VT01
+VT01        408     409     410     411    1401    1402    1403    1404+VT02
+VT02       1405    1406    1407    1408    1409    1410    1411    2601+VT03
+VT03       2602    2603    2604    2605    2606    2607    2608    2609+VT04
+VT04       2610    2611
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON V-TAIL CONTROL SURFACE
SET1         405    2601    2602    2603    2604    2605    2606    2607+VC01
+VC01       2608    2609    2610    2611    2401    2402    2403    2404+VC02
+VC02       2405    2406    2407    2408    2409    2410    2411
$
$ *****  END OF AERODYNAMIC FLUTTER INPUTS  *****
$
EIGR           1    MGIV                              10
$
$ EIGRL          1                      10       0
$
$   BEAM PROPERTIES FOR RIGHT WING ELASTIC AXIS
PBEAM        101       1   1000.   1021.   247.3      0.   174.3      0.
PBEAM        102       1   1000.   1005.   227.7      0.   171.5      0.
PBEAM        103       1   1000.   989.3   208.8      0.   168.7      0.
PBEAM        104       1   1000.    974.   190.5      0.    166.      0.
PBEAM        105       1   1000.   958.7    173.      0.   163.3      0.
PBEAM        106       1   1000.   943.7   156.2      0.   160.6      0.
PBEAM        107       1   1000.   928.8   140.2      0.   157.9      0.
```

```
PBEAM        108       1   1000.    914.   124.8      0.   155.3      0.
PBEAM        109       1   1000.   899.4   110.3      0.   152.7      0.
PBEAM        110       1   1000.    885.   96.95      0.   150.1      0.
PBEAM        111       1   1000.   870.7   92.06      0.   147.6      0.
PBEAM        112       1   1000.   856.6   86.48      0.   145.1      0.
PBEAM        113       1   1000.   842.6   79.99      0.   142.6      0.
PBEAM        114       1   1000.   828.8   75.44      0.   140.1      0.
PBEAM        115       1   1000.   815.2   71.21      0.   137.7      0.
PBEAM        116       1   1000.   801.6   68.65      0.   135.3      0.
PBEAM        117       1   1000.   788.3   67.96      0.    133.      0.
PBEAM        118       1   1000.   769.7   66.91      0.   129.7      0.
PBEAM        119       1   1000.   746.1   65.52      0.   125.5      0.
PBEAM        120       1   1000.   723.1   64.11      0.   121.4      0.
PBEAM        121       1   1000.   700.5   62.75      0.   117.4      0.
PBEAM        122       1   1000.   678.4   61.39      0.   113.5      0.
PBEAM        123       1   1000.   656.7   60.02      0.   109.7      0.
PBEAM        124       1   1000.   635.5   58.67      0.    106.      0.
PBEAM        125       1   1000.   614.8   57.33      0.   102.3      0.
PBEAM        126       1   1000.   594.6   56.01      0.   98.78      0.
PBEAM        127       1   1000.   574.8    54.7      0.    95.3      0.
PBEAM        128       1   1000.   555.4    53.4      0.   91.91      0.
PBEAM        129       1   1000.   536.5   52.12      0.    88.6      0.
PBEAM        130       1   1000.    518.   50.86      0.   85.37      0.
PBEAM        131       1   1000.   499.9   49.61      0.   82.22      0.
PBEAM        132       1   1000.   482.3   48.37      0.   79.15      0.
PBEAM        133       1   1000.   465.1   47.15      0.   76.15      0.
PBEAM        134       1   1000.   448.3   45.95      0.   73.23      0.
PBEAM        135       1   1000.   431.9   44.76      0.   70.39      0.
PBEAM        136       1   1000.   415.9   43.58      0.   67.62      0.
PBEAM        137       1   1000.   400.3   42.42      0.   64.93      0.
PBEAM        138       1   1000.   385.1   41.27      0.    62.3      0.
PBEAM        139       1   1000.   370.3   40.14      0.   59.75      0.
PBEAM        140       1   1000.   355.9   39.03      0.   57.27      0.
$   BEAM PROPERTIES FOR RIGHT WING TIP BOOM
PBEAM        201       2   1000.   83.46   90.29      0.   238.6      0.
PBEAM        202       2   1000.   132.9   146.5      0.   238.6      0.
PBEAM        203       2   1000.   182.3   202.8      0.   238.6      0.
PBEAM        204       2   1000.   231.8   259.1      0.   238.6      0.
PBEAM        205       2   1000.   281.2   315.3      0.   238.6      0.
PBEAM        206       2   1000.   330.7   371.6      0.   238.6      0.
PBEAM        207       2   1000.   380.1   427.8      0.   238.6      0.
PBEAM        208       2   1000.   429.5   484.1      0.   238.6      0.
PBEAM        209       2   1000.    479.   540.4      0.   238.6      0.
PBEAM        210       2   1000.   528.4   596.6      0.   238.6      0.
PBEAM        211       2   1000.   577.8   652.9      0.   238.6      0.
PBEAM        212       2   1000.   627.3   709.1      0.   238.6      0.
PBEAM        213       2   1000.   676.7   765.4      0.   238.6      0.
PBEAM        214       2   1000.   726.2   821.7      0.   238.6      0.
PBEAM        215       2   1000.   704.4   793.9      0.   238.6      0.
PBEAM        216       2   1000.   682.7   766.2      0.   238.6      0.
PBEAM        217       2   1000.    661.   738.4      0.   238.6      0.
PBEAM        218       2   1000.   639.3   710.7      0.   238.6      0.
PBEAM        219       2   1000.    597.   659.8      0.   221.1      0.
PBEAM        220       2   1000.   556.2   610.7      0.   204.5      0.
PBEAM        221       2   1000.   516.7   563.3      0.   188.8      0.
PBEAM        222       2   1000.   478.6   517.7      0.   173.9      0.
PBEAM        223       2   1000.   441.9   473.7      0.   159.8      0.
PBEAM        224       2   1000.   406.6   431.5      0.   146.5      0.
PBEAM        225       2   1000.   372.6   391.1      0.    134.      0.
PBEAM        226       2   1000.    340.   352.3      0.   122.1      0.
PBEAM        227       2   1000.   308.8   315.3      0.    111.      0.
PBEAM        228       2   1000.   278.9   279.9      0.   100.6      0.
PBEAM        229       2   1000.   253.6   249.5      0.   113.6      0.
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PBEAM        230       2   1000.   226.1   217.3      0.   102.3      0.
PBEAM        231       2   1000.    200.   186.8      0.   91.71      0.
PBEAM        232       2   1000.   177.6   160.2      0.   98.27      0.
PBEAM        233       2   1000.   153.9   132.9      0.   87.36      0.
PBEAM        234       2   1000.   131.7   107.3      0.   77.29      0.
PBEAM        235       2   1000.   112.4   85.01      0.   79.37      0.
PBEAM        236       2   1000.   94.08   64.02      0.   79.38      0.
PBEAM        237       2   1000.    75.6   43.23      0.   69.04      0.
PBEAM        238       2   1000.   59.53    25.2      0.    67.1      0.
PBEAM        239       2   1000.   44.55   8.614      0.   63.92      0.
PBEAM        240       2   1000.    30.7   8.007      0.   59.78      0.
PBEAM        241       2   1000.   14.37   3.655      0.   27.47      0.
PBEAM        242       2   1000.   3.024   3.024      0.    22.9      0.
$   BEAM PROPERTIES FOR RIGHT SIDE HORIZONTAL TAIL
PBEAM        301       3   1000.   1047.   54.91      0.    179.      0.
PBEAM        302       3   1000.   894.1    41.7      0.   151.7      0.
PBEAM        303       3   1000.   756.8   30.83      0.   127.4      0.
PBEAM        304       3   1000.   634.3   22.05      0.   105.8      0.
PBEAM        305       3   1000.   525.8   15.11      0.   86.74      0.
PBEAM        306       3   1000.   430.5   9.772      0.   70.15      0.
PBEAM        307       3   1000.   347.4   5.823      0.   55.82      0.
PBEAM        308       3   1000.   275.8   3.046      0.   43.59      0.
PBEAM        309       3   1000.   214.8   1.241      0.   33.28      0.
PBEAM        310       3   1000.   163.5  0.2188      0.   24.75      0.
$   BEAM PROPERTIES FOR RIGHT SIDE VERTICAL TAIL
PBEAM        401       4   1000.   542.6   24.42      0.   73.63      0.
PBEAM        402       4   1000.   486.7   18.52      0.   66.03      0.
PBEAM        403       4   1000.   434.7   13.68      0.   58.98      0.
PBEAM        404       4   1000.   386.6   9.785      0.   52.45      0.
PBEAM        405       4   1000.   342.1   6.712      0.   46.42      0.
PBEAM        406       4   1000.   301.3    4.35      0.   40.87      0.
PBEAM        407       4   1000.   263.8   2.599      0.   35.79      0.
PBEAM        408       4   1000.   229.5   1.365      0.   31.14      0.
PBEAM        409       4   1000.   198.4  0.5584      0.   26.91      0.
PBEAM        410       4   1000.   170.2 0.09922      0.   23.09      0.
$
$ FEMAP Material 1 : Generic - WING AND CHORDWISE SPINES
MAT1           11000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - BOOM
MAT1           21000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - HORIZONTAL
MAT1           31000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - VERTICAL
MAT1           41000000.1000000.     0.3      0.      0.      0.
$
$   GRID 100 REPRESENTS PROPULSION SYSTEM
RBE2         504     101  123456     100
$  CONNECTIONS TO WING-TIP BOOM, HORIZONTAL AND VERTICAL TAILS
$
RBE2         501     141  123456     216
RBE2         502     238  123456     301
RBE2         503     240  123456     401
$
GRID         100       0   125.8     0.0    86.1       0
$
$  GRIDS FOR RIGHT WING BEAM
$
GRID         101       0  156.51    0.00   48.98       0
GRID         102       0  156.48   13.15   49.67       0
GRID         103       0  156.45   26.29   50.37       0
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GRID         104       0  156.41   39.44   51.06       0
GRID         105       0  156.38   52.59   51.75       0
GRID         106       0  156.34   65.74   52.45       0
GRID         107       0  156.31   78.88   53.14       0
GRID         108       0  156.28   92.03   53.83       0
GRID         109       0  156.24  105.18   54.53       0
GRID         110       0  156.21  118.32   55.22       0
GRID         111       0  156.18  131.47   55.91       0
GRID         112       0  156.14  144.62   56.61       0
GRID         113       0  156.11  157.76   57.30       0
GRID         114       0  156.08  170.91   57.99       0
GRID         115       0  156.04  184.06   58.69       0
GRID         116       0  156.01  197.21   59.38       0
GRID         117       0  155.98  210.35   60.07       0
GRID         118       0  155.94  223.50   60.77       0
GRID         119       0  155.88  236.63   61.46       0
GRID         120       0  155.82  249.76   62.16       0
GRID         121       0  155.76  262.89   62.86       0
GRID         122       0  155.70  276.02   63.55       0
GRID         123       0  155.64  289.15   64.25       0
GRID         124       0  155.58  302.28   64.95       0
GRID         125       0  155.52  315.41   65.64       0
GRID         126       0  155.46  328.54   66.34       0
GRID         127       0  155.39  341.67   67.04       0
GRID         128       0  155.33  354.80   67.73       0
GRID         129       0  155.27  367.93   68.43       0
GRID         130       0  155.21  381.07   69.13       0
GRID         131       0  155.15  394.20   69.82       0
GRID         132       0  155.09  407.33   70.52       0
GRID         133       0  155.03  420.46   71.22       0
GRID         134       0  154.97  433.59   71.91       0
GRID         135       0  154.91  446.72   72.61       0
GRID         136       0  154.85  459.85   73.31       0
GRID         137       0  154.79  472.98   74.00       0
GRID         138       0  154.72  486.11   74.70       0
GRID         139       0  154.66  499.24   75.40       0
GRID         140       0  154.60  512.37   76.09       0
GRID         141       0  154.54  525.50   76.79       0
$
$ RIGHT SIDE WING SURFACE LEADING-EDGE GRID POINTS
$
GRID        1101       0  132.83    0.00   48.98       0
GRID        1102       0  132.92   13.15   49.67       0
GRID        1103       0  133.01   26.29   50.37       0
GRID        1104       0  133.10   39.44   51.06       0
GRID        1105       0  133.18   52.59   51.75       0
GRID        1106       0  133.27   65.74   52.45       0
GRID        1107       0  133.36   78.88   53.14       0
GRID        1108       0  133.45   92.03   53.83       0
GRID        1109       0  133.54  105.18   54.53       0
GRID        1110       0  133.63  118.32   55.22       0
GRID        1111       0  133.71  131.47   55.91       0
GRID        1112       0  133.80  144.62   56.61       0
GRID        1113       0  133.89  157.76   57.30       0
GRID        1114       0  133.98  170.91   57.99       0
GRID        1115       0  134.07  184.06   58.69       0
GRID        1116       0  134.16  197.21   59.38       0
GRID        1117       0  134.24  210.35   60.07       0
GRID        1118       0  134.33  223.50   60.77       0
GRID        1119       0  134.49  236.63   61.46       0
GRID        1120       0  134.65  249.76   62.16       0
GRID        1121       0  134.81  262.89   62.86       0
GRID        1122       0  134.97  276.02   63.55       0
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GRID        1123       0  135.14  289.15   64.25       0
GRID        1124       0  135.30  302.28   64.95       0
GRID        1125       0  135.46  315.41   65.64       0
GRID        1126       0  135.62  328.54   66.34       0
GRID        1127       0  135.78  341.67   67.04       0
GRID        1128       0  135.94  354.80   67.73       0
GRID        1129       0  136.10  367.93   68.43       0
GRID        1130       0  136.26  381.07   69.13       0
GRID        1131       0  136.42  394.20   69.82       0
GRID        1132       0  136.58  407.33   70.52       0
GRID        1133       0  136.74  420.46   71.22       0
GRID        1134       0  136.90  433.59   71.91       0
GRID        1135       0  137.06  446.72   72.61       0
GRID        1136       0  137.22  459.85   73.31       0
GRID        1137       0  137.38  472.98   74.00       0
GRID        1138       0  137.55  486.11   74.70       0
GRID        1139       0  137.71  499.24   75.40       0
GRID        1140       0  137.87  512.37   76.09       0
GRID        1141       0  138.03  525.50   76.79       0
$
$ RIGHT SIDE WING SURFACE TRAILING-EDGE GRID POINTS
$
GRID        2101       0  192.03    0.00   48.98       0
GRID        2102       0  191.82   13.15   49.67       0
GRID        2103       0  191.60   26.29   50.37       0
GRID        2104       0  191.39   39.44   51.06       0
GRID        2105       0  191.17   52.59   51.75       0
GRID        2106       0  190.95   65.74   52.45       0
GRID        2107       0  190.74   78.88   53.14       0
GRID        2108       0  190.52   92.03   53.83       0
GRID        2109       0  190.30  105.18   54.53       0
GRID        2110       0  190.09  118.32   55.22       0
GRID        2111       0  189.87  131.47   55.91       0
GRID        2112       0  189.66  144.62   56.61       0
GRID        2113       0  189.44  157.76   57.30       0
GRID        2114       0  189.22  170.91   57.99       0
GRID        2115       0  189.01  184.06   58.69       0
GRID        2116       0  188.79  197.21   59.38       0
GRID        2117       0  188.58  210.35   60.07       0
GRID        2118       0  188.36  223.50   60.77       0
GRID        2119       0  187.97  236.63   61.46       0
GRID        2120       0  187.57  249.76   62.16       0
GRID        2121       0  187.18  262.89   62.86       0
GRID        2122       0  186.79  276.02   63.55       0
GRID        2123       0  186.39  289.15   64.25       0
GRID        2124       0  186.00  302.28   64.95       0
GRID        2125       0  185.61  315.41   65.64       0
GRID        2126       0  185.21  328.54   66.34       0
GRID        2127       0  184.82  341.67   67.04       0
GRID        2128       0  184.43  354.80   67.73       0
GRID        2129       0  184.03  367.93   68.43       0
GRID        2130       0  183.64  381.07   69.13       0
GRID        2131       0  183.25  394.20   69.82       0
GRID        2132       0  182.85  407.33   70.52       0
GRID        2133       0  182.46  420.46   71.22       0
GRID        2134       0  182.07  433.59   71.91       0
GRID        2135       0  181.67  446.72   72.61       0
GRID        2136       0  181.28  459.85   73.31       0
GRID        2137       0  180.89  472.98   74.00       0
GRID        2138       0  180.49  486.11   74.70       0
GRID        2139       0  180.10  499.24   75.40       0
GRID        2140       0  179.71  512.37   76.09       0
GRID        2141       0  179.31  525.50   76.79       0
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$
$  RIGHT WING * LEADING AND TRAILING EDGE GRIDS ARE DEPENDENT ON MAIN BEAM
$
RBE2        1201     101  123456    1101    2101
RBE2        1202     102  123456    1102    2102
RBE2        1203     103  123456    1103    2103
RBE2        1204     104  123456    1104    2104
RBE2        1205     105  123456    1105    2105
RBE2        1206     106  123456    1106    2106
RBE2        1207     107  123456    1107    2107
RBE2        1208     108  123456    1108    2108
RBE2        1209     109  123456    1109    2109
RBE2        1210     110  123456    1110    2110
RBE2        1211     111  123456    1111    2111
RBE2        1212     112  123456    1112    2112
RBE2        1213     113  123456    1113    2113
RBE2        1214     114  123456    1114    2114
RBE2        1215     115  123456    1115    2115
RBE2        1216     116  123456    1116    2116
RBE2        1217     117  123456    1117    2117
RBE2        1218     118  123456    1118    2118
RBE2        1219     119  123456    1119    2119
RBE2        1220     120  123456    1120    2120
RBE2        1221     121  123456    1121    2121
RBE2        1222     122  123456    1122    2122
RBE2        1223     123  123456    1123    2123
RBE2        1224     124  123456    1124    2124
RBE2        1225     125  123456    1125    2125
RBE2        1226     126  123456    1126    2126
RBE2        1227     127  123456    1127    2127
RBE2        1228     128  123456    1128    2128
RBE2        1229     129  123456    1129    2129
RBE2        1230     130  123456    1130    2130
RBE2        1231     131  123456    1131    2131
RBE2        1232     132  123456    1132    2132
RBE2        1233     133  123456    1133    2133
RBE2        1234     134  123456    1134    2134
RBE2        1235     135  123456    1135    2135
RBE2        1236     136  123456    1136    2136
RBE2        1237     137  123456    1137    2137
RBE2        1238     138  123456    1138    2138
RBE2        1239     139  123456    1139    2139
RBE2        1240     140  123456    1140    2140
RBE2        1241     141  123456    1141    2141
$
$  GRIDS FOR RIGHT SIDE WING-TIP BOOM
$
GRID         201       0     25.   525.5    77.5       0
GRID         202       0 33.6111   525.5    77.5       0
GRID         203       0 42.2222   525.5    77.5       0
GRID         204       0 50.8333   525.5    77.5       0
GRID         205       0 59.4444   525.5    77.5       0
GRID         206       0 68.0556   525.5    77.5       0
GRID         207       0 76.6667   525.5    77.5       0
GRID         208       0 85.2778   525.5    77.5       0
GRID         209       0 93.8889   525.5    77.5       0
GRID         210       0   102.5   525.5    77.5       0
GRID         211       0 111.111   525.5    77.5       0
GRID         212       0 119.722   525.5    77.5       0
GRID         213       0 128.333   525.5    77.5       0
GRID         214       0 136.944   525.5    77.5       0
GRID         215       0 145.556   525.5    77.5       0
GRID         216       0 154.167   525.5    77.5       0
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GRID         217       0 162.778   525.5    77.5       0
GRID         218       0 171.389   525.5    77.5       0
GRID         219       0    180.   525.5    77.5       0
GRID         220       0    190.   525.5    77.5       0
GRID         221       0    200.   525.5    77.5       0
GRID         222       0    210.   525.5    77.5       0
GRID         223       0    220.   525.5    77.5       0
GRID         224       0    230.   525.5    77.5       0
GRID         225       0    240.   525.5    77.5       0
GRID         226       0    250.   525.5    77.5       0
GRID         227       0    260.   525.5    77.5       0
GRID         228       0    270.   525.5    77.5       0
GRID         229       0    280.   525.5    77.5       0
GRID         230       0    290.   525.5    77.5       0
GRID         231       0    300.   525.5    77.5       0
GRID         232       0    310.   525.5    77.5       0
GRID         233       0    320.   525.5    77.5       0
GRID         234       0    330.   525.5    77.5       0
GRID         235       0    340.   525.5    77.5       0
GRID         236       0    350.   525.5    77.5       0
GRID         237       0    360.   525.5    77.5       0
GRID         238       0    370.   525.5    77.5       0
GRID         239       0    380.   525.5    77.5       0
GRID         240       0    390.   525.5    77.5       0
GRID         241       0    400.   525.5    77.5       0
GRID         242       0    410.   525.5    77.5       0
GRID         243       0    420.   525.5    77.5       0
$
$   ***********************************************
$      RIGHT SIDE HORIZONTAL TAIL DEFINITION
$   ***********************************************
$  GRIDS FOR RIGHT SIDE HORIZONTAL TAIL BEAM
$
GRID         301       0  379.75  525.50   77.36       0
GRID         302       0  379.61  535.00   79.01       0
GRID         303       0  379.47  544.50   80.67       0
GRID         304       0  379.34  554.00   82.33       0
GRID         305       0  379.20  563.50   83.98       0
GRID         306       0  379.06  573.00   85.64       0
GRID         307       0  378.92  582.50   87.30       0
GRID         308       0  378.79  592.00   88.95       0
GRID         309       0  378.65  601.50   90.61       0
GRID         310       0  378.51  611.00   92.27       0
GRID         311       0  378.37  620.50   93.92       0
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL MAIN BEAM
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 5
GRID         331       0  379.75  525.50   77.36       5
GRID         332       0  379.61  535.00   79.01       5
GRID         333       0  379.47  544.50   80.67       5
GRID         334       0  379.34  554.00   82.33       5
GRID         335       0  379.20  563.50   83.98       5
GRID         336       0  379.06  573.00   85.64       5
GRID         337       0  378.92  582.50   87.30       5
GRID         338       0  378.79  592.00   88.95       5
GRID         339       0  378.65  601.50   90.61       5
GRID         340       0  378.51  611.00   92.27       5
GRID         341       0  378.37  620.50   93.92       5
$   DUPLICATE GRIDS ON H-TAIL ARE DEPENDENT ON ELASTIC AXIS BEAM
RBE2         521     301  123456     331
RBE2         522     302  123456     332
RBE2         523     303  123456     333
RBE2         524     304  123456     334
RBE2         525     305  123456     335
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RBE2         526     306  123456     336
RBE2         527     307  123456     337
RBE2         528     308  123456     338
RBE2         529     309  123456     339
RBE2         530     310  123456     340
RBE2         531     311  123456     341
$
$  RIGHT SIDE HORIZONTAL TAIL LEADING EDGE
$
GRID        1301       0  355.08  525.50   77.36       0
GRID        1302       0  356.17  535.00   79.01       0
GRID        1303       0  357.27  544.50   80.67       0
GRID        1304       0  358.36  554.00   82.33       0
GRID        1305       0  359.46  563.50   83.98       0
GRID        1306       0  360.56  573.00   85.64       0
GRID        1307       0  361.65  582.50   87.30       0
GRID        1308       0  362.75  592.00   88.95       0
GRID        1309       0  363.85  601.50   90.61       0
GRID        1310       0  364.94  611.00   92.27       0
GRID        1311       0  366.04  620.50   93.92       0
$
$  DISPLACEMENT OF H-TAIL L.E. IS DEPENDENT ON ELASTIC AXIS
RBE2        1251     301  123456    1301
RBE2        1252     302  123456    1302
RBE2        1253     303  123456    1303
RBE2        1254     304  123456    1304
RBE2        1255     305  123456    1305
RBE2        1256     306  123456    1306
RBE2        1257     307  123456    1307
RBE2        1258     308  123456    1308
RBE2        1259     309  123456    1309
RBE2        1260     310  123456    1310
RBE2        1261     311  123456    1311
$
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL LEADING EDGE
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 5
GRID        1331       0  355.08  525.50   77.36       5
GRID        1332       0  356.17  535.00   79.01       5
GRID        1333       0  357.27  544.50   80.67       5
GRID        1334       0  358.36  554.00   82.33       5
GRID        1335       0  359.46  563.50   83.98       5
GRID        1336       0  360.56  573.00   85.64       5
GRID        1337       0  361.65  582.50   87.30       5
GRID        1338       0  362.75  592.00   88.95       5
GRID        1339       0  363.85  601.50   90.61       5
GRID        1340       0  364.94  611.00   92.27       5
GRID        1341       0  366.04  620.50   93.92       5
$  DUPLICATE GRIDS ON H-TAIL LEADING EDGE ARE DEPENDENT ON ELASTIC AXIS
RBE2         541     301  123456    1331
RBE2         542     302  123456    1332
RBE2         543     303  123456    1333
RBE2         544     304  123456    1334
RBE2         545     305  123456    1335
RBE2         546     306  123456    1336
RBE2         547     307  123456    1337
RBE2         548     308  123456    1338
RBE2         549     309  123456    1339
RBE2         550     310  123456    1340
RBE2         551     311  123456    1341
$
$  RIGHT SIDE HORIZONTAL TAIL TRAILING EDGE
$
GRID        2301       0  416.83  525.50   77.36       0
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GRID        2302       0  414.84  535.00   79.01       0
GRID        2303       0  412.85  544.50   80.67       0
GRID        2304       0  410.86  554.00   82.33       0
GRID        2305       0  408.87  563.50   83.98       0
GRID        2306       0  406.88  573.00   85.64       0
GRID        2307       0  404.88  582.50   87.30       0
GRID        2308       0  402.89  592.00   88.95       0
GRID        2309       0  400.90  601.50   90.61       0
GRID        2310       0  398.91  611.00   92.27       0
GRID        2311       0  396.92  620.50   93.92       0
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL TRAILING EDGE
$  THE OUTPUT FOR THESE GRIDS WILL BE IN COORD. SYST. 5
GRID        2331       0  416.83  525.50   77.36       5
GRID        2332       0  414.84  535.00   79.01       5
GRID        2333       0  412.85  544.50   80.67       5
GRID        2334       0  410.86  554.00   82.33       5
GRID        2335       0  408.87  563.50   83.98       5
GRID        2336       0  406.88  573.00   85.64       5
GRID        2337       0  404.88  582.50   87.30       5
GRID        2338       0  402.89  592.00   88.95       5
GRID        2339       0  400.90  601.50   90.61       5
GRID        2340       0  398.91  611.00   92.27       5
GRID        2341       0  396.92  620.50   93.92       5
$  DUPLICATE H-TAIL T.E. GRIDS ARE DEPENDENT ON ORIGINAL T.E. GRIDS
RBE2         561    2301  123456    2331
RBE2         562    2302  123456    2332
RBE2         563    2303  123456    2333
RBE2         564    2304  123456    2334
RBE2         565    2305  123456    2335
RBE2         566    2306  123456    2336
RBE2         567    2307  123456    2337
RBE2         568    2308  123456    2338
RBE2         569    2309  123456    2339
RBE2         570    2310  123456    2340
RBE2         571    2311  123456    2341
$
$  GRIDS AT 80% CHORD HINGE-LINE OF RIGHT SIDE HORIZONTAL TAIL
GRID        2501       0 404.480 525.500  77.360       0
GRID        2502       0 403.106 535.000  79.010       0
GRID        2503       0 401.734 544.500  80.670       0
GRID        2504       0 400.360 554.000  82.330       0
GRID        2505       0 398.988 563.500  83.980       0
GRID        2506       0 397.616 573.000  85.640       0
GRID        2507       0 396.234 582.500  87.300       0
GRID        2508       0 394.862 592.000  88.950       0
GRID        2509       0 393.490 601.500  90.610       0
GRID        2510       0 392.116 611.000  92.270       0
GRID        2511       0 390.744 620.500  93.920       0
$
$    ****************************************************
$    END OF RIGHT SIDE HORIZONTAL TAIL DEFINITION
$    ****************************************************
$
$    ****************************************************
$    RIGHT SIDE VERTICAL TAIL DEFINITION
$    ****************************************************
$
$  GRIDS FOR RIGHT SIDE VERTICAL TAIL BEAM
GRID         401       0  410.39  525.50   77.50       0
GRID         402       0  411.39  522.60   85.47       0
GRID         403       0  412.38  519.70   93.44       0
GRID         404       0  413.38  516.80  101.41       0
GRID         405       0  414.37  513.90  109.38       0
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GRID         406       0  415.37  511.00  117.34       0
GRID         407       0  416.36  508.10  125.31       0
GRID         408       0  417.36  505.20  133.28       0
GRID         409       0  418.35  502.30  141.25       0
GRID         410       0  419.35  499.40  149.22       0
GRID         411       0  420.34  496.50  157.19       0
$   THIS GROUP OF GRIDS GENERATES OUTPUT IN COORD. SYSTEM 6
$   THE Z-AXIS FOR COORD. SYS. 5 IS NORMAL TO PLANE OF V-TAIL
GRID         431       0  410.39  525.50   77.50       6
GRID         432       0  411.39  522.60   85.47       6
GRID         433       0  412.38  519.70   93.44       6
GRID         434       0  413.38  516.80  101.41       6
GRID         435       0  414.37  513.90  109.38       6
GRID         436       0  415.37  511.00  117.34       6
GRID         437       0  416.36  508.10  125.31       6
GRID         438       0  417.36  505.20  133.28       6
GRID         439       0  418.35  502.30  141.25       6
GRID         440       0  419.35  499.40  149.22       6
GRID         441       0  420.34  496.50  157.19       6
$  DUPLICATE GRIDS OF MAIN V-TAIL ARE DEPENDENT ON ELASTIC AXIS GRIDS
RBE2         581     401  123456     431
RBE2         582     402  123456     432
RBE2         583     403  123456     433
RBE2         584     404  123456     434
RBE2         585     405  123456     435
RBE2         586     406  123456     436
RBE2         587     407  123456     437
RBE2         588     408  123456     438
RBE2         589     409  123456     439
RBE2         590     410  123456     440
RBE2         591     411  123456     441
$
$  RIGHT SIDE VERTICAL TAIL LEADING EDGE
$
GRID        1401       0  390.67  525.50   77.50       0
GRID        1402       0  392.36  522.60   85.47       0
GRID        1403       0  394.05  519.70   93.44       0
GRID        1404       0  395.73  516.80  101.41       0
GRID        1405       0  397.42  513.90  109.38       0
GRID        1406       0  399.11  511.00  117.34       0
GRID        1407       0  400.79  508.10  125.31       0
GRID        1408       0  402.48  505.20  133.28       0
GRID        1409       0  404.17  502.30  141.25       0
GRID        1410       0  405.85  499.40  149.22       0
GRID        1411       0  407.54  496.50  157.19       0
$
$  LEADING EDGE V-TAIL GRIDS ARE DEPENDENT ON ELASTIC AXIS
RBE2        1271     401  123456    1401
RBE2        1272     402  123456    1402
RBE2        1273     403  123456    1403
RBE2        1274     404  123456    1404
RBE2        1275     405  123456    1405
RBE2        1276     406  123456    1406
RBE2        1277     407  123456    1407
RBE2        1278     408  123456    1408
RBE2        1279     409  123456    1409
RBE2        1280     410  123456    1410
RBE2        1281     411  123456    1411
$
$  DUPLICATE GRIDS FOR VERTICAL TAIL LEADING EDGE
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 6
GRID        1431       0  390.67  525.50   77.50       6
GRID        1432       0  392.36  522.60   85.47       6
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GRID        1433       0  394.05  519.70   93.44       6
GRID        1434       0  395.73  516.80  101.41       6
GRID        1435       0  397.42  513.90  109.38       6
GRID        1436       0  399.11  511.00  117.34       6
GRID        1437       0  400.79  508.10  125.31       6
GRID        1438       0  402.48  505.20  133.28       6
GRID        1439       0  404.17  502.30  141.25       6
GRID        1440       0  405.85  499.40  149.22       6
GRID        1441       0  407.54  496.50  157.19       6
$  V-TAIL LEADING EDGE DUPLICATE GRIDS ARE DEPENDENT ON ELASTIC AXIS GRIDS
RBE2         601     401  123456    1431
RBE2         602     402  123456    1432
RBE2         603     403  123456    1433
RBE2         604     404  123456    1434
RBE2         605     405  123456    1435
RBE2         606     406  123456    1436
RBE2         607     407  123456    1437
RBE2         608     408  123456    1438
RBE2         609     409  123456    1439
RBE2         610     410  123456    1440
RBE2         611     411  123456    1441
$
$  RIGHT SIDE VERTICAL TAIL TRAILING EDGE
$
GRID        2401       0  439.97  525.50   77.50       0
GRID        2402       0  439.93  522.60   85.47       0
GRID        2403       0  439.89  519.70   93.44       0
GRID        2404       0  439.84  516.80  101.41       0
GRID        2405       0  439.80  513.90  109.38       0
GRID        2406       0  439.76  511.00  117.34       0
GRID        2407       0  439.71  508.10  125.31       0
GRID        2408       0  439.67  505.20  133.28       0
GRID        2409       0  439.63  502.30  141.25       0
GRID        2410       0  439.58  499.40  149.22       0
GRID        2411       0  439.54  496.50  157.19       0
$  DUPLICATE GRIDS FOR VERTICAL TAIL TRAILING EDGE
$  THE OUTPUT FOR THESE GRIDS WILL BE IN COORD. SYST. 6
GRID        2431       0  439.97  525.50   77.50       6
GRID        2432       0  439.93  522.60   85.47       6
GRID        2433       0  439.89  519.70   93.44       6
GRID        2434       0  439.84  516.80  101.41       6
GRID        2435       0  439.80  513.90  109.38       6
GRID        2436       0  439.76  511.00  117.34       6
GRID        2437       0  439.71  508.10  125.31       6
GRID        2438       0  439.67  505.20  133.28       6
GRID        2439       0  439.63  502.30  141.25       6
GRID        2440       0  439.58  499.40  149.22       6
GRID        2441       0  439.54  496.50  157.19       6
$  DUPLICATE V-TAIL T.E. GRIDS ARE DEPENDENT ON ORIGINAL GRIDS
RBE2         621    2401  123456    2431
RBE2         622    2402  123456    2432
RBE2         623    2403  123456    2433
RBE2         624    2404  123456    2434
RBE2         625    2405  123456    2435
RBE2         626    2406  123456    2436
RBE2         627    2407  123456    2437
RBE2         628    2408  123456    2438
RBE2         629    2409  123456    2439
RBE2         630    2410  123456    2440
RBE2         631    2411  123456    2441
$
$  GRIDS AT 80% CHORD HINGE-LINE OF RIGHT SIDE VERTICAL TAIL
GRID        2601       0 430.110 525.500  77.500       0
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GRID        2602       0 430.416 522.600  85.470       0
GRID        2603       0 430.722 519.700  93.440       0
GRID        2604       0 431.018 516.800 101.410       0
GRID        2605       0 431.324 513.900 109.380       0
GRID        2606       0 431.630 511.000 117.340       0
GRID        2607       0 431.926 508.100 125.310       0
GRID        2608       0 432.232 505.200 133.280       0
GRID        2609       0 432.538 502.300 141.250       0
GRID        2610       0 432.834 499.400 149.220       0
GRID        2611       0 433.140 496.500 157.190       0
$
$    ***************************************************
$      END OF RIGHT SIDE VERTICAL TAIL DEFINITION
$    ***************************************************
$
$   MAIN BEAMS FOR RIGHT WING
CBEAM        101     101     101     102     -1.      0.      0.
CBEAM        102     102     102     103     -1.      0.      0.
CBEAM        103     103     103     104     -1.      0.      0.
CBEAM        104     104     104     105     -1.      0.      0.
CBEAM        105     105     105     106     -1.      0.      0.
CBEAM        106     106     106     107     -1.      0.      0.
CBEAM        107     107     107     108     -1.      0.      0.
CBEAM        108     108     108     109     -1.      0.      0.
CBEAM        109     109     109     110     -1.      0.      0.
CBEAM        110     110     110     111     -1.      0.      0.
CBEAM        111     111     111     112     -1.      0.      0.
CBEAM        112     112     112     113     -1.      0.      0.
CBEAM        113     113     113     114     -1.      0.      0.
CBEAM        114     114     114     115     -1.      0.      0.
CBEAM        115     115     115     116     -1.      0.      0.
CBEAM        116     116     116     117     -1.      0.      0.
CBEAM        117     117     117     118     -1.      0.      0.
CBEAM        118     118     118     119     -1.      0.      0.
CBEAM        119     119     119     120     -1.      0.      0.
CBEAM        120     120     120     121     -1.      0.      0.
CBEAM        121     121     121     122     -1.      0.      0.
CBEAM        122     122     122     123     -1.      0.      0.
CBEAM        123     123     123     124     -1.      0.      0.
CBEAM        124     124     124     125     -1.      0.      0.
CBEAM        125     125     125     126     -1.      0.      0.
CBEAM        126     126     126     127     -1.      0.      0.
CBEAM        127     127     127     128     -1.      0.      0.
CBEAM        128     128     128     129     -1.      0.      0.
CBEAM        129     129     129     130     -1.      0.      0.
CBEAM        130     130     130     131     -1.      0.      0.
CBEAM        131     131     131     132     -1.      0.      0.
CBEAM        132     132     132     133     -1.      0.      0.
CBEAM        133     133     133     134     -1.      0.      0.
CBEAM        134     134     134     135     -1.      0.      0.
CBEAM        135     135     135     136     -1.      0.      0.
CBEAM        136     136     136     137     -1.      0.      0.
CBEAM        137     137     137     138     -1.      0.      0.
CBEAM        138     138     138     139     -1.      0.      0.
CBEAM        139     139     139     140     -1.      0.      0.
CBEAM        140     140     140     141     -1.      0.      0.
$   BEAMS FOR RIGHT WING TIP BOOM
CBEAM        201     201     201     202      0.      1.      0.
CBEAM        202     202     202     203      0.      1.      0.
CBEAM        203     203     203     204      0.      1.      0.
CBEAM        204     204     204     205      0.      1.      0.
CBEAM        205     205     205     206      0.      1.      0.
CBEAM        206     206     206     207      0.      1.      0.
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CBEAM        207     207     207     208      0.      1.      0.
CBEAM        208     208     208     209      0.      1.      0.
CBEAM        209     209     209     210      0.      1.      0.
CBEAM        210     210     210     211      0.      1.      0.
CBEAM        211     211     211     212      0.      1.      0.
CBEAM        212     212     212     213      0.      1.      0.
CBEAM        213     213     213     214      0.      1.      0.
CBEAM        214     214     214     215      0.      1.      0.
CBEAM        215     215     215     216      0.      1.      0.
CBEAM        216     216     216     217      0.      1.      0.
CBEAM        217     217     217     218      0.      1.      0.
CBEAM        218     218     218     219      0.      1.      0.
CBEAM        219     219     219     220      0.      1.      0.
CBEAM        220     220     220     221      0.      1.      0.
CBEAM        221     221     221     222      0.      1.      0.
CBEAM        222     222     222     223      0.      1.      0.
CBEAM        223     223     223     224      0.      1.      0.
CBEAM        224     224     224     225      0.      1.      0.
CBEAM        225     225     225     226      0.      1.      0.
CBEAM        226     226     226     227      0.      1.      0.
CBEAM        227     227     227     228      0.      1.      0.
CBEAM        228     228     228     229      0.      1.      0.
CBEAM        229     229     229     230      0.      1.      0.
CBEAM        230     230     230     231      0.      1.      0.
CBEAM        231     231     231     232      0.      1.      0.
CBEAM        232     232     232     233      0.      1.      0.
CBEAM        233     233     233     234      0.      1.      0.
CBEAM        234     234     234     235      0.      1.      0.
CBEAM        235     235     235     236      0.      1.      0.
CBEAM        236     236     236     237      0.      1.      0.
CBEAM        237     237     237     238      0.      1.      0.
CBEAM        238     238     238     239      0.      1.      0.
CBEAM        239     239     239     240      0.      1.      0.
CBEAM        240     240     240     241      0.      1.      0.
CBEAM        241     241     241     242      0.      1.      0.
CBEAM        242     242     242     243      0.      1.      0.
$   RIGHT SIDE HORIZONTAL TAIL BEAMS
CBEAM        301     301     301     302     -1.      0.      0.
CBEAM        302     302     302     303     -1.      0.      0.
CBEAM        303     303     303     304     -1.      0.      0.
CBEAM        304     304     304     305     -1.      0.      0.
CBEAM        305     305     305     306     -1.      0.      0.
CBEAM        306     306     306     307     -1.      0.      0.
CBEAM        307     307     307     308     -1.      0.      0.
CBEAM        308     308     308     309     -1.      0.      0.
CBEAM        309     309     309     310     -1.      0.      0.
CBEAM        310     310     310     311     -1.      0.      0.
$   RIGHT SIDE VERTICAL TAIL BEAMS
CBEAM        401     401     401     402      1.      0.      0.
CBEAM        402     402     402     403      1.      0.      0.
CBEAM        403     403     403     404      1.      0.      0.
CBEAM        404     404     404     405      1.      0.      0.
CBEAM        405     405     405     406      1.      0.      0.
CBEAM        406     406     406     407      1.      0.      0.
CBEAM        407     407     407     408      1.      0.      0.
CBEAM        408     408     408     409      1.      0.      0.
CBEAM        409     409     409     410      1.      0.      0.
CBEAM        410     410     410     411      1.      0.      0.
$
$ Fuselage Rigid Body Mass (50% for 1/2 symm model)
$
CONM2        601     100      -1   446.1  125.80    0.00    86.1       0 MASS601
+MASS601  2.64E5       0  8.90E5       0       0  6.95E5
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$
$ **********************
$ LUMPED MASSES FOR RIGHT-WING
$ **********************
$   RIGHT WING
CONM2        602     102      -1    7.91  157.54    6.57   49.16       0 MASS602
CONM2        603     103      -1    7.75  157.67   19.72   49.83       0 MASS603
CONM2        604     104      -1    7.60  157.80   32.87   50.50       0 MASS604
CONM2        605     105      -1    7.45  157.92   46.01   51.17       0 MASS605
CONM2        606     106      -1    7.30  158.05   59.16   51.84       0 MASS606
CONM2        607     107      -1    7.16  158.17   72.31   52.51       0 MASS607
CONM2        608     108      -1    7.03  158.30   85.46   53.17       0 MASS608
CONM2        609     109      -1    6.90  158.42   98.60   53.84       0 MASS609
CONM2        610     110      -1    6.77  158.54  111.75   54.51       0 MASS610
CONM2        611     111      -1    6.66  158.65  124.90   55.18       0 MASS611
CONM2        612     112      -1    6.57  158.71  138.04   55.86       0 MASS612
CONM2        613     113      -1    6.49  158.77  151.19   56.54       0 MASS613
CONM2        614     114      -1    6.41  158.82  164.34   57.22       0 MASS614
CONM2        615     115      -1    6.35  158.83  177.49   57.91       0 MASS615
CONM2        616     116      -1    6.30  158.82  190.63   58.60       0 MASS616
CONM2        617     117      -1    6.26  158.79  203.78   59.29       0 MASS617
CONM2        618     118      -1    6.24  158.74  216.93   59.99       0 MASS618
CONM2        619     119      -1    6.19  158.66  230.07   60.69       0 MASS619
$
+MASS602   114.0       0  2357.1       0       0  2471.1
+MASS603   111.7       0  2285.6       0       0  2397.2
+MASS604   109.4       0  2216.7       0       0  2326.1
+MASS605   107.3       0  2150.3       0       0  2257.6
+MASS606   105.2       0  2086.5       0       0  2191.6
+MASS607   103.2       0  2025.0       0       0  2128.2
+MASS608   101.2       0  1966.0       0       0  2067.2
+MASS609    99.4       0  1909.2       0       0  2008.6
+MASS610    97.6       0  1854.7       0       0  1952.3
+MASS611    95.9       0  1802.8       0       0  1898.7
+MASS612    94.6       0  1760.2       0       0  1854.9
+MASS613    93.4       0  1719.1       0       0  1812.6
+MASS614    92.3       0  1679.5       0       0  1771.8
+MASS615    91.5       0  1646.6       0       0  1738.0
+MASS616    90.7       0  1615.4       0       0  1706.1
+MASS617    90.2       0  1587.8       0       0  1678.0
+MASS618    89.8       0  1563.6       0       0  1653.4
+MASS619    88.9       0  1527.9       0       0  1616.9
$
$   ***************************************************************
$      BEGIN FUEL STATIONS
$   ***************************************************************
$
$ No Fuel
$
$CONM2        620     120      -1    6.14  158.56  243.20   61.53       0 MASS620
$CONM2        621     121      -1    6.10  158.46  256.33   62.23       0 MASS621
$CONM2        622     122      -1    6.05  158.36  269.46   62.93       0 MASS622
$CONM2        623     123      -1    6.00  158.26  282.59   63.63       0 MASS623
$CONM2        624     124      -1    5.95  158.16  295.72   64.33       0 MASS624
$CONM2        625     125      -1    5.91  158.06  308.85   65.03       0 MASS625
$CONM2        626     126      -1    5.86  157.96  321.98   65.73       0 MASS626
$
$ No Fuel
$
$+MASS620    88.3       0  1485.1       0       0  1573.4
$+MASS621    87.6       0  1443.1       0       0  1530.7
$+MASS622    86.9       0  1402.0       0       0  1488.9
$+MASS623    86.2       0  1361.5       0       0  1447.8
```

```
$+MASS624    85.5       0  1321.9       0       0  1407.5
$+MASS625    84.9       0  1283.1       0       0  1367.9
$+MASS626    84.2       0  1245.0       0       0  1329.1
$
$ With Fuel
$
CONM2        620     120      -1   56.86  157.65  243.20   61.53       0 MASS620
CONM2        621     121      -1   55.70  157.57  256.33   62.23       0 MASS621
CONM2        622     122      -1   54.55  157.49  269.46   62.93       0 MASS622
CONM2        623     123      -1   53.41  157.41  282.59   63.63       0 MASS623
CONM2        624     124      -1   52.28  157.33  295.72   64.33       0 MASS624
CONM2        625     125      -1   51.17  157.25  308.85   65.03       0 MASS625
CONM2        626     126      -1   50.07  157.17  321.98   65.73       0 MASS626
$
$ With Fuel
$
+MASS620   816.9       0  8807.9       0       0  9165.0
+MASS621   800.2       0  8456.6       0       0  8805.8
+MASS622   783.7       0  8116.0       0       0  8457.4
+MASS623   767.3       0  7785.8       0       0  8119.6
+MASS624   751.2       0  7465.9       0       0  7792.1
+MASS625   735.2       0  7156.0       0       0  7474.7
+MASS626   719.4       0  6856.0       0       0  7167.2
$
$   ****************************************************************
$      END FUEL STATIONS
$   ****************************************************************
$
CONM2        627     127      -1    5.81  157.86  335.11   66.31       0 MASS627
CONM2        628     128      -1    5.76  157.76  348.24   67.01       0 MASS628
CONM2        629     129      -1    5.72  157.66  361.37   67.71       0 MASS629
CONM2        630     130      -1    5.67  157.56  374.50   68.42       0 MASS630
CONM2        631     131      -1    5.62  157.46  387.63   69.12       0 MASS631
CONM2        632     132      -1    5.58  157.37  400.76   69.82       0 MASS632
CONM2        633     133      -1    5.53  157.27  413.89   70.52       0 MASS633
CONM2        634     134      -1    5.48  157.17  427.02   71.23       0 MASS634
CONM2        635     135      -1    5.43  157.07  440.15   71.93       0 MASS635
CONM2        636     136      -1   12.39  155.86  453.28   72.81       0 MASS636
CONM2        637     137      -1    5.34  156.87  466.41   73.33       0 MASS637
CONM2        638     138      -1   12.29  155.76  479.54   74.19       0 MASS638
CONM2        639     139      -1    5.24  156.67  492.67   74.74       0 MASS639
CONM2        640     140      -1   12.20  155.67  505.80   75.58       0 MASS640
CONM2        641     141      -1    5.15  156.47  518.93   76.14       0 MASS641
$
+MASS627    83.5       0  1207.6       0       0  1291.1
+MASS628    82.8       0  1171.0       0       0  1253.8
+MASS629    82.1       0  1135.2       0       0  1217.3
+MASS630    81.5       0  1100.0       0       0  1181.5
+MASS631    80.8       0  1065.6       0       0  1146.4
+MASS632    80.1       0  1031.9       0       0  1112.0
+MASS633    79.4       0   999.0       0       0  1078.4
+MASS634    78.7       0   966.7       0       0  1045.4
+MASS635    78.1       0   935.1       0       0  1013.2
+MASS636    77.4       0   974.4       0       0   974.4
+MASS637    76.7       0   874.0       0       0   950.7
+MASS638    76.0       0   912.3       0       0   912.3
+MASS639    75.3       0   815.6       0       0   890.9
+MASS640    74.7       0   853.1       0       0   853.1
+MASS641    74.0       0   759.8       0       0   833.8
$
$   LUMPED MASSES ON RIGHT WING-TIP BOOM
CONM2        702     202      -1   11.25   33.61  525.50   77.50       0 MASS702
CONM2        703     203      -1   16.33   42.22  525.50   77.50       0 MASS703
```

```
CONM2        704     204      -1   16.41   50.83  525.50   77.50       0 MASS704
CONM2        705     205      -1   11.48   59.44  525.50   77.50       0 MASS705
CONM2        706     206      -1    1.56   68.06  525.50   77.50       0 MASS706
CONM2        707     207      -1    1.64   76.67  525.50   77.50       0 MASS707
CONM2        708     208      -1    1.72   85.28  525.50   77.50       0 MASS708
CONM2        709     209      -1    1.79   93.89  525.50   77.50       0 MASS709
CONM2        710     210      -1    1.87  102.50  525.50   77.50       0 MASS710
CONM2        711     211      -1    1.95  111.11  525.50   77.50       0 MASS711
CONM2        712     212      -1    2.02  119.72  525.50   77.50       0 MASS712
CONM2        713     213      -1    2.10  128.33  525.50   77.50       0 MASS713
CONM2        714     214      -1    2.18  136.94  525.50   77.50       0 MASS714
CONM2        715     215      -1    2.25  145.56  525.50   77.50       0 MASS715
CONM2        716     216      -1    2.22  154.17  525.50   77.50       0 MASS716
CONM2        717     217      -1    2.18  162.78  525.50   77.50       0 MASS717
CONM2        718     218      -1    5.65  171.39  525.50   77.50       0 MASS718
CONM2        719     219      -1    2.11  180.00  525.50   77.50       0 MASS719
CONM2        720     220      -1    2.41  190.00  525.50   77.50       0 MASS720
CONM2        721     221      -1    2.35  200.00  525.50   77.50       0 MASS721
CONM2        722     222      -1    2.30  210.00  525.50   77.50       0 MASS722
CONM2        723     223      -1    2.24  220.00  525.50   77.50       0 MASS723
CONM2        724     224      -1    2.17  230.00  525.50   77.50       0 MASS724
CONM2        725     225      -1    2.11  240.00  525.50   77.50       0 MASS725
CONM2        726     226      -1    2.05  250.00  525.50   77.50       0 MASS726
CONM2        727     227      -1    1.98  260.00  525.50   77.50       0 MASS727
CONM2        728     228      -1    1.91  270.00  525.50   77.50       0 MASS728
CONM2        729     229      -1    1.84  280.00  525.50   77.50       0 MASS729
CONM2        730     230      -1    1.89  290.00  525.50   77.50       0 MASS730
CONM2        731     231      -1    1.81  300.00  525.50   77.50       0 MASS731
CONM2        732     232      -1    1.73  310.00  525.50   77.50       0 MASS732
CONM2        733     233      -1    1.76  320.00  525.50   77.50       0 MASS733
CONM2        734     234      -1    1.66  330.00  525.50   77.50       0 MASS734
CONM2        735     235      -1    1.56  340.00  525.50   77.50       0 MASS735
CONM2        736     236      -1    1.56  350.00  525.50   77.50       0 MASS736
CONM2        737     237      -1    1.54  360.00  525.50   77.50       0 MASS737
CONM2        738     238      -1    1.42  370.00  525.50   77.50       0 MASS738
CONM2        739     239      -1    1.37  380.00  525.50   77.50       0 MASS739
CONM2        740     240      -1    1.31  390.00  525.50   77.50       0 MASS740
CONM2        741     241      -1    1.29  400.00  525.50   77.50       0 MASS741
CONM2        742     242      -1    0.80  410.00  525.50   77.50       0 MASS742
CONM2        743     243      -1    0.71  420.00  525.50   77.50       0 MASS743
$
$
+MASS702   316.5       0   126.6       0       0   126.6
+MASS703   459.3       0   330.6       0       0   330.6
+MASS704   461.5       0   332.1       0       0   332.1
+MASS705   323.0       0   232.5       0       0   232.5
+MASS706    87.8       0    53.6       0       0    53.6
+MASS707    92.2       0    56.2       0       0    56.2
+MASS708    96.5       0    58.8       0       0    58.8
+MASS709   100.8       0    61.5       0       0    61.5
+MASS710   105.1       0    64.1       0       0    64.1
+MASS711   109.5       0    66.8       0       0    66.8
+MASS712   113.8       0    69.4       0       0    69.4
+MASS713   118.1       0    72.0       0       0    72.0
+MASS714   122.5       0    74.7       0       0    74.7
+MASS715   126.8       0    77.3       0       0    77.3
+MASS716   124.8       0    76.1       0       0    76.1
+MASS717   122.7       0    74.9       0       0    74.9
+MASS718   158.8       0   114.3       0       0   114.3
+MASS719   118.7       0    72.4       0       0    72.4
+MASS720   128.9       0    84.6       0       0    84.6
+MASS721   119.5       0    79.4       0       0    79.4
+MASS722   110.5       0    74.4       0       0    74.4
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+MASS723   101.8       0    69.6       0       0    69.6
+MASS724    93.6       0    64.9       0       0    64.9
+MASS725    85.8       0    60.5       0       0    60.5
+MASS726    78.3       0    56.2       0       0    56.2
+MASS727    71.3       0    52.1       0       0    52.1
+MASS728    64.5       0    48.2       0       0    48.2
+MASS729    58.2       0    44.4       0       0    44.4
+MASS730    56.0       0    43.8       0       0    43.8
+MASS731    50.0       0    40.1       0       0    40.1
+MASS732    44.3       0    36.6       0       0    36.6
+MASS733    41.8       0    35.5       0       0    35.5
+MASS734    36.5       0    32.1       0       0    32.1
+MASS735    31.6       0    28.8       0       0    28.8
+MASS736    29.0       0    27.5       0       0    27.5
+MASS737    26.2       0    26.0       0       0    26.0
+MASS738    21.9       0    22.8       0       0    22.8
+MASS739    19.3       0    21.1       0       0    21.1
+MASS740    16.6       0    19.2       0       0    19.2
+MASS741    14.7       0    18.1       0       0    18.1
+MASS742     8.1       0    10.7       0       0    10.7
+MASS743     6.4       0     9.1       0       0     9.1
$   LUMPED MASSES FOR RIGHT SIDE HORIZONTAL TAIL
CONM2        802     302      -1    4.97  387.10  530.25   77.80       0 MASS802
CONM2        803     303      -1    4.73  386.66  539.75   79.47       0 MASS803
CONM2        804     304      -1    7.69  387.79  549.25   81.06       0 MASS804
CONM2        805     305      -1    4.26  385.75  558.75   82.82       0 MASS805
CONM2        806     306      -1    4.03  385.29  568.25   84.49       0 MASS806
CONM2        807     307      -1    7.00  387.18  577.75   86.04       0 MASS807
CONM2        808     308      -1    3.58  384.33  587.25   87.84       0 MASS808
CONM2        809     309      -1    3.35  383.83  596.75   89.51       0 MASS809
CONM2        810     310      -1    6.34  386.70  606.25   91.01       0 MASS810
CONM2        811     311      -1    2.92  382.81  615.75   92.87       0 MASS811
$
+MASS802    37.4       0  1504.7       0       0  1542.1
+MASS803    35.6       0  1289.2       0       0  1324.7
+MASS804    33.8       0  1149.5       0       0  1149.5
+MASS805    32.0       0   923.6       0       0   955.6
+MASS806    30.3       0   770.9       0       0   801.2
+MASS807    28.6       0   710.0       0       0   710.0
+MASS808    26.9       0   519.2       0       0   546.1
+MASS809    25.2       0   417.6       0       0   442.8
+MASS810    23.6       0   427.7       0       0   427.7
+MASS811    22.0       0   256.7       0       0   278.7
$   LUMPED MASSES FOR RIGHT SIDE VERTICAL TAIL
CONM2        902     402      -1    3.06  413.63  524.05   81.48       0 MASS902
CONM2        903     403      -1    2.91  414.65  521.15   89.45       0 MASS903
CONM2        904     404      -1    5.97  418.34  518.25   97.42       0 MASS904
CONM2        905     405      -1    2.63  416.67  515.35  105.39       0 MASS905
CONM2        906     406      -1    2.49  417.67  512.45  113.36       0 MASS906
CONM2        907     407      -1    2.36  418.66  509.55  121.33       0 MASS907
CONM2        908     408      -1    5.43  422.59  506.65  129.30       0 MASS908
CONM2        909     409      -1     2.1  420.61  503.75  137.27       0 MASS909
CONM2        910     410      -1    1.98  421.57  500.85  145.23       0 MASS910
CONM2        911     411      -1    1.86  422.50  497.95  153.20       0 MASS911
$
+MASS902    18.3       0   616.3       0       0   597.9
+MASS903    17.5       0   547.1       0       0   529.7
+MASS904    16.6       0   483.7       0       0   467.1
+MASS905    15.8       0   425.8       0       0   410.0
+MASS906    14.9       0   373.1       0       0   358.2
+MASS907    14.1       0   325.3       0       0   311.2
+MASS908    13.3       0   282.3       0       0   269.0
+MASS909    12.6       0   243.7       0       0   231.1
```

```
+MASS910    11.8       0   209.3       0       0   197.5
+MASS911    11.1       0   178.9       0       0   167.8
$
$
PBEAM       2301       1   100.    1000.  1000.       0.  1000.
PBEAM       2401       1   100.    1000.  1000.       0.  1000.
$
$   RIGHT SIDE BEAMS FROM H-TAIL MAIN BEAM TO HINGE LINE
CBEAM       2301    2301    301     2501     302
CBEAM       2302    2301    302     2502     301
CBEAM       2303    2301    303     2503     301
CBEAM       2304    2301    304     2504     301
CBEAM       2305    2301    305     2505     301
CBEAM       2306    2301    306     2506     301
CBEAM       2307    2301    307     2507     301
CBEAM       2308    2301    308     2508     301
CBEAM       2309    2301    309     2509     301
CBEAM       2310    2301    310     2510     301
CBEAM       2311    2301    311     2511     301
$
$   RIGHT SIDE BEAMS FROM H-TAIL HINGE LINE TO H-TAIL TRAILING EDGE
CBEAM       2321    2301    2501    2301    2502
CBEAM       2322    2301    2502    2302    2501
CBEAM       2323    2301    2503    2303    2501
CBEAM       2324    2301    2504    2304    2501
CBEAM       2325    2301    2505    2305    2501
CBEAM       2326    2301    2506    2306    2501
CBEAM       2327    2301    2507    2307    2501
CBEAM       2328    2301    2508    2308    2501
CBEAM       2329    2301    2509    2309    2501
CBEAM       2330    2301    2510    2310    2501
CBEAM       2331    2301    2511    2311    2501
$   RIGHT SIDE BEAMS FROM V-TAIL MAIN BEAM TO HINGE LINE
CBEAM       2401    2401    401     2601     402
CBEAM       2402    2401    402     2602     401
CBEAM       2403    2401    403     2603     401
CBEAM       2404    2401    404     2604     401
CBEAM       2405    2401    405     2605     401
CBEAM       2406    2401    406     2606     401
CBEAM       2407    2401    407     2607     401
CBEAM       2408    2401    408     2608     401
CBEAM       2409    2401    409     2609     401
CBEAM       2410    2401    410     2610     401
CBEAM       2411    2401    411     2611     401
$
$   RIGHT SIDE BEAMS FROM V-TAIL HINGE LINE TO V-TAIL TRAILING EDGE
CBEAM       2421    2401    2601    2401    2602
CBEAM       2422    2401    2602    2402    2601
CBEAM       2423    2401    2603    2403    2601
CBEAM       2424    2401    2604    2404    2601
CBEAM       2425    2401    2605    2405    2601
CBEAM       2426    2401    2606    2406    2601
CBEAM       2427    2401    2607    2407    2601
CBEAM       2428    2401    2608    2408    2601
CBEAM       2429    2401    2609    2409    2601
CBEAM       2430    2401    2610    2410    2601
CBEAM       2431    2401    2611    2411    2601
$
ENDDATA
```

APPENDIX C

MSC/NASTRAN file used in the one-dimensional gust analysis

```
$   TO EXECUTE THIS FILE USE THE FOLLOWING:
$   NAST705  VK06 SCRATCH=YES MEM=12MW NEWS=NO
$
SOL  146  $  AEROELASTIC DYNAMIC RESPONSE
TIME 120.0    $  TIME IN MINUTES
$
CEND
$
TITLE = SEMISPAN MODEL * VON KARMAN PSD * M=0.090 * H=1000.0 FT.
SUBTITLE = SYMMETRIC RESPONSE * FUEL 166.95 LB. * V=98.3 FT/SEC
LABEL = GUST SCALE LENGTH=1000 FEET * GUST VELOCITY=1.0 IN/SEC.
$
METHOD = 1  $  SINV EIGENVALUE EXTRACTION METHOD
SPC = 1  $  BOUNDARY CONDITION CONSTRAINTS
SDAMPING = 25  $  MODAL STRUCTURAL DAMPING (TABDMP1)
FREQUENCY = 41  $  SET OF SOLUTION FORCING FREQUENCIES (FREQ1)
RANDOM = 111  $  PSD SPECIFICATION (RANDPS)
K2PP = STIFF  $  D.O.F. FOR OUTPUT OF VON KARMAN SPECTRUM (DMIG)
$ ECHO = UNSORT
ECHO = NONE  $  SUPPRESS PRINTOUT OF BULK DATA DECK
$
OUTPUT
$
SET 40 = 9990   $  EXTRA POINT FOR GENERATION OF VON KARMAN PSD
DISPLACEMENT(PHASE) = 40
SDISPLACEMENT(PHASE) = 40
$
SUBCASE  1  $  APPLY VON KARMAN GUST
GUST = 36  $  GUST SELECTION  (GUST)
DLOAD = 46  $ APPLY LOAD TO EPOINT TO GET PSD OF GUST (RLOAD1)
$
OUTPUT(XYOUT)
XYPRINT  SDISP PSDF/9990(T1)
XYPRINT  DISP  PSDF/9990(T1)
XYPRINT  ACCE  PSDF/95(T1)
XYPRINT  ACCE  PSDF/95(T3)
XYPRINT  ACCE  PSDF/95(R2)
XYPRINT  ELFORCE  PSDF/101(4)
XYPRINT  ELFORCE  PSDF/101(5)
XYPRINT  ELFORCE  PSDF/101(6)
XYPRINT  ELFORCE  PSDF/101(7)
XYPRINT  ELFORCE  PSDF/101(9)
XYPRINT  ELFORCE  PSDF/140(4)
XYPRINT  ELFORCE  PSDF/140(5)
XYPRINT  ELFORCE  PSDF/140(6)
XYPRINT  ELFORCE  PSDF/140(7)
XYPRINT  ELFORCE  PSDF/140(9)
XYPRINT  ELFORCE  PSDF/216(164)
XYPRINT  ELFORCE  PSDF/216(165)
XYPRINT  ELFORCE  PSDF/216(166)
XYPRINT  ELFORCE  PSDF/216(167)
XYPRINT  ELFORCE  PSDF/216(169)
XYPRINT  ELFORCE  PSDF/217(4)
XYPRINT  ELFORCE  PSDF/217(5)
XYPRINT  ELFORCE  PSDF/217(6)
XYPRINT  ELFORCE  PSDF/217(7)
XYPRINT  ELFORCE  PSDF/217(9)
$
```

```
BEGIN BULK
$
$   INPUT UNITS: ARE INCHES, POUNDS, SECONDS FOR LENGTH, MASS, AND TIME
$
PARAM, POST, -1   $  IDEAS POST-PROCESSING
$
PARAM, LMODES, 32  $   USE THE 32 LOWEST NORMAL MODES
$
$ PARAM, VREF, 20.2537  $  CONVERT FROM IN/SEC TO KNOTS IN SOL 145
$ PARAM, VREF, 12.0  $  USE VELOCITY UNITS OF FEET/SECOND IN SOL 145
$
$ CHANGES "WEIGHT" INPUT DATA TO "MASS" DATA
PARAM,WTMASS,0.002588
$
$ REQUESTS MASS PROPERTIES SUMMARY
PARAM,GRDPNT,0  $ WITH RESPECT TO ORIGIN OF BASIC C.S.
$
$  DEFINE LOCAL COORDINATE SYSTEMS FOR HORIZONTAL AND VERTICAL TAILS
SPC1, 1, 123456, 30, 40   $   GRIDS 30 AND 40 ONLY USED FOR ORIENTATION
GRID, 30, 0, 379.75, 521.5678, 100.0   $   DEFINES DIRECTION OF Z-AXIS (H-TAIL)
GRID, 40, 0, 410.39, 587.3362, 100.0   $   DEFINES DIRECTION OF Z-AXIS (V-TAIL)
$
$  COORDINATE SYSTEM 12 IS A REFERENCE AXIS SYSTEM FOR STABILITY DERIVATIVES
CORD2R        12       0 156.51    0.0   48.98   156.51   0.0     40.0  +CO12
+CO12      140.0  0.0     48.98
$    LOCAL COORD. SYSTEM FOR HORIZONTAL TAIL
CORD1R, 5, 301, 30, 2301   $   Z-AXIS NORMAL TO PLANE OF HORIZ. TAIL
$    LOCAL COORD. SYSTEM FOR VERTICAL TAIL
CORD1R, 6, 401, 40, 2401   $   Z-AXIS NORMAL TO PLANE OF VERT. TAIL
$
$  LOCAL COORDINATE SYSTEM TO DEFINE Y-AXIS OF RIGHT H-TAIL HINGE LINE
CORD2R        13       0 404.480 525.50  77.360  404.480521.5678 100.0  +CO13
+CO13      450.0531.888378.46955
$  LOCAL COORDINATE SYSTEM TO DEFINE Y-AXIS OF RIGHT V-TAIL HINGE LINE
CORD2R        14       0 433.14  496.50 157.190  433.140614.1537 200.0  +CO14
+CO14      500.0497.3168154.9451
$
$   SELECT THE DESIRED BOUNDARY CONDITIONS
$ Fixed Root
$ SPC            1     101  123456      0.
$
$ Symmetric BC  *  CONSTRAIN GRIDS ON CENTERLINE
SPC            1     101     246     0.0      95     246     0.0
$
$ Antisymmetric BC
$ SPC            1     101  135         0.
$
$    ******************************************************
$      SECTION FOR DYNAMIC RESPONSE TO GUST LOADING
$    ******************************************************
$
PARAM, MACH, 0.090   $ DESIRED MACH NUMBER
PARAM, Q, 0.077444  $   DYNAMIC PRESSURE IN PSI AT 1000 FT. (V=1179.6 IN/SEC)
PARAM, GUSTAERO, -1
$
$   STRUCTURAL MODAL DAMPING = 0.02 IN EACH MODE
TABDMP1       25       G                                                +TDMP1
+TDMP1       0.0    0.02    60.0    0.02    ENDT
$
$    ******************************************************
$      FOLLOWING GROUP OF INPUT IS FOR THE VON KARMAN PSD
$
RANDPS       111       1       1     1.0     0.0     121
```

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$  VON KARMAN GUST WITH (L/U)=10.1729 SEC., AND WG=1.0 IN/SEC
TABRNDG      121       1 10.1729     1.0
$   VELOCITY ON 'GUST' MUST BE SAME AS ON 'AERO' INPUT RECORD.
GUST          36      468.4774-4     0.0  1179.6
RLOAD1        46      56                      66
$   APPLY VON KARMAN GUST TO THE EPOINT FOR SUBSEQUENT OUTPUT
DAREA         56    9990             1.0
EPOINT      9990
$  TABLED1 PROVIDES FREQUENCY INTERVAL OVER WHICH LOADS ARE GENERATED
TABLED1       66                                                          +TDVK1
+TDVK1       0.0     1.0    60.0     1.0    ENDT
$  SETS OF FREQUENCIES USED IN SOLUTION OF FREQUENCY RESPONSE PROBLEMS
FREQ1         41  0.0001  0.0001       9
FREQ1         41   0.001   0.001       9
FREQ1         41   0.010   0.010       9
FREQ1         41    0.10    0.05    1198
$  DMIG DEFINES AN EPOINT USED TO OUTPUT THE VON KARMAN PSD
DMIG       STIFF       0       6       1       0
DMIG       STIFF    9990       0            9990       0     1.0
$
$    *******************************************************
$      END OF SECTION FOR DYNAMIC RESPONSE TO GUST LOADING
$    *******************************************************
$
$ ************************************************************
$    BEGIN AERODYNAMIC FLUTTER CARDS
$ ************************************************************
$
$ VALUE OF FIELD 6 (SYMXZ) IS 1 FOR SYM CASE, -1 FOR ASYM,  0 FOR FIXED
$       2       3       4       5       6       7       8       9       1
$   AERO. DENSITY UNITS: LB-SEC**2/IN**4 (SEA-LEVEL)
AERO           0  1179.6   54.031.1463-7       1       0
$
$ Inboard Wing   (RIGHT SIDE)
CAERO1  10001   1       0       17      8                       1       +CA101
+CA101  132.83  0.0     48.98   59.2    134.33  223.5   60.77   54.03
$
$GRID   101     0       156.51    0.00   48.98
$ (156.51-132.83)/59.2=0.40 chord
$
$ Outboard Wing   (RIGHT SIDE)
CAERO1  20001   1       0       23      8                       1       +CA102
+CA102  134.33  223.5   60.77   54.03    138.03  525.5   76.79    41.28
$
$GRID   118     0       155.94  223.50   60.77
$ (155.94-134.33)/54.03=0.40 chord
$
$   RIGHT-SIDE HORIZONTAL TAIL
$   THE H-TAIL PANEL SPANS THE AREA FROM THE LEADING EDGE TO THE HINGE LINE
CAERO1  30001   1       0       20      8                       1       +CA103
+CA103  355.08  525.5   77.36   49.40   366.04  620.5   93.92   24.704
$
$   RIGHT-SIDE CONTROL SURFACE PANEL ON HORIZONTAL TAIL
CAERO1  31001      1      0      20       2                       1      +CA103A
+CA103A 404.480 525.50  77.360  12.35   390.744 620.50  93.920  6.176
$
$GRID   301     0       379.75  525.50   77.36
$ (379.75-355.08)/61.75=0.40 chord
$
$   RIGHT-SIDE VERTICAL TAIL
$ CAERO1  40001   1       0       16      8                       1       +CA104
$ +CA104  390.67  525.5   77.5    49.3    407.54  496.5   157.19  32.00
$
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$  REDEFINE POINTS 1 AND 4 FOR VERTICAL TAIL (SWAP POINTS 1 AND 4)
CAERO1  40001   1       0       20      8                       1       +CA104
+CA104  407.54  496.5   157.19  25.60   390.67  525.5   77.5    39.44
$
$  RIGHT-SIDE CONTROL SURFACE PANEL ON VERTICAL TAIL
CAERO1  41001      1       0      20       2                       1     +CA104A
+CA104A 433.140  496.50  157.190  6.40   430.110 525.50  77.50   9.86
$
$GRID   401     0       410.39  525.50  77.50
$ (410.39-390.67)/49.30=0.40 chord
$
$                       DENS    MACH    VEL     INTERP  MODES   PK TOL (0.001 default)
FLUTTER 30      PK      1       2       4       L       10
FLFACT  1       1.0
FLFACT  2       0.0
$
$  FOR PK METHOD, 'FLFACT 4' IS A VELOCITY TABLE (UNITS IN/SEC)
$  A MINUS SIGN FOR A VELOCITY IS A REQUEST FOR EIGENVALUE OUTPUT
FLFACT  4       176.0   528.0    880.0  1320.0  1760.0  2640.0  3520.0  +FL01
+FL01   4400.0  5280.0  6200.0  7040.0
$
$   TABLES OF MACH NUMBER AND REDUCED FREQUENCY
MKAERO1     0.09                                                        +MK1
+MK1     0.00001   0.005    0.01    0.02    0.04    0.06    0.08     0.1
MKAERO1     0.09                                                        +MK2
+MK2         0.2     0.4     0.6     0.8     1.0     2.0     3.0     4.0
MKAERO1     0.09                                                        +MK3
+MK3         5.0     6.0     7.0     8.0     9.0    10.0
$
PAERO1  1
$
$  TEST USAGE OF SURFACE SPLINES ON ALL LIFTING SURFACES
$   SPLINE1 = 100   RIGHT-SIDE INBOARD WING
$   SPLINE1 = 200   RIGHT-SIDE OUTBOARD WING
$   SPLINE1 = 300   RIGHT-SIDE HORIZONTAL TAIL WITHOUT CONTROL SURFACE
$   SPLINE1 = 305   RIGHT-SIDE CONTROL SURFACE ON HORIZONTAL TAIL
$   SPLINE1 = 400   RIGHT-SIDE VERTICAL TAIL WITHOUT CONTROL SURFACE
$   SPLINE1 = 405   RIGHT-SIDE CONTROL SURFACE ON VERTICAL TAIL
$
SPLINE1 100     10001   10001   10136   100
SPLINE1 200     20001   20001   20184   200
$
SPLINE1 300     30001   30001   30160   300
SPLINE1 400     40001   40001   40160   400
$
SPLINE1 305     31001   31001   31040   305
SPLINE1 405     41001   41001   41040   405
$
$   GRIDS UTILIZED FOR RIGHT SIDE INBOARD WING SURFACE SPLINES
SET1         100     101     102     103     104     105     106     107+IW01
+IW01        108     109     110     111     112     113     114     115+IW02
+IW02        116     117     118    1101    1102    1103    1104    1105+IW03
+IW03       1106    1107    1108    1109    1110    1111    1112    1113+IW04
+IW04       1114    1115    1116    1117    1118    2101    2102    2103+IW05
+IW05       2104    2105    2106    2107    2108    2109    2110    2111+IW06
+IW06       2112    2113    2114    2115    2116    2117    2118
$   GRIDS UTILIZED FOR RIGHT SIDE OUTBOARD WING SURFACE SPLINES
SET1         200     118     119     120     121     122     123     124+OW01
+OW01        125     126     127     128     129     130     131     132+OW02
+OW02        133     134     135     136     137     138     139     140+OW03
+OW03        141    1118    1119    1120    1121    1122    1123    1124+OW04
+OW04       1125    1126    1127    1128    1129    1130    1131    1132+OW05
+OW05       1133    1134    1135    1136    1137    1138    1139    1140+OW06
```

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+OW06       1141    2118    2119    2120    2121    2122    2123    2124+OW07
+OW07       2125    2126    2127    2128    2129    2130    2131    2132+OW08
+OW08       2133    2134    2135    2136    2137    2138    2139    2140+OW09
+OW09       2141
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON H-TAIL
SET1         300     301     302     303     304     305     306     307+HT01
+HT01        308     309     310     311    1301    1302    1303    1304+HT02
+HT02       1305    1306    1307    1308    1309    1310    1311    2501+HT03
+HT03       2502    2503    2504    2505    2506    2507    2508    2509+HT04
+HT04       2510    2511
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON H-TAIL CONTROL SURFACE
SET1         305    2501    2502    2503    2504    2505    2506    2507+HC01
+HC01       2508    2509    2510    2511    2301    2302    2303    2304+HC02
+HC02       2305    2306    2307    2308    2309    2310    2311
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON V-TAIL
SET1         400     401     402     403     404     405     406     407+VT01
+VT01        408     409     410     411    1401    1402    1403    1404+VT02
+VT02       1405    1406    1407    1408    1409    1410    1411    2601+VT03
+VT03       2602    2603    2604    2605    2606    2607    2608    2609+VT04
+VT04       2610    2611
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON V-TAIL CONTROL SURFACE
SET1         405    2601    2602    2603    2604    2605    2606    2607+VC01
+VC01       2608    2609    2610    2611    2401    2402    2403    2404+VC02
+VC02       2405    2406    2407    2408    2409    2410    2411
$
$ *****  END OF AERODYNAMIC FLUTTER INPUTS  *****
$
EIGR           1    SINV     0.0    60.0              40
$
$   CREATE A NEW GRID POINT AT THE C.G. FOR THE CURRENT FUEL MASS CONDITION
$   USE A CBEAM TO CONNECT THIS NEW GRID TO GRID 101
GRID          95       0160.9484     0.077.08521       0
CBEAM         95      95     101      95     1.0     0.0     0.0
PBEAM         95       1   100.0  1000.0  1000.0     0.0  1000.0
$
$   GRID 100 REPRESENTS PROPULSION SYSTEM
RBE2         504     101  123456     100
$  CONNECTIONS TO WING-TIP BOOM, HORIZONTAL AND VERTICAL TAILS
$
RBE2         501     141  123456     216
RBE2         502     238  123456     301
RBE2         503     240  123456     401
$
GRID         100       0   125.8     0.0    86.1       0
$
$  GRIDS FOR RIGHT WING BEAM
$
GRID         101       0  156.51    0.00   48.98       0
GRID         102       0  156.48   13.15   49.67       0
GRID         103       0  156.45   26.29   50.37       0
GRID         104       0  156.41   39.44   51.06       0
GRID         105       0  156.38   52.59   51.75       0
GRID         106       0  156.34   65.74   52.45       0
GRID         107       0  156.31   78.88   53.14       0
GRID         108       0  156.28   92.03   53.83       0
GRID         109       0  156.24  105.18   54.53       0
GRID         110       0  156.21  118.32   55.22       0
GRID         111       0  156.18  131.47   55.91       0
GRID         112       0  156.14  144.62   56.61       0
GRID         113       0  156.11  157.76   57.30       0
GRID         114       0  156.08  170.91   57.99       0
GRID         115       0  156.04  184.06   58.69       0
GRID         116       0  156.01  197.21   59.38       0
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GRID          117       0  155.98  210.35   60.07       0
GRID          118       0  155.94  223.50   60.77       0
GRID          119       0  155.88  236.63   61.46       0
GRID          120       0  155.82  249.76   62.16       0
GRID          121       0  155.76  262.89   62.86       0
GRID          122       0  155.70  276.02   63.55       0
GRID          123       0  155.64  289.15   64.25       0
GRID          124       0  155.58  302.28   64.95       0
GRID          125       0  155.52  315.41   65.64       0
GRID          126       0  155.46  328.54   66.34       0
GRID          127       0  155.39  341.67   67.04       0
GRID          128       0  155.33  354.80   67.73       0
GRID          129       0  155.27  367.93   68.43       0
GRID          130       0  155.21  381.07   69.13       0
GRID          131       0  155.15  394.20   69.82       0
GRID          132       0  155.09  407.33   70.52       0
GRID          133       0  155.03  420.46   71.22       0
GRID          134       0  154.97  433.59   71.91       0
GRID          135       0  154.91  446.72   72.61       0
GRID          136       0  154.85  459.85   73.31       0
GRID          137       0  154.79  472.98   74.00       0
GRID          138       0  154.72  486.11   74.70       0
GRID          139       0  154.66  499.24   75.40       0
GRID          140       0  154.60  512.37   76.09       0
GRID          141       0  154.54  525.50   76.79       0
$
$ RIGHT SIDE WING SURFACE LEADING-EDGE GRID POINTS
$
GRID         1101       0  132.83    0.00   48.98       0
GRID         1102       0  132.92   13.15   49.67       0
GRID         1103       0  133.01   26.29   50.37       0
GRID         1104       0  133.10   39.44   51.06       0
GRID         1105       0  133.18   52.59   51.75       0
GRID         1106       0  133.27   65.74   52.45       0
GRID         1107       0  133.36   78.88   53.14       0
GRID         1108       0  133.45   92.03   53.83       0
GRID         1109       0  133.54  105.18   54.53       0
GRID         1110       0  133.63  118.32   55.22       0
GRID         1111       0  133.71  131.47   55.91       0
GRID         1112       0  133.80  144.62   56.61       0
GRID         1113       0  133.89  157.76   57.30       0
GRID         1114       0  133.98  170.91   57.99       0
GRID         1115       0  134.07  184.06   58.69       0
GRID         1116       0  134.16  197.21   59.38       0
GRID         1117       0  134.24  210.35   60.07       0
GRID         1118       0  134.33  223.50   60.77       0
GRID         1119       0  134.49  236.63   61.46       0
GRID         1120       0  134.65  249.76   62.16       0
GRID         1121       0  134.81  262.89   62.86       0
GRID         1122       0  134.97  276.02   63.55       0
GRID         1123       0  135.14  289.15   64.25       0
GRID         1124       0  135.30  302.28   64.95       0
GRID         1125       0  135.46  315.41   65.64       0
GRID         1126       0  135.62  328.54   66.34       0
GRID         1127       0  135.78  341.67   67.04       0
GRID         1128       0  135.94  354.80   67.73       0
GRID         1129       0  136.10  367.93   68.43       0
GRID         1130       0  136.26  381.07   69.13       0
GRID         1131       0  136.42  394.20   69.82       0
GRID         1132       0  136.58  407.33   70.52       0
GRID         1133       0  136.74  420.46   71.22       0
GRID         1134       0  136.90  433.59   71.91       0
GRID         1135       0  137.06  446.72   72.61       0
```

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GRID        1136       0  137.22  459.85   73.31       0
GRID        1137       0  137.38  472.98   74.00       0
GRID        1138       0  137.55  486.11   74.70       0
GRID        1139       0  137.71  499.24   75.40       0
GRID        1140       0  137.87  512.37   76.09       0
GRID        1141       0  138.03  525.50   76.79       0
$
$ RIGHT SIDE WING SURFACE TRAILING-EDGE GRID POINTS
$
GRID        2101       0  192.03    0.00   48.98       0
GRID        2102       0  191.82   13.15   49.67       0
GRID        2103       0  191.60   26.29   50.37       0
GRID        2104       0  191.39   39.44   51.06       0
GRID        2105       0  191.17   52.59   51.75       0
GRID        2106       0  190.95   65.74   52.45       0
GRID        2107       0  190.74   78.88   53.14       0
GRID        2108       0  190.52   92.03   53.83       0
GRID        2109       0  190.30  105.18   54.53       0
GRID        2110       0  190.09  118.32   55.22       0
GRID        2111       0  189.87  131.47   55.91       0
GRID        2112       0  189.66  144.62   56.61       0
GRID        2113       0  189.44  157.76   57.30       0
GRID        2114       0  189.22  170.91   57.99       0
GRID        2115       0  189.01  184.06   58.69       0
GRID        2116       0  188.79  197.21   59.38       0
GRID        2117       0  188.58  210.35   60.07       0
GRID        2118       0  188.36  223.50   60.77       0
GRID        2119       0  187.97  236.63   61.46       0
GRID        2120       0  187.57  249.76   62.16       0
GRID        2121       0  187.18  262.89   62.86       0
GRID        2122       0  186.79  276.02   63.55       0
GRID        2123       0  186.39  289.15   64.25       0
GRID        2124       0  186.00  302.28   64.95       0
GRID        2125       0  185.61  315.41   65.64       0
GRID        2126       0  185.21  328.54   66.34       0
GRID        2127       0  184.82  341.67   67.04       0
GRID        2128       0  184.43  354.80   67.73       0
GRID        2129       0  184.03  367.93   68.43       0
GRID        2130       0  183.64  381.07   69.13       0
GRID        2131       0  183.25  394.20   69.82       0
GRID        2132       0  182.85  407.33   70.52       0
GRID        2133       0  182.46  420.46   71.22       0
GRID        2134       0  182.07  433.59   71.91       0
GRID        2135       0  181.67  446.72   72.61       0
GRID        2136       0  181.28  459.85   73.31       0
GRID        2137       0  180.89  472.98   74.00       0
GRID        2138       0  180.49  486.11   74.70       0
GRID        2139       0  180.10  499.24   75.40       0
GRID        2140       0  179.71  512.37   76.09       0
GRID        2141       0  179.31  525.50   76.79       0
$
$  RIGHT WING * LEADING AND TRAILING EDGE GRIDS ARE DEPENDENT ON MAIN BEAM
$
RBE2        1201     101  123456    1101    2101
RBE2        1202     102  123456    1102    2102
RBE2        1203     103  123456    1103    2103
RBE2        1204     104  123456    1104    2104
RBE2        1205     105  123456    1105    2105
RBE2        1206     106  123456    1106    2106
RBE2        1207     107  123456    1107    2107
RBE2        1208     108  123456    1108    2108
RBE2        1209     109  123456    1109    2109
RBE2        1210     110  123456    1110    2110
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RBE2        1211     111  123456    1111    2111
RBE2        1212     112  123456    1112    2112
RBE2        1213     113  123456    1113    2113
RBE2        1214     114  123456    1114    2114
RBE2        1215     115  123456    1115    2115
RBE2        1216     116  123456    1116    2116
RBE2        1217     117  123456    1117    2117
RBE2        1218     118  123456    1118    2118
RBE2        1219     119  123456    1119    2119
RBE2        1220     120  123456    1120    2120
RBE2        1221     121  123456    1121    2121
RBE2        1222     122  123456    1122    2122
RBE2        1223     123  123456    1123    2123
RBE2        1224     124  123456    1124    2124
RBE2        1225     125  123456    1125    2125
RBE2        1226     126  123456    1126    2126
RBE2        1227     127  123456    1127    2127
RBE2        1228     128  123456    1128    2128
RBE2        1229     129  123456    1129    2129
RBE2        1230     130  123456    1130    2130
RBE2        1231     131  123456    1131    2131
RBE2        1232     132  123456    1132    2132
RBE2        1233     133  123456    1133    2133
RBE2        1234     134  123456    1134    2134
RBE2        1235     135  123456    1135    2135
RBE2        1236     136  123456    1136    2136
RBE2        1237     137  123456    1137    2137
RBE2        1238     138  123456    1138    2138
RBE2        1239     139  123456    1139    2139
RBE2        1240     140  123456    1140    2140
RBE2        1241     141  123456    1141    2141
$
$  GRIDS FOR RIGHT SIDE WING-TIP BOOM
$
GRID         201       0     25.   525.5    77.5       0
GRID         202       0 33.6111   525.5    77.5       0
GRID         203       0 42.2222   525.5    77.5       0
GRID         204       0 50.8333   525.5    77.5       0
GRID         205       0 59.4444   525.5    77.5       0
GRID         206       0 68.0556   525.5    77.5       0
GRID         207       0 76.6667   525.5    77.5       0
GRID         208       0 85.2778   525.5    77.5       0
GRID         209       0 93.8889   525.5    77.5       0
GRID         210       0   102.5   525.5    77.5       0
GRID         211       0 111.111   525.5    77.5       0
GRID         212       0 119.722   525.5    77.5       0
GRID         213       0 128.333   525.5    77.5       0
GRID         214       0 136.944   525.5    77.5       0
GRID         215       0 145.556   525.5    77.5       0
GRID         216       0 154.167   525.5    77.5       0
GRID         217       0 162.778   525.5    77.5       0
GRID         218       0 171.389   525.5    77.5       0
GRID         219       0    180.   525.5    77.5       0
GRID         220       0    190.   525.5    77.5       0
GRID         221       0    200.   525.5    77.5       0
GRID         222       0    210.   525.5    77.5       0
GRID         223       0    220.   525.5    77.5       0
GRID         224       0    230.   525.5    77.5       0
GRID         225       0    240.   525.5    77.5       0
GRID         226       0    250.   525.5    77.5       0
GRID         227       0    260.   525.5    77.5       0
GRID         228       0    270.   525.5    77.5       0
GRID         229       0    280.   525.5    77.5       0
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GRID         230       0    290.   525.5    77.5       0
GRID         231       0    300.   525.5    77.5       0
GRID         232       0    310.   525.5    77.5       0
GRID         233       0    320.   525.5    77.5       0
GRID         234       0    330.   525.5    77.5       0
GRID         235       0    340.   525.5    77.5       0
GRID         236       0    350.   525.5    77.5       0
GRID         237       0    360.   525.5    77.5       0
GRID         238       0    370.   525.5    77.5       0
GRID         239       0    380.   525.5    77.5       0
GRID         240       0    390.   525.5    77.5       0
GRID         241       0    400.   525.5    77.5       0
GRID         242       0    410.   525.5    77.5       0
GRID         243       0    420.   525.5    77.5       0
$
$   ***********************************************
$      RIGHT SIDE HORIZONTAL TAIL DEFINITION
$   ***********************************************
$  GRIDS FOR RIGHT SIDE HORIZONTAL TAIL BEAM
$
GRID         301       0  379.75  525.50   77.36       0
GRID         302       0  379.61  535.00   79.01       0
GRID         303       0  379.47  544.50   80.67       0
GRID         304       0  379.34  554.00   82.33       0
GRID         305       0  379.20  563.50   83.98       0
GRID         306       0  379.06  573.00   85.64       0
GRID         307       0  378.92  582.50   87.30       0
GRID         308       0  378.79  592.00   88.95       0
GRID         309       0  378.65  601.50   90.61       0
GRID         310       0  378.51  611.00   92.27       0
GRID         311       0  378.37  620.50   93.92       0
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL MAIN BEAM
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 5
GRID         331       0  379.75  525.50   77.36       5
GRID         332       0  379.61  535.00   79.01       5
GRID         333       0  379.47  544.50   80.67       5
GRID         334       0  379.34  554.00   82.33       5
GRID         335       0  379.20  563.50   83.98       5
GRID         336       0  379.06  573.00   85.64       5
GRID         337       0  378.92  582.50   87.30       5
GRID         338       0  378.79  592.00   88.95       5
GRID         339       0  378.65  601.50   90.61       5
GRID         340       0  378.51  611.00   92.27       5
GRID         341       0  378.37  620.50   93.92       5
$   DUPLICATE GRIDS ON H-TAIL ARE DEPENDENT ON ELASTIC AXIS BEAM
RBE2         521     301  123456     331
RBE2         522     302  123456     332
RBE2         523     303  123456     333
RBE2         524     304  123456     334
RBE2         525     305  123456     335
RBE2         526     306  123456     336
RBE2         527     307  123456     337
RBE2         528     308  123456     338
RBE2         529     309  123456     339
RBE2         530     310  123456     340
RBE2         531     311  123456     341
$
$  RIGHT SIDE HORIZONTAL TAIL LEADING EDGE
$
GRID        1301       0  355.08  525.50   77.36       0
GRID        1302       0  356.17  535.00   79.01       0
GRID        1303       0  357.27  544.50   80.67       0
GRID        1304       0  358.36  554.00   82.33       0
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GRID        1305       0  359.46  563.50   83.98       0
GRID        1306       0  360.56  573.00   85.64       0
GRID        1307       0  361.65  582.50   87.30       0
GRID        1308       0  362.75  592.00   88.95       0
GRID        1309       0  363.85  601.50   90.61       0
GRID        1310       0  364.94  611.00   92.27       0
GRID        1311       0  366.04  620.50   93.92       0
$
$  DISPLACEMENT OF H-TAIL L.E. IS DEPENDENT ON ELASTIC AXIS
RBE2        1251     301  123456    1301
RBE2        1252     302  123456    1302
RBE2        1253     303  123456    1303
RBE2        1254     304  123456    1304
RBE2        1255     305  123456    1305
RBE2        1256     306  123456    1306
RBE2        1257     307  123456    1307
RBE2        1258     308  123456    1308
RBE2        1259     309  123456    1309
RBE2        1260     310  123456    1310
RBE2        1261     311  123456    1311
$
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL LEADING EDGE
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 5
GRID        1331       0  355.08  525.50   77.36       5
GRID        1332       0  356.17  535.00   79.01       5
GRID        1333       0  357.27  544.50   80.67       5
GRID        1334       0  358.36  554.00   82.33       5
GRID        1335       0  359.46  563.50   83.98       5
GRID        1336       0  360.56  573.00   85.64       5
GRID        1337       0  361.65  582.50   87.30       5
GRID        1338       0  362.75  592.00   88.95       5
GRID        1339       0  363.85  601.50   90.61       5
GRID        1340       0  364.94  611.00   92.27       5
GRID        1341       0  366.04  620.50   93.92       5
$  DUPLICATE GRIDS ON H-TAIL LEADING EDGE ARE DEPENDENT ON ELASTIC AXIS
RBE2         541     301  123456    1331
RBE2         542     302  123456    1332
RBE2         543     303  123456    1333
RBE2         544     304  123456    1334
RBE2         545     305  123456    1335
RBE2         546     306  123456    1336
RBE2         547     307  123456    1337
RBE2         548     308  123456    1338
RBE2         549     309  123456    1339
RBE2         550     310  123456    1340
RBE2         551     311  123456    1341
$
$  RIGHT SIDE HORIZONTAL TAIL TRAILING EDGE
$
GRID        2301       0  416.83  525.50   77.36       0
GRID        2302       0  414.84  535.00   79.01       0
GRID        2303       0  412.85  544.50   80.67       0
GRID        2304       0  410.86  554.00   82.33       0
GRID        2305       0  408.87  563.50   83.98       0
GRID        2306       0  406.88  573.00   85.64       0
GRID        2307       0  404.88  582.50   87.30       0
GRID        2308       0  402.89  592.00   88.95       0
GRID        2309       0  400.90  601.50   90.61       0
GRID        2310       0  398.91  611.00   92.27       0
GRID        2311       0  396.92  620.50   93.92       0
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL TRAILING EDGE
$  THE OUTPUT FOR THESE GRIDS WILL BE IN COORD. SYST. 5
GRID        2331       0  416.83  525.50   77.36       5
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GRID        2332       0  414.84  535.00   79.01       5
GRID        2333       0  412.85  544.50   80.67       5
GRID        2334       0  410.86  554.00   82.33       5
GRID        2335       0  408.87  563.50   83.98       5
GRID        2336       0  406.88  573.00   85.64       5
GRID        2337       0  404.88  582.50   87.30       5
GRID        2338       0  402.89  592.00   88.95       5
GRID        2339       0  400.90  601.50   90.61       5
GRID        2340       0  398.91  611.00   92.27       5
GRID        2341       0  396.92  620.50   93.92       5
$  DUPLICATE H-TAIL T.E. GRIDS ARE DEPENDENT ON ORIGINAL T.E. GRIDS
RBE2         561    2301  123456    2331
RBE2         562    2302  123456    2332
RBE2         563    2303  123456    2333
RBE2         564    2304  123456    2334
RBE2         565    2305  123456    2335
RBE2         566    2306  123456    2336
RBE2         567    2307  123456    2337
RBE2         568    2308  123456    2338
RBE2         569    2309  123456    2339
RBE2         570    2310  123456    2340
RBE2         571    2311  123456    2341
$
$  GRIDS AT 80% CHORD HINGE-LINE OF RIGHT SIDE HORIZONTAL TAIL
GRID        2501       0 404.480 525.500  77.360       0
GRID        2502       0 403.106 535.000  79.010       0
GRID        2503       0 401.734 544.500  80.670       0
GRID        2504       0 400.360 554.000  82.330       0
GRID        2505       0 398.988 563.500  83.980       0
GRID        2506       0 397.616 573.000  85.640       0
GRID        2507       0 396.234 582.500  87.300       0
GRID        2508       0 394.862 592.000  88.950       0
GRID        2509       0 393.490 601.500  90.610       0
GRID        2510       0 392.116 611.000  92.270       0
GRID        2511       0 390.744 620.500  93.920       0
$
$    ******************************************************
$    END OF RIGHT SIDE HORIZONTAL TAIL DEFINITION
$    ******************************************************
$
$    ******************************************************
$    RIGHT SIDE VERTICAL TAIL DEFINITION
$    ******************************************************
$
$  GRIDS FOR RIGHT SIDE VERTICAL TAIL BEAM
GRID         401       0  410.39  525.50   77.50       0
GRID         402       0  411.39  522.60   85.47       0
GRID         403       0  412.38  519.70   93.44       0
GRID         404       0  413.38  516.80  101.41       0
GRID         405       0  414.37  513.90  109.38       0
GRID         406       0  415.37  511.00  117.34       0
GRID         407       0  416.36  508.10  125.31       0
GRID         408       0  417.36  505.20  133.28       0
GRID         409       0  418.35  502.30  141.25       0
GRID         410       0  419.35  499.40  149.22       0
GRID         411       0  420.34  496.50  157.19       0
$   THIS GROUP OF GRIDS GENERATES OUTPUT IN COORD. SYSTEM 6
$   THE Z-AXIS FOR COORD. SYS. 5 IS NORMAL TO PLANE OF V-TAIL
GRID         431       0  410.39  525.50   77.50       6
GRID         432       0  411.39  522.60   85.47       6
GRID         433       0  412.38  519.70   93.44       6
GRID         434       0  413.38  516.80  101.41       6
GRID         435       0  414.37  513.90  109.38       6
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GRID         436       0  415.37  511.00  117.34       6
GRID         437       0  416.36  508.10  125.31       6
GRID         438       0  417.36  505.20  133.28       6
GRID         439       0  418.35  502.30  141.25       6
GRID         440       0  419.35  499.40  149.22       6
GRID         441       0  420.34  496.50  157.19       6
$  DUPLICATE GRIDS OF MAIN V-TAIL ARE DEPENDENT ON ELASTIC AXIS GRIDS
RBE2         581     401  123456     431
RBE2         582     402  123456     432
RBE2         583     403  123456     433
RBE2         584     404  123456     434
RBE2         585     405  123456     435
RBE2         586     406  123456     436
RBE2         587     407  123456     437
RBE2         588     408  123456     438
RBE2         589     409  123456     439
RBE2         590     410  123456     440
RBE2         591     411  123456     441
$
$  RIGHT SIDE VERTICAL TAIL LEADING EDGE
$
GRID        1401       0  390.67  525.50   77.50       0
GRID        1402       0  392.36  522.60   85.47       0
GRID        1403       0  394.05  519.70   93.44       0
GRID        1404       0  395.73  516.80  101.41       0
GRID        1405       0  397.42  513.90  109.38       0
GRID        1406       0  399.11  511.00  117.34       0
GRID        1407       0  400.79  508.10  125.31       0
GRID        1408       0  402.48  505.20  133.28       0
GRID        1409       0  404.17  502.30  141.25       0
GRID        1410       0  405.85  499.40  149.22       0
GRID        1411       0  407.54  496.50  157.19       0
$
$  LEADING EDGE V-TAIL GRIDS ARE DEPENDENT ON ELASTIC AXIS
RBE2        1271     401  123456    1401
RBE2        1272     402  123456    1402
RBE2        1273     403  123456    1403
RBE2        1274     404  123456    1404
RBE2        1275     405  123456    1405
RBE2        1276     406  123456    1406
RBE2        1277     407  123456    1407
RBE2        1278     408  123456    1408
RBE2        1279     409  123456    1409
RBE2        1280     410  123456    1410
RBE2        1281     411  123456    1411
$
$  DUPLICATE GRIDS FOR VERTICAL TAIL LEADING EDGE
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 6
GRID        1431       0  390.67  525.50   77.50       6
GRID        1432       0  392.36  522.60   85.47       6
GRID        1433       0  394.05  519.70   93.44       6
GRID        1434       0  395.73  516.80  101.41       6
GRID        1435       0  397.42  513.90  109.38       6
GRID        1436       0  399.11  511.00  117.34       6
GRID        1437       0  400.79  508.10  125.31       6
GRID        1438       0  402.48  505.20  133.28       6
GRID        1439       0  404.17  502.30  141.25       6
GRID        1440       0  405.85  499.40  149.22       6
GRID        1441       0  407.54  496.50  157.19       6
$  V-TAIL LEADING EDGE DUPLICATE GRIDS ARE DEPENDENT ON ELASTIC AXIS GRIDS
RBE2         601     401  123456    1431
RBE2         602     402  123456    1432
RBE2         603     403  123456    1433
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RBE2         604     404  123456    1434
RBE2         605     405  123456    1435
RBE2         606     406  123456    1436
RBE2         607     407  123456    1437
RBE2         608     408  123456    1438
RBE2         609     409  123456    1439
RBE2         610     410  123456    1440
RBE2         611     411  123456    1441
$
$  RIGHT SIDE VERTICAL TAIL TRAILING EDGE
$
GRID        2401       0  439.97  525.50   77.50       0
GRID        2402       0  439.93  522.60   85.47       0
GRID        2403       0  439.89  519.70   93.44       0
GRID        2404       0  439.84  516.80  101.41       0
GRID        2405       0  439.80  513.90  109.38       0
GRID        2406       0  439.76  511.00  117.34       0
GRID        2407       0  439.71  508.10  125.31       0
GRID        2408       0  439.67  505.20  133.28       0
GRID        2409       0  439.63  502.30  141.25       0
GRID        2410       0  439.58  499.40  149.22       0
GRID        2411       0  439.54  496.50  157.19       0
$  DUPLICATE GRIDS FOR VERTICAL TAIL TRAILING EDGE
$  THE OUTPUT FOR THESE GRIDS WILL BE IN COORD. SYST. 6
GRID        2431       0  439.97  525.50   77.50       6
GRID        2432       0  439.93  522.60   85.47       6
GRID        2433       0  439.89  519.70   93.44       6
GRID        2434       0  439.84  516.80  101.41       6
GRID        2435       0  439.80  513.90  109.38       6
GRID        2436       0  439.76  511.00  117.34       6
GRID        2437       0  439.71  508.10  125.31       6
GRID        2438       0  439.67  505.20  133.28       6
GRID        2439       0  439.63  502.30  141.25       6
GRID        2440       0  439.58  499.40  149.22       6
GRID        2441       0  439.54  496.50  157.19       6
$  DUPLICATE V-TAIL T.E. GRIDS ARE DEPENDENT ON ORIGINAL GRIDS
RBE2         621    2401  123456    2431
RBE2         622    2402  123456    2432
RBE2         623    2403  123456    2433
RBE2         624    2404  123456    2434
RBE2         625    2405  123456    2435
RBE2         626    2406  123456    2436
RBE2         627    2407  123456    2437
RBE2         628    2408  123456    2438
RBE2         629    2409  123456    2439
RBE2         630    2410  123456    2440
RBE2         631    2411  123456    2441
$
$  GRIDS AT 80% CHORD HINGE-LINE OF RIGHT SIDE VERTICAL TAIL
GRID        2601       0 430.110 525.500  77.500       0
GRID        2602       0 430.416 522.600  85.470       0
GRID        2603       0 430.722 519.700  93.440       0
GRID        2604       0 431.018 516.800 101.410       0
GRID        2605       0 431.324 513.900 109.380       0
GRID        2606       0 431.630 511.000 117.340       0
GRID        2607       0 431.926 508.100 125.310       0
GRID        2608       0 432.232 505.200 133.280       0
GRID        2609       0 432.538 502.300 141.250       0
GRID        2610       0 432.834 499.400 149.220       0
GRID        2611       0 433.140 496.500 157.190       0
$
$    ***************************************************
$      END OF RIGHT SIDE VERTICAL TAIL DEFINITION
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$    ***************************************************
$
$   MAIN BEAMS FOR RIGHT WING
CBEAM        101     101     101     102     -1.      0.      0.
CBEAM        102     102     102     103     -1.      0.      0.
CBEAM        103     103     103     104     -1.      0.      0.
CBEAM        104     104     104     105     -1.      0.      0.
CBEAM        105     105     105     106     -1.      0.      0.
CBEAM        106     106     106     107     -1.      0.      0.
CBEAM        107     107     107     108     -1.      0.      0.
CBEAM        108     108     108     109     -1.      0.      0.
CBEAM        109     109     109     110     -1.      0.      0.
CBEAM        110     110     110     111     -1.      0.      0.
CBEAM        111     111     111     112     -1.      0.      0.
CBEAM        112     112     112     113     -1.      0.      0.
CBEAM        113     113     113     114     -1.      0.      0.
CBEAM        114     114     114     115     -1.      0.      0.
CBEAM        115     115     115     116     -1.      0.      0.
CBEAM        116     116     116     117     -1.      0.      0.
CBEAM        117     117     117     118     -1.      0.      0.
CBEAM        118     118     118     119     -1.      0.      0.
CBEAM        119     119     119     120     -1.      0.      0.
CBEAM        120     120     120     121     -1.      0.      0.
CBEAM        121     121     121     122     -1.      0.      0.
CBEAM        122     122     122     123     -1.      0.      0.
CBEAM        123     123     123     124     -1.      0.      0.
CBEAM        124     124     124     125     -1.      0.      0.
CBEAM        125     125     125     126     -1.      0.      0.
CBEAM        126     126     126     127     -1.      0.      0.
CBEAM        127     127     127     128     -1.      0.      0.
CBEAM        128     128     128     129     -1.      0.      0.
CBEAM        129     129     129     130     -1.      0.      0.
CBEAM        130     130     130     131     -1.      0.      0.
CBEAM        131     131     131     132     -1.      0.      0.
CBEAM        132     132     132     133     -1.      0.      0.
CBEAM        133     133     133     134     -1.      0.      0.
CBEAM        134     134     134     135     -1.      0.      0.
CBEAM        135     135     135     136     -1.      0.      0.
CBEAM        136     136     136     137     -1.      0.      0.
CBEAM        137     137     137     138     -1.      0.      0.
CBEAM        138     138     138     139     -1.      0.      0.
CBEAM        139     139     139     140     -1.      0.      0.
CBEAM        140     140     140     141     -1.      0.      0.
$   BEAMS FOR RIGHT WING TIP BOOM
CBEAM        201     201     201     202      0.      1.      0.
CBEAM        202     202     202     203      0.      1.      0.
CBEAM        203     203     203     204      0.      1.      0.
CBEAM        204     204     204     205      0.      1.      0.
CBEAM        205     205     205     206      0.      1.      0.
CBEAM        206     206     206     207      0.      1.      0.
CBEAM        207     207     207     208      0.      1.      0.
CBEAM        208     208     208     209      0.      1.      0.
CBEAM        209     209     209     210      0.      1.      0.
CBEAM        210     210     210     211      0.      1.      0.
CBEAM        211     211     211     212      0.      1.      0.
CBEAM        212     212     212     213      0.      1.      0.
CBEAM        213     213     213     214      0.      1.      0.
CBEAM        214     214     214     215      0.      1.      0.
CBEAM        215     215     215     216      0.      1.      0.
CBEAM        216     216     216     217      0.      1.      0.
CBEAM        217     217     217     218      0.      1.      0.
CBEAM        218     218     218     219      0.      1.      0.
CBEAM        219     219     219     220      0.      1.      0.
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CBEAM        220     220     220     221      0.      1.      0.
CBEAM        221     221     221     222      0.      1.      0.
CBEAM        222     222     222     223      0.      1.      0.
CBEAM        223     223     223     224      0.      1.      0.
CBEAM        224     224     224     225      0.      1.      0.
CBEAM        225     225     225     226      0.      1.      0.
CBEAM        226     226     226     227      0.      1.      0.
CBEAM        227     227     227     228      0.      1.      0.
CBEAM        228     228     228     229      0.      1.      0.
CBEAM        229     229     229     230      0.      1.      0.
CBEAM        230     230     230     231      0.      1.      0.
CBEAM        231     231     231     232      0.      1.      0.
CBEAM        232     232     232     233      0.      1.      0.
CBEAM        233     233     233     234      0.      1.      0.
CBEAM        234     234     234     235      0.      1.      0.
CBEAM        235     235     235     236      0.      1.      0.
CBEAM        236     236     236     237      0.      1.      0.
CBEAM        237     237     237     238      0.      1.      0.
CBEAM        238     238     238     239      0.      1.      0.
CBEAM        239     239     239     240      0.      1.      0.
CBEAM        240     240     240     241      0.      1.      0.
CBEAM        241     241     241     242      0.      1.      0.
CBEAM        242     242     242     243      0.      1.      0.
$   RIGHT SIDE HORIZONTAL TAIL BEAMS
CBEAM        301     301     301     302     -1.      0.      0.
CBEAM        302     302     302     303     -1.      0.      0.
CBEAM        303     303     303     304     -1.      0.      0.
CBEAM        304     304     304     305     -1.      0.      0.
CBEAM        305     305     305     306     -1.      0.      0.
CBEAM        306     306     306     307     -1.      0.      0.
CBEAM        307     307     307     308     -1.      0.      0.
CBEAM        308     308     308     309     -1.      0.      0.
CBEAM        309     309     309     310     -1.      0.      0.
CBEAM        310     310     310     311     -1.      0.      0.
$   RIGHT SIDE VERTICAL TAIL BEAMS
CBEAM        401     401     401     402      1.      0.      0.
CBEAM        402     402     402     403      1.      0.      0.
CBEAM        403     403     403     404      1.      0.      0.
CBEAM        404     404     404     405      1.      0.      0.
CBEAM        405     405     405     406      1.      0.      0.
CBEAM        406     406     406     407      1.      0.      0.
CBEAM        407     407     407     408      1.      0.      0.
CBEAM        408     408     408     409      1.      0.      0.
CBEAM        409     409     409     410      1.      0.      0.
CBEAM        410     410     410     411      1.      0.      0.
$
$   BEAM PROPERTIES FOR RIGHT WING ELASTIC AXIS
PBEAM        101       1   1000.   1021.   247.3      0.   174.3      0.
PBEAM        102       1   1000.   1005.   227.7      0.   171.5      0.
PBEAM        103       1   1000.   989.3   208.8      0.   168.7      0.
PBEAM        104       1   1000.    974.   190.5      0.    166.      0.
PBEAM        105       1   1000.   958.7    173.      0.   163.3      0.
PBEAM        106       1   1000.   943.7   156.2      0.   160.6      0.
PBEAM        107       1   1000.   928.8   140.2      0.   157.9      0.
PBEAM        108       1   1000.    914.   124.8      0.   155.3      0.
PBEAM        109       1   1000.   899.4   110.3      0.   152.7      0.
PBEAM        110       1   1000.    885.   96.95      0.   150.1      0.
PBEAM        111       1   1000.   870.7   92.06      0.   147.6      0.
PBEAM        112       1   1000.   856.6   86.48      0.   145.1      0.
PBEAM        113       1   1000.   842.6   79.99      0.   142.6      0.
PBEAM        114       1   1000.   828.8   75.44      0.   140.1      0.
PBEAM        115       1   1000.   815.2   71.21      0.   137.7      0.
PBEAM        116       1   1000.   801.6   68.65      0.   135.3      0.
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PBEAM        117       1   1000.   788.3   67.96      0.    133.      0.
PBEAM        118       1   1000.   769.7   66.91      0.   129.7      0.
PBEAM        119       1   1000.   746.1   65.52      0.   125.5      0.
PBEAM        120       1   1000.   723.1   64.11      0.   121.4      0.
PBEAM        121       1   1000.   700.5   62.75      0.   117.4      0.
PBEAM        122       1   1000.   678.4   61.39      0.   113.5      0.
PBEAM        123       1   1000.   656.7   60.02      0.   109.7      0.
PBEAM        124       1   1000.   635.5   58.67      0.    106.      0.
PBEAM        125       1   1000.   614.8   57.33      0.   102.3      0.
PBEAM        126       1   1000.   594.6   56.01      0.   98.78      0.
PBEAM        127       1   1000.   574.8    54.7      0.    95.3      0.
PBEAM        128       1   1000.   555.4    53.4      0.   91.91      0.
PBEAM        129       1   1000.   536.5   52.12      0.    88.6      0.
PBEAM        130       1   1000.    518.   50.86      0.   85.37      0.
PBEAM        131       1   1000.   499.9   49.61      0.   82.22      0.
PBEAM        132       1   1000.   482.3   48.37      0.   79.15      0.
PBEAM        133       1   1000.   465.1   47.15      0.   76.15      0.
PBEAM        134       1   1000.   448.3   45.95      0.   73.23      0.
PBEAM        135       1   1000.   431.9   44.76      0.   70.39      0.
PBEAM        136       1   1000.   415.9   43.58      0.   67.62      0.
PBEAM        137       1   1000.   400.3   42.42      0.   64.93      0.
PBEAM        138       1   1000.   385.1   41.27      0.    62.3      0.
PBEAM        139       1   1000.   370.3   40.14      0.   59.75      0.
PBEAM        140       1   1000.   355.9   39.03      0.   57.27      0.
$   BEAM PROPERTIES FOR RIGHT WING TIP BOOM
PBEAM        201       2   1000.   83.46   90.29      0.   238.6      0.
PBEAM        202       2   1000.   132.9   146.5      0.   238.6      0.
PBEAM        203       2   1000.   182.3   202.8      0.   238.6      0.
PBEAM        204       2   1000.   231.8   259.1      0.   238.6      0.
PBEAM        205       2   1000.   281.2   315.3      0.   238.6      0.
PBEAM        206       2   1000.   330.7   371.6      0.   238.6      0.
PBEAM        207       2   1000.   380.1   427.8      0.   238.6      0.
PBEAM        208       2   1000.   429.5   484.1      0.   238.6      0.
PBEAM        209       2   1000.    479.   540.4      0.   238.6      0.
PBEAM        210       2   1000.   528.4   596.6      0.   238.6      0.
PBEAM        211       2   1000.   577.8   652.9      0.   238.6      0.
PBEAM        212       2   1000.   627.3   709.1      0.   238.6      0.
PBEAM        213       2   1000.   676.7   765.4      0.   238.6      0.
PBEAM        214       2   1000.   726.2   821.7      0.   238.6      0.
PBEAM        215       2   1000.   704.4   793.9      0.   238.6      0.
PBEAM        216       2   1000.   682.7   766.2      0.   238.6      0.
PBEAM        217       2   1000.    661.   738.4      0.   238.6      0.
PBEAM        218       2   1000.   639.3   710.7      0.   238.6      0.
PBEAM        219       2   1000.    597.   659.8      0.   221.1      0.
PBEAM        220       2   1000.   556.2   610.7      0.   204.5      0.
PBEAM        221       2   1000.   516.7   563.3      0.   188.8      0.
PBEAM        222       2   1000.   478.6   517.7      0.   173.9      0.
PBEAM        223       2   1000.   441.9   473.7      0.   159.8      0.
PBEAM        224       2   1000.   406.6   431.5      0.   146.5      0.
PBEAM        225       2   1000.   372.6   391.1      0.    134.      0.
PBEAM        226       2   1000.    340.   352.3      0.   122.1      0.
PBEAM        227       2   1000.   308.8   315.3      0.    111.      0.
PBEAM        228       2   1000.   278.9   279.9      0.   100.6      0.
PBEAM        229       2   1000.   253.6   249.5      0.   113.6      0.
PBEAM        230       2   1000.   226.1   217.3      0.   102.3      0.
PBEAM        231       2   1000.    200.   186.8      0.   91.71      0.
PBEAM        232       2   1000.   177.6   160.2      0.   98.27      0.
PBEAM        233       2   1000.   153.9   132.9      0.   87.36      0.
PBEAM        234       2   1000.   131.7   107.3      0.   77.29      0.
PBEAM        235       2   1000.   112.4   85.01      0.   79.37      0.
PBEAM        236       2   1000.   94.08   64.02      0.   79.38      0.
PBEAM        237       2   1000.    75.6   43.23      0.   69.04      0.
PBEAM        238       2   1000.   59.53    25.2      0.    67.1      0.
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PBEAM        239       2   1000.   44.55   8.614      0.   63.92      0.
PBEAM        240       2   1000.    30.7   8.007      0.   59.78      0.
PBEAM        241       2   1000.   14.37   3.655      0.   27.47      0.
PBEAM        242       2   1000.   3.024   3.024      0.    22.9      0.
$   BEAM PROPERTIES FOR RIGHT SIDE HORIZONTAL TAIL
PBEAM        301       3   1000.   1047.   54.91      0.    179.      0.
PBEAM        302       3   1000.   894.1    41.7      0.   151.7      0.
PBEAM        303       3   1000.   756.8   30.83      0.   127.4      0.
PBEAM        304       3   1000.   634.3   22.05      0.   105.8      0.
PBEAM        305       3   1000.   525.8   15.11      0.   86.74      0.
PBEAM        306       3   1000.   430.5   9.772      0.   70.15      0.
PBEAM        307       3   1000.   347.4   5.823      0.   55.82      0.
PBEAM        308       3   1000.   275.8   3.046      0.   43.59      0.
PBEAM        309       3   1000.   214.8   1.241      0.   33.28      0.
PBEAM        310       3   1000.   163.5  0.2188      0.   24.75      0.
$   BEAM PROPERTIES FOR RIGHT SIDE VERTICAL TAIL
PBEAM        401       4   1000.   542.6   24.42      0.   73.63      0.
PBEAM        402       4   1000.   486.7   18.52      0.   66.03      0.
PBEAM        403       4   1000.   434.7   13.68      0.   58.98      0.
PBEAM        404       4   1000.   386.6   9.785      0.   52.45      0.
PBEAM        405       4   1000.   342.1   6.712      0.   46.42      0.
PBEAM        406       4   1000.   301.3    4.35      0.   40.87      0.
PBEAM        407       4   1000.   263.8   2.599      0.   35.79      0.
PBEAM        408       4   1000.   229.5   1.365      0.   31.14      0.
PBEAM        409       4   1000.   198.4  0.5584      0.   26.91      0.
PBEAM        410       4   1000.   170.2 0.09922      0.   23.09      0.
$
$       MATERIAL  PROPERTIES
$ FEMAP Material 1 : Generic - WING AND CHORDWISE SPINES
MAT1           11000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - BOOM
MAT1           21000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - HORIZONTAL
MAT1           31000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - VERTICAL
MAT1           41000000.1000000.     0.3      0.      0.      0.
$
$     LUMPED  MASSES
$ Fuselage Rigid Body Mass (50% for 1/2 symm model)
$
CONM2        601     100      -1   446.1  125.80    0.00    86.1       0 MASS601
+MASS601  2.64E5       0  8.90E5       0       0  6.95E5
$
$ ************************************
$ LUMPED MASSES FOR RIGHT-WING
$ ************************************
$   RIGHT WING
CONM2        602     102      -1    7.91  157.54    6.57   49.16       0 MASS602
CONM2        603     103      -1    7.75  157.67   19.72   49.83       0 MASS603
CONM2        604     104      -1    7.60  157.80   32.87   50.50       0 MASS604
CONM2        605     105      -1    7.45  157.92   46.01   51.17       0 MASS605
CONM2        606     106      -1    7.30  158.05   59.16   51.84       0 MASS606
CONM2        607     107      -1    7.16  158.17   72.31   52.51       0 MASS607
CONM2        608     108      -1    7.03  158.30   85.46   53.17       0 MASS608
CONM2        609     109      -1    6.90  158.42   98.60   53.84       0 MASS609
CONM2        610     110      -1    6.77  158.54  111.75   54.51       0 MASS610
CONM2        611     111      -1    6.66  158.65  124.90   55.18       0 MASS611
CONM2        612     112      -1    6.57  158.71  138.04   55.86       0 MASS612
CONM2        613     113      -1    6.49  158.77  151.19   56.54       0 MASS613
CONM2        614     114      -1    6.41  158.82  164.34   57.22       0 MASS614
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CONM2        615     115      -1    6.35  158.83  177.49   57.91       0 MASS615
CONM2        616     116      -1    6.30  158.82  190.63   58.60       0 MASS616
CONM2        617     117      -1    6.26  158.79  203.78   59.29       0 MASS617
CONM2        618     118      -1    6.24  158.74  216.93   59.99       0 MASS618
CONM2        619     119      -1    6.19  158.66  230.07   60.69       0 MASS619
$
+MASS602   114.0       0  2357.1       0       0  2471.1
+MASS603   111.7       0  2285.6       0       0  2397.2
+MASS604   109.4       0  2216.7       0       0  2326.1
+MASS605   107.3       0  2150.3       0       0  2257.6
+MASS606   105.2       0  2086.5       0       0  2191.6
+MASS607   103.2       0  2025.0       0       0  2128.2
+MASS608   101.2       0  1966.0       0       0  2067.2
+MASS609    99.4       0  1909.2       0       0  2008.6
+MASS610    97.6       0  1854.7       0       0  1952.3
+MASS611    95.9       0  1802.8       0       0  1898.7
+MASS612    94.6       0  1760.2       0       0  1854.9
+MASS613    93.4       0  1719.1       0       0  1812.6
+MASS614    92.3       0  1679.5       0       0  1771.8
+MASS615    91.5       0  1646.6       0       0  1738.0
+MASS616    90.7       0  1615.4       0       0  1706.1
+MASS617    90.2       0  1587.8       0       0  1678.0
+MASS618    89.8       0  1563.6       0       0  1653.4
+MASS619    88.9       0  1527.9       0       0  1616.9
$
$   ***************************************************************
$      BEGIN FUEL STATIONS
$   ***************************************************************
$
$ No Fuel
$
$CONM2        620     120      -1    6.14  158.56  243.20   61.53       0 MASS620
$CONM2        621     121      -1    6.10  158.46  256.33   62.23       0 MASS621
$CONM2        622     122      -1    6.05  158.36  269.46   62.93       0 MASS622
$CONM2        623     123      -1    6.00  158.26  282.59   63.63       0 MASS623
$CONM2        624     124      -1    5.95  158.16  295.72   64.33       0 MASS624
$CONM2        625     125      -1    5.91  158.06  308.85   65.03       0 MASS625
$CONM2        626     126      -1    5.86  157.96  321.98   65.73       0 MASS626
$
$ No Fuel
$
$+MASS620    88.3       0  1485.1       0       0  1573.4
$+MASS621    87.6       0  1443.1       0       0  1530.7
$+MASS622    86.9       0  1402.0       0       0  1488.9
$+MASS623    86.2       0  1361.5       0       0  1447.8
$+MASS624    85.5       0  1321.9       0       0  1407.5
$+MASS625    84.9       0  1283.1       0       0  1367.9
$+MASS626    84.2       0  1245.0       0       0  1329.1
$
$ WITH FUEL AT AN ALTITUDE OF 1000 FEET (10/15/98)
$
CONM2        620     120      -1  25.379  157.65  243.20   61.53       0 MASS620
CONM2        621     121      -1  24.861  157.57  256.33   62.23       0 MASS621
CONM2        622     122      -1  24.348  157.49  269.46   62.93       0 MASS622
CONM2        623     123      -1  23.839  157.41  282.59   63.63       0 MASS623
CONM2        624     124      -1  23.335  157.33  295.72   64.33       0 MASS624
CONM2        625     125      -1  22.839  157.25  308.85   65.03       0 MASS625
CONM2        626     126      -1  22.348  157.17  321.98   65.73       0 MASS626
$
$ WITH FUEL AT AN ALTITUDE OF 1000 FEET (10/15/98)
$
+MASS620  364.62       0 3931.34       0       0 4090.73
+MASS621  357.16       0 3774.54       0       0 3930.40
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+MASS622  349.80       0 3622.52       0       0 3774.90
+MASS623  342.48       0 3475.13       0       0 3624.12
+MASS624  335.29       0 3332.35       0       0 3477.95
+MASS625  328.15       0 3194.03       0       0 3336.28
+MASS626  321.10       0 3060.12       0       0 3199.03
$
$ With Fuel
$
$ CONM2        620     120      -1   56.86  157.65  243.20   61.53       0 MASS620
$ CONM2        621     121      -1   55.70  157.57  256.33   62.23       0 MASS621
$ CONM2        622     122      -1   54.55  157.49  269.46   62.93       0 MASS622
$ CONM2        623     123      -1   53.41  157.41  282.59   63.63       0 MASS623
$ CONM2        624     124      -1   52.28  157.33  295.72   64.33       0 MASS624
$ CONM2        625     125      -1   51.17  157.25  308.85   65.03       0 MASS625
$ CONM2        626     126      -1   50.07  157.17  321.98   65.73       0 MASS626
$
$ With Fuel
$
$ +MASS620   816.9       0  8807.9       0       0  9165.0
$ +MASS621   800.2       0  8456.6       0       0  8805.8
$ +MASS622   783.7       0  8116.0       0       0  8457.4
$ +MASS623   767.3       0  7785.8       0       0  8119.6
$ +MASS624   751.2       0  7465.9       0       0  7792.1
$ +MASS625   735.2       0  7156.0       0       0  7474.7
$ +MASS626   719.4       0  6856.0       0       0  7167.2
$
$   ****************************************************************
$      END FUEL STATIONS
$   ****************************************************************
$
CONM2        627     127      -1    5.81  157.86  335.11   66.31       0 MASS627
CONM2        628     128      -1    5.76  157.76  348.24   67.01       0 MASS628
CONM2        629     129      -1    5.72  157.66  361.37   67.71       0 MASS629
CONM2        630     130      -1    5.67  157.56  374.50   68.42       0 MASS630
CONM2        631     131      -1    5.62  157.46  387.63   69.12       0 MASS631
CONM2        632     132      -1    5.58  157.37  400.76   69.82       0 MASS632
CONM2        633     133      -1    5.53  157.27  413.89   70.52       0 MASS633
CONM2        634     134      -1    5.48  157.17  427.02   71.23       0 MASS634
CONM2        635     135      -1    5.43  157.07  440.15   71.93       0 MASS635
CONM2        636     136      -1   12.39  155.86  453.28   72.81       0 MASS636
CONM2        637     137      -1    5.34  156.87  466.41   73.33       0 MASS637
CONM2        638     138      -1   12.29  155.76  479.54   74.19       0 MASS638
CONM2        639     139      -1    5.24  156.67  492.67   74.74       0 MASS639
CONM2        640     140      -1   12.20  155.67  505.80   75.58       0 MASS640
CONM2        641     141      -1    5.15  156.47  518.93   76.14       0 MASS641
$
+MASS627    83.5       0  1207.6       0       0  1291.1
+MASS628    82.8       0  1171.0       0       0  1253.8
+MASS629    82.1       0  1135.2       0       0  1217.3
+MASS630    81.5       0  1100.0       0       0  1181.5
+MASS631    80.8       0  1065.6       0       0  1146.4
+MASS632    80.1       0  1031.9       0       0  1112.0
+MASS633    79.4       0   999.0       0       0  1078.4
+MASS634    78.7       0   966.7       0       0  1045.4
+MASS635    78.1       0   935.1       0       0  1013.2
+MASS636    77.4       0   974.4       0       0   974.4
+MASS637    76.7       0   874.0       0       0   950.7
+MASS638    76.0       0   912.3       0       0   912.3
+MASS639    75.3       0   815.6       0       0   890.9
+MASS640    74.7       0   853.1       0       0   853.1
+MASS641    74.0       0   759.8       0       0   833.8
$
$   LUMPED MASSES ON RIGHT WING-TIP BOOM
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CONM2        702     202      -1   11.25   33.61  525.50   77.50        0 MASS702
CONM2        703     203      -1   16.33   42.22  525.50   77.50        0 MASS703
CONM2        704     204      -1   16.41   50.83  525.50   77.50        0 MASS704
CONM2        705     205      -1   11.48   59.44  525.50   77.50        0 MASS705
CONM2        706     206      -1    1.56   68.06  525.50   77.50        0 MASS706
CONM2        707     207      -1    1.64   76.67  525.50   77.50        0 MASS707
CONM2        708     208      -1    1.72   85.28  525.50   77.50        0 MASS708
CONM2        709     209      -1    1.79   93.89  525.50   77.50        0 MASS709
CONM2        710     210      -1    1.87  102.50  525.50   77.50        0 MASS710
CONM2        711     211      -1    1.95  111.11  525.50   77.50        0 MASS711
CONM2        712     212      -1    2.02  119.72  525.50   77.50        0 MASS712
CONM2        713     213      -1    2.10  128.33  525.50   77.50        0 MASS713
CONM2        714     214      -1    2.18  136.94  525.50   77.50        0 MASS714
CONM2        715     215      -1    2.25  145.56  525.50   77.50        0 MASS715
CONM2        716     216      -1    2.22  154.17  525.50   77.50        0 MASS716
CONM2        717     217      -1    2.18  162.78  525.50   77.50        0 MASS717
CONM2        718     218      -1    5.65  171.39  525.50   77.50        0 MASS718
CONM2        719     219      -1    2.11  180.00  525.50   77.50        0 MASS719
CONM2        720     220      -1    2.41  190.00  525.50   77.50        0 MASS720
CONM2        721     221      -1    2.35  200.00  525.50   77.50        0 MASS721
CONM2        722     222      -1    2.30  210.00  525.50   77.50        0 MASS722
CONM2        723     223      -1    2.24  220.00  525.50   77.50        0 MASS723
CONM2        724     224      -1    2.17  230.00  525.50   77.50        0 MASS724
CONM2        725     225      -1    2.11  240.00  525.50   77.50        0 MASS725
CONM2        726     226      -1    2.05  250.00  525.50   77.50        0 MASS726
CONM2        727     227      -1    1.98  260.00  525.50   77.50        0 MASS727
CONM2        728     228      -1    1.91  270.00  525.50   77.50        0 MASS728
CONM2        729     229      -1    1.84  280.00  525.50   77.50        0 MASS729
CONM2        730     230      -1    1.89  290.00  525.50   77.50        0 MASS730
CONM2        731     231      -1    1.81  300.00  525.50   77.50        0 MASS731
CONM2        732     232      -1    1.73  310.00  525.50   77.50        0 MASS732
CONM2        733     233      -1    1.76  320.00  525.50   77.50        0 MASS733
CONM2        734     234      -1    1.66  330.00  525.50   77.50        0 MASS734
CONM2        735     235      -1    1.56  340.00  525.50   77.50        0 MASS735
CONM2        736     236      -1    1.56  350.00  525.50   77.50        0 MASS736
CONM2        737     237      -1    1.54  360.00  525.50   77.50        0 MASS737
CONM2        738     238      -1    1.42  370.00  525.50   77.50        0 MASS738
CONM2        739     239      -1    1.37  380.00  525.50   77.50        0 MASS739
CONM2        740     240      -1    1.31  390.00  525.50   77.50        0 MASS740
CONM2        741     241      -1    1.29  400.00  525.50   77.50        0 MASS741
CONM2        742     242      -1    0.80  410.00  525.50   77.50        0 MASS742
CONM2        743     243      -1    0.71  420.00  525.50   77.50        0 MASS743
$
$
+MASS702   316.5       0   126.6       0       0   126.6
+MASS703   459.3       0   330.6       0       0   330.6
+MASS704   461.5       0   332.1       0       0   332.1
+MASS705   323.0       0   232.5       0       0   232.5
+MASS706    87.8       0    53.6       0       0    53.6
+MASS707    92.2       0    56.2       0       0    56.2
+MASS708    96.5       0    58.8       0       0    58.8
+MASS709   100.8       0    61.5       0       0    61.5
+MASS710   105.1       0    64.1       0       0    64.1
+MASS711   109.5       0    66.8       0       0    66.8
+MASS712   113.8       0    69.4       0       0    69.4
+MASS713   118.1       0    72.0       0       0    72.0
+MASS714   122.5       0    74.7       0       0    74.7
+MASS715   126.8       0    77.3       0       0    77.3
+MASS716   124.8       0    76.1       0       0    76.1
+MASS717   122.7       0    74.9       0       0    74.9
+MASS718   158.8       0   114.3       0       0   114.3
+MASS719   118.7       0    72.4       0       0    72.4
+MASS720   128.9       0    84.6       0       0    84.6
```

```
+MASS721   119.5       0    79.4       0       0    79.4
+MASS722   110.5       0    74.4       0       0    74.4
+MASS723   101.8       0    69.6       0       0    69.6
+MASS724    93.6       0    64.9       0       0    64.9
+MASS725    85.8       0    60.5       0       0    60.5
+MASS726    78.3       0    56.2       0       0    56.2
+MASS727    71.3       0    52.1       0       0    52.1
+MASS728    64.5       0    48.2       0       0    48.2
+MASS729    58.2       0    44.4       0       0    44.4
+MASS730    56.0       0    43.8       0       0    43.8
+MASS731    50.0       0    40.1       0       0    40.1
+MASS732    44.3       0    36.6       0       0    36.6
+MASS733    41.8       0    35.5       0       0    35.5
+MASS734    36.5       0    32.1       0       0    32.1
+MASS735    31.6       0    28.8       0       0    28.8
+MASS736    29.0       0    27.5       0       0    27.5
+MASS737    26.2       0    26.0       0       0    26.0
+MASS738    21.9       0    22.8       0       0    22.8
+MASS739    19.3       0    21.1       0       0    21.1
+MASS740    16.6       0    19.2       0       0    19.2
+MASS741    14.7       0    18.1       0       0    18.1
+MASS742     8.1       0    10.7       0       0    10.7
+MASS743     6.4       0     9.1       0       0     9.1
$   LUMPED MASSES FOR RIGHT SIDE HORIZONTAL TAIL
CONM2        802     302      -1    4.97  387.10  530.25   77.80       0 MASS802
CONM2        803     303      -1    4.73  386.66  539.75   79.47       0 MASS803
CONM2        804     304      -1    7.69  387.79  549.25   81.06       0 MASS804
CONM2        805     305      -1    4.26  385.75  558.75   82.82       0 MASS805
CONM2        806     306      -1    4.03  385.29  568.25   84.49       0 MASS806
CONM2        807     307      -1    7.00  387.18  577.75   86.04       0 MASS807
CONM2        808     308      -1    3.58  384.33  587.25   87.84       0 MASS808
CONM2        809     309      -1    3.35  383.83  596.75   89.51       0 MASS809
CONM2        810     310      -1    6.34  386.70  606.25   91.01       0 MASS810
CONM2        811     311      -1    2.92  382.81  615.75   92.87       0 MASS811
$
+MASS802    37.4       0  1504.7       0       0  1542.1
+MASS803    35.6       0  1289.2       0       0  1324.7
+MASS804    33.8       0  1149.5       0       0  1149.5
+MASS805    32.0       0   923.6       0       0   955.6
+MASS806    30.3       0   770.9       0       0   801.2
+MASS807    28.6       0   710.0       0       0   710.0
+MASS808    26.9       0   519.2       0       0   546.1
+MASS809    25.2       0   417.6       0       0   442.8
+MASS810    23.6       0   427.7       0       0   427.7
+MASS811    22.0       0   256.7       0       0   278.7
$   LUMPED MASSES FOR RIGHT SIDE VERTICAL TAIL
CONM2        902     402      -1    3.06  413.63  524.05   81.48       0 MASS902
CONM2        903     403      -1    2.91  414.65  521.15   89.45       0 MASS903
CONM2        904     404      -1    5.97  418.34  518.25   97.42       0 MASS904
CONM2        905     405      -1    2.63  416.67  515.35  105.39       0 MASS905
CONM2        906     406      -1    2.49  417.67  512.45  113.36       0 MASS906
CONM2        907     407      -1    2.36  418.66  509.55  121.33       0 MASS907
CONM2        908     408      -1    5.43  422.59  506.65  129.30       0 MASS908
CONM2        909     409      -1     2.1  420.61  503.75  137.27       0 MASS909
CONM2        910     410      -1    1.98  421.57  500.85  145.23       0 MASS910
CONM2        911     411      -1    1.86  422.50  497.95  153.20       0 MASS911
$
+MASS902    18.3       0   616.3       0       0   597.9
+MASS903    17.5       0   547.1       0       0   529.7
+MASS904    16.6       0   483.7       0       0   467.1
+MASS905    15.8       0   425.8       0       0   410.0
+MASS906    14.9       0   373.1       0       0   358.2
+MASS907    14.1       0   325.3       0       0   311.2
```

```
+MASS908    13.3       0   282.3       0       0   269.0
+MASS909    12.6       0   243.7       0       0   231.1
+MASS910    11.8       0   209.3       0       0   197.5
+MASS911    11.1       0   178.9       0       0   167.8
$
$
PBEAM       2301       1   100.    1000.  1000.       0.  1000.
PBEAM       2401       1   100.    1000.  1000.       0.  1000.
$
$   RIGHT SIDE BEAMS FROM H-TAIL MAIN BEAM TO HINGE LINE
CBEAM       2301    2301    301     2501     302
CBEAM       2302    2301    302     2502     301
CBEAM       2303    2301    303     2503     301
CBEAM       2304    2301    304     2504     301
CBEAM       2305    2301    305     2505     301
CBEAM       2306    2301    306     2506     301
CBEAM       2307    2301    307     2507     301
CBEAM       2308    2301    308     2508     301
CBEAM       2309    2301    309     2509     301
CBEAM       2310    2301    310     2510     301
CBEAM       2311    2301    311     2511     301
$
$   RIGHT SIDE BEAMS FROM H-TAIL HINGE LINE TO H-TAIL TRAILING EDGE
CBEAM       2321    2301    2501    2301    2502
CBEAM       2322    2301    2502    2302    2501
CBEAM       2323    2301    2503    2303    2501
CBEAM       2324    2301    2504    2304    2501
CBEAM       2325    2301    2505    2305    2501
CBEAM       2326    2301    2506    2306    2501
CBEAM       2327    2301    2507    2307    2501
CBEAM       2328    2301    2508    2308    2501
CBEAM       2329    2301    2509    2309    2501
CBEAM       2330    2301    2510    2310    2501
CBEAM       2331    2301    2511    2311    2501
$   RIGHT SIDE BEAMS FROM V-TAIL MAIN BEAM TO HINGE LINE
CBEAM       2401    2401    401     2601     402
CBEAM       2402    2401    402     2602     401
CBEAM       2403    2401    403     2603     401
CBEAM       2404    2401    404     2604     401
CBEAM       2405    2401    405     2605     401
CBEAM       2406    2401    406     2606     401
CBEAM       2407    2401    407     2607     401
CBEAM       2408    2401    408     2608     401
CBEAM       2409    2401    409     2609     401
CBEAM       2410    2401    410     2610     401
CBEAM       2411    2401    411     2611     401
$
$   RIGHT SIDE BEAMS FROM V-TAIL HINGE LINE TO V-TAIL TRAILING EDGE
CBEAM       2421    2401    2601    2401    2602
CBEAM       2422    2401    2602    2402    2601
CBEAM       2423    2401    2603    2403    2601
CBEAM       2424    2401    2604    2404    2601
CBEAM       2425    2401    2605    2405    2601
CBEAM       2426    2401    2606    2406    2601
CBEAM       2427    2401    2607    2407    2601
CBEAM       2428    2401    2608    2408    2601
CBEAM       2429    2401    2609    2409    2601
CBEAM       2430    2401    2610    2410    2601
CBEAM       2431    2401    2611    2411    2601
$
ENDDATA
```

APPENDIX D

MSC/NASTRAN files used in the frequency response analysis of the two-dimensional gust analysis of the Alliance airplane

- **Program gustv5_l.dat**

```
$                    ERATST PROOF OF CONCEPT AIPRPLANE
$ERAST PROOF OF CONCEPT AIRPLANE USING FULL MODEL AND TWO DIMENSIONAL GUST
$
$      FREQUENCY RESPONSE


$   TO EXECUTE THIS FILE USE THE FOLLOWING:
$   NAST705 GUSTV5_l SCRATCH=YES MEM=12MW NEWS=NO
$
$ASSIGN INPUT4='strip.dat' UNIT=12,FORM=FORMATTED
SOL  146  $  AEROELASTIC DYNAMIC RESPONSE
TIME 500.00    $  TIME IN MINUTES
INCLUDE 'alterv4.dat'
compile freqrs
alter 241 $
putsys (0, 209) $
alter 242 $
putsys (1, 209) $
CEND
TITLE = FULL MODEL * VON KARMAN PSD * M=0.090 * H=1000.0 FT.
SUBTITLE =  FUEL 166.95 LB. * V=98.3 FT/SEC
LABEL = GUST SCALE LENGTH=1000 FEET * GUST VELOCITY=1.0 IN/SEC.
$
LINE = 999999
ECHO = NONE
METHOD = 1  $  SINV EIGENVALUE EXTRACTION METHOD
SDAMPING = 25  $  MODAL STRUCTURAL DAMPING (TABDMP1)
FREQUENCY = 41  $  SET OF SOLUTION FORCING FREQUENCIES (FREQ1)
$
SUBCASE  1  $  APPLY VON KARMAN GUST
  PARAM, NSTRIPRM, 80
  GUST = 1005  $  GUST SELECTION  (GUST) (HAS TO BE 1005)
  DLOAD = 46  $ APPLY LOAD TO EPOINT TO GET PSD OF GUST (RLOAD1)
OUTPUT(XYOUT)
$$$$$$$$$$$$$$$$$$$$$$
  XYPUNCH  ELFORCE RESPONSE / 101(4,11)
  XYPUNCH  ELFORCE RESPONSE / 101(5,12)
  XYPUNCH  ELFORCE RESPONSE / 101(6,13)
  XYPUNCH  ELFORCE RESPONSE / 101(7,14)
  XYPUNCH  ELFORCE RESPONSE / 101(9,16)
  XYPUNCH  ELFORCE RESPONSE / 140(4,11)
  XYPUNCH  ELFORCE RESPONSE / 140(5,12)
  XYPUNCH  ELFORCE RESPONSE / 140(6,13)
  XYPUNCH  ELFORCE RESPONSE / 140(7,14)
  XYPUNCH  ELFORCE RESPONSE / 140(9,16)
  XYPUNCH  ELFORCE RESPONSE / 217(4,11)
  XYPUNCH  ELFORCE RESPONSE / 217(5,12)
  XYPUNCH  ELFORCE RESPONSE / 217(6,13)
  XYPUNCH  ELFORCE RESPONSE / 217(7,14)
  XYPUNCH  ELFORCE RESPONSE / 217(9,16)
$$$$$$$$$$$$$$$$$$$$$$
BEGIN BULK
suport,101,123456
include 'strip1440left'
$
```

```
PARAM, LMODES, 64   $   for free-free, 64 NORMAL MODES < 60 Hz
$ CHANGES "WEIGHT" INPUT DATA TO "MASS" DATA
PARAM,WTMASS,0.002588
$
$ REQUESTS MASS PROPERTIES SUMMARY
PARAM,GRDPNT,0
$
$    ******************************************************
$      SECTION FOR DYNAMIC RESPONSE TO GUST LOADING
$    ******************************************************
$
PARAM, MACH, 0.090   $ DESIRED MACH NUMBER
PARAM, Q, 0.077444  $   DYNAMIC PRESSURE IN PSI AT 1000 FT. (V=1179.6 IN/SEC)
PARAM, GUSTAERO, -1
$
$   STRUCTURAL MODAL DAMPING = 0.02 IN EACH MODE
TABDMP1       25       G                                                +TDMP1
+TDMP1       0.0    0.02    60.0    0.02    ENDT
$
RANDPS       111       1       1     1.0     0.0     121
$   VELOCITY ON 'GUST' MUST BE SAME AS ON 'AERO' INPUT RECORD.
$GUST ID HAS TO BE 1005
GUST        1005      468.4774-4     0.0  1179.6
RLOAD1        46      56                      66
DAREA         56    9990             1.0
EPOINT      9990
$
$ TABLED1 PROVIDES FREQUENCY INTERVAL OVER WHICH LOADS ARE GENERATED
TABLED1       66                                                       +TDVK1
+TDVK1       0.0     1.0    40.0     1.0    ENDT
$  SETS OF FREQUENCIES USED IN SOLUTION OF FREQUENCY RESPONSE PROBLEMS
FREQ2         41    0.01     50.     200
$
$  DMIG DEFINES AN EPOINT USED TO OUTPUT THE VON KARMAN PSD
DMIG       STIFF       0       6       1       0
DMIG       STIFF    9990       0            9990       0     1.0
$
$   AERO. DENSITY UNITS: LB-SEC**2/IN**4 (SEA-LEVEL)
AERO           0  1179.6   54.031.1463-7       0       0
$
$   CREATE TABLE OF MACH NUMBER AND REDUCED FREQ. FOR AERO. CALC.
MKAERO1     0.09                                                       +MK1
+MK1     0.00001   0.005    0.01    0.02    0.04    0.06    0.08     0.1
MKAERO1     0.09                                                       +MK2
+MK2         0.2     0.4     0.6     0.8     1.0     2.0     3.0     4.0
MKAERO1     0.09                                                       +MK3
+MK3         5.0     6.0     7.0     8.0     9.0    10.0
$
PAERO1  1
$
$ INCLUDE THE SPLINE DEFINITIONS
INCLUDE 'full_spline.dat'
$
$ INCLUDE THE AERODYNAMIC MODEL
INCLUDE 'full_aero.dat'
$
EIGR           1    SINV     0.0    60.0              80
$
$ INCLUDE THE STRUCTURAL MODEL
INCLUDE 'full_struc.dat'
$
$ INCLUDE THE MASS DISTRIBUTION FILE
INCLUDE 'full_mass.dat'
```

```
$
ENDDATA
$
```

- **Program full_struc.dat**

```
$
$   CREATE A NEW GRID POINT AT THE C.G. FOR THE CURRENT FUEL MASS CONDITION
$   USE A CBEAM TO CONNECT THIS NEW GRID TO GRID 101
GRID          95       0160.9484     0.077.08521       0
CBEAM         95      95     101      95     1.0     0.0     0.0
PBEAM         95       1   100.0  1000.0  1000.0     0.0  1000.0
$
$  DEFINE LOCAL COORDINATE SYSTEMS FOR HORIZONTAL AND VERTICAL TAILS
SPC1, 1, 123456, 30, 40   $   GRIDS 30 AND 40 ONLY USED FOR ORIENTATION
GRID, 30, 0, 379.75, 521.5678, 100.0   $  DEFINES DIRECTION OF Z-AXIS (H-TAIL)
GRID, 40, 0, 410.39, 587.3362, 100.0   $  DEFINES DIRECTION OF Z-AXIS (V-TAIL)
$
$  COORDINATE SYSTEM 12 IS A REFERENCE AXIS SYSTEM FOR STABILITY DERIVATIVES
$  ORIGIN OF COORDINATE SYSTEM 12 IS AT GRID 101
CORD2R        12       0 156.51    0.0   48.98   156.51   0.0     40.0  +CO12
+CO12      140.0  0.0     48.98
$    LOCAL COORD. SYSTEM FOR RIGHT SIDE HORIZONTAL TAIL
CORD1R, 5, 301, 30, 2301   $   Z-AXIS NORMAL TO PLANE OF HORIZ. TAIL
$    LOCAL COORD. SYSTEM FOR RIGHT SIDE VERTICAL TAIL
CORD1R, 6, 401, 40, 2401   $   Z-AXIS NORMAL TO PLANE OF VERT. TAIL
$
$  LOCAL COORDINATE SYSTEM TO DEFINE Y-AXIS OF RIGHT H-TAIL HINGE LINE
CORD2R        13       0 404.480 525.50  77.360  404.480521.5678 100.0  +CO13
+CO13      450.0531.888378.46955
$  LOCAL COORDINATE SYSTEM TO DEFINE Y-AXIS OF RIGHT V-TAIL HINGE LINE
CORD2R        14       0 433.14  496.50 157.190  433.140614.1537 200.0  +CO14
+CO14      500.0497.3168154.9451
$
$  LOCAL COORD. SYSTEM TO DEFINE Y-AXIS OF LEFT H-TAIL HINGE LINE
CORD2R        15       0 390.744 -620.50 93.920 390.744 -619.444  100.0 +CO15
+CO15    450.0  -628.81695.36436
$  LOCAL COORD. SYSTEM TO DEFINE Y-AXIS OF LEFT V-TAIL HINGE LINE
CORD2R        16       0 430.110 -525.50 77.500 430.110 -587.336  100.0 +CO16
+CO16    450.0  -525.74376.83217
$
CORD2C         1       0      0.      0.      0.      0.      0.      1.+FEMAPC1
+FEMAPC1      1.      0.      1.
CORD2S         2       0      0.      0.      0.      0.      0.      1.+FEMAPC2
+FEMAPC2      1.      0.      1.
$
$    ******************************************************
$   BEAM PROPERTIES FOR RIGHT WING (ALSO LEFT WING) ELASTIC AXIS
PBEAM        101       1   1000.   1021.   247.3      0.   174.3      0.
PBEAM        102       1   1000.   1005.   227.7      0.   171.5      0.
PBEAM        103       1   1000.   989.3   208.8      0.   168.7      0.
PBEAM        104       1   1000.    974.   190.5      0.    166.      0.
PBEAM        105       1   1000.   958.7    173.      0.   163.3      0.
PBEAM        106       1   1000.   943.7   156.2      0.   160.6      0.
PBEAM        107       1   1000.   928.8   140.2      0.   157.9      0.
PBEAM        108       1   1000.    914.   124.8      0.   155.3      0.
PBEAM        109       1   1000.   899.4   110.3      0.   152.7      0.
PBEAM        110       1   1000.    885.   96.95      0.   150.1      0.
PBEAM        111       1   1000.   870.7   92.06      0.   147.6      0.
PBEAM        112       1   1000.   856.6   86.48      0.   145.1      0.
PBEAM        113       1   1000.   842.6   79.99      0.   142.6      0.
PBEAM        114       1   1000.   828.8   75.44      0.   140.1      0.
PBEAM        115       1   1000.   815.2   71.21      0.   137.7      0.
```

```
PBEAM        116       1   1000.   801.6   68.65      0.   135.3      0.
PBEAM        117       1   1000.   788.3   67.96      0.    133.      0.
PBEAM        118       1   1000.   769.7   66.91      0.   129.7      0.
PBEAM        119       1   1000.   746.1   65.52      0.   125.5      0.
PBEAM        120       1   1000.   723.1   64.11      0.   121.4      0.
PBEAM        121       1   1000.   700.5   62.75      0.   117.4      0.
PBEAM        122       1   1000.   678.4   61.39      0.   113.5      0.
PBEAM        123       1   1000.   656.7   60.02      0.   109.7      0.
PBEAM        124       1   1000.   635.5   58.67      0.    106.      0.
PBEAM        125       1   1000.   614.8   57.33      0.   102.3      0.
PBEAM        126       1   1000.   594.6   56.01      0.   98.78      0.
PBEAM        127       1   1000.   574.8    54.7      0.    95.3      0.
PBEAM        128       1   1000.   555.4    53.4      0.   91.91      0.
PBEAM        129       1   1000.   536.5   52.12      0.    88.6      0.
PBEAM        130       1   1000.    518.   50.86      0.   85.37      0.
PBEAM        131       1   1000.   499.9   49.61      0.   82.22      0.
PBEAM        132       1   1000.   482.3   48.37      0.   79.15      0.
PBEAM        133       1   1000.   465.1   47.15      0.   76.15      0.
PBEAM        134       1   1000.   448.3   45.95      0.   73.23      0.
PBEAM        135       1   1000.   431.9   44.76      0.   70.39      0.
PBEAM        136       1   1000.   415.9   43.58      0.   67.62      0.
PBEAM        137       1   1000.   400.3   42.42      0.   64.93      0.
PBEAM        138       1   1000.   385.1   41.27      0.    62.3      0.
PBEAM        139       1   1000.   370.3   40.14      0.   59.75      0.
PBEAM        140       1   1000.   355.9   39.03      0.   57.27      0.
$   BEAM PROPERTIES FOR RIGHT WING (ALSO LEFT WING) TIP BOOM
PBEAM        201       2   1000.   83.46   90.29      0.   238.6      0.
PBEAM        202       2   1000.   132.9   146.5      0.   238.6      0.
PBEAM        203       2   1000.   182.3   202.8      0.   238.6      0.
PBEAM        204       2   1000.   231.8   259.1      0.   238.6      0.
PBEAM        205       2   1000.   281.2   315.3      0.   238.6      0.
PBEAM        206       2   1000.   330.7   371.6      0.   238.6      0.
PBEAM        207       2   1000.   380.1   427.8      0.   238.6      0.
PBEAM        208       2   1000.   429.5   484.1      0.   238.6      0.
PBEAM        209       2   1000.    479.   540.4      0.   238.6      0.
PBEAM        210       2   1000.   528.4   596.6      0.   238.6      0.
PBEAM        211       2   1000.   577.8   652.9      0.   238.6      0.
PBEAM        212       2   1000.   627.3   709.1      0.   238.6      0.
PBEAM        213       2   1000.   676.7   765.4      0.   238.6      0.
PBEAM        214       2   1000.   726.2   821.7      0.   238.6      0.
PBEAM        215       2   1000.   704.4   793.9      0.   238.6      0.
PBEAM        216       2   1000.   682.7   766.2      0.   238.6      0.
PBEAM        217       2   1000.    661.   738.4      0.   238.6      0.
PBEAM        218       2   1000.   639.3   710.7      0.   238.6      0.
PBEAM        219       2   1000.    597.   659.8      0.   221.1      0.
PBEAM        220       2   1000.   556.2   610.7      0.   204.5      0.
PBEAM        221       2   1000.   516.7   563.3      0.   188.8      0.
PBEAM        222       2   1000.   478.6   517.7      0.   173.9      0.
PBEAM        223       2   1000.   441.9   473.7      0.   159.8      0.
PBEAM        224       2   1000.   406.6   431.5      0.   146.5      0.
PBEAM        225       2   1000.   372.6   391.1      0.    134.      0.
PBEAM        226       2   1000.    340.   352.3      0.   122.1      0.
PBEAM        227       2   1000.   308.8   315.3      0.    111.      0.
PBEAM        228       2   1000.   278.9   279.9      0.   100.6      0.
PBEAM        229       2   1000.   253.6   249.5      0.   113.6      0.
PBEAM        230       2   1000.   226.1   217.3      0.   102.3      0.
PBEAM        231       2   1000.    200.   186.8      0.   91.71      0.
PBEAM        232       2   1000.   177.6   160.2      0.   98.27      0.
PBEAM        233       2   1000.   153.9   132.9      0.   87.36      0.
PBEAM        234       2   1000.   131.7   107.3      0.   77.29      0.
PBEAM        235       2   1000.   112.4   85.01      0.   79.37      0.
PBEAM        236       2   1000.   94.08   64.02      0.   79.38      0.
PBEAM        237       2   1000.    75.6   43.23      0.   69.04      0.
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PBEAM        238       2   1000.   59.53    25.2      0.    67.1      0.
PBEAM        239       2   1000.   44.55   8.614      0.   63.92      0.
PBEAM        240       2   1000.    30.7   8.007      0.   59.78      0.
PBEAM        241       2   1000.   14.37   3.655      0.   27.47      0.
PBEAM        242       2   1000.   3.024   3.024      0.    22.9      0.
$   BEAM PROPERTIES FOR RIGHT SIDE (ALSO LEFT SIDE) HORIZONTAL TAIL
PBEAM        301       3   1000.   1047.   54.91      0.    179.      0.
PBEAM        302       3   1000.   894.1    41.7      0.   151.7      0.
PBEAM        303       3   1000.   756.8   30.83      0.   127.4      0.
PBEAM        304       3   1000.   634.3   22.05      0.   105.8      0.
PBEAM        305       3   1000.   525.8   15.11      0.   86.74      0.
PBEAM        306       3   1000.   430.5   9.772      0.   70.15      0.
PBEAM        307       3   1000.   347.4   5.823      0.   55.82      0.
PBEAM        308       3   1000.   275.8   3.046      0.   43.59      0.
PBEAM        309       3   1000.   214.8   1.241      0.   33.28      0.
PBEAM        310       3   1000.   163.5  0.2188      0.   24.75      0.
$
PBEAM       2301       1   100.    1000.  1000.       0.  1000.
$
$   BEAM PROPERTIES FOR RIGHT SIDE (ALSO LEFT SIDE) VERTICAL TAIL
PBEAM        401       4   1000.   542.6   24.42      0.   73.63      0.
PBEAM        402       4   1000.   486.7   18.52      0.   66.03      0.
PBEAM        403       4   1000.   434.7   13.68      0.   58.98      0.
PBEAM        404       4   1000.   386.6   9.785      0.   52.45      0.
PBEAM        405       4   1000.   342.1   6.712      0.   46.42      0.
PBEAM        406       4   1000.   301.3    4.35      0.   40.87      0.
PBEAM        407       4   1000.   263.8   2.599      0.   35.79      0.
PBEAM        408       4   1000.   229.5   1.365      0.   31.14      0.
PBEAM        409       4   1000.   198.4  0.5584      0.   26.91      0.
PBEAM        410       4   1000.   170.2 0.09922      0.   23.09      0.
$
PBEAM       2401       1   100.    1000.  1000.       0.  1000.
$
$ FEMAP Material 1 : Generic - WING AND CHORDWISE SPINES
MAT1           11000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - BOOM
MAT1           21000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - HORIZONTAL
MAT1           31000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - VERTICAL
MAT1           41000000.1000000.     0.3      0.      0.      0.
$
$   GRID 100 REPRESENTS PROPULSION SYSTEM
RBE2         504     101  123456     100
$
$  CONNECTIONS TO WING-TIP BOOM, HORIZ. AND VERT. TAILS ON RIGHT SIDE
RBE2         501     141  123456     216
RBE2         502     238  123456     301
RBE2         503     240  123456     401
$
GRID         100       0   125.8     0.0    86.1       0
$
$  GRIDS FOR RIGHT WING BEAM
$
GRID         101       0  156.51    0.00   48.98       0
GRID         102       0  156.48   13.15   49.67       0
GRID         103       0  156.45   26.29   50.37       0
GRID         104       0  156.41   39.44   51.06       0
GRID         105       0  156.38   52.59   51.75       0
GRID         106       0  156.34   65.74   52.45       0
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GRID         107       0  156.31   78.88   53.14       0
GRID         108       0  156.28   92.03   53.83       0
GRID         109       0  156.24  105.18   54.53       0
GRID         110       0  156.21  118.32   55.22       0
GRID         111       0  156.18  131.47   55.91       0
GRID         112       0  156.14  144.62   56.61       0
GRID         113       0  156.11  157.76   57.30       0
GRID         114       0  156.08  170.91   57.99       0
GRID         115       0  156.04  184.06   58.69       0
GRID         116       0  156.01  197.21   59.38       0
GRID         117       0  155.98  210.35   60.07       0
GRID         118       0  155.94  223.50   60.77       0
GRID         119       0  155.88  236.63   61.46       0
GRID         120       0  155.82  249.76   62.16       0
GRID         121       0  155.76  262.89   62.86       0
GRID         122       0  155.70  276.02   63.55       0
GRID         123       0  155.64  289.15   64.25       0
GRID         124       0  155.58  302.28   64.95       0
GRID         125       0  155.52  315.41   65.64       0
GRID         126       0  155.46  328.54   66.34       0
GRID         127       0  155.39  341.67   67.04       0
GRID         128       0  155.33  354.80   67.73       0
GRID         129       0  155.27  367.93   68.43       0
GRID         130       0  155.21  381.07   69.13       0
GRID         131       0  155.15  394.20   69.82       0
GRID         132       0  155.09  407.33   70.52       0
GRID         133       0  155.03  420.46   71.22       0
GRID         134       0  154.97  433.59   71.91       0
GRID         135       0  154.91  446.72   72.61       0
GRID         136       0  154.85  459.85   73.31       0
GRID         137       0  154.79  472.98   74.00       0
GRID         138       0  154.72  486.11   74.70       0
GRID         139       0  154.66  499.24   75.40       0
GRID         140       0  154.60  512.37   76.09       0
GRID         141       0  154.54  525.50   76.79       0
$
$ RIGHT SIDE WING SURFACE LEADING-EDGE GRID POINTS
$
GRID        1101       0  132.83    0.00   48.98       0
GRID        1102       0  132.92   13.15   49.67       0
GRID        1103       0  133.01   26.29   50.37       0
GRID        1104       0  133.10   39.44   51.06       0
GRID        1105       0  133.18   52.59   51.75       0
GRID        1106       0  133.27   65.74   52.45       0
GRID        1107       0  133.36   78.88   53.14       0
GRID        1108       0  133.45   92.03   53.83       0
GRID        1109       0  133.54  105.18   54.53       0
GRID        1110       0  133.63  118.32   55.22       0
GRID        1111       0  133.71  131.47   55.91       0
GRID        1112       0  133.80  144.62   56.61       0
GRID        1113       0  133.89  157.76   57.30       0
GRID        1114       0  133.98  170.91   57.99       0
GRID        1115       0  134.07  184.06   58.69       0
GRID        1116       0  134.16  197.21   59.38       0
GRID        1117       0  134.24  210.35   60.07       0
GRID        1118       0  134.33  223.50   60.77       0
GRID        1119       0  134.49  236.63   61.46       0
GRID        1120       0  134.65  249.76   62.16       0
GRID        1121       0  134.81  262.89   62.86       0
GRID        1122       0  134.97  276.02   63.55       0
GRID        1123       0  135.14  289.15   64.25       0
GRID        1124       0  135.30  302.28   64.95       0
GRID        1125       0  135.46  315.41   65.64       0
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GRID        1126       0  135.62  328.54   66.34       0
GRID        1127       0  135.78  341.67   67.04       0
GRID        1128       0  135.94  354.80   67.73       0
GRID        1129       0  136.10  367.93   68.43       0
GRID        1130       0  136.26  381.07   69.13       0
GRID        1131       0  136.42  394.20   69.82       0
GRID        1132       0  136.58  407.33   70.52       0
GRID        1133       0  136.74  420.46   71.22       0
GRID        1134       0  136.90  433.59   71.91       0
GRID        1135       0  137.06  446.72   72.61       0
GRID        1136       0  137.22  459.85   73.31       0
GRID        1137       0  137.38  472.98   74.00       0
GRID        1138       0  137.55  486.11   74.70       0
GRID        1139       0  137.71  499.24   75.40       0
GRID        1140       0  137.87  512.37   76.09       0
GRID        1141       0  138.03  525.50   76.79       0
$
$ RIGHT SIDE WING SURFACE TRAILING-EDGE GRID POINTS
$
GRID        2101       0  192.03    0.00   48.98       0
GRID        2102       0  191.82   13.15   49.67       0
GRID        2103       0  191.60   26.29   50.37       0
GRID        2104       0  191.39   39.44   51.06       0
GRID        2105       0  191.17   52.59   51.75       0
GRID        2106       0  190.95   65.74   52.45       0
GRID        2107       0  190.74   78.88   53.14       0
GRID        2108       0  190.52   92.03   53.83       0
GRID        2109       0  190.30  105.18   54.53       0
GRID        2110       0  190.09  118.32   55.22       0
GRID        2111       0  189.87  131.47   55.91       0
GRID        2112       0  189.66  144.62   56.61       0
GRID        2113       0  189.44  157.76   57.30       0
GRID        2114       0  189.22  170.91   57.99       0
GRID        2115       0  189.01  184.06   58.69       0
GRID        2116       0  188.79  197.21   59.38       0
GRID        2117       0  188.58  210.35   60.07       0
GRID        2118       0  188.36  223.50   60.77       0
GRID        2119       0  187.97  236.63   61.46       0
GRID        2120       0  187.57  249.76   62.16       0
GRID        2121       0  187.18  262.89   62.86       0
GRID        2122       0  186.79  276.02   63.55       0
GRID        2123       0  186.39  289.15   64.25       0
GRID        2124       0  186.00  302.28   64.95       0
GRID        2125       0  185.61  315.41   65.64       0
GRID        2126       0  185.21  328.54   66.34       0
GRID        2127       0  184.82  341.67   67.04       0
GRID        2128       0  184.43  354.80   67.73       0
GRID        2129       0  184.03  367.93   68.43       0
GRID        2130       0  183.64  381.07   69.13       0
GRID        2131       0  183.25  394.20   69.82       0
GRID        2132       0  182.85  407.33   70.52       0
GRID        2133       0  182.46  420.46   71.22       0
GRID        2134       0  182.07  433.59   71.91       0
GRID        2135       0  181.67  446.72   72.61       0
GRID        2136       0  181.28  459.85   73.31       0
GRID        2137       0  180.89  472.98   74.00       0
GRID        2138       0  180.49  486.11   74.70       0
GRID        2139       0  180.10  499.24   75.40       0
GRID        2140       0  179.71  512.37   76.09       0
GRID        2141       0  179.31  525.50   76.79       0
$
$  RIGHT WING * LEADING AND TRAILING EDGE GRIDS ARE DEPENDENT ON MAIN BEAM
$
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RBE2        1201     101  123456    1101    2101
RBE2        1202     102  123456    1102    2102
RBE2        1203     103  123456    1103    2103
RBE2        1204     104  123456    1104    2104
RBE2        1205     105  123456    1105    2105
RBE2        1206     106  123456    1106    2106
RBE2        1207     107  123456    1107    2107
RBE2        1208     108  123456    1108    2108
RBE2        1209     109  123456    1109    2109
RBE2        1210     110  123456    1110    2110
RBE2        1211     111  123456    1111    2111
RBE2        1212     112  123456    1112    2112
RBE2        1213     113  123456    1113    2113
RBE2        1214     114  123456    1114    2114
RBE2        1215     115  123456    1115    2115
RBE2        1216     116  123456    1116    2116
RBE2        1217     117  123456    1117    2117
RBE2        1218     118  123456    1118    2118
RBE2        1219     119  123456    1119    2119
RBE2        1220     120  123456    1120    2120
RBE2        1221     121  123456    1121    2121
RBE2        1222     122  123456    1122    2122
RBE2        1223     123  123456    1123    2123
RBE2        1224     124  123456    1124    2124
RBE2        1225     125  123456    1125    2125
RBE2        1226     126  123456    1126    2126
RBE2        1227     127  123456    1127    2127
RBE2        1228     128  123456    1128    2128
RBE2        1229     129  123456    1129    2129
RBE2        1230     130  123456    1130    2130
RBE2        1231     131  123456    1131    2131
RBE2        1232     132  123456    1132    2132
RBE2        1233     133  123456    1133    2133
RBE2        1234     134  123456    1134    2134
RBE2        1235     135  123456    1135    2135
RBE2        1236     136  123456    1136    2136
RBE2        1237     137  123456    1137    2137
RBE2        1238     138  123456    1138    2138
RBE2        1239     139  123456    1139    2139
RBE2        1240     140  123456    1140    2140
RBE2        1241     141  123456    1141    2141
$
$  GRIDS FOR RIGHT SIDE WING-TIP BOOM
$
GRID         201       0     25.   525.5    77.5       0
GRID         202       0 33.6111   525.5    77.5       0
GRID         203       0 42.2222   525.5    77.5       0
GRID         204       0 50.8333   525.5    77.5       0
GRID         205       0 59.4444   525.5    77.5       0
GRID         206       0 68.0556   525.5    77.5       0
GRID         207       0 76.6667   525.5    77.5       0
GRID         208       0 85.2778   525.5    77.5       0
GRID         209       0 93.8889   525.5    77.5       0
GRID         210       0   102.5   525.5    77.5       0
GRID         211       0 111.111   525.5    77.5       0
GRID         212       0 119.722   525.5    77.5       0
GRID         213       0 128.333   525.5    77.5       0
GRID         214       0 136.944   525.5    77.5       0
GRID         215       0 145.556   525.5    77.5       0
GRID         216       0 154.167   525.5    77.5       0
GRID         217       0 162.778   525.5    77.5       0
GRID         218       0 171.389   525.5    77.5       0
GRID         219       0    180.   525.5    77.5       0
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GRID         220       0    190.   525.5    77.5       0
GRID         221       0    200.   525.5    77.5       0
GRID         222       0    210.   525.5    77.5       0
GRID         223       0    220.   525.5    77.5       0
GRID         224       0    230.   525.5    77.5       0
GRID         225       0    240.   525.5    77.5       0
GRID         226       0    250.   525.5    77.5       0
GRID         227       0    260.   525.5    77.5       0
GRID         228       0    270.   525.5    77.5       0
GRID         229       0    280.   525.5    77.5       0
GRID         230       0    290.   525.5    77.5       0
GRID         231       0    300.   525.5    77.5       0
GRID         232       0    310.   525.5    77.5       0
GRID         233       0    320.   525.5    77.5       0
GRID         234       0    330.   525.5    77.5       0
GRID         235       0    340.   525.5    77.5       0
GRID         236       0    350.   525.5    77.5       0
GRID         237       0    360.   525.5    77.5       0
GRID         238       0    370.   525.5    77.5       0
GRID         239       0    380.   525.5    77.5       0
GRID         240       0    390.   525.5    77.5       0
GRID         241       0    400.   525.5    77.5       0
GRID         242       0    410.   525.5    77.5       0
GRID         243       0    420.   525.5    77.5       0
$
$   ***********************************************
$      RIGHT SIDE HORIZONTAL TAIL DEFINITION
$   ***********************************************
$  GRIDS FOR RIGHT SIDE HORIZONTAL TAIL BEAM
$
GRID         301       0  379.75  525.50   77.36       0
GRID         302       0  379.61  535.00   79.01       0
GRID         303       0  379.47  544.50   80.67       0
GRID         304       0  379.34  554.00   82.33       0
GRID         305       0  379.20  563.50   83.98       0
GRID         306       0  379.06  573.00   85.64       0
GRID         307       0  378.92  582.50   87.30       0
GRID         308       0  378.79  592.00   88.95       0
GRID         309       0  378.65  601.50   90.61       0
GRID         310       0  378.51  611.00   92.27       0
GRID         311       0  378.37  620.50   93.92       0
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL MAIN BEAM
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 5
GRID         331       0  379.75  525.50   77.36       5
GRID         332       0  379.61  535.00   79.01       5
GRID         333       0  379.47  544.50   80.67       5
GRID         334       0  379.34  554.00   82.33       5
GRID         335       0  379.20  563.50   83.98       5
GRID         336       0  379.06  573.00   85.64       5
GRID         337       0  378.92  582.50   87.30       5
GRID         338       0  378.79  592.00   88.95       5
GRID         339       0  378.65  601.50   90.61       5
GRID         340       0  378.51  611.00   92.27       5
GRID         341       0  378.37  620.50   93.92       5
$   DUPLICATE GRIDS ON H-TAIL ARE DEPENDENT ON ELASTIC AXIS BEAM
RBE2         521     301  123456     331
RBE2         522     302  123456     332
RBE2         523     303  123456     333
RBE2         524     304  123456     334
RBE2         525     305  123456     335
RBE2         526     306  123456     336
RBE2         527     307  123456     337
RBE2         528     308  123456     338
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RBE2         529     309  123456     339
RBE2         530     310  123456     340
RBE2         531     311  123456     341
$
$  RIGHT SIDE HORIZONTAL TAIL LEADING EDGE
$
GRID        1301       0  355.08  525.50   77.36       0
GRID        1302       0  356.17  535.00   79.01       0
GRID        1303       0  357.27  544.50   80.67       0
GRID        1304       0  358.36  554.00   82.33       0
GRID        1305       0  359.46  563.50   83.98       0
GRID        1306       0  360.56  573.00   85.64       0
GRID        1307       0  361.65  582.50   87.30       0
GRID        1308       0  362.75  592.00   88.95       0
GRID        1309       0  363.85  601.50   90.61       0
GRID        1310       0  364.94  611.00   92.27       0
GRID        1311       0  366.04  620.50   93.92       0
$
$  DISPLACEMENT OF H-TAIL L.E. IS DEPENDENT ON ELASTIC AXIS
RBE2        1251     301  123456    1301
RBE2        1252     302  123456    1302
RBE2        1253     303  123456    1303
RBE2        1254     304  123456    1304
RBE2        1255     305  123456    1305
RBE2        1256     306  123456    1306
RBE2        1257     307  123456    1307
RBE2        1258     308  123456    1308
RBE2        1259     309  123456    1309
RBE2        1260     310  123456    1310
RBE2        1261     311  123456    1311
$
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL LEADING EDGE
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 5
GRID        1331       0  355.08  525.50   77.36       5
GRID        1332       0  356.17  535.00   79.01       5
GRID        1333       0  357.27  544.50   80.67       5
GRID        1334       0  358.36  554.00   82.33       5
GRID        1335       0  359.46  563.50   83.98       5
GRID        1336       0  360.56  573.00   85.64       5
GRID        1337       0  361.65  582.50   87.30       5
GRID        1338       0  362.75  592.00   88.95       5
GRID        1339       0  363.85  601.50   90.61       5
GRID        1340       0  364.94  611.00   92.27       5
GRID        1341       0  366.04  620.50   93.92       5
$  DUPLICATE GRIDS ON H-TAIL LEADING EDGE ARE DEPENDENT ON ELASTIC AXIS
RBE2         541     301  123456    1331
RBE2         542     302  123456    1332
RBE2         543     303  123456    1333
RBE2         544     304  123456    1334
RBE2         545     305  123456    1335
RBE2         546     306  123456    1336
RBE2         547     307  123456    1337
RBE2         548     308  123456    1338
RBE2         549     309  123456    1339
RBE2         550     310  123456    1340
RBE2         551     311  123456    1341
$
$  RIGHT SIDE HORIZONTAL TAIL TRAILING EDGE
$
GRID        2301       0  416.83  525.50   77.36       0
GRID        2302       0  414.84  535.00   79.01       0
GRID        2303       0  412.85  544.50   80.67       0
GRID        2304       0  410.86  554.00   82.33       0
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GRID        2305       0  408.87  563.50   83.98       0
GRID        2306       0  406.88  573.00   85.64       0
GRID        2307       0  404.88  582.50   87.30       0
GRID        2308       0  402.89  592.00   88.95       0
GRID        2309       0  400.90  601.50   90.61       0
GRID        2310       0  398.91  611.00   92.27       0
GRID        2311       0  396.92  620.50   93.92       0
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL TRAILING EDGE
$  THE OUTPUT FOR THESE GRIDS WILL BE IN COORD. SYST. 5
GRID        2331       0  416.83  525.50   77.36       5
GRID        2332       0  414.84  535.00   79.01       5
GRID        2333       0  412.85  544.50   80.67       5
GRID        2334       0  410.86  554.00   82.33       5
GRID        2335       0  408.87  563.50   83.98       5
GRID        2336       0  406.88  573.00   85.64       5
GRID        2337       0  404.88  582.50   87.30       5
GRID        2338       0  402.89  592.00   88.95       5
GRID        2339       0  400.90  601.50   90.61       5
GRID        2340       0  398.91  611.00   92.27       5
GRID        2341       0  396.92  620.50   93.92       5
$  DUPLICATE H-TAIL T.E. GRIDS ARE DEPENDENT ON ORIGINAL T.E. GRIDS
RBE2         561    2301  123456    2331
RBE2         562    2302  123456    2332
RBE2         563    2303  123456    2333
RBE2         564    2304  123456    2334
RBE2         565    2305  123456    2335
RBE2         566    2306  123456    2336
RBE2         567    2307  123456    2337
RBE2         568    2308  123456    2338
RBE2         569    2309  123456    2339
RBE2         570    2310  123456    2340
RBE2         571    2311  123456    2341
$
$  GRIDS AT 80% CHORD HINGE-LINE OF RIGHT SIDE HORIZONTAL TAIL
GRID        2501       0 404.480 525.500  77.360       0
GRID        2502       0 403.106 535.000  79.010       0
GRID        2503       0 401.734 544.500  80.670       0
GRID        2504       0 400.360 554.000  82.330       0
GRID        2505       0 398.988 563.500  83.980       0
GRID        2506       0 397.616 573.000  85.640       0
GRID        2507       0 396.234 582.500  87.300       0
GRID        2508       0 394.862 592.000  88.950       0
GRID        2509       0 393.490 601.500  90.610       0
GRID        2510       0 392.116 611.000  92.270       0
GRID        2511       0 390.744 620.500  93.920       0
$
$    ****************************************************
$    END OF RIGHT SIDE HORIZONTAL TAIL DEFINITION
$    ****************************************************
$
$    ****************************************************
$    RIGHT SIDE VERTICAL TAIL DEFINITION
$    ****************************************************
$
$  GRIDS FOR RIGHT SIDE VERTICAL TAIL BEAM
GRID         401       0  410.39  525.50   77.50       0
GRID         402       0  411.39  522.60   85.47       0
GRID         403       0  412.38  519.70   93.44       0
GRID         404       0  413.38  516.80  101.41       0
GRID         405       0  414.37  513.90  109.38       0
GRID         406       0  415.37  511.00  117.34       0
GRID         407       0  416.36  508.10  125.31       0
GRID         408       0  417.36  505.20  133.28       0
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GRID         409       0  418.35  502.30  141.25       0
GRID         410       0  419.35  499.40  149.22       0
GRID         411       0  420.34  496.50  157.19       0
$   THIS GROUP OF GRIDS GENERATES OUTPUT IN COORD. SYSTEM 6
$   THE Z-AXIS FOR COORD. SYS. 5 IS NORMAL TO PLANE OF V-TAIL
GRID         431       0  410.39  525.50   77.50       6
GRID         432       0  411.39  522.60   85.47       6
GRID         433       0  412.38  519.70   93.44       6
GRID         434       0  413.38  516.80  101.41       6
GRID         435       0  414.37  513.90  109.38       6
GRID         436       0  415.37  511.00  117.34       6
GRID         437       0  416.36  508.10  125.31       6
GRID         438       0  417.36  505.20  133.28       6
GRID         439       0  418.35  502.30  141.25       6
GRID         440       0  419.35  499.40  149.22       6
GRID         441       0  420.34  496.50  157.19       6
$  DUPLICATE GRIDS OF MAIN V-TAIL ARE DEPENDENT ON ELASTIC AXIS GRIDS
RBE2         581     401  123456     431
RBE2         582     402  123456     432
RBE2         583     403  123456     433
RBE2         584     404  123456     434
RBE2         585     405  123456     435
RBE2         586     406  123456     436
RBE2         587     407  123456     437
RBE2         588     408  123456     438
RBE2         589     409  123456     439
RBE2         590     410  123456     440
RBE2         591     411  123456     441
$
$  RIGHT SIDE VERTICAL TAIL LEADING EDGE
$
GRID        1401       0  390.67  525.50   77.50       0
GRID        1402       0  392.36  522.60   85.47       0
GRID        1403       0  394.05  519.70   93.44       0
GRID        1404       0  395.73  516.80  101.41       0
GRID        1405       0  397.42  513.90  109.38       0
GRID        1406       0  399.11  511.00  117.34       0
GRID        1407       0  400.79  508.10  125.31       0
GRID        1408       0  402.48  505.20  133.28       0
GRID        1409       0  404.17  502.30  141.25       0
GRID        1410       0  405.85  499.40  149.22       0
GRID        1411       0  407.54  496.50  157.19       0
$
$  LEADING EDGE V-TAIL GRIDS ARE DEPENDENT ON ELASTIC AXIS
RBE2        1271     401  123456    1401
RBE2        1272     402  123456    1402
RBE2        1273     403  123456    1403
RBE2        1274     404  123456    1404
RBE2        1275     405  123456    1405
RBE2        1276     406  123456    1406
RBE2        1277     407  123456    1407
RBE2        1278     408  123456    1408
RBE2        1279     409  123456    1409
RBE2        1280     410  123456    1410
RBE2        1281     411  123456    1411
$
$  DUPLICATE GRIDS FOR VERTICAL TAIL LEADING EDGE
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 6
GRID        1431       0  390.67  525.50   77.50       6
GRID        1432       0  392.36  522.60   85.47       6
GRID        1433       0  394.05  519.70   93.44       6
GRID        1434       0  395.73  516.80  101.41       6
GRID        1435       0  397.42  513.90  109.38       6
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GRID        1436       0  399.11  511.00  117.34       6
GRID        1437       0  400.79  508.10  125.31       6
GRID        1438       0  402.48  505.20  133.28       6
GRID        1439       0  404.17  502.30  141.25       6
GRID        1440       0  405.85  499.40  149.22       6
GRID        1441       0  407.54  496.50  157.19       6
$  V-TAIL LEADING EDGE DUPLICATE GRIDS ARE DEPENDENT ON ELASTIC AXIS GRIDS
RBE2         601     401  123456    1431
RBE2         602     402  123456    1432
RBE2         603     403  123456    1433
RBE2         604     404  123456    1434
RBE2         605     405  123456    1435
RBE2         606     406  123456    1436
RBE2         607     407  123456    1437
RBE2         608     408  123456    1438
RBE2         609     409  123456    1439
RBE2         610     410  123456    1440
RBE2         611     411  123456    1441
$
$  RIGHT SIDE VERTICAL TAIL TRAILING EDGE
$
GRID        2401       0  439.97  525.50   77.50       0
GRID        2402       0  439.93  522.60   85.47       0
GRID        2403       0  439.89  519.70   93.44       0
GRID        2404       0  439.84  516.80  101.41       0
GRID        2405       0  439.80  513.90  109.38       0
GRID        2406       0  439.76  511.00  117.34       0
GRID        2407       0  439.71  508.10  125.31       0
GRID        2408       0  439.67  505.20  133.28       0
GRID        2409       0  439.63  502.30  141.25       0
GRID        2410       0  439.58  499.40  149.22       0
GRID        2411       0  439.54  496.50  157.19       0
$  DUPLICATE GRIDS FOR VERTICAL TAIL TRAILING EDGE
$  THE OUTPUT FOR THESE GRIDS WILL BE IN COORD. SYST. 6
GRID        2431       0  439.97  525.50   77.50       6
GRID        2432       0  439.93  522.60   85.47       6
GRID        2433       0  439.89  519.70   93.44       6
GRID        2434       0  439.84  516.80  101.41       6
GRID        2435       0  439.80  513.90  109.38       6
GRID        2436       0  439.76  511.00  117.34       6
GRID        2437       0  439.71  508.10  125.31       6
GRID        2438       0  439.67  505.20  133.28       6
GRID        2439       0  439.63  502.30  141.25       6
GRID        2440       0  439.58  499.40  149.22       6
GRID        2441       0  439.54  496.50  157.19       6
$  DUPLICATE V-TAIL T.E. GRIDS ARE DEPENDENT ON ORIGINAL GRIDS
RBE2         621    2401  123456    2431
RBE2         622    2402  123456    2432
RBE2         623    2403  123456    2433
RBE2         624    2404  123456    2434
RBE2         625    2405  123456    2435
RBE2         626    2406  123456    2436
RBE2         627    2407  123456    2437
RBE2         628    2408  123456    2438
RBE2         629    2409  123456    2439
RBE2         630    2410  123456    2440
RBE2         631    2411  123456    2441
$
$  GRIDS AT 80% CHORD HINGE-LINE OF RIGHT SIDE VERTICAL TAIL
GRID        2601       0 430.110 525.500  77.500       0
GRID        2602       0 430.416 522.600  85.470       0
GRID        2603       0 430.722 519.700  93.440       0
GRID        2604       0 431.018 516.800 101.410       0
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GRID        2605       0 431.324 513.900 109.380       0
GRID        2606       0 431.630 511.000 117.340       0
GRID        2607       0 431.926 508.100 125.310       0
GRID        2608       0 432.232 505.200 133.280       0
GRID        2609       0 432.538 502.300 141.250       0
GRID        2610       0 432.834 499.400 149.220       0
GRID        2611       0 433.140 496.500 157.190       0
$
$    ***************************************************
$      END OF RIGHT SIDE VERTICAL TAIL DEFINITION
$    ***************************************************
$
$   MAIN BEAMS FOR RIGHT WING
CBEAM        101     101     101     102     -1.      0.      0.
CBEAM        102     102     102     103     -1.      0.      0.
CBEAM        103     103     103     104     -1.      0.      0.
CBEAM        104     104     104     105     -1.      0.      0.
CBEAM        105     105     105     106     -1.      0.      0.
CBEAM        106     106     106     107     -1.      0.      0.
CBEAM        107     107     107     108     -1.      0.      0.
CBEAM        108     108     108     109     -1.      0.      0.
CBEAM        109     109     109     110     -1.      0.      0.
CBEAM        110     110     110     111     -1.      0.      0.
CBEAM        111     111     111     112     -1.      0.      0.
CBEAM        112     112     112     113     -1.      0.      0.
CBEAM        113     113     113     114     -1.      0.      0.
CBEAM        114     114     114     115     -1.      0.      0.
CBEAM        115     115     115     116     -1.      0.      0.
CBEAM        116     116     116     117     -1.      0.      0.
CBEAM        117     117     117     118     -1.      0.      0.
CBEAM        118     118     118     119     -1.      0.      0.
CBEAM        119     119     119     120     -1.      0.      0.
CBEAM        120     120     120     121     -1.      0.      0.
CBEAM        121     121     121     122     -1.      0.      0.
CBEAM        122     122     122     123     -1.      0.      0.
CBEAM        123     123     123     124     -1.      0.      0.
CBEAM        124     124     124     125     -1.      0.      0.
CBEAM        125     125     125     126     -1.      0.      0.
CBEAM        126     126     126     127     -1.      0.      0.
CBEAM        127     127     127     128     -1.      0.      0.
CBEAM        128     128     128     129     -1.      0.      0.
CBEAM        129     129     129     130     -1.      0.      0.
CBEAM        130     130     130     131     -1.      0.      0.
CBEAM        131     131     131     132     -1.      0.      0.
CBEAM        132     132     132     133     -1.      0.      0.
CBEAM        133     133     133     134     -1.      0.      0.
CBEAM        134     134     134     135     -1.      0.      0.
CBEAM        135     135     135     136     -1.      0.      0.
CBEAM        136     136     136     137     -1.      0.      0.
CBEAM        137     137     137     138     -1.      0.      0.
CBEAM        138     138     138     139     -1.      0.      0.
CBEAM        139     139     139     140     -1.      0.      0.
CBEAM        140     140     140     141     -1.      0.      0.
$   BEAMS FOR RIGHT WING TIP BOOM
CBEAM        201     201     201     202      0.      1.      0.
CBEAM        202     202     202     203      0.      1.      0.
CBEAM        203     203     203     204      0.      1.      0.
CBEAM        204     204     204     205      0.      1.      0.
CBEAM        205     205     205     206      0.      1.      0.
CBEAM        206     206     206     207      0.      1.      0.
CBEAM        207     207     207     208      0.      1.      0.
CBEAM        208     208     208     209      0.      1.      0.
CBEAM        209     209     209     210      0.      1.      0.
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CBEAM        210     210     210     211      0.      1.      0.
CBEAM        211     211     211     212      0.      1.      0.
CBEAM        212     212     212     213      0.      1.      0.
CBEAM        213     213     213     214      0.      1.      0.
CBEAM        214     214     214     215      0.      1.      0.
CBEAM        215     215     215     216      0.      1.      0.
CBEAM        216     216     216     217      0.      1.      0.
CBEAM        217     217     217     218      0.      1.      0.
CBEAM        218     218     218     219      0.      1.      0.
CBEAM        219     219     219     220      0.      1.      0.
CBEAM        220     220     220     221      0.      1.      0.
CBEAM        221     221     221     222      0.      1.      0.
CBEAM        222     222     222     223      0.      1.      0.
CBEAM        223     223     223     224      0.      1.      0.
CBEAM        224     224     224     225      0.      1.      0.
CBEAM        225     225     225     226      0.      1.      0.
CBEAM        226     226     226     227      0.      1.      0.
CBEAM        227     227     227     228      0.      1.      0.
CBEAM        228     228     228     229      0.      1.      0.
CBEAM        229     229     229     230      0.      1.      0.
CBEAM        230     230     230     231      0.      1.      0.
CBEAM        231     231     231     232      0.      1.      0.
CBEAM        232     232     232     233      0.      1.      0.
CBEAM        233     233     233     234      0.      1.      0.
CBEAM        234     234     234     235      0.      1.      0.
CBEAM        235     235     235     236      0.      1.      0.
CBEAM        236     236     236     237      0.      1.      0.
CBEAM        237     237     237     238      0.      1.      0.
CBEAM        238     238     238     239      0.      1.      0.
CBEAM        239     239     239     240      0.      1.      0.
CBEAM        240     240     240     241      0.      1.      0.
CBEAM        241     241     241     242      0.      1.      0.
CBEAM        242     242     242     243      0.      1.      0.
$   RIGHT SIDE HORIZONTAL TAIL BEAMS
CBEAM        301     301     301     302     -1.      0.      0.
CBEAM        302     302     302     303     -1.      0.      0.
CBEAM        303     303     303     304     -1.      0.      0.
CBEAM        304     304     304     305     -1.      0.      0.
CBEAM        305     305     305     306     -1.      0.      0.
CBEAM        306     306     306     307     -1.      0.      0.
CBEAM        307     307     307     308     -1.      0.      0.
CBEAM        308     308     308     309     -1.      0.      0.
CBEAM        309     309     309     310     -1.      0.      0.
CBEAM        310     310     310     311     -1.      0.      0.
$   RIGHT SIDE VERTICAL TAIL BEAMS
CBEAM        401     401     401     402      1.      0.      0.
CBEAM        402     402     402     403      1.      0.      0.
CBEAM        403     403     403     404      1.      0.      0.
CBEAM        404     404     404     405      1.      0.      0.
CBEAM        405     405     405     406      1.      0.      0.
CBEAM        406     406     406     407      1.      0.      0.
CBEAM        407     407     407     408      1.      0.      0.
CBEAM        408     408     408     409      1.      0.      0.
CBEAM        409     409     409     410      1.      0.      0.
CBEAM        410     410     410     411      1.      0.      0.
$
$
$   RIGHT SIDE BEAMS FROM H-TAIL MAIN BEAM TO HINGE LINE
CBEAM       2301    2301    301     2501     302
CBEAM       2302    2301    302     2502     301
CBEAM       2303    2301    303     2503     301
CBEAM       2304    2301    304     2504     301
CBEAM       2305    2301    305     2505     301
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CBEAM       2306    2301    306     2506     301
CBEAM       2307    2301    307     2507     301
CBEAM       2308    2301    308     2508     301
CBEAM       2309    2301    309     2509     301
CBEAM       2310    2301    310     2510     301
CBEAM       2311    2301    311     2511     301
$
$   RIGHT SIDE BEAMS FROM H-TAIL HINGE LINE TO H-TAIL TRAILING EDGE
CBEAM       2321    2301    2501    2301    2502
CBEAM       2322    2301    2502    2302    2501
CBEAM       2323    2301    2503    2303    2501
CBEAM       2324    2301    2504    2304    2501
CBEAM       2325    2301    2505    2305    2501
CBEAM       2326    2301    2506    2306    2501
CBEAM       2327    2301    2507    2307    2501
CBEAM       2328    2301    2508    2308    2501
CBEAM       2329    2301    2509    2309    2501
CBEAM       2330    2301    2510    2310    2501
CBEAM       2331    2301    2511    2311    2501
$   RIGHT SIDE BEAMS FROM V-TAIL MAIN BEAM TO HINGE LINE
CBEAM       2401    2401    401     2601     402
CBEAM       2402    2401    402     2602     401
CBEAM       2403    2401    403     2603     401
CBEAM       2404    2401    404     2604     401
CBEAM       2405    2401    405     2605     401
CBEAM       2406    2401    406     2606     401
CBEAM       2407    2401    407     2607     401
CBEAM       2408    2401    408     2608     401
CBEAM       2409    2401    409     2609     401
CBEAM       2410    2401    410     2610     401
CBEAM       2411    2401    411     2611     401
$
$   RIGHT SIDE BEAMS FROM V-TAIL HINGE LINE TO V-TAIL TRAILING EDGE
CBEAM       2421    2401    2601    2401    2602
CBEAM       2422    2401    2602    2402    2601
CBEAM       2423    2401    2603    2403    2601
CBEAM       2424    2401    2604    2404    2601
CBEAM       2425    2401    2605    2405    2601
CBEAM       2426    2401    2606    2406    2601
CBEAM       2427    2401    2607    2407    2601
CBEAM       2428    2401    2608    2408    2601
CBEAM       2429    2401    2609    2409    2601
CBEAM       2430    2401    2610    2410    2601
CBEAM       2431    2401    2611    2411    2601
$
$  CONNECTIONS OF WING TO BOOM, H-TAIL, V-TAIL ON LEFT SIDE
RBE2        3102    3039  123456    3055
RBE2        3103    3077  123456    3083
RBE2        3104    3079  123456    3094
$
$  NODES ON LEFT WING ELASTIC AXIS
GRID        3000       0 156.480 -13.150  49.670       0
GRID        3001       0 156.450 -26.290  50.370       0
GRID        3002       0 156.410 -39.440  51.060       0
GRID        3003       0 156.380 -52.590  51.750       0
GRID        3004       0 156.340 -65.740  52.450       0
GRID        3005       0 156.310 -78.880  53.140       0
GRID        3006       0 156.280 -92.030  53.830       0
GRID        3007       0 156.240-105.180  54.530       0
GRID        3008       0 156.210-118.320  55.220       0
GRID        3009       0 156.180-131.470  55.910       0
GRID        3010       0 156.140-144.620  56.610       0
GRID        3011       0 156.110-157.760  57.300       0
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GRID        3012       0 156.080-170.910  57.990       0
GRID        3013       0 156.040-184.060  58.690       0
GRID        3014       0 156.010-197.210  59.380       0
GRID        3015       0 155.980-210.350  60.070       0
GRID        3016       0 155.940-223.500  60.770       0
GRID        3017       0 155.880-236.630  61.460       0
GRID        3018       0 155.820-249.760  62.160       0
GRID        3019       0 155.760-262.890  62.860       0
GRID        3020       0 155.700-276.020  63.550       0
GRID        3021       0 155.640-289.150  64.250       0
GRID        3022       0 155.580-302.280  64.950       0
GRID        3023       0 155.520-315.410  65.640       0
GRID        3024       0 155.460-328.540  66.340       0
GRID        3025       0 155.390-341.670  67.040       0
GRID        3026       0 155.330-354.800  67.730       0
GRID        3027       0 155.270-367.930  68.430       0
GRID        3028       0 155.210-381.070  69.130       0
GRID        3029       0 155.150-394.200  69.820       0
GRID        3030       0 155.090-407.330  70.520       0
GRID        3031       0 155.030-420.460  71.220       0
GRID        3032       0 154.970-433.590  71.910       0
GRID        3033       0 154.910-446.720  72.610       0
GRID        3034       0 154.850-459.850  73.310       0
GRID        3035       0 154.790-472.980  74.000       0
GRID        3036       0 154.720-486.110  74.700       0
GRID        3037       0 154.660-499.240  75.400       0
GRID        3038       0 154.600-512.370  76.090       0
GRID        3039       0 154.540-525.500  76.790       0
$   NODES ON LEFT WING LEADING EDGE CHORD
GRID        3105       0 132.920 -13.150  49.670       0
GRID        3106       0 133.010 -26.290  50.370       0
GRID        3107       0 133.100 -39.440  51.060       0
GRID        3108       0 133.180 -52.590  51.750       0
GRID        3109       0 133.270 -65.740  52.450       0
GRID        3110       0 133.360 -78.880  53.140       0
GRID        3111       0 133.450 -92.030  53.830       0
GRID        3112       0 133.540-105.180  54.530       0
GRID        3113       0 133.630-118.320  55.220       0
GRID        3114       0 133.710-131.470  55.910       0
GRID        3115       0 133.800-144.620  56.610       0
GRID        3116       0 133.890-157.760  57.300       0
GRID        3117       0 133.980-170.910  57.990       0
GRID        3118       0 134.070-184.060  58.690       0
GRID        3119       0 134.160-197.210  59.380       0
GRID        3120       0 134.240-210.350  60.070       0
GRID        3121       0 134.330-223.500  60.770       0
GRID        3122       0 134.490-236.630  61.460       0
GRID        3123       0 134.650-249.760  62.160       0
GRID        3124       0 134.810-262.890  62.860       0
GRID        3125       0 134.970-276.020  63.550       0
GRID        3126       0 135.140-289.150  64.250       0
GRID        3127       0 135.300-302.280  64.950       0
GRID        3128       0 135.460-315.410  65.640       0
GRID        3129       0 135.620-328.540  66.340       0
GRID        3130       0 135.780-341.670  67.040       0
GRID        3131       0 135.940-354.800  67.730       0
GRID        3132       0 136.100-367.930  68.430       0
GRID        3133       0 136.260-381.070  69.130       0
GRID        3134       0 136.420-394.200  69.820       0
GRID        3135       0 136.580-407.330  70.520       0
GRID        3136       0 136.740-420.460  71.220       0
GRID        3137       0 136.900-433.590  71.910       0
GRID        3138       0 137.060-446.720  72.610       0
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GRID        3139       0 137.220-459.850  73.310       0
GRID        3140       0 137.380-472.980  74.000       0
GRID        3141       0 137.550-486.110  74.700       0
GRID        3142       0 137.710-499.240  75.400       0
GRID        3143       0 137.870-512.370  76.090       0
GRID        3144       0 138.030-525.500  76.790       0
$   NODES ON LEFT WING TRAILING EDGE CHORD
GRID        3167       0 191.820 -13.150  49.670       0
GRID        3168       0 191.600 -26.290  50.370       0
GRID        3169       0 191.390 -39.440  51.060       0
GRID        3170       0 191.170 -52.590  51.750       0
GRID        3171       0 190.950 -65.740  52.450       0
GRID        3172       0 190.740 -78.880  53.140       0
GRID        3173       0 190.520 -92.030  53.830       0
GRID        3174       0 190.300-105.180  54.530       0
GRID        3175       0 190.090-118.320  55.220       0
GRID        3176       0 189.870-131.470  55.910       0
GRID        3177       0 189.660-144.620  56.610       0
GRID        3178       0 189.440-157.760  57.300       0
GRID        3179       0 189.220-170.910  57.990       0
GRID        3180       0 189.010-184.060  58.690       0
GRID        3181       0 188.790-197.210  59.380       0
GRID        3182       0 188.580-210.350  60.070       0
GRID        3183       0 188.360-223.500  60.770       0
GRID        3184       0 187.970-236.630  61.460       0
GRID        3185       0 187.570-249.760  62.160       0
GRID        3186       0 187.180-262.890  62.860       0
GRID        3187       0 186.790-276.020  63.550       0
GRID        3188       0 186.390-289.150  64.250       0
GRID        3189       0 186.000-302.280  64.950       0
GRID        3190       0 185.610-315.410  65.640       0
GRID        3191       0 185.210-328.540  66.340       0
GRID        3192       0 184.820-341.670  67.040       0
GRID        3193       0 184.430-354.800  67.730       0
GRID        3194       0 184.030-367.930  68.430       0
GRID        3195       0 183.640-381.070  69.130       0
GRID        3196       0 183.250-394.200  69.820       0
GRID        3197       0 182.850-407.330  70.520       0
GRID        3198       0 182.460-420.460  71.220       0
GRID        3199       0 182.070-433.590  71.910       0
GRID        3200       0 181.670-446.720  72.610       0
GRID        3201       0 181.280-459.850  73.310       0
GRID        3202       0 180.890-472.980  74.000       0
GRID        3203       0 180.490-486.110  74.700       0
GRID        3204       0 180.100-499.240  75.400       0
GRID        3205       0 179.710-512.370  76.090       0
GRID        3206       0 179.310-525.500  76.790       0
$   NODES ON LEFT WING BOOM
GRID        3040       0  25.000-525.500  77.500       0
GRID        3041       0  33.611-525.500  77.500       0
GRID        3042       0  42.222-525.500  77.500       0
GRID        3043       0  50.833-525.500  77.500       0
GRID        3044       0  59.444-525.500  77.500       0
GRID        3045       0  68.056-525.500  77.500       0
GRID        3046       0  76.667-525.500  77.500       0
GRID        3047       0  85.278-525.500  77.500       0
GRID        3048       0  93.889-525.500  77.500       0
GRID        3049       0 102.500-525.500  77.500       0
GRID        3050       0 111.111-525.500  77.500       0
GRID        3051       0 119.722-525.500  77.500       0
GRID        3052       0 128.333-525.500  77.500       0
GRID        3053       0 136.944-525.500  77.500       0
GRID        3054       0 145.556-525.500  77.500       0
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GRID        3055       0 154.167-525.500  77.500       0
GRID        3056       0 162.778-525.500  77.500       0
GRID        3057       0 171.389-525.500  77.500       0
GRID        3058       0 180.000-525.500  77.500       0
GRID        3059       0 190.000-525.500  77.500       0
GRID        3060       0 200.000-525.500  77.500       0
GRID        3061       0 210.000-525.500  77.500       0
GRID        3062       0 220.000-525.500  77.500       0
GRID        3063       0 230.000-525.500  77.500       0
GRID        3064       0 240.000-525.500  77.500       0
GRID        3065       0 250.000-525.500  77.500       0
GRID        3066       0 260.000-525.500  77.500       0
GRID        3067       0 270.000-525.500  77.500       0
GRID        3068       0 280.000-525.500  77.500       0
GRID        3069       0 290.000-525.500  77.500       0
GRID        3070       0 300.000-525.500  77.500       0
GRID        3071       0 310.000-525.500  77.500       0
GRID        3072       0 320.000-525.500  77.500       0
GRID        3073       0 330.000-525.500  77.500       0
GRID        3074       0 340.000-525.500  77.500       0
GRID        3075       0 350.000-525.500  77.500       0
GRID        3076       0 360.000-525.500  77.500       0
GRID        3077       0 370.000-525.500  77.500       0
GRID        3078       0 380.000-525.500  77.500       0
GRID        3079       0 390.000-525.500  77.500       0
GRID        3080       0 400.000-525.500  77.500       0
GRID        3081       0 410.000-525.500  77.500       0
GRID        3082       0 420.000-525.500  77.500       0
$   NODES ON LEFT-SIDE H-TAIL ELASTIC AXIS
GRID        3083       0 379.750-525.500  77.360       0
GRID        3084       0 379.610-535.000  79.010       0
GRID        3085       0 379.470-544.500  80.670       0
GRID        3086       0 379.340-554.000  82.330       0
GRID        3087       0 379.200-563.500  83.980       0
GRID        3088       0 379.060-573.000  85.640       0
GRID        3089       0 378.920-582.500  87.300       0
GRID        3090       0 378.790-592.000  88.950       0
GRID        3091       0 378.650-601.500  90.610       0
GRID        3092       0 378.510-611.000  92.270       0
GRID        3093       0 378.370-620.500  93.920       0
$   NODES ON LEFT-SIDE H-TAIL LEADING EDGE
GRID        3145       0 355.080-525.500  77.360       0
GRID        3146       0 356.170-535.000  79.010       0
GRID        3147       0 357.270-544.500  80.670       0
GRID        3148       0 358.360-554.000  82.330       0
GRID        3149       0 359.460-563.500  83.980       0
GRID        3150       0 360.560-573.000  85.640       0
GRID        3151       0 361.650-582.500  87.300       0
GRID        3152       0 362.750-592.000  88.950       0
GRID        3153       0 363.850-601.500  90.610       0
GRID        3154       0 364.940-611.000  92.270       0
GRID        3155       0 366.040-620.500  93.920       0
$   NODES ON LEFT-SIDE H-TAIL TRAILING EDGE
GRID        3207       0 416.830-525.500  77.360       0
GRID        3208       0 414.840-535.000  79.010       0
GRID        3209       0 412.850-544.500  80.670       0
GRID        3210       0 410.860-554.000  82.330       0
GRID        3211       0 408.870-563.500  83.980       0
GRID        3212       0 406.880-573.000  85.640       0
GRID        3213       0 404.880-582.500  87.300       0
GRID        3214       0 402.890-592.000  88.950       0
GRID        3215       0 400.900-601.500  90.610       0
GRID        3216       0 398.910-611.000  92.270       0
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GRID        3217       0 396.920-620.500  93.920       0
$
$  GRIDS AT 80% CHORD HINGE-LINE OF LEFT SIDE HORIZONTAL TAIL
GRID        3401       0 404.480-525.500  77.360       0
GRID        3402       0 403.106-535.000  79.010       0
GRID        3403       0 401.734-544.500  80.670       0
GRID        3404       0 400.360-554.000  82.330       0
GRID        3405       0 398.988-563.500  83.980       0
GRID        3406       0 397.616-573.000  85.640       0
GRID        3407       0 396.234-582.500  87.300       0
GRID        3408       0 394.862-592.000  88.950       0
GRID        3409       0 393.490-601.500  90.610       0
GRID        3410       0 392.116-611.000  92.270       0
GRID        3411       0 390.744-620.500  93.920       0
$
$   NODES ON LEFT-SIDE VERTICAL TAIL ELASTIC AXIS
GRID        3094       0 410.390-525.500  77.500       0
GRID        3095       0 411.390-522.600  85.470       0
GRID        3096       0 412.380-519.700  93.440       0
GRID        3097       0 413.380-516.800 101.410       0
GRID        3098       0 414.370-513.900 109.380       0
GRID        3099       0 415.370-511.000 117.340       0
GRID        3100       0 416.360-508.100 125.310       0
GRID        3101       0 417.360-505.200 133.280       0
GRID        3102       0 418.350-502.300 141.250       0
GRID        3103       0 419.350-499.400 149.220       0
GRID        3104       0 420.340-496.500 157.190       0
$   NODES ON LEFT-SIDE VERTICAL TAIL LEADING EDGE
GRID        3156       0 390.670-525.500  77.500       0
GRID        3157       0 392.360-522.600  85.470       0
GRID        3158       0 394.050-519.700  93.440       0
GRID        3159       0 395.730-516.800 101.410       0
GRID        3160       0 397.420-513.900 109.380       0
GRID        3161       0 399.110-511.000 117.340       0
GRID        3162       0 400.790-508.100 125.310       0
GRID        3163       0 402.480-505.200 133.280       0
GRID        3164       0 404.170-502.300 141.250       0
GRID        3165       0 405.850-499.400 149.220       0
GRID        3166       0 407.540-496.500 157.190       0
$   NODES ON LEFT-SIDE VERTICAL TAIL TRAILING EDGE
GRID        3218       0 439.970-525.500  77.500       0
GRID        3219       0 439.930-522.600  85.470       0
GRID        3220       0 439.890-519.700  93.440       0
GRID        3221       0 439.840-516.800 101.410       0
GRID        3222       0 439.800-513.900 109.380       0
GRID        3223       0 439.760-511.000 117.340       0
GRID        3224       0 439.710-508.100 125.310       0
GRID        3225       0 439.670-505.200 133.280       0
GRID        3226       0 439.630-502.300 141.250       0
GRID        3227       0 439.580-499.400 149.220       0
GRID        3228       0 439.540-496.500 157.190       0
$
$
$  GRIDS AT 80% CHORD HINGE-LINE OF LEFT SIDE VERTICAL TAIL
GRID        3501       0 430.110-525.500  77.500       0
GRID        3502       0 430.416-522.600  85.470       0
GRID        3503       0 430.722-519.700  93.440       0
GRID        3504       0 431.018-516.800 101.410       0
GRID        3505       0 431.324-513.900 109.380       0
GRID        3506       0 431.630-511.000 117.340       0
GRID        3507       0 431.926-508.100 125.310       0
GRID        3508       0 432.232-505.200 133.280       0
GRID        3509       0 432.538-502.300 141.250       0
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GRID        3510       0 432.834-499.400 149.220       0
GRID        3511       0 433.140-496.500 157.190       0
$
$   LEFT-SIDE WING ELASTIC AXIS BEAMS
CBEAM       3000     101    3000     101    -1.0     0.0     0.0
CBEAM       3001     102    3001    3000    -1.0     0.0     0.0
CBEAM       3002     103    3002    3001    -1.0     0.0     0.0
CBEAM       3003     104    3003    3002    -1.0     0.0     0.0
CBEAM       3004     105    3004    3003    -1.0     0.0     0.0
CBEAM       3005     106    3005    3004    -1.0     0.0     0.0
CBEAM       3006     107    3006    3005    -1.0     0.0     0.0
CBEAM       3007     108    3007    3006    -1.0     0.0     0.0
CBEAM       3008     109    3008    3007    -1.0     0.0     0.0
CBEAM       3009     110    3009    3008    -1.0     0.0     0.0
CBEAM       3010     111    3010    3009    -1.0     0.0     0.0
CBEAM       3011     112    3011    3010    -1.0     0.0     0.0
CBEAM       3012     113    3012    3011    -1.0     0.0     0.0
CBEAM       3013     114    3013    3012    -1.0     0.0     0.0
CBEAM       3014     115    3014    3013    -1.0     0.0     0.0
CBEAM       3015     116    3015    3014    -1.0     0.0     0.0
CBEAM       3016     117    3016    3015    -1.0     0.0     0.0
CBEAM       3017     118    3017    3016    -1.0     0.0     0.0
CBEAM       3018     119    3018    3017    -1.0     0.0     0.0
CBEAM       3019     120    3019    3018    -1.0     0.0     0.0
CBEAM       3020     121    3020    3019    -1.0     0.0     0.0
CBEAM       3021     122    3021    3020    -1.0     0.0     0.0
CBEAM       3022     123    3022    3021    -1.0     0.0     0.0
CBEAM       3023     124    3023    3022    -1.0     0.0     0.0
CBEAM       3024     125    3024    3023    -1.0     0.0     0.0
CBEAM       3025     126    3025    3024    -1.0     0.0     0.0
CBEAM       3026     127    3026    3025    -1.0     0.0     0.0
CBEAM       3027     128    3027    3026    -1.0     0.0     0.0
CBEAM       3028     129    3028    3027    -1.0     0.0     0.0
CBEAM       3029     130    3029    3028    -1.0     0.0     0.0
CBEAM       3030     131    3030    3029    -1.0     0.0     0.0
CBEAM       3031     132    3031    3030    -1.0     0.0     0.0
CBEAM       3032     133    3032    3031    -1.0     0.0     0.0
CBEAM       3033     134    3033    3032    -1.0     0.0     0.0
CBEAM       3034     135    3034    3033    -1.0     0.0     0.0
CBEAM       3035     136    3035    3034    -1.0     0.0     0.0
CBEAM       3036     137    3036    3035    -1.0     0.0     0.0
CBEAM       3037     138    3037    3036    -1.0     0.0     0.0
CBEAM       3038     139    3038    3037    -1.0     0.0     0.0
CBEAM       3039     140    3039    3038    -1.0     0.0     0.0
$
$   LEFT-SIDE BEAMS FOR BOOM AT WING-TIP
CBEAM       3040     201    3041    3040     0.0    -1.0     0.0
CBEAM       3041     202    3042    3041     0.0    -1.0     0.0
CBEAM       3042     203    3043    3042     0.0    -1.0     0.0
CBEAM       3043     204    3044    3043     0.0    -1.0     0.0
CBEAM       3044     205    3045    3044     0.0    -1.0     0.0
CBEAM       3045     206    3046    3045     0.0    -1.0     0.0
CBEAM       3046     207    3047    3046     0.0    -1.0     0.0
CBEAM       3047     208    3048    3047     0.0    -1.0     0.0
CBEAM       3048     209    3049    3048     0.0    -1.0     0.0
CBEAM       3049     210    3050    3049     0.0    -1.0     0.0
CBEAM       3050     211    3051    3050     0.0    -1.0     0.0
CBEAM       3051     212    3052    3051     0.0    -1.0     0.0
CBEAM       3052     213    3053    3052     0.0    -1.0     0.0
CBEAM       3053     214    3054    3053     0.0    -1.0     0.0
CBEAM       3054     215    3055    3054     0.0    -1.0     0.0
CBEAM       3055     216    3056    3055     0.0    -1.0     0.0
CBEAM       3056     217    3057    3056     0.0    -1.0     0.0
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CBEAM       3057     218    3058    3057     0.0    -1.0     0.0
CBEAM       3058     219    3059    3058     0.0    -1.0     0.0
CBEAM       3059     220    3060    3059     0.0    -1.0     0.0
CBEAM       3060     221    3061    3060     0.0    -1.0     0.0
CBEAM       3061     222    3062    3061     0.0    -1.0     0.0
CBEAM       3062     223    3063    3062     0.0    -1.0     0.0
CBEAM       3063     224    3064    3063     0.0    -1.0     0.0
CBEAM       3064     225    3065    3064     0.0    -1.0     0.0
CBEAM       3065     226    3066    3065     0.0    -1.0     0.0
CBEAM       3066     227    3067    3066     0.0    -1.0     0.0
CBEAM       3067     228    3068    3067     0.0    -1.0     0.0
CBEAM       3068     229    3069    3068     0.0    -1.0     0.0
CBEAM       3069     230    3070    3069     0.0    -1.0     0.0
CBEAM       3070     231    3071    3070     0.0    -1.0     0.0
CBEAM       3071     232    3072    3071     0.0    -1.0     0.0
CBEAM       3072     233    3073    3072     0.0    -1.0     0.0
CBEAM       3073     234    3074    3073     0.0    -1.0     0.0
CBEAM       3074     235    3075    3074     0.0    -1.0     0.0
CBEAM       3075     236    3076    3075     0.0    -1.0     0.0
CBEAM       3076     237    3077    3076     0.0    -1.0     0.0
CBEAM       3077     238    3078    3077     0.0    -1.0     0.0
CBEAM       3078     239    3079    3078     0.0    -1.0     0.0
CBEAM       3079     240    3080    3079     0.0    -1.0     0.0
CBEAM       3080     241    3081    3080     0.0    -1.0     0.0
CBEAM       3081     242    3082    3081     0.0    -1.0     0.0
$
$   LEFT-SIDE BEAMS FOR ELASTIC AXIS OF HORIZONTAL TAIL
CBEAM       3082     301    3084    3083    -1.0     0.0     0.0
CBEAM       3083     302    3085    3084    -1.0     0.0     0.0
CBEAM       3084     303    3086    3085    -1.0     0.0     0.0
CBEAM       3085     304    3087    3086    -1.0     0.0     0.0
CBEAM       3086     305    3088    3087    -1.0     0.0     0.0
CBEAM       3087     306    3089    3088    -1.0     0.0     0.0
CBEAM       3088     307    3090    3089    -1.0     0.0     0.0
CBEAM       3089     308    3091    3090    -1.0     0.0     0.0
CBEAM       3090     309    3092    3091    -1.0     0.0     0.0
CBEAM       3091     310    3093    3092    -1.0     0.0     0.0
$
$  LEFT-SIDE BEAMS ON H-TAIL FROM ELASTIC AXIS TO HINGE LINE.
CBEAM       3309    2301    3083    3401    3084
CBEAM       3310    2301    3084    3402    3083
CBEAM       3311    2301    3085    3403    3083
CBEAM       3312    2301    3086    3404    3083
CBEAM       3313    2301    3087    3405    3083
CBEAM       3314    2301    3088    3406    3083
CBEAM       3315    2301    3089    3407    3083
CBEAM       3316    2301    3090    3408    3083
CBEAM       3317    2301    3091    3409    3083
CBEAM       3318    2301    3092    3410    3083
CBEAM       3319    2301    3093    3411    3083
$   LEFT-SIDE BEAMS ON H-TAIL FROM HINGE LINE TO T.E.
CBEAM       3401    2301    3401    3207    3402
CBEAM       3402    2301    3402    3208    3401
CBEAM       3403    2301    3403    3209    3401
CBEAM       3404    2301    3404    3210    3401
CBEAM       3405    2301    3405    3211    3401
CBEAM       3406    2301    3406    3212    3401
CBEAM       3407    2301    3407    3213    3401
CBEAM       3408    2301    3408    3214    3401
CBEAM       3409    2301    3409    3215    3401
CBEAM       3410    2301    3410    3216    3401
CBEAM       3411    2301    3411    3217    3401
$   LEFT-SIDE BEAMS FOR ELASTIC AXIS OF VERTICAL TAIL
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CBEAM       3092     401    3095    3094     1.0     0.0     0.0
CBEAM       3093     402    3096    3095     1.0     0.0     0.0
CBEAM       3094     403    3097    3096     1.0     0.0     0.0
CBEAM       3095     404    3098    3097     1.0     0.0     0.0
CBEAM       3096     405    3099    3098     1.0     0.0     0.0
CBEAM       3097     406    3100    3099     1.0     0.0     0.0
CBEAM       3098     407    3101    3100     1.0     0.0     0.0
CBEAM       3099     408    3102    3101     1.0     0.0     0.0
CBEAM       3100     409    3103    3102     1.0     0.0     0.0
CBEAM       3101     410    3104    3103     1.0     0.0     0.0
$
$  LEFT-SIDE BEAMS ON V-TAIL FROM E.A. TO HINGE LINE
CBEAM       3320    2401    3094    3501    3095
CBEAM       3321    2401    3095    3502    3094
CBEAM       3322    2401    3096    3503    3094
CBEAM       3323    2401    3097    3504    3094
CBEAM       3324    2401    3098    3505    3094
CBEAM       3325    2401    3099    3506    3094
CBEAM       3326    2401    3100    3507    3094
CBEAM       3327    2401    3101    3508    3094
CBEAM       3328    2401    3102    3509    3094
CBEAM       3329    2401    3103    3510    3094
CBEAM       3330    2401    3104    3511    3094
$   LEFT-SIDE BEAMS ON V-TAIL FROM HINGE LINE TO T.E.
CBEAM       3420    2401    3501    3218    3502
CBEAM       3421    2401    3502    3219    3501
CBEAM       3422    2401    3503    3220    3501
CBEAM       3423    2401    3504    3221    3501
CBEAM       3424    2401    3505    3222    3501
CBEAM       3425    2401    3506    3223    3501
CBEAM       3426    2401    3507    3224    3501
CBEAM       3427    2401    3508    3225    3501
CBEAM       3428    2401    3509    3226    3501
CBEAM       3429    2401    3510    3227    3501
CBEAM       3430    2401    3511    3228    3501
$
$   LEFT-SIDE WING LEADING AND TRAILING EDGE GRIDS ARE DEPENDENT ON E.A.GRIDS
RBE2        3207    3000  123456    3105    3167
RBE2        3208    3001  123456    3106    3168
RBE2        3209    3002  123456    3107    3169
RBE2        3210    3003  123456    3108    3170
RBE2        3211    3004  123456    3109    3171
RBE2        3212    3005  123456    3110    3172
RBE2        3213    3006  123456    3111    3173
RBE2        3214    3007  123456    3112    3174
RBE2        3215    3008  123456    3113    3175
RBE2        3216    3009  123456    3114    3176
RBE2        3217    3010  123456    3115    3177
RBE2        3218    3011  123456    3116    3178
RBE2        3219    3012  123456    3117    3179
RBE2        3220    3013  123456    3118    3180
RBE2        3221    3014  123456    3119    3181
RBE2        3222    3015  123456    3120    3182
RBE2        3223    3016  123456    3121    3183
RBE2        3224    3017  123456    3122    3184
RBE2        3225    3018  123456    3123    3185
RBE2        3226    3019  123456    3124    3186
RBE2        3227    3020  123456    3125    3187
RBE2        3228    3021  123456    3126    3188
RBE2        3229    3022  123456    3127    3189
RBE2        3230    3023  123456    3128    3190
RBE2        3231    3024  123456    3129    3191
RBE2        3232    3025  123456    3130    3192
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RBE2        3233    3026  123456    3131    3193
RBE2        3234    3027  123456    3132    3194
RBE2        3235    3028  123456    3133    3195
RBE2        3236    3029  123456    3134    3196
RBE2        3237    3030  123456    3135    3197
RBE2        3238    3031  123456    3136    3198
RBE2        3239    3032  123456    3137    3199
RBE2        3240    3033  123456    3138    3200
RBE2        3241    3034  123456    3139    3201
RBE2        3242    3035  123456    3140    3202
RBE2        3243    3036  123456    3141    3203
RBE2        3244    3037  123456    3142    3204
RBE2        3245    3038  123456    3143    3205
RBE2        3246    3039  123456    3144    3206
$   LEFT-SIDE HORIZONTAL TAIL L.E.IS DEPENDENT ON ELASTIC AXIS
RBE2        3247    3083  123456    3145
RBE2        3248    3084  123456    3146
RBE2        3249    3085  123456    3147
RBE2        3250    3086  123456    3148
RBE2        3251    3087  123456    3149
RBE2        3252    3088  123456    3150
RBE2        3253    3089  123456    3151
RBE2        3254    3090  123456    3152
RBE2        3255    3091  123456    3153
RBE2        3256    3092  123456    3154
RBE2        3257    3093  123456    3155
$   LEFT-SIDE VERTICAL TAIL L.E.IS DEPENDENT ON ELASTIC AXIS
RBE2        3258    3094  123456    3156
RBE2        3259    3095  123456    3157
RBE2        3260    3096  123456    3158
RBE2        3261    3097  123456    3159
RBE2        3262    3098  123456    3160
RBE2        3263    3099  123456    3161
RBE2        3264    3100  123456    3162
RBE2        3265    3101  123456    3163
RBE2        3266    3102  123456    3164
RBE2        3267    3103  123456    3165
RBE2        3268    3104  123456    3166
$
```

- **Program full_mass.dat**

```
$      Centerline mass
CONM2        601     100      -1 892.200 125.800 0.00000 86.1000        +
+       528.0E+3 0.000001780.E+3 0.00000 0.000001390.E+3
$      Right wing masses
CONM2        602     102      -1 7.91000 157.540 6.57000 49.1600        +
+        114.000 0.00000 2357.10 0.00000 0.00000 2471.10
CONM2        603     103      -1 7.75000 157.670 19.7200 49.8300        +
+        111.700 0.00000 2285.60 0.00000 0.00000 2397.20
CONM2        604     104      -1 7.60000 157.800 32.8700 50.5000        +
+        109.400 0.00000 2216.70 0.00000 0.00000 2326.10
CONM2        605     105      -1 7.45000 157.920 46.0100 51.1700        +
+        107.300 0.00000 2150.30 0.00000 0.00000 2257.60
CONM2        606     106      -1 7.30000 158.050 59.1600 51.8400        +
+        105.200 0.00000 2086.50 0.00000 0.00000 2191.60
CONM2        607     107      -1 7.16000 158.170 72.3100 52.5100        +
+        103.200 0.00000 2025.00 0.00000 0.00000 2128.20
CONM2        608     108      -1 7.03000 158.300 85.4600 53.1700        +
+        101.200 0.00000 1966.00 0.00000 0.00000 2067.20
CONM2        609     109      -1 6.90000 158.420 98.6000 53.8400        +
+        99.4000 0.00000 1909.20 0.00000 0.00000 2008.60
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CONM2        610     110      -1 6.77000 158.540 111.750 54.5100        +
+        97.6000 0.00000 1854.70 0.00000 0.00000 1952.30
CONM2        611     111      -1 6.66000 158.650 124.900 55.1800        +
+        95.9000 0.00000 1802.80 0.00000 0.00000 1898.70
CONM2        612     112      -1 6.57000 158.710 138.040 55.8600        +
+        94.6000 0.00000 1760.20 0.00000 0.00000 1854.90
CONM2        613     113      -1 6.49000 158.770 151.190 56.5400        +
+        93.4000 0.00000 1719.10 0.00000 0.00000 1812.60
CONM2        614     114      -1 6.41000 158.820 164.340 57.2200        +
+        92.3000 0.00000 1679.50 0.00000 0.00000 1771.80
CONM2        615     115      -1 6.35000 158.830 177.490 57.9100        +
+        91.5000 0.00000 1646.60 0.00000 0.00000 1738.00
CONM2        616     116      -1 6.30000 158.820 190.630 58.6000        +
+        90.7000 0.00000 1615.40 0.00000 0.00000 1706.10
CONM2        617     117      -1 6.26000 158.790 203.780 59.2900        +
+        90.2000 0.00000 1587.80 0.00000 0.00000 1678.00
CONM2        618     118      -1 6.24000 158.740 216.930 59.9900        +
+        89.8000 0.00000 1563.60 0.00000 0.00000 1653.40
CONM2        619     119      -1 6.19000 158.660 230.070 60.6900        +
+        88.9000 0.00000 1527.90 0.00000 0.00000 1616.90
$      Right wing full fuel masses
CONM2        620     120      -1 25.3790 157.650 243.200 61.5300        +
+        364.620 0.00000 3931.34 0.00000 0.00000 4090.73
CONM2        621     121      -1 24.8610 157.570 256.330 62.2300        +
+        357.160 0.00000 3774.54 0.00000 0.00000 3930.40
CONM2        622     122      -1 24.3480 157.490 269.460 62.9300        +
+        349.800 0.00000 3622.52 0.00000 0.00000 3774.90
CONM2        623     123      -1 23.3890 157.410 282.590 63.6300        +
+        342.480 0.00000 3475.13 0.00000 0.00000 3624.12
CONM2        624     124      -1 23.3350 157.330 295.720 64.3300        +
+        335.290 0.00000 3332.35 0.00000 0.00000 3477.95
CONM2        625     125      -1 22.8390 157.250 308.850 65.0300        +
+        328.150 0.00000 3194.03 0.00000 0.00000 3336.28
CONM2        626     126      -1 22.3480 157.170 321.980 65.7300        +
+        321.100 0.00000 3060.12 0.00000 0.00000 3199.03
$
$      Right wing no fuel
$
$CONM2        620     120      -1    6.14  158.56  243.20   61.53       0 MASS620
$+MASS620    88.3       0  1485.1       0       0  1573.4
$CONM2        621     121      -1    6.10  158.46  256.33   62.23       0 MASS621
$+MASS621    87.6       0  1443.1       0       0  1530.7
$CONM2        622     122      -1    6.05  158.36  269.46   62.93       0 MASS622
$+MASS622    86.9       0  1402.0       0       0  1488.9
$CONM2        623     123      -1    6.00  158.26  282.59   63.63       0 MASS623
$+MASS623    86.2       0  1361.5       0       0  1447.8
$CONM2        624     124      -1    5.95  158.16  295.72   64.33       0 MASS624
$+MASS624    85.5       0  1321.9       0       0  1407.5
$CONM2        625     125      -1    5.91  158.06  308.85   65.03       0 MASS625
$+MASS625    84.9       0  1283.1       0       0  1367.9
$CONM2        626     126      -1    5.86  157.96  321.98   65.73       0 MASS626
$+MASS626    84.2       0  1245.0       0       0  1329.1
$
$      Right wing masses (continued)
CONM2        627     127      -1 5.81000 157.860 335.110 66.3100        +
+        83.5000 0.00000 1207.60 0.00000 0.00000 1291.10
CONM2        628     128      -1 5.76000 157.760 348.240 67.0100        +
+        82.8000 0.00000 1171.00 0.00000 0.00000 1253.80
CONM2        629     129      -1 5.72000 157.660 361.370 67.7100        +
+        82.1000 0.00000 1135.20 0.00000 0.00000 1217.30
CONM2        630     130      -1 5.67000 157.560 374.500 68.4200        +
+        81.5000 0.00000 1100.00 0.00000 0.00000 1181.50
CONM2        631     131      -1 5.62000 157.460 387.630 69.1200        +
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+        80.8000 0.00000 1065.60 0.00000 0.00000 1146.40
CONM2        632     132      -1 5.58000 157.370 400.760 69.8200        +
+        80.1000 0.00000 1031.90 0.00000 0.00000 1112.00
CONM2        633     133      -1 5.53000 157.270 413.890 70.5200        +
+        79.4000 0.00000 999.000 0.00000 0.00000 1078.40
CONM2        634     134      -1 5.48000 157.170 427.020 71.2300        +
+        78.7000 0.00000 966.700 0.00000 0.00000 1045.40
CONM2        635     135      -1 5.43000 157.070 440.150 71.9300        +
+        78.1000 0.00000 935.100 0.00000 0.00000 1013.20
CONM2        636     136      -1 12.3900 155.860 453.280 72.8100        +
+        77.4000 0.00000 974.400 0.00000 0.00000 974.400
CONM2        637     137      -1 5.34000 156.870 466.410 73.3300        +
+        76.7000 0.00000 874.000 0.00000 0.00000 950.700
CONM2        638     138      -1 12.2900 155.760 479.540 74.1900        +
+        76.0000 0.00000 912.300 0.00000 0.00000 912.300
CONM2        639     139      -1 5.24000 156.670 492.670 74.7400        +
+        75.3000 0.00000 815.600 0.00000 0.00000 890.900
CONM2        640     140      -1 12.2000 155.670 505.800 75.5800        +
+        74.7000 0.00000 853.100 0.00000 0.00000 853.100
CONM2        641     141      -1 5.15000 156.470 518.930 76.1400        +
+        74.0000 0.00000 759.800 0.00000 0.00000 833.800
$       Right wing tip boom masses
CONM2        702     202      -1 11.2500 33.6100 525.500 77.5000        +
+        316.500 0.00000 126.600 0.00000 0.00000 126.600
CONM2        703     203      -1 16.3300 42.2200 525.500 77.5000        +
+        459.300 0.00000 330.600 0.00000 0.00000 330.600
CONM2        704     204      -1 16.4100 50.8300 525.500 77.5000        +
+        461.500 0.00000 332.100 0.00000 0.00000 332.100
CONM2        705     205      -1 11.4800 59.4400 525.500 77.5000        +
+        323.000 0.00000 232.500 0.00000 0.00000 232.500
CONM2        706     206      -1 1.56000 68.0600 525.500 77.5000        +
+        87.8000 0.00000 53.6000 0.00000 0.00000 53.6000
CONM2        707     207      -1 1.64000 76.6700 525.500 77.5000        +
+        92.2000 0.00000 56.2000 0.00000 0.00000 56.2000
CONM2        708     208      -1 1.72000 85.2800 525.500 77.5000        +
+        96.5000 0.00000 58.8000 0.00000 0.00000 58.8000
CONM2        709     209      -1 1.79000 93.8900 525.500 77.5000        +
+        100.800 0.00000 61.5000 0.00000 0.00000 61.5000
CONM2        710     210      -1 1.87000 102.500 525.500 77.5000        +
+        105.100 0.00000 64.1000 0.00000 0.00000 64.1000
CONM2        711     211      -1 1.95000 111.110 525.500 77.5000        +
+        109.500 0.00000 66.8000 0.00000 0.00000 66.8000
CONM2        712     212      -1 2.02000 119.720 525.500 77.5000        +
+        113.800 0.00000 69.4000 0.00000 0.00000 69.4000
CONM2        713     213      -1 2.10000 128.330 525.500 77.5000        +
+        118.100 0.00000 72.0000 0.00000 0.00000 72.0000
CONM2        714     214      -1 2.18000 136.940 525.500 77.5000        +
+        122.500 0.00000 74.7000 0.00000 0.00000 74.7000
CONM2        715     215      -1 2.25000 145.560 525.500 77.5000        +
+        126.800 0.00000 77.3000 0.00000 0.00000 77.3000
CONM2        716     216      -1 2.22000 154.170 525.500 77.5000        +
+        124.800 0.00000 76.1000 0.00000 0.00000 76.1000
CONM2        717     217      -1 2.18000 162.780 525.500 77.5000        +
+        122.700 0.00000 74.9000 0.00000 0.00000 74.9000
CONM2        718     218      -1 5.65000 171.390 525.500 77.5000        +
+        158.800 0.00000 114.300 0.00000 0.00000 114.300
CONM2        719     219      -1 2.11000 180.000 525.500 77.5000        +
+        118.700 0.00000 72.4000 0.00000 0.00000 72.4000
CONM2        720     220      -1 2.41000 190.000 525.500 77.5000        +
+        128.900 0.00000 84.6000 0.00000 0.00000 84.6000
CONM2        721     221      -1 2.35000 200.000 525.500 77.5000        +
+        119.500 0.00000 79.4000 0.00000 0.00000 79.4000
CONM2        722     222      -1 2.30000 210.000 525.500 77.5000        +
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+       110.500 0.00000 74.4000 0.00000 0.00000 74.4000
CONM2       723     223      -1 2.24000 220.000 525.500 77.5000        +
+       101.800 0.00000 69.6000 0.00000 0.00000 69.6000
CONM2       724     224      -1 2.17000 230.000 525.500 77.5000        +
+       93.6000 0.00000 64.9000 0.00000 0.00000 64.9000
CONM2       725     225      -1 2.11000 240.000 525.500 77.5000        +
+       85.8000 0.00000 60.5000 0.00000 0.00000 60.5000
CONM2       726     226      -1 2.05000 250.000 525.500 77.5000        +
+       78.3000 0.00000 56.2000 0.00000 0.00000 56.2000
CONM2       727     227      -1 1.98000 260.000 525.500 77.5000        +
+       71.3000 0.00000 52.1000 0.00000 0.00000 52.1000
CONM2       728     228      -1 1.91000 270.000 525.500 77.5000        +
+       64.5000 0.00000 48.2000 0.00000 0.00000 48.2000
CONM2       729     229      -1 1.84000 280.000 525.500 77.5000        +
+       58.2000 0.00000 44.4000 0.00000 0.00000 44.4000
CONM2       730     230      -1 1.89000 290.000 525.500 77.5000        +
+       56.0000 0.00000 43.8000 0.00000 0.00000 43.8000
CONM2       731     231      -1 1.81000 300.000 525.500 77.5000        +
+       50.0000 0.00000 40.1000 0.00000 0.00000 40.1000
CONM2       732     232      -1 1.73000 310.000 525.500 77.5000        +
+       44.3000 0.00000 36.6000 0.00000 0.00000 36.6000
CONM2       733     233      -1 1.76000 320.000 525.500 77.5000        +
+       41.8000 0.00000 35.5000 0.00000 0.00000 35.5000
CONM2       734     234      -1 1.66000 330.000 525.500 77.5000        +
+       36.5000 0.00000 32.1000 0.00000 0.00000 32.1000
CONM2       735     235      -1 1.56000 340.000 525.500 77.5000        +
+       31.6000 0.00000 28.8000 0.00000 0.00000 28.8000
CONM2       736     236      -1 1.56000 350.000 525.500 77.5000        +
+       29.0000 0.00000 27.5000 0.00000 0.00000 27.5000
CONM2       737     237      -1 1.54000 360.000 525.500 77.5000        +
+       26.2000 0.00000 26.0000 0.00000 0.00000 26.0000
CONM2       738     238      -1 1.42000 370.000 525.500 77.5000        +
+       21.9000 0.00000 22.8000 0.00000 0.00000 22.8000
CONM2       739     239      -1 1.37000 380.000 525.500 77.5000        +
+       19.3000 0.00000 21.1000 0.00000 0.00000 21.1000
CONM2       740     240      -1 1.31000 390.000 525.500 77.5000        +
+       16.6000 0.00000 19.2000 0.00000 0.00000 19.2000
CONM2       741     241      -1 1.29000 400.000 525.500 77.5000        +
+       14.7000 0.00000 18.1000 0.00000 0.00000 18.1000
CONM2       742     242      -1 0.80000 410.000 525.500 77.5000        +
+       8.10000 0.00000 10.7000 0.00000 0.00000 10.7000
CONM2       743     243      -1 0.71000 420.000 525.500 77.5000        +
+       6.40000 0.00000 9.10000 0.00000 0.00000 9.10000
$      Right half horizontal tail masses
CONM2       802     302      -1 4.97000 387.100 530.250 77.8000        +
+       37.4000 0.00000 1504.70 0.00000 0.00000 1542.10
CONM2       803     303      -1 4.73000 386.660 539.750 79.4700        +
+       35.6000 0.00000 1289.20 0.00000 0.00000 1324.70
CONM2       804     304      -1 7.69000 387.790 549.250 81.0600        +
+       33.8000 0.00000 1149.50 0.00000 0.00000 1149.50
CONM2       805     305      -1 4.26000 385.750 558.750 82.8200        +
+       32.0000 0.00000 923.600 0.00000 0.00000 955.600
CONM2       806     306      -1 4.03000 385.290 568.250 84.4900        +
+       30.3000 0.00000 770.900 0.00000 0.00000 801.200
CONM2       807     307      -1 7.00000 387.180 577.750 86.0400        +
+       28.6000 0.00000 710.000 0.00000 0.00000 710.000
CONM2       808     308      -1 3.58000 384.330 587.250 87.8400        +
+       26.9000 0.00000 519.200 0.00000 0.00000 546.100
CONM2       809     309      -1 3.35000 383.830 596.750 89.5100        +
+       25.2000 0.00000 417.600 0.00000 0.00000 442.800
CONM2       810     310      -1 6.34000 386.700 606.250 91.0100        +
+       23.6000 0.00000 427.700 0.00000 0.00000 427.700
CONM2       811     311      -1 2.92000 382.810 615.750 92.8700        +
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+        22.0000 0.00000 256.700 0.00000 0.00000 278.700
$      Right half vertical tail masses
CONM2        902     402      -1 3.06000 413.630 524.050 81.4800        +
+        18.3000 0.00000 616.300 0.00000 0.00000 597.900
CONM2        903     403      -1 2.91000 414.650 521.150 89.4500        +
+        17.5000 0.00000 547.100 0.00000 0.00000 529.700
CONM2        904     404      -1 5.97000 418.340 518.250 97.4200        +
+        16.6000 0.00000 483.700 0.00000 0.00000 467.100
CONM2        905     405      -1 2.63000 416.670 515.350 105.390        +
+        15.8000 0.00000 425.800 0.00000 0.00000 410.000
CONM2        906     406      -1 2.49000 417.670 512.450 113.360        +
+        14.9000 0.00000 373.100 0.00000 0.00000 358.200
CONM2        907     407      -1 2.36000 418.660 509.550 121.330        +
+        14.1000 0.00000 325.300 0.00000 0.00000 311.200
CONM2        908     408      -1 5.43000 422.590 506.650 129.300        +
+        13.3000 0.00000 282.300 0.00000 0.00000 269.000
CONM2        909     409      -1 2.10000 420.610 503.750 137.270        +
+        12.6000 0.00000 243.700 0.00000 0.00000 231.100
CONM2        910     410      -1 1.98000 421.570 500.850 145.230        +
+        11.8000 0.00000 209.300 0.00000 0.00000 197.500
CONM2        911     411      -1 1.86000 422.500 497.950 153.200        +
+        11.1000 0.00000 178.900 0.00000 0.00000 167.800
$
$      Left half wing masses
CONM2       3105    3000      -1 7.91000 157.540-6.57000 49.1600        +
+        114.000 0.00000 2357.10 0.00000 0.00000 2471.10
CONM2       3106    3001      -1 7.75000 157.670-19.7200 49.8300        +
+        111.700 0.00000 2285.60 0.00000 0.00000 2397.20
CONM2       3107    3002      -1 7.60000 157.800-32.8700 50.5000        +
+        109.400 0.00000 2216.70 0.00000 0.00000 2326.10
CONM2       3108    3003      -1 7.45000 157.920-46.0100 51.1700        +
+        107.300 0.00000 2150.30 0.00000 0.00000 2257.60
CONM2       3109    3004      -1 7.30000 158.050-59.1600 51.8400        +
+        105.200 0.00000 2086.50 0.00000 0.00000 2191.60
CONM2       3110    3005      -1 7.16000 158.170-72.3100 52.5100        +
+        103.200 0.00000 2025.00 0.00000 0.00000 2128.20
CONM2       3111    3006      -1 7.03000 158.300-85.4600 53.1700        +
+        101.200 0.00000 1966.00 0.00000 0.00000 2067.20
CONM2       3112    3007      -1 6.90000 158.420-98.6000 53.8400        +
+        99.4000 0.00000 1909.20 0.00000 0.00000 2008.60
CONM2       3113    3008      -1 6.77000 158.540-111.750 54.5100        +
+        97.6000 0.00000 1854.70 0.00000 0.00000 1952.30
CONM2       3114    3009      -1 6.66000 158.650-124.900 55.1800        +
+        95.9000 0.00000 1802.80 0.00000 0.00000 1898.70
CONM2       3115    3010      -1 6.57000 158.710-138.040 55.8600        +
+        94.6000 0.00000 1760.20 0.00000 0.00000 1854.90
CONM2       3116    3011      -1 6.49000 158.770-151.190 56.5400        +
+        93.4000 0.00000 1719.10 0.00000 0.00000 1812.60
CONM2       3117    3012      -1 6.41000 158.820-164.340 57.2200        +
+        92.3000 0.00000 1679.50 0.00000 0.00000 1771.80
CONM2       3118    3013      -1 6.35000 158.830-177.490 57.9100        +
+        91.5000 0.00000 1646.60 0.00000 0.00000 1738.00
CONM2       3119    3014      -1 6.30000 158.820-190.630 58.6000        +
+        90.7000 0.00000 1615.40 0.00000 0.00000 1706.10
CONM2       3120    3015      -1 6.26000 158.790-203.780 59.2900        +
+        90.2000 0.00000 1587.80 0.00000 0.00000 1678.00
CONM2       3121    3016      -1 6.24000 158.740-216.930 59.9900        +
+        89.8000 0.00000 1563.60 0.00000 0.00000 1653.40
CONM2       3122    3017      -1 6.19000 158.660-230.070 60.6900        +
+        88.9000 0.00000 1527.90 0.00000 0.00000 1616.90
$      Left wing full fuel condition
CONM2       3123    3018      -1 25.3790 157.650-243.200 61.5300        +
+        364.620 0.00000 3931.34 0.00000 0.00000 4090.73
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CONM2       3124    3019      -1 24.8610 157.570-256.330 62.2300        +
+        357.160 0.00000 3774.54 0.00000 0.00000 3930.40
CONM2       3125    3020      -1 24.3480 157.490-269.460 62.9300        +
+        349.800 0.00000 3622.52 0.00000 0.00000 3774.90
CONM2       3126    3021      -1 23.3890 157.410-282.590 63.6300        +
+        342.480 0.00000 3475.13 0.00000 0.00000 3624.12
CONM2       3127    3022      -1 23.3350 157.330-295.720 64.3300        +
+        335.290 0.00000 3332.35 0.00000 0.00000 3477.95
CONM2       3128    3023      -1 22.8390 157.250-308.850 65.0300        +
+        328.150 0.00000 3194.03 0.00000 0.00000 3336.28
CONM2       3129    3024      -1 22.3480 157.170-321.980 65.7300        +
+        321.100 0.00000 3060.12 0.00000 0.00000 3199.03
$      End of full fuel masses for left wing
$
$    Left wing fuel empty condition
$
$CONM2       3123    3018      -1    6.14  158.56 -243.20   61.53       0 MAS3123
$+MAS3123    88.3       0  1485.1       0       0  1573.4
$CONM2       3124    3019      -1    6.10  158.46 -256.33   62.23       0 MAS3124
$+MAS3124    87.6       0  1443.1       0       0  1530.7
$CONM2       3125    3020      -1    6.05  158.36 -269.46   62.93       0 MAS3125
$+MAS3125    86.9       0  1402.0       0       0  1488.9
$CONM2       3126    3021      -1    6.00  158.26 -282.59   63.63       0 MAS3126
$+MAS3126    86.2       0  1361.5       0       0  1447.8
$CONM2       3127    3022      -1    5.95  158.16 -295.72   64.33       0 MAS3127
$+MAS3127    85.5       0  1321.9       0       0  1407.5
$CONM2       3128    3023      -1    5.91  158.06 -308.85   65.03       0 MAS3128
$+MAS3128    84.9       0  1283.1       0       0  1367.9
$CONM2       3129    3024      -1    5.86  157.96 -321.98   65.73       0 MAS3129
$+MAS3129    84.2       0  1245.0       0       0  1329.1
$    End of left wing fuel empty condition
$
$    Left wing masses (continued)
CONM2       3130    3025      -1 5.81000 157.860-335.110 66.3100        +
+        83.5000 0.00000 1207.60 0.00000 0.00000 1291.10
CONM2       3131    3026      -1 5.76000 157.760-348.240 67.0100        +
+        82.8000 0.00000 1171.00 0.00000 0.00000 1253.80
CONM2       3132    3027      -1 5.72000 157.660-361.370 67.7100        +
+        82.1000 0.00000 1135.20 0.00000 0.00000 1217.30
CONM2       3133    3028      -1 5.67000 157.560-374.500 68.4200        +
+        81.5000 0.00000 1100.00 0.00000 0.00000 1181.50
CONM2       3134    3029      -1 5.62000 157.460-387.630 69.1200        +
+        80.8000 0.00000 1065.60 0.00000 0.00000 1146.40
CONM2       3135    3030      -1 5.58000 157.370-400.760 69.8200        +
+        80.1000 0.00000 1031.90 0.00000 0.00000 1112.00
CONM2       3136    3031      -1 5.53000 157.270-413.890 70.5200        +
+        79.4000 0.00000 999.000 0.00000 0.00000 1078.40
CONM2       3137    3032      -1 5.48000 157.170-427.020 71.2300        +
+        78.7000 0.00000 966.700 0.00000 0.00000 1045.40
CONM2       3138    3033      -1 5.43000 157.070-440.150 71.9300        +
+        78.1000 0.00000 935.100 0.00000 0.00000 1013.20
CONM2       3139    3034      -1 12.3900 155.860-453.280 72.8100        +
+        77.4000 0.00000 974.400 0.00000 0.00000 974.400
CONM2       3140    3035      -1 5.34000 156.870-466.410 73.3300        +
+        76.7000 0.00000 874.000 0.00000 0.00000 950.700
CONM2       3141    3036      -1 12.2900 155.760-479.540 74.1900        +
+        76.0000 0.00000 912.300 0.00000 0.00000 912.300
CONM2       3142    3037      -1 5.24000 156.670-492.670 74.7400        +
+        75.3000 0.00000 815.600 0.00000 0.00000 890.900
CONM2       3143    3038      -1 12.2000 155.670-505.800 75.5800        +
+        74.7000 0.00000 853.100 0.00000 0.00000 853.100
CONM2       3144    3039      -1 5.15000 156.470-518.930 76.1400        +
+        74.0000 0.00000 759.800 0.00000 0.00000 833.800
```

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$     Left half wing tip boom masses
CONM2       3145    3041      -1 11.2500 33.6100-525.500 77.5000        +
+        316.500 0.00000 126.600 0.00000 0.00000 126.600
CONM2       3146    3042      -1 16.3300 42.2200-525.500 77.5000        +
+        459.300 0.00000 330.600 0.00000 0.00000 330.600
CONM2       3147    3043      -1 16.4100 50.8300-525.500 77.5000        +
+        461.500 0.00000 332.100 0.00000 0.00000 332.100
CONM2       3148    3044      -1 11.4800 59.4400-525.500 77.5000        +
+        323.000 0.00000 232.500 0.00000 0.00000 232.500
CONM2       3149    3045      -1 1.56000 68.0600-525.500 77.5000        +
+        87.8000 0.00000 53.6000 0.00000 0.00000 53.6000
CONM2       3150    3046      -1 1.64000 76.6700-525.500 77.5000        +
+        92.2000 0.00000 56.2000 0.00000 0.00000 56.2000
CONM2       3151    3047      -1 1.72000 85.2800-525.500 77.5000        +
+        96.5000 0.00000 58.8000 0.00000 0.00000 58.8000
CONM2       3152    3048      -1 1.79000 93.8900-525.500 77.5000        +
+        100.800 0.00000 61.5000 0.00000 0.00000 61.5000
CONM2       3153    3049      -1 1.87000 102.500-525.500 77.5000        +
+        105.100 0.00000 64.1000 0.00000 0.00000 64.1000
CONM2       3154    3050      -1 1.95000 111.110-525.500 77.5000        +
+        109.500 0.00000 66.8000 0.00000 0.00000 66.8000
CONM2       3155    3051      -1 2.02000 119.720-525.500 77.5000        +
+        113.800 0.00000 69.4000 0.00000 0.00000 69.4000
CONM2       3156    3052      -1 2.10000 128.330-525.500 77.5000        +
+        118.100 0.00000 72.0000 0.00000 0.00000 72.0000
CONM2       3157    3053      -1 2.18000 136.940-525.500 77.5000        +
+        122.500 0.00000 74.7000 0.00000 0.00000 74.7000
CONM2       3158    3054      -1 2.25000 145.560-525.500 77.5000        +
+        126.800 0.00000 77.3000 0.00000 0.00000 77.3000
CONM2       3159    3055      -1 2.22000 154.170-525.500 77.5000        +
+        124.800 0.00000 76.1000 0.00000 0.00000 76.1000
CONM2       3160    3056      -1 2.18000 162.780-525.500 77.5000        +
+        122.700 0.00000 74.9000 0.00000 0.00000 74.9000
CONM2       3161    3057      -1 5.65000 171.390-525.500 77.5000        +
+        158.800 0.00000 114.300 0.00000 0.00000 114.300
CONM2       3162    3058      -1 2.11000 180.000-525.500 77.5000        +
+        118.700 0.00000 72.4000 0.00000 0.00000 72.4000
CONM2       3163    3059      -1 2.41000 190.000-525.500 77.5000        +
+        128.900 0.00000 84.6000 0.00000 0.00000 84.6000
CONM2       3164    3060      -1 2.35000 200.000-525.500 77.5000        +
+        119.500 0.00000 79.4000 0.00000 0.00000 79.4000
CONM2       3165    3061      -1 2.30000 210.000-525.500 77.5000        +
+        110.500 0.00000 74.4000 0.00000 0.00000 74.4000
CONM2       3166    3062      -1 2.24000 220.000-525.500 77.5000        +
+        101.800 0.00000 69.6000 0.00000 0.00000 69.6000
CONM2       3167    3063      -1 2.17000 230.000-525.500 77.5000        +
+        93.6000 0.00000 64.9000 0.00000 0.00000 64.9000
CONM2       3168    3064      -1 2.11000 240.000-525.500 77.5000        +
+        85.8000 0.00000 60.5000 0.00000 0.00000 60.5000
CONM2       3169    3065      -1 2.05000 250.000-525.500 77.5000        +
+        78.3000 0.00000 56.2000 0.00000 0.00000 56.2000
CONM2       3170    3066      -1 1.98000 260.000-525.500 77.5000        +
+        71.3000 0.00000 52.1000 0.00000 0.00000 52.1000
CONM2       3171    3067      -1 1.91000 270.000-525.500 77.5000        +
+        64.5000 0.00000 48.2000 0.00000 0.00000 48.2000
CONM2       3172    3068      -1 1.84000 280.000-525.500 77.5000        +
+        58.2000 0.00000 44.4000 0.00000 0.00000 44.4000
CONM2       3173    3069      -1 1.89000 290.000-525.500 77.5000        +
+        56.0000 0.00000 43.8000 0.00000 0.00000 43.8000
CONM2       3174    3070      -1 1.81000 300.000-525.500 77.5000        +
+        50.0000 0.00000 40.1000 0.00000 0.00000 40.1000
CONM2       3175    3071      -1 1.73000 310.000-525.500 77.5000        +
+        44.3000 0.00000 36.6000 0.00000 0.00000 36.6000
```

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CONM2       3176    3072      -1 1.76000 320.000-525.500 77.5000        +
+        41.8000 0.00000 35.5000 0.00000 0.00000 35.5000
CONM2       3177    3073      -1 1.66000 330.000-525.500 77.5000        +
+        36.5000 0.00000 32.1000 0.00000 0.00000 32.1000
CONM2       3178    3074      -1 1.56000 340.000-525.500 77.5000        +
+        31.6000 0.00000 28.8000 0.00000 0.00000 28.8000
CONM2       3179    3075      -1 1.56000 350.000-525.500 77.5000        +
+        29.0000 0.00000 27.5000 0.00000 0.00000 27.5000
CONM2       3180    3076      -1 1.54000 360.000-525.500 77.5000        +
+        26.2000 0.00000 26.0000 0.00000 0.00000 26.0000
CONM2       3181    3077      -1 1.42000 370.000-525.500 77.5000        +
+        21.9000 0.00000 22.8000 0.00000 0.00000 22.8000
CONM2       3182    3078      -1 1.37000 380.000-525.500 77.5000        +
+        19.3000 0.00000 21.1000 0.00000 0.00000 21.1000
CONM2       3183    3079      -1 1.31000 390.000-525.500 77.5000        +
+        16.6000 0.00000 19.2000 0.00000 0.00000 19.2000
CONM2       3184    3080      -1 1.29000 400.000-525.500 77.5000        +
+        14.7000 0.00000 18.1000 0.00000 0.00000 18.1000
CONM2       3185    3081      -1 0.80000 410.000-525.500 77.5000        +
+        8.10000 0.00000 10.7000 0.00000 0.00000 10.7000
CONM2       3186    3082      -1 0.71000 420.000-525.500 77.5000        +
+        6.40000 0.00000 9.10000 0.00000 0.00000 9.10000
$      Left half horizontal tail masses
CONM2       3187    3084      -1 4.97000 387.100-530.250 77.8000        +
+        37.4000 0.00000 1504.70 0.00000 0.00000 1542.10
CONM2       3188    3085      -1 4.73000 386.660-539.750 79.4700        +
+        35.6000 0.00000 1289.20 0.00000 0.00000 1324.70
CONM2       3189    3086      -1 7.69000 387.790-549.250 81.0600        +
+        33.8000 0.00000 1149.50 0.00000 0.00000 1149.50
CONM2       3190    3087      -1 4.26000 385.750-558.750 82.8200        +
+        32.0000 0.00000 923.600 0.00000 0.00000 955.600
CONM2       3191    3088      -1 4.03000 385.290-568.250 84.4900        +
+        30.3000 0.00000 770.900 0.00000 0.00000 801.200
CONM2       3192    3089      -1 7.00000 387.180-577.750 86.0400        +
+        28.6000 0.00000 710.000 0.00000 0.00000 710.000
CONM2       3193    3090      -1 3.58000 384.330-587.250 87.8400        +
+        26.9000 0.00000 519.200 0.00000 0.00000 546.100
CONM2       3194    3091      -1 3.35000 383.830-596.750 89.5100        +
+        25.2000 0.00000 417.600 0.00000 0.00000 442.800
CONM2       3195    3092      -1 6.34000 386.700-606.250 91.0100        +
+        23.6000 0.00000 427.700 0.00000 0.00000 427.700
CONM2       3196    3093      -1 2.92000 382.810-615.750 92.8700        +
+        22.0000 0.00000 256.700 0.00000 0.00000 278.700
$     Left half vertical tail masses
CONM2       3197    3095      -1 3.06000 413.630-524.050 81.4800        +
+        18.3000 0.00000 616.300 0.00000 0.00000 597.900
CONM2       3198    3096      -1 2.91000 414.650-521.150 89.4500        +
+        17.5000 0.00000 547.100 0.00000 0.00000 529.700
CONM2       3199    3097      -1 5.97000 418.340-518.250 97.4200        +
+        16.6000 0.00000 483.700 0.00000 0.00000 467.100
CONM2       3200    3098      -1 2.63000 416.670-515.350 105.390        +
+        15.8000 0.00000 425.800 0.00000 0.00000 410.000
CONM2       3201    3099      -1 2.49000 417.670-512.450 113.360        +
+        14.9000 0.00000 373.100 0.00000 0.00000 358.200
CONM2       3202    3100      -1 2.36000 418.660-509.550 121.330        +
+        14.1000 0.00000 325.300 0.00000 0.00000 311.200
CONM2       3203    3101      -1 5.43000 422.590-506.650 129.300        +
+        13.3000 0.00000 282.300 0.00000 0.00000 269.000
CONM2       3204    3102      -1 2.10000 420.610-503.750 137.270        +
+        12.6000 0.00000 243.700 0.00000 0.00000 231.100
CONM2       3205    3103      -1 1.98000 421.570-500.850 145.230        +
+        11.8000 0.00000 209.300 0.00000 0.00000 197.500
CONM2       3206    3104      -1 1.86000 422.500-497.950 153.200        +
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```
+        11.1000 0.00000 178.900 0.00000 0.00000 167.800
$
```

- **Program full_aero.dat**

```
$     *****  DEFINE AERODYNAMIC PANELS FOR RIGHT SIDE  *****
$   RIGHT-SIDE INBOARD WING
CAERO1  10001   1       0       17      8                       1       +CA101
+CA101  132.83  0.0     48.98   59.2    134.33  223.5   60.77   54.03

$   RIGHT-SIDE OUTBOARD WING
CAERO1  20001   1       0       23      8                       1       +CA102
+CA102  134.33  223.5   60.77   54.03    138.03  525.5   76.79    41.28
$
$   RIGHT-SIDE HORIZONTAL TAIL UP TO THE HING LINE
CAERO1  30001   1       0       20      8                       1       +CA103
+CA103  355.08  525.5   77.36   49.40   366.04  620.5   93.92   24.704
$
$   RIGHT-SIDE CONTROL SURFACE PANEL ON HORIZONTAL TAIL
CAERO1  31001      1      0      20       2                       1      +CA103A
+CA103A 404.480 525.50  77.360  12.35   390.744 620.50  93.920  6.176
$
$   RIGHT-SIDE VERTICAL TAIL UP TO THE HINGE LINE
CAERO1  40001   1       0       20      8                       1       +CA104
+CA104  407.54  496.5   157.19  25.60   390.67  525.5   77.5    39.44
$
$  RIGHT-SIDE CONTROL SURFACE PANEL ON VERTICAL TAIL
CAERO1  41001      1       0      20       2                       1     +CA104A
+CA104A 433.140  496.50  157.190  6.40   430.110 525.50  77.50   9.86
$
$     *****  BEGIN LEFT SIDE AERODYNAMIC PANEL DEFINITION  *****
$    LEFT-SIDE INBOARD WING
CAERO1   51001     1       0      17       8                       1     +CA110
+CA110   134.33  -223.50  60.77  54.03   132.83   0.0    48.98   59.20
$    LEFT-SIDE OUTBOARD WING
CAERO1   61001     1       0      23       8                       1     +CA210
+CA210   138.03  -525.50  76.79  41.28   134.33  -223.50 60.77   54.03
$    LEFT-SIDE HORIZONTAL TAIL FROM LEADING EDGE TO HINGE LINE
CAERO1   72001     1       0      20       8                       1     +CA307
+CA307   366.04  -620.50  93.92  24.704  355.08  -525.50 77.36   49.40
$    CONTROL SURFACE ON LEFT-SIDE HORIZONTAL TAIL
CAERO1   73001     1       0      20       2                       1     +CA315
+CA315   390.744 -620.50  93.92   6.176  404.48  -525.50 77.36   12.35
$    LEFT-SIDE VERTICAL TAIL FROM LEADING EDGE TO HINGE LINE
CAERO1   82001     1       0      20       8                       1     +CA407
+CA407   390.670 -525.50  77.50  39.44   407.54  -496.50 157.19  25.60
$    CONTROL SURFACE ON LEFT-SIDE VERTICAL TAIL
CAERO1   83001     1       0      20       2                       1     +CA415
+CA415   430.110 -525.50  77.50   9.86   433.14  -496.50 157.19   6.40
```

- **Program full_spline.dat**

```
$
$  USE SURFACE SPLINES ON ALL LIFTING SURFACES
$   SPLINE1 = 100   RIGHT-SIDE INBOARD WING
$   SPLINE1 = 110   LEFT-SIDE INBOARD WING
$   SPLINE1 = 200   RIGHT-SIDE OUTBOARD WING
$   SPLINE1 = 210   LEFT-SIDE OUTBOARD WING
$   SPLINE1 = 300   RIGHT-SIDE HORIZONTAL TAIL WITHOUT CONTROL SURFACE
$   SPLINE1 = 310   LEFT-SIDE HORIZONTAL TAIL WITHOUT CONTROL SURFACE
$   SPLINE1 = 350   RIGHT-SIDE CONTROL SURFACE ON HORIZONTAL TAIL
$   SPLINE1 = 360   LEFT-SIDE CONTROL SURFACE ON HORIZONTAL TAIL
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$   SPLINE1 = 400   RIGHT-SIDE VERTICAL TAIL WITHOUT CONTROL SURFACE
$   SPLINE1 = 410   LEFT-SIDE VERTICAL TAIL WITHOUT CONTROL SURFACE
$   SPLINE1 = 450   RIGHT-SIDE CONTROL SURFACE ON VERTICAL TAIL
$   SPLINE1 = 460   LEFT-SIDE CONTROL SURFACE ON VERTICAL TAIL
$
$   RIGHT-SIDE SURFACE SPLINE PARAMETERS
$
SPLINE1 100     10001   10001   10136   100
SPLINE1 200     20001   20001   20184   200
$
SPLINE1 300     30001   30001   30160   300
SPLINE1 400     40001   40001   40160   400
$
SPLINE1 350     31001   31001   31040   350
SPLINE1 450     41001   41001   41040   450
$
$   LEFT-SIDE SURFACE SPLINE PARAMETERS
$
SPLINE1 110     51001   51001   51136   110
SPLINE1 210     61001   61001   61184   210
$
SPLINE1 310     72001   72001   72160   310
SPLINE1 410     82001   82001   82160   410
$
SPLINE1 360     73001   73001   73040   360
SPLINE1 460     83001   83001   83040   460
$
$   GRIDS UTILIZED FOR RIGHT SIDE INBOARD WING SURFACE SPLINES
SET1         100     101     102     103     104     105     106     107+RIW01
+RIW01       108     109     110     111     112     113     114     115+RIW02
+RIW02       116     117     118    1101    1102    1103    1104    1105+RIW03
+RIW03      1106    1107    1108    1109    1110    1111    1112    1113+RIW04
+RIW04      1114    1115    1116    1117    1118    2101    2102    2103+RIW05
+RIW05      2104    2105    2106    2107    2108    2109    2110    2111+RIW06
+RIW06      2112    2113    2114    2115    2116    2117    2118
$   GRIDS UTILIZED FOR RIGHT SIDE OUTBOARD WING SURFACE SPLINES
SET1         200     118     119     120     121     122     123     124+ROW01
+ROW01       125     126     127     128     129     130     131     132+ROW02
+ROW02       133     134     135     136     137     138     139     140+ROW03
+ROW03       141    1118    1119    1120    1121    1122    1123    1124+ROW04
+ROW04      1125    1126    1127    1128    1129    1130    1131    1132+ROW05
+ROW05      1133    1134    1135    1136    1137    1138    1139    1140+ROW06
+ROW06      1141    2118    2119    2120    2121    2122    2123    2124+ROW07
+ROW07      2125    2126    2127    2128    2129    2130    2131    2132+ROW08
+ROW08      2133    2134    2135    2136    2137    2138    2139    2140+ROW09
+ROW09      2141
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON H-TAIL
SET1         300     301     302     303     304     305     306     307+RHT01
+RHT01       308     309     310     311    1301    1302    1303    1304+RHT02
+RHT02      1305    1306    1307    1308    1309    1310    1311    2501+RHT03
+RHT03      2502    2503    2504    2505    2506    2507    2508    2509+RHT04
+RHT04      2510    2511
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON H-TAIL CONTROL SURFACE
SET1         350    2501    2502    2503    2504    2505    2506    2507+RHC01
+RHC01      2508    2509    2510    2511    2301    2302    2303    2304+RHC02
+RHC02      2305    2306    2307    2308    2309    2310    2311
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON V-TAIL
SET1         400     401     402     403     404     405     406     407+RVT01
+RVT01       408     409     410     411    1401    1402    1403    1404+RVT02
+RVT02      1405    1406    1407    1408    1409    1410    1411    2601+RVT03
+RVT03      2602    2603    2604    2605    2606    2607    2608    2609+RVT04
+RVT04      2610    2611
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON V-TAIL CONTROL SURFACE
```

```
SET1         450    2601    2602    2603    2604    2605    2606    2607+RVC01
+RVC01      2608    2609    2610    2611    2401    2402    2403    2404+RVC02
+RVC02      2405    2406    2407    2408    2409    2410    2411
$
$  GRIDS UTILIZED FOR LEFT-SIDE INBOARD WING SURFACE SPLINE
SET1         110     101    1101    2101    3000    3001    3002    3003+LIW01
+LIW01      3004    3005    3006    3007    3008    3009    3010    3011+LIW02
+LIW02      3012    3013    3014    3015    3016    3105    3106    3107+LIW03
+LIW03      3108    3109    3110    3111    3112    3113    3114    3115+LIW04
+LIW04      3116    3117    3118    3119    3120    3121    3167    3168+LIW05
+LIW05      3169    3170    3171    3172    3173    3174    3175    3176+LIW06
+LIW06      3177    3178    3179    3180    3181    3182    3183
$
SET1         210    3016    3017    3018    3019    3020    3021    3022+LOW01
+LOW01      3023    3024    3025    3026    3027    3028    3029    3030+LOW02
+LOW02      3031    3032    3033    3034    3035    3036    3037    3038+LOW03
+LOW03      3039    3121    3122    3123    3124    3125    3126    3127+LOW04
+LOW04      3128    3129    3130    3131    3132    3133    3134    3135+LOW05
+LOW05      3136    3137    3138    3139    3140    3141    3142    3143+LOW06
+LOW06      3144    3183    3184    3185    3186    3187    3188    3189+LOW07
+LOW07      3190    3191    3192    3193    3194    3195    3196    3197+LOW08
+LOW08      3198    3199    3200    3201    3202    3203    3204    3205+LOW09
+LOW09      3206
$
SET1         310    3083    3084    3085    3086    3087    3088    3089+LHT01
+LHT01      3090    3091    3092    3093    3145    3146    3147    3148+LHT02
+LHT02      3149    3150    3151    3152    3153    3154    3155    3401+LHT03
+LHT03      3402    3403    3404    3405    3406    3407    3408    3409+LHT04
+LHT04      3410    3411
$
SET1         360    3401    3402    3403    3404    3405    3406    3407+LHC01
+LHC01      3408    3409    3410    3411    3207    3208    3209    3210+LHC02
+LHC02      3211    3212    3213    3214    3215    3216    3217
$
SET1         410    3094    3095    3096    3097    3098    3099    3100+LVT01
+LVT01      3101    3102    3103    3104    3156    3157    3158    3159+LVT02
+LVT02      3160    3161    3162    3163    3164    3165    3166    3501+LVT03
+LVT03      3502    3503    3504    3505    3506    3507    3508    3509+LVT04
+LVT04      3510    3511
$
SET1         460    3501    3502    3503    3504    3505    3506    3507+LVC01
+LVC01      3508    3509    3510    3511    3218    3219    3220    3221+LVC02
+LVC02      3222    3223    3224    3225    3226    3227    3228
```

- **Program alterv4.dat**

```
compile  seaero list ref
ALTER 'IF ( EXTRCV=0 ) THEN',''
ALTER 'CALL SESUM '(1,+2),''
ALTER 'IF ( NOT(NOPH2 OR SAVERSTL) ) THEN',''
ALTER 'IF ( FOURIER ) THEN'(1,-3),''(1,-1)
ALTER 'CALL FDRMGEN  USET,VGFD'(1,-1),''
$ALTER 'DELETE /QHH,QHJ,QKH,,',''
ALTER 'TYPE PARM,,I,N,KCNT=1,CNTR=0,NOMKLIST=1,NUMI','' $
TYPE PARM,,I,N,KCNT,CNTR,NOMKLIST,NUMI $
TYPE PARM,,I,N,NSKIPPDF $
TYPE PARM,,I,Y,NSTRIPRM $
ALTER 'IF ( OPPHIB>=0 OR OPPHIPA>=0'
ENDIF $ NOEDTS>0
NSKIPPDF=0 $ INITIALIZE
COPY  AERO/AEROTEMP/ALWAYS/-1 $
COPY  CASES/CASETEMP/ALWAYS/-1 $
DO WHILE (NSKIPPDF<NSTRIPRM ) THEN $
NSKIPPDF=NSKIPPDF+1  $
```

```
$    CASE      CASECC,/CASE1/'TRAN'/S,N,NSKIPPDF $
$    PVT       PVT,CASE1//   $
$    PARAML    CASE1//'DTI'/1/1//S,N,SUBID  $
     MESSAGE   //' NSKIPPDF='/NSKIPPDF  $
CNTR=0 $ INITIALIZE
KCNT=1 $ INITIALIZE
NOMKLIST=1 $ INITIALIZE
DELETE /AERO,CASES,,, $
COPY AEROTEMP/AERO/ALWAYS/-1 $
COPY CASETEMP/CASES/ALWAYS/-1 $
DELETE /QHHL,QHJL,QKHL,, $
DELETE /QHHA,QHJA,QKHA,, $
$DELETE /QHH,QHJ,QKH,, $
DELETE /PPF,FOL,AUPF,AQPF,AQMPF $
DELETE /AUHF,QMGF,QSGF,PHF, $
DELETE /FOL1,PPF1,AULF,PSF1,AUHF1 $
DELETE /IUG1,IQG1,IEF1,IES1,IEE1 $
DELETE /IUG2,IQG2,IEF2,IES2,IEE2  $
ALTER 'CALL SUPER3  CASECC  ,        ,AULF'
ENDDO $ NSKIPPDFX>=0
ALTER 'AMP      AJJ0' $
DMIIN DMI,DMINDX/ISTRIP,,,,,,,,,/ $ USE MATRIX ISTRIP DEFINED IN DMI
MATMOD ISTRIP,,,,,/ISTRIP1COL,/1/NSKIPPDF $ SELECTS THE COLUMN FROM ISTRIP
$                                          $ BY THE INDEX NSTRIPPRM
MATMOD  ISTRIP1COL,,,,,/ISTRIPDIAG,/28 $ DIAGONALIZES THE ABOVE SELECTED COLUMN
$ MPYAD ISTRIP,QHJ,/QHJTEMP/ $ CREATE THE NEW QHJ CORRESPONDING TO THE STRIP
MPYAD ISTRIPDIAG,QHJ,/QHJTEMP/ $ CREATE THE NEW QHJ CORRESPONDING TO THE STRIP
DELETE /QHJ,,,, $
ADD QHJTEMP,/QHJ $
$matprn QHJ// $
ALTER 'MATMOD   AERO,QHHA,,,,/QHHL,/22'(1,-2)
     MESSAGE   //' KCNT='/KCNT/' NOMKLIST='/NOMKLIST/
                '  DOAMP='/ DOAMP  $
ALTER 'DOAMP = (NOQHH','IF ( DOAMP ) THEN'
     MESSAGE   //' NOQHJ='/NOQHJ/' NOQHH='/NOQHH/
                '  GUSTAERO='/ GUSTAERO  $
ALTER ') SDR1     ,,QHJ,,,,,,,,,/,QHJA,/CNTR/'(1,+1),''
endalter $
```

- **Program strip1440_left**

```
$dmi    istrip         0       2       2       2        M rows  N cols
dmi     istrip         0       2       2       2            1440      80
$left inner wing, out to in
dmi     istrip         1     7211.0D0   thru         728
dmi     istrip         2     7291.0D0   thru         736
dmi     istrip         3     7371.0D0   thru         744
dmi     istrip         4     7451.0D0   thru         752
dmi     istrip         5     7531.0D0   thru         760
dmi     istrip         6     7611.0D0   thru         768
dmi     istrip         7     7691.0D0   thru         776
dmi     istrip         8     7771.0D0   thru         784
dmi     istrip         9     7851.0D0   thru         792
dmi     istrip        10     7931.0D0   thru         800
dmi     istrip        11     8011.0D0   thru         808
dmi     istrip        12     8091.0D0   thru         816
dmi     istrip        13     8171.0D0   thru         824
dmi     istrip        14     8251.0D0   thru         832
dmi     istrip        15     8331.0D0   thru         840
dmi     istrip        16     8411.0D0   thru         848
dmi     istrip        17     8491.0D0   thru         856
$left outer wing, out to in
dmi     istrip        18     8571.0D0   thru         864
dmi     istrip        19     8651.0D0   thru         872
```

```
dmi     istrip        20     8731.0D0   thru         880
dmi     istrip        21     8811.0D0   thru         888
dmi     istrip        22     8891.0D0   thru         896
dmi     istrip        23     8971.0D0   thru         904
dmi     istrip        24     9051.0D0   thru         912
dmi     istrip        25     9131.0D0   thru         920
dmi     istrip        26     9211.0D0   thru         928
dmi     istrip        27     9291.0D0   thru         936
dmi     istrip        28     9371.0D0   thru         944
dmi     istrip        29     9451.0D0   thru         952
dmi     istrip        30     9531.0D0   thru         960
dmi     istrip        31     9611.0D0   thru         968
dmi     istrip        32     9691.0D0   thru         976
dmi     istrip        33     9771.0D0   thru         984
dmi     istrip        34     9851.0D0   thru         992
dmi     istrip        35     9931.0D0   thru        1000
dmi     istrip        36    10011.0D0   thru        1008
dmi     istrip        37    10091.0D0   thru        1016
dmi     istrip        38    10171.0D0   thru        1024
dmi     istrip        39    10251.0D0   thru        1032
dmi     istrip        40    10331.0D0   thru        1040
$left htail
dmi     istrip        41    10411.0D0   thru        1048    12011.0D0
        1.0D0
dmi     istrip        42    10491.0D0   thru        1056    12031.0D0
        1.0D0
dmi     istrip        43    10571.0D0   thru        1064    12051.0D0
        1.0D0
dmi     istrip        44    10651.0D0   thru        1072    12071.0D0
        1.0D0
dmi     istrip        45    10731.0D0   thru        1080    12091.0D0
        1.0D0
dmi     istrip        46    10811.0D0   thru        1088    12111.0D0
        1.0D0
dmi     istrip        47    10891.0D0   thru        1096    12131.0D0
        1.0D0
dmi     istrip        48    10971.0D0   thru        1104    12151.0D0
        1.0D0
dmi     istrip        49    11051.0D0   thru        1112    12171.0D0
        1.0D0
dmi     istrip        50    11131.0D0   thru        1120    12191.0D0
        1.0D0
dmi     istrip        51    11211.0D0   thru        1128    12211.0D0
        1.0D0
dmi     istrip        52    11291.0D0   thru        1136    12231.0D0
        1.0D0
dmi     istrip        53    11371.0D0   thru        1144    12251.0D0
        1.0D0
dmi     istrip        54    11451.0D0   thru        1152    12271.0D0
        1.0D0
dmi     istrip        55    11531.0D0   thru        1160    12291.0D0
        1.0D0
dmi     istrip        56    11611.0D0   thru        1168    12311.0D0
        1.0D0
dmi     istrip        57    11691.0D0   thru        1176    12331.0D0
        1.0D0
dmi     istrip        58    11771.0D0   thru        1184    12351.0D0
        1.0D0
dmi     istrip        59    11851.0D0   thru        1192    12371.0D0
        1.0D0
dmi     istrip        60    11931.0D0   thru        1200    12391.0D0
        1.0D0
$left vtail
```

```
dmi     istrip        61    12411.0D0   thru        1248    14011.0D0
        1.0D0
dmi     istrip        62    12491.0D0   thru        1256    14031.0D0
        1.0D0
dmi     istrip        63    12571.0D0   thru        1264    14051.0D0
        1.0D0
dmi     istrip        64    12651.0D0   thru        1272    14071.0D0
        1.0D0
dmi     istrip        65    12731.0D0   thru        1280    14091.0D0
        1.0D0
dmi     istrip        66    12811.0D0   thru        1288    14111.0D0
        1.0D0
dmi     istrip        67    12891.0D0   thru        1296    14131.0D0
        1.0D0
dmi     istrip        68    12971.0D0   thru        1304    14151.0D0
        1.0D0
dmi     istrip        69    13051.0D0   thru        1312    14171.0D0
        1.0D0
dmi     istrip        70    13131.0D0   thru        1320    14191.0D0
        1.0D0
dmi     istrip        71    13211.0D0   thru        1328    14211.0D0
        1.0D0
dmi     istrip        72    13291.0D0   thru        1336    14231.0D0
        1.0D0
dmi     istrip        73    13371.0D0   thru        1344    14251.0D0
        1.0D0
dmi     istrip        74    13451.0D0   thru        1352    14271.0D0
        1.0D0
dmi     istrip        75    13531.0D0   thru        1360    14291.0D0
        1.0D0
dmi     istrip        76    13611.0D0   thru        1368    14311.0D0
        1.0D0
dmi     istrip        77    13691.0D0   thru        1376    14331.0D0
        1.0D0
dmi     istrip        78    13771.0D0   thru        1384    14351.0D0
        1.0D0
dmi     istrip        79    13851.0D0   thru        1392    14371.0D0
        1.0D0
dmi     istrip        80    13931.0D0   thru        1400    14391.0D0
         1.0D0
```

- **Program strip1440_right**

```
$dmi    istrip         0       2       2       2        M rows  N cols
dmi     istrip         0       2       2       2            1440      80
$rt inner wing
$dmi    istrip  col     row star1.0D0   thru    row end
dmi     istrip         1       11.0D0   thru           8
dmi     istrip         2       91.0D0   thru          16
dmi     istrip         3      171.0D0   thru          24
dmi     istrip         4      251.0D0   thru          32
dmi     istrip         5      331.0D0   thru          40
dmi     istrip         6      411.0D0   thru          48
dmi     istrip         7      491.0D0   thru          56
dmi     istrip         8      571.0D0   thru          64
dmi     istrip         9      651.0D0   thru          72
dmi     istrip        10      731.0D0   thru          80
dmi     istrip        11      811.0D0   thru          88
dmi     istrip        12      891.0D0   thru          96
dmi     istrip        13      971.0D0   thru         104
dmi     istrip        14     1051.0D0   thru         112
dmi     istrip        15     1131.0D0   thru         120
```

```
dmi     istrip        16     1211.0D0   thru         128
dmi     istrip        17     1291.0D0   thru         136
$rt outer wg
dmi     istrip        18     1371.0D0   thru         144
dmi     istrip        19     1451.0D0   thru         152
dmi     istrip        20     1531.0D0   thru         160
dmi     istrip        21     1611.0D0   thru         168
dmi     istrip        22     1691.0D0   thru         176
dmi     istrip        23     1771.0D0   thru         184
dmi     istrip        24     1851.0D0   thru         192
dmi     istrip        25     1931.0D0   thru         200
dmi     istrip        26     2011.0D0   thru         208
dmi     istrip        27     2091.0D0   thru         216
dmi     istrip        28     2171.0D0   thru         224
dmi     istrip        29     2251.0D0   thru         232
dmi     istrip        30     2331.0D0   thru         240
dmi     istrip        31     2411.0D0   thru         248
dmi     istrip        32     2491.0D0   thru         256
dmi     istrip        33     2571.0D0   thru         264
dmi     istrip        34     2651.0D0   thru         272
dmi     istrip        35     2731.0D0   thru         280
dmi     istrip        36     2811.0D0   thru         288
dmi     istrip        37     2891.0D0   thru         296
dmi     istrip        38     2971.0D0   thru         304
dmi     istrip        39     3051.0D0   thru         312
dmi     istrip        40     3131.0D0   thru         320
$rt htail
dmi     istrip        41     3211.0D0   thru         328     4811.0D0
        1.0D0
dmi     istrip        42     3291.0D0   thru         336     4831.0D0
        1.0D0
dmi     istrip        43     3371.0D0   thru         344     4851.0D0
        1.0D0
dmi     istrip        44     3451.0D0   thru         352     4871.0D0
        1.0D0
dmi     istrip        45     3531.0D0   thru         360     4891.0D0
        1.0D0
dmi     istrip        46     3611.0D0   thru         368     4911.0D0
        1.0D0
dmi     istrip        47     3691.0D0   thru         376     4931.0D0
        1.0D0
dmi     istrip        48     3771.0D0   thru         384     4951.0D0
        1.0D0
dmi     istrip        49     3851.0D0   thru         392     4971.0D0
        1.0D0
dmi     istrip        50     3931.0D0   thru         400     4991.0D0
         1.0D0
dmi     istrip        51     4011.0D0   thru         408     5011.0D0
        1.0D0
dmi     istrip        52     4091.0D0   thru         416     5031.0D0
        1.0D0
dmi     istrip        53     4171.0D0   thru         424     5051.0D0
        1.0D0
dmi     istrip        54     4251.0D0   thru         432     5071.0D0
        1.0D0
dmi     istrip        55     4331.0D0   thru         440     5091.0D0
        1.0D0
dmi     istrip        56     4411.0D0   thru         448     5111.0D0
        1.0D0
dmi     istrip        57     4491.0D0   thru         456     5131.0D0
        1.0D0
dmi     istrip        58     4571.0D0   thru         464     5151.0D0
        1.0D0
```

```
dmi     istrip        59     4651.0D0   thru         472     5171.0D0
        1.0D0
dmi     istrip        60     4731.0D0   thru         480     5191.0D0
        1.0D0
$rt vtail
dmi     istrip        61     5211.0D0   thru         528     6811.0D0
        1.0D0
dmi     istrip        62     5291.0D0   thru         536     6831.0D0
        1.0D0
dmi     istrip        63     5371.0D0   thru         544     6851.0D0
        1.0D0
dmi     istrip        64     5451.0D0   thru         552     6871.0D0
        1.0D0
dmi     istrip        65     5531.0D0   thru         560     6891.0D0
        1.0D0
dmi     istrip        66     5611.0D0   thru         568     6911.0D0
         1.0D0
dmi     istrip        67     5691.0D0   thru         576     6931.0D0
        1.0D0
dmi     istrip        68     5771.0D0   thru         584     6951.0D0
        1.0D0
dmi     istrip        69     5851.0D0   thru         592     6971.0D0
        1.0D0
dmi     istrip        70     5931.0D0   thru         600     6991.0D0
        1.0D0
dmi     istrip        71     6011.0D0   thru         608     7011.0D0
        1.0D0
dmi     istrip        72     6091.0D0   thru         616     7031.0D0
        1.0D0
dmi     istrip        73     6171.0D0   thru         624     7051.0D0
        1.0D0
dmi     istrip        74     6251.0D0   thru         632     7071.0D0
        1.0D0
dmi     istrip        75     6331.0D0   thru         640     7091.0D0
        1.0D0
dmi     istrip        76     6411.0D0   thru         648     7111.0D0
        1.0D0
dmi     istrip        77     6491.0D0   thru         656     7131.0D0
        1.0D0
dmi     istrip        78     6571.0D0   thru         664     7151.0D0
        1.0D0
dmi     istrip        79     6651.0D0   thru         672     7171.0D0
        1.0D0
dmi     istrip        80     6731.0D0   thru         680     7191.0D0
```

APPENDIX E

MATLAB programs used in the frequency response analysis of the two-dimensional gust analysis of the Alliance airplane

- **Program calc_response.m**

```
function [freq,auto,psd,rms,no] = calc_response
%[FREQUENCY APS CPS,RMS,NO] = CALC_RESPONSE
% Calculates the power spctral density matrix. each column of the matrix is the % PSD
of one response quantity as a function of frequency. Case information data % should be
changed in the file 'case_info.data'
%
% See also READ_F06, READ_PCH, CASE_INFO.DATA

% read case information from file "case_info.data"

fid = fopen('case_info.data');
num_strips = fscanf(fid,'%*s %*s %*s %f',1);
num_frequencies = fscanf(fid,'%*s %*s %*s %f',1);
num_responses = fscanf(fid,'%*s %*s %*s %f',1);
sigmaw = fscanf(fid,'%*s %*s %*s %*s %f',1);
V = fscanf(fid,'%*s %*s %f',1);
L = fscanf(fid,'%*s %*s %*s %f',1);
f06_fname = fscanf(fid,'%*s %*s %*s %*s %s',1);
pch_fname = fscanf(fid,'%*s %*s %*s %*s %s',1);
sep_fname = fscanf(fid,'%*s %*s %*s %*s %s',1);

fclose(fid);
save case_info num_strips num_frequencies  num_responses sigmaw V L f06_fname
pch_fname sep_fname
case_info = load ('case_info.mat')

if strcmp(pch_fname,'none');
  [freq frf] = read_f06(f06_fname,num_strips,num_responses,num_frequencies); %read f06
data
else
  [freq frf] = read_pch(pch_fname,num_strips,num_responses,num_frequencies); %read
punch file data
end

%save 'frfdata' freq frf;
%load frfdata
omega = 2*pi*freq;

% read the coordinates of the centers of the strips

fid = fopen(sep_fname);
y = fscanf(fid,'%*s %*s %*d %f')';
fclose(fid);
%y=1e-9*y;
% calculate the separation distance between the ith and jth strips

for istrip = 1:num_strips
   s(istrip,:) = abs(y(istrip) - y);
end

% For each frequency calculate the PSD of the responces

for ifreq = 1:num_frequencies
   phi = gust_cross_spectra(omega(ifreq),L,V,s,sigmaw);
   frfi = squeeze(frf(ifreq,:,:));
   psd(ifreq,:,:) = frfi'*phi*frfi;
```

```
end
for iresp = 1:num_responses
   auto(:,iresp) = real(psd(:,iresp,iresp));
end
[rms no] = calc_statistics(freq,auto);
```

- **Program calc_statistics.m**

```
function [rms,no] = calc_statistics(freq,auto)
% [RMS No] = CALC_STATISTICS(FREQ,AUTO)
% Calculates the root mean square value (RMS) and the zero crossing rate (No)
% of the variables in that have the auto power spectral densities AUTO. Auto is
% arranged in column format (each aps in one column with the elements corresponding
% to the frequencies in FREQ).

% Caculate the rms values
% Generate tow matrices one for aps(j,i) and the other for aps(j,i+1) to take
advantage
% of the vectorization capabilities of Matlab

[n_frequencies n_vars] = size(auto);
autoi = auto(1:n_frequencies-1,:);
autoip1 = auto(2:n_frequencies,:);
freqmat = repmat(freq,1,n_vars);
freqi = freqmat(1:n_frequencies-1,:);
freqip1 = freqmat(2:n_frequencies,:);
ms = 0.5 * sum(((autoi+autoip1).*(freqip1-freqi)),1);
rms = sqrt(ms);
alpha = 3*freqi.^2 + 2*freqi.*freqip1 + freqip1.^2;
beta = freqi.^2 + 2*freqi.*freqip1 + 3*freqip1.^2;
r = sqrt(sum(((alpha.*autoi+beta.*autoip1).*(freqip1-freqi)),1)/12);
no = r./rms;
```

- **Program gust_cross-spectra.m**

```
function phi12 = gust_cross_spectra(omega,L,V,s,sigmaw)
% PHI12 = GUST_CROSS_SPECTRA(OMEGA,L,V,S,SIGMAW)
% CALCULATES THE TWO DIMENSIONAL GUST LOAD CROSS SPECTRA BETWEEN TWO
% STRIPS A WITH A SEPARATION DISTANCE S. OMEGA IS THE FREQUENCY, V IS THE VELOCITY,
% L IS THE GUST SCALE OF TURBULANCE, AND SIGMAW IS THE RMS VALUE OF THE GUST VELOSITY.
sigma = s/L;
r = sigma==0;
sigma = sigma+r;
nu = omega * L / V;
z = sigma .* sqrt(1 + ( 1.339 .* nu ) .^ 2 ) / 1.339;
phi12 = sqrt(2*pi)*sigmaw^2 * 2^(2/3) *L/( V * gamma(1/3) * (1.339) ^ (8/3) ) ...
      * (8*1.3339^2 * sigma .^ (5/3) .* besselk((5/6),z) ./ (3 * z .^ (5/6) ) ...
       - sigma .^ (11/3) .* besselk((11/6),z) ./ z .^ (11/6) );
phiii = 2 *sigmaw^2 * L/V * ( 1 + 8/3 *( 1.339 * nu ) .^ 2 ) ...
        ./ ( 1 + (1.339 * nu ) .^ 2 ) .^ (11/6);
phi12 = phi12 - r.* phi12 + r * phiii;
```

- **Program read_pch.m**

```
function [frequency,frf] = read_pch(fname,num_strips,num_responses,num_frequencies)
% [FREQUENCY RESP] = READ_PCH(PCH FILE NAME, NUMBER OF STRIPS, NUMBER OF RESPONCES,
NUMBER OF FREQUENCIES)
% Reads the data in the punch file and stores it into a 3-d array with the following
index order
% (frequency index,strip number index, response index)

fp = fopen(fname);
```

```
% Loop over the strips

for istrip = 1:num_strips

  % Loop over the responses

  for iresponse = 1:num_responses

    % skip header line that which is not needed

    line = fscanf(fp, '%*s %*s %*d %*d %*d %d',1);

    % read the real part of the response

    data = fscanf(fp, '%f %f', [4 num_frequencies]);
    data1 = data(3,:);

    % Skip header line which is not needed

    line = fscanf(fp, '%*s %*s %d %d %d %d',[1 4]);

    % read the imaginary part of the data

    data = fscanf(fp, '%f %f', [4 num_frequencies]);

    % Arrange the data in a 3-d array (frequency index, strip number index, response
index)

    frf(:,istrip,iresponse) = data1 + i*data(3,:);

  % Close looping over the response
  end

% Close looping over the strip number
end

%close the data file
fclose(fp);

% Write the frequency vector

frequency = data(2,:)';
```

- **Program read_f06.m**

```
function [frequency,frf] = read_f06(fname,num_strips,num_responses,num_frequencies)
% RESP = READ_F06(F06 FILE NAME, NUMBER OF STRIPS, NUMBER OF RESPONCES, NUMBER OF
FREQUENCIES)
% Reads the data in the f06 file and stores it into a 3-d array with the following
index order
% (frequency index,strip number index, response index)

fp = fopen(fname);

line=zeros(1,40);
x = char(line(29:40));
y = 'PRINT NUMBER';

% Loop over the strips

for istrip = 1:num_strips

  % Loop over the responses
```

```
  for iresponse = 1:num_responses

    % skip text lines that which not needed

    line=zeros(1,40);
    x = char(line(29:40));
    while ~ strcmp(x,y);
      line = fgetl(fp);
      if length(line) < 40 ; line = zeros(1,40);end
      x = char(line(29:40));
    end

    % read the magnitude of the response

    data = fscanf(fp, '%f %f', [3 num_frequencies]);
    data1 = data(3,:);

    % Skip text lines which are not needed

    line=zeros(1,40);
    x = char(line(29:40));
    while ~ strcmp(x,y);
      line = fgetl(fp);
      if length(line) < 40 ; line = zeros(1,40);end
      x = char(line(29:40));
    end

    % read the phase of the data

    data = fscanf(fp, '%f %f', [3 num_frequencies]);

    % Arrange the data in a 3-d array (frequency index, strip number index, response
index)

    frf(:,istrip,iresponse) = data1 + i*data(3,:);

  % Close looping over the response
  end

% Close looping over the strip number
end

%close the data file
fclose(fp);

% Write the frequency vector

frequency = data(2,:)';
```

- **Program case_info.data**

```
number of strips              160
number of frequencies         201
number of responses           40
rms of gust velocity          1
forward velocity              1179.6
gust scale length             12000
nastran f06 file name         none
nastran pch file name
/home0/naser/Nastran_results/1440noskip/k_10/gustv5_span.pch
strip coordinate file name    yspan160_0
```

- **Program yspan160**

```
Box no.   1    6.57353
Box no.   9    19.7206
Box no.   17    32.8676
Box no.   25    46.0147
Box no.   33    59.1618
Box no.   41    72.3088
Box no.   49    85.4559
Box no.   57    98.6029
Box no.   65    111.750
Box no.   73    124.897
Box no.   81    138.044
Box no.   89    151.191
Box no.   97    164.338
Box no.   105    177.485
Box no.   113    190.632
Box no.   121    203.779
Box no.   129    216.926
Box no.   137    230.065
Box no.   145    243.196
Box no.   153    256.326
Box no.   161    269.457
Box no.   169    282.587
Box no.   177    295.717
Box no.   185    308.848
Box no.   193    321.978
Box no.   201    335.109
Box no.   209    348.239
Box no.   217    361.370
Box no.   225    374.500
Box no.   233    387.630
Box no.   241    400.761
Box no.   249    413.891
Box no.   257    427.022
Box no.   265    440.152
Box no.   273    453.283
Box no.   281    466.413
Box no.   289    479.543
Box no.   297    492.674
Box no.   305    505.804
Box no.   313    518.935
Box no.   321    527.875
Box no.   329    532.625
Box no.   337    537.375
Box no.   345    542.125
Box no.   353    546.875
Box no.   361    551.625
Box no.   369    556.375
Box no.   377    561.125
Box no.   385    565.875
Box no.   393    570.625
Box no.   401    575.375
Box no.   409    580.125
Box no.   417    584.875
Box no.   425    589.625
Box no.   433    594.375
Box no.   441    599.125
Box no.   449    603.875
Box no.   457    608.625
Box no.   465    613.375
Box no.   473    618.125
Box no.   521    497.225
Box no.   529    498.675
```

Box no.	537	500.125
Box no.	545	501.575
Box no.	553	503.025
Box no.	561	504.475
Box no.	569	505.925
Box no.	577	507.375
Box no.	585	508.825
Box no.	593	510.275
Box no.	601	511.725
Box no.	609	513.175
Box no.	617	514.625
Box no.	625	516.075
Box no.	633	517.525
Box no.	641	518.975
Box no.	649	520.425
Box no.	657	521.875
Box no.	665	523.325
Box no.	673	524.775
Box no.	721	-216.926
Box no.	729	-203.779
Box no.	737	-190.632
Box no.	745	-177.485
Box no.	753	-164.338
Box no.	761	-151.191
Box no.	769	-138.044
Box no.	777	-124.897
Box no.	785	-111.750
Box no.	793	-98.6029
Box no.	801	-85.4559
Box no.	809	-72.3088
Box no.	817	-59.1618
Box no.	825	-46.0147
Box no.	833	-32.8676
Box no.	841	-19.7206
Box no.	849	-6.57353
Box no.	857	-518.935
Box no.	865	-505.804
Box no.	873	-492.674
Box no.	881	-479.543
Box no.	889	-466.413
Box no.	897	-453.283
Box no.	905	-440.152
Box no.	913	-427.022
Box no.	921	-413.891
Box no.	929	-400.761
Box no.	937	-387.630
Box no.	945	-374.500
Box no.	953	-361.370
Box no.	961	-348.239
Box no.	969	-335.109
Box no.	977	-321.978
Box no.	985	-308.848
Box no.	993	-295.717
Box no.	1001	-282.587
Box no.	1009	-269.457
Box no.	1017	-256.326
Box no.	1025	-243.196
Box no.	1033	-230.065
Box no.	1041	-618.125
Box no.	1049	-613.375
Box no.	1057	-608.625
Box no.	1065	-603.875
Box no.	1073	-599.125

Box no.	1081	-594.375
Box no.	1089	-589.625
Box no.	1097	-584.875
Box no.	1105	-580.125
Box no.	1113	-575.375
Box no.	1121	-570.625
Box no.	1129	-565.875
Box no.	1137	-561.125
Box no.	1145	-556.375
Box no.	1153	-551.625
Box no.	1161	-546.875
Box no.	1169	-542.125
Box no.	1177	-537.375
Box no.	1185	-532.625
Box no.	1193	-527.875
Box no.	1241	-524.775
Box no.	1249	-523.325
Box no.	1257	-521.875
Box no.	1265	-520.425
Box no.	1273	-518.975
Box no.	1281	-517.525
Box no.	1289	-516.075
Box no.	1297	-514.625
Box no.	1305	-513.175
Box no.	1313	-511.725
Box no.	1321	-510.275
Box no.	1329	-508.825
Box no.	1337	-507.375
Box no.	1345	-505.925
Box no.	1353	-504.475
Box no.	1361	-503.025
Box no.	1369	-501.575
Box no.	1377	-500.125
Box no.	1385	-498.675
Box no.	1393	-497.225

APPENDIX F

MSC/NASTRAN files used in the frequency response analysis of the BAH wing under two-dimensional gust loads

- **Program ha146c_full2.dat**

```
$ DEC/CMS REPLACEMENT HISTORY, Element HA146C.DAT
$ *2     6-JUL-1994 14:13:13 A_BOYADJIAN "68 PLUS/G/ CHANGE DBSDIR: TO TPLDIR: FOR
INCLUDE CARDS"
$ *1     5-JUL-1994 17:05:32 A_BOYADJIAN "68 PLUS/G/ NEW FOR V68 AERO_SS BOOK"
$ DEC/CMS REPLACEMENT HISTORY, Element HA146C.DAT
ID MSC, HA146C $ E_JOHNSON V68  5-JUL-1994
$ID MSC,HA146C
$$$$$$$$           HANDBOOK FOR AEROELASTIC ANALYSIS EXAMPLE            $$$$$$$$
$                                                                              $
$       MODEL DESCRIPTION       BAH JET TRANSPORT WING EXAMPLE                 $
$                               USING A STIFF AILERON. RESPONSE                $
$                               TO TWO DIMENSIONAL RANDOM GUST.                $
$                                                                              $
$       SOLUTION                AEROELASTIC RESPONSE USING THE DOUBLET-LATTICE $
$                               METHOD AERODYNAMICS AT MACH NO. OF 0           $
$                               AND CORRELATION STRIPS WITH A DMAP ALTER       $
$                                                                              $
$       OUTPUT                  XY PLOTS OF GRID POINT LOADS AND               $
$                               ACCELERATIONS                                  $
$                                                                              $
$$$$$$$$                                                             $$$$$$$$
TIME 30   $ CPU TIME IN MINUTES
SOL 146   $ DYNAMIC AEROELASTIC RESPONSE
include 'alterv4.dat'
CEND
LINE = 99999
TITLE = BAH JET TRANSPORT WING DYNAMIC ANALYSIS HA146C
LABEL = RESPONSE TO TWO DIMENSIONAL GUST
ECHO = NONE
  METHOD = 1              $ SINV EIGENVALUE EXTRACTION METHOD
  SDAMP  = 2000           $ STRUCTURAL DAMPING (2 PERCENT SPECIFIED)
  FREQUENCY  = 40         $ FREQUENCY LIST
  RANDOM = 1031           $ PSD SPECIFICATION (RANDPS)
  K2PP   = STIFF          $ DMIG STIFFNESS
OUTPUT
 SET 1 = 11
SUBCASE 1
  PARAM, NSTRIPRM, 11
  LABEL =  RANDOM GUST ANALYSIS
  GUST  = 1005            $ APPLY THE RANDOM GUST
OUTPUT(XYOUT)             $ FREQ RESP PACKAGE (COMPLEX NUMBERS)
$$$$$$$$$$$$$$$$$$$$
  XYPRINT,XYPUNCH  ELFORCE    RESPONSE / 802(5,12)
  XYPRINT,XYPUNCH  ELFORCE    RESPONSE / 803(5,12)
  XYPRINT,XYPUNCH  ACCE       RESPONSE / 11(T3RM,T3IP)
  XYPRINT,XYPUNCH  ACCE       RESPONSE / 10(T3RM,T3IP)
$
BEGIN BULK
SUPORT  11      345
include 'BAH_strip'
$
INCLUDE 'bahstru_full2.dat'
$
$
$        TABDMP1 DEFINES DAMPING COEFFICIENTS (G1) VERSES FREQUENCY (F1).
$        (3 PERCENT STRUCTURAL DAMPING IS SPECIFIED OVER THE ENTIRE FREQUENCY
```

```
$        RANGE. VALUES ARE LINEARLY INTERPOLATED AND EXTRAPOLATED. A 2%
$        STRUCTURAL DAMPING IS ROUGHLY EQUIVALENT TO 1.5% CRITICAL DAMPING.)
$
$       ID      TYPE
TABDMP1 2000      G                                                     +TABDMP
+TABDMP 0.      .02     10.     .02     ENDT
$
$* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
$
$                  * * DYNAMIC LOAD AND RESPONSE DATA * *
$
$        GUST DEFINES A STATIONARY VERTICAL GUST.  LISTED ARE T/RLOAD ENTRY
$        ID, RATIO OF GUST VEL/VEHICLE VEL, LOCATION OF THE GUST WITH RESPECT
$        TO THE ORIGIN OF THE AERO COORDINATE SYSTEM AND VEHICLE VELOCITY.
$
$       SID     DLOAD   WG      X0      V
GUST    1005    3002    .001435  0.     8360.
$
$        RLOAD1 DEFINES A FREQUENCY DEPENDENT DYNAMIC LOAD.  LISTED ARE
$        THE ID, DAREA ID, DELAY ID, DPHASE ID AND TABLEDI ENTRIES.
$
$       SID     L       M       N       TC      TD
RLOAD1  3002    3003                    3004
$
$        DAREA DEFINES THE DOF WHERE THE LOAD IS APPLIED AND A SCALE FACTOR.
$
$       SID     P       C       A
DAREA   3003    11              1.
$
$        TABLED1 DEFINES A TABULAR FUNCTION OF A FREQUENCY-DEPENDENT LOAD.
$
$       SID
TABLED1 3004                                                          +T1004
$       X1      Y1      X2      Y2      ETC.
+T1004  0.      0.      0.001   1.0     10.0    1.0     ENDT
$
$        RANDPS DEFINES POWER SPECTRAL DENISITY FACTORS FOR RANDOM
$        ANALYSIS. LISTED ARE EXCITED AND APPLIED LOAD SET IDS AND
$        THEIR SCALE FACTORS.
$
$       SID     J       K       X       Y       TID
RANDPS  1031    1       1       1.0     0.      1032
$
$  VON KARMAN GUST WITH (L/U)=0.7180 SEC., AND WG=1.0 IN/SEC
TABRNDG 1032    1        0.7180 1.0
$* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
$
$                       * * * AERODYNAMIC DATA * * *
$
$                (THIS MODEL USES THE LB-IN-SEC SYSTEM)
$
$                        * * ELEMENT GEOMETRY * *
$
$        THE AERO ENTRY DEFINES BASIC AERODYNAMIC PARAMETERS. ACSID IS THE
$        AERO COORDINATE SYSTEM. VELOCITY. REFC IS THE REFERENECE
$        COORDINATE SYSTEM. RHOREF IS REFERENCE DENSITY. SYMXZ AND
$        SYMXY ARE SYMMETRY KEYS.
$
$       ACSID   VELOCITY REFC   RHOREF  SYMXZ   SYMXY
AERO    0       8360.   131.232 1.1468-70       0
$
INCLUDE 'bahaero_full2.dat'
$
```

```
$        THE MKAERO1 ENTRY DEFINES COMBINATIONS OF MACH NUMBER AND REDUCED
$        FREQUENCY EACH OF WHICH WILL BE USED TO GENERATE A MATRIX OF
$        GENERALIZED AERODYNAMIC FORCES.
$
$       M1      M2      M3      M4      ETC
MKAERO1 .62                                                             +MK
$       K1      K2      K3      K4      ETC
+MK     0.001   0.05    0.10    0.20    0.50    1.0     2.0
$
$       PARAM,GUSTAERO,-1 IS REQUIRED IF GUST LOADS ARE TO BE COMPUTED.
$
PARAM   GUSTAERO -1
$
$       PARAM,M SPECIFIES MACH NUMBER.
$
PARAM   M       0.62
$
$       PARAM,Q SPECIFIES DYNAMIC PRESSURE.
$
PARAM   Q       4.00747
$       PARAM LMOD SPECIFIES THE NUMBER OF MODES TO BE INCLUDED
$
PARAM, LMODES, 10  $INCLUDE THE FIRST 10 MODES
$
PARAM, DDRMM, -1
$* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
$
$               * * VIBRATION AND FREQUENCY RESPONSE DATA * *
$
$        EIGR DEFINES EIGENVALUE EXTRACTION DATA.  LISTED ARE THE
$        EIGENVALUE EXTRACTION METHOD, FREQUENCY RANGE, NUMBER OF
$        EXPECTED AND DESIRED ROOTS AND THE METHOD OF NORMALIZATION.
$
$       SID     METHOD  F1      F2      NE      ND
EIGR    1       SINV    0.0     25.0            30
$
$        FREQ AND FREQ1 DEFINE THE SET OF FREQUENCIES USED TO OBTAIN
$        THE FREQUENCY RESPONSE SOLUTION.  FREQ LISTS ARBITRARILY
$        SPACED FREQUENCIES.  FREQ1 PROVIDES EQUALLY SPACED FREQUENCIES
$        BY SPECIFYING THE STARTING FREQUENCY, THE FREQUENCY INCREMENT
$        AND NUMBER OF INCREMENTS.
$
$       SID     F1      DF      NDF
FREQ1   40      0.05    0.05    350
$
$* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
$
$       THE EPOINT ENTRY DEFINES AN "EXTRA" POINT IN THE MODEL.
$
EPOINT  50
$
$        DISJOINT DOF ADDED TO THE STRUCTURAL STIFFNESS MATRIX
$        WHICH IS USED TO CHECK THE INPUT GUST PSD.
$
$       NAME    "0"     IFO     TIN     TOUT    POLAR           NCOL
DMIG    STIFF   0       6       1       0
DMIG    STIFF   50      0               50      0       1.
$
$* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
ENDDATA
```

- **Program bahstru_full2.dat**

```
$*** * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * ***$
$                                                                      $
$                     * * * STRUCTURAL DATA * * *                      $
$                                                                      $
$                        (LB-IN-SEC SYSTEM)                            $
$                                                                      $
$                       * * GRID GEOMETRY * *                          $
$                                                                      $
$                                                                      $
$   RIGHT HAND SIDE
$       ID      CP      X1      X2      X3      CD      PS      SEID
GRID    1               -20.25  90.                     12456
GRID    2                81.    90.                     12456
GRID    3               -17.85  186.                    12456
GRID    4                71.4   186.                    12456
GRID    5               -15.8   268.                    12456
GRID    6                63.2   268.                    12456
GRID    7               -13.3   368.                    12456
GRID    8                53.2   368.                    12456
GRID    9               -11.05  458.                    12456
GRID    10               44.2   458.                    12456
GRID    11               0.0    0.                      126
GRID    12               0.0    45.                     126
$                                                                      $
$   LEFT HAND SIDE
GRID    91              -20.25  -90.                    12456
GRID    92               81.    -90.                    12456
GRID    93              -17.85  -186.                   12456
GRID    94               71.4   -186.                   12456
GRID    95              -15.8   -268.                   12456
GRID    96               63.2   -268.                   12456
GRID    97              -13.3   -368.                   12456
GRID    98               53.2   -368.                   12456
GRID    99              -11.05  -458.                   12456
GRID    910              44.2   -458.                   12456
GRID    911              0.0    0.                      126
GRID    912              0.0    -45.                    126
$                                                                      $
$                 * * STRUCTURAL STIFFNESS PROPERTIES * *              $
$                                                                      $
$                  * FLEXIBILITY INFLUENCE COEFFICIENTS *              $
$                                                                      $
$        THE GENEL ENTRY DEFINES A GENERAL ELEMENT IN TERMS OF ITS     $
$        STRUCTURAL INFLUENCE COEFFICIENTS.  IT LISTS THE ELEMENT      $
$        ID NO. AND PAIRS OF GRID POINT NUMBERS PLUS THEIR UNCON-      $
$        STRAINED DOFS.  THIS IS FOLLOWED BY THE CORRESPONDING PAIRS   $
$        THAT WERE CONSTRAINED TO OBTAIN THE INFLUENCE COEFFICIENTS.   $
$        THIS IS FOLLOWED BY THE LOWER TRIANGULAR PART OF THE MATRIX   $
$        OF INFLUENCE COEFFICIENTS.  FINALLY, A MATRIX OF GEOMETRIC    $
$        CONSTANTS IS LISTED.  THESE CONSTANTS PRODUCE TOTAL FORCES    $
$        AND MOMENTS DUE TO DEFLECTIONS IN EACH MODE, IN THIS CASE     $
$        LIFT, ROLLING MOMENT, PITCHING MOMENT AND WING ROOT BENDING   $
$        MOMENT.                                                       $
$                                                                      $
$   RIGHT HAND SIDE
$       EID             UI1     CI1     UI2     CI2     UI3     CI3
GENEL   432             1       3       2       3       3       3       +01
+01     4       3       5       3       6       3       7       3       +02
+02     8       3       9       3       10      3                       +03
$      "UD"             UD1     CD1     UD2     CD2     UD3     CD3
+03     UD              11      3       11      4       11      5       +04
$    "K"|"Z"    Z11     Z21     Z31     ETC      (BY COLUMNS)
```

```
+04     Z       8.7172-61.3361-61.2778-56.2720-61.6251-51.0492-52.0478-5+05
+05     1.5630-52.4285-52.0403-53.0861-56.2720-63.2297-51.0492-53.3529-5+06
+06     1.5630-53.5021-52.0257-53.5785-52.7732-51.5726-54.8255-53.7628-5+07
+07     7.3284-56.4338-59.5810-58.8378-56.3749-53.7628-58.0136-56.4338-5+08
+08     1.0012-48.8378-51.1811-41.2758-41.1344-41.9350-41.8160-42.5283-4+09
+09     2.4294-41.6999-41.8160-42.2920-42.4294-42.8249-43.6862-43.5052-4+10
+10     5.2675-45.1171-44.2292-45.1171-45.7187-48.4840-48.2340-49.2340-4+11
$      "S"      S11     S12     S13     ETC      (BY ROWS)
+11     S       1.0     90.0    20.25   1.0     90.0    -81.0   1.0     +12
+12     186.0   17.85   1.0     186.0   -71.41  1.0     268.0   15.80   +13
+13     1.0     268.0   -63.2   1.0     368.0   13.3    1.0     368.0   +14
+14     -53.2   1.0     458.0   11.05   1.0     458.0   -44.2
$                                                                       $
$   LEFT HAND SIDE
$       EID             UI1     CI1     UI2     CI2     UI3     CI3
GENEL   9432            91      3       92      3       93      3       +901
+901    94      3       95      3       96      3       97      3       +902
+902    98      3       99      3       910     3                       +903
$      "UD"             UD1     CD1     UD2     CD2     UD3     CD3
+903    UD              911     3       911     4       911     5       +904
$    "K"|"Z"    Z11     Z21     Z31     ETC      (BY COLUMNS)
+904    Z       8.7172-61.3361-61.2778-56.2720-61.6251-51.0492-52.0478-5+905
+905    1.5630-52.4285-52.0403-53.0861-56.2720-63.2297-51.0492-53.3529-5+906
+906    1.5630-53.5021-52.0257-53.5785-52.7732-51.5726-54.8255-53.7628-5+907
+907    7.3284-56.4338-59.5810-58.8378-56.3749-53.7628-58.0136-56.4338-5+908
+908    1.0012-48.8378-51.1811-41.2758-41.1344-41.9350-41.8160-42.5283-4+909
+909    2.4294-41.6999-41.8160-42.2920-42.4294-42.8249-43.6862-43.5052-4+910
+910    5.2675-45.1171-44.2292-45.1171-45.7187-48.4840-48.2340-49.2340-4+911
$      "S"      S11     S12     S13     ETC      (BY ROWS)
+911    S       1.0     -90.0   20.25   1.0     -90.0   -81.0   1.0     +912
+912    -186.0  17.85   1.0     -186.0  -71.41  1.0     -268.0  15.80   +913
+913    1.0     -268.0  -63.2   1.0     -368.0  13.3    1.0     -368.0  +914
+914    -53.2   1.0     -458.0  11.05   1.0     -458.0  -44.2
$
$
$                                                                       $
$                 * * MASS AND INERTIA PROPERTIES * *                  $
$                                                                       $
$                           * WING MASSES *                            $
$                                                                       $
$        THE CMASS2 ENTRY DEFINES A SCALAR MASS ELEMENT WITHOUT         $
$        REFERENCE TO A PROPERTY ENTRY.  IT LISTS THE MASS, THE         $
$        GRID NO. AND ITS DOF COMPONENTS.  WHEN TWO GRID POINTS         $
$        ARE LISTED THE MASS IS ADDED TO BOTH POINTS.                   $
$                                                                       $
$  RIGHT HAND SIDE
$
$       EID     M       G1      C1      G2      C2
CMASS2  101     5248.7  1       3
CMASS2  102     134.9   1       3       2       3
CMASS2  103     790.3   2       3
CMASS2  201     9727.   3       3
CMASS2  202     11005.  3       3       4       3
CMASS2  203     473.    4       3
CMASS2  301     3253.6  5       3
CMASS2  302     -139.7  5       3       6       3
CMASS2  303     946.3   6       3
CMASS2  401     2617.8  7       3
CMASS2  402     21.     7       3       8       3
CMASS2  403     782.3   8       3
CMASS2  501     494.8   9       3
CMASS2  502     -7.3    9       3       10      3
CMASS2  503     185.2   10      3
```

```
CMASS2  113     0.005   11      3
CMASS2  114     0.005   11      4
CMASS2  115     0.005   11      5
$                                                                       $
$  LEFT HAND SIDE
$
$
$       EID     M       G1      C1      G2      C2
CMASS2  9101    5248.7  91      3
CMASS2  9102    134.9   91      3       92      3
CMASS2  9103    790.3   92      3
CMASS2  9201    9727.   93      3
CMASS2  9202    11005.  93      3       94      3
CMASS2  9203    473.    94      3
CMASS2  9301    3253.6  95      3
CMASS2  9302    -139.7  95      3       96      3
CMASS2  9303    946.3   96      3
CMASS2  9401    2617.8  97      3
CMASS2  9402    21.     97      3       98      3
CMASS2  9403    782.3   98      3
CMASS2  9501    494.8   99      3
CMASS2  9502    -7.3    99      3       910     3
CMASS2  9503    185.2   910     3
CMASS2  9113    0.005   911     3
CMASS2  9114    0.005   911     4
CMASS2  9115    0.005   911     5

$                 * FUSELAGE MASS AND INERTIA VALUES *                  $
$                                                                       $
$        THE CONM1 ENTRY DEFINES A 6 BY 6 SYMMETRIC INERTIA MATRIX      $
$        FOR A GRID POINT.  LISTED IS THE ID, THE GRID POINT NO.,       $
$        THE COORDINATE SYSTEM IN WHICH THE INERTIA MATRIX IS           $
$        DEFINED AND THE LOWER LEFT TRIANGULAR PART OF THE MATRIX.      $
$
$  RIGHT HAND SIDE
$
$       EID     G       CID     M11     M21     M22     M31     M32
CONM1   1       12                                                      +51
$       M33     M41     M42     M43     M44     M51     M52     M53
+51     17400.                          8.47+6                          +52
$       M54     M55     M61     M62     M63     M64     M65     M66
+52             4.35+09
$                                                                       $
$  LEFT HAND SIDE
$       EID     G       CID     M11     M21     M22     M31     M32
CONM1   2       912                                                     +53
$       M33     M41     M42     M43     M44     M51     M52     M53
+53     17400.                          8.47+6                          +54
$       M54     M55     M61     M62     M63     M64     M65     M66
+54             4.35+09

$                     * * STRUCTURAL PARAMETERS * *                     $
$                                                                       $
$        THE PARAM,WTMASS,GINV CAUSES ALL THE STRUCTURAL MASSES AND     $
$        MASS DENSITIES TO BE MULTIPLIED BY GINV (I.E., BY ONE OVER     $
$        THE ACCELERATION OF GRAVITY).  THE DYNAMIC PRESSURE SUPPLIED   $
$        FOR AERODYNAMIC FORCE CALCULATIONS WILL NOT BE MULTIPLIED      $
$        BY GINV.                                                       $
$                                                                       $
PARAM   WTMASS  .0025907
$                                                                       $
$        THE PARAM,GRDPNT,XX ENTRY CAUSES THE GRID POINT WEIGHT         $
$        GENERATOR TO BE EXECUTED USING GRID POINT XX AS THE REF-       $
```

```
$        ERENCE POINT.  THEN THE INERTIA MATRIX, THE TRANSFER MATRIX    $
$        FROM BASIC TO PRINCIPAL AXES AND OTHER PERTINENT INERTIA       $
$        DATA ARE PRINTED.                                              $
$                                                                       $
PARAM   GRDPNT  11
$                                                                       $
$
$CBARS AMD MAT1S
$CBAR    45      10      11      12      -1.0    0.0     0.0
$CBAR    945     10      11      912     1.0     0.0     0.0
$PBAR    10      10      1.0             1.0     1.0
$2345678$2345678$2345678$2345678$2345678$2345678$2345678$2345678
pbeam    10      10      1.0     1.0     1.0             1.0
pbeam    11      11      1.0     1.0     1.0             1.0
cbeam    801     11      912     12      -1.0    0.0     0.0
cbeam    802     10      11      12      -1.0    0.0     0.0
cbeam    803     10      911     912      1.0    0.0     0.0
MAT1    10      1.+14           0.33
MAT1    11      1.+20           0.33
$RBE2    801     12      345     912
```

- **bahaero_full2.dat**

```
$        THIS CORD2R ENTRY DEFINES THE AERO COORDINATE SYSTEM           $
$        FLAGGED BY THE AERO ENTRY.  LISTED ARE THE ORIGIN, A           $
$        POINT ALONG THE Z AXIS AND A POINT IN THE X-Z PLANE,           $
$        ALL IN THE RID COORDINATE SYSTEM.  NOTE THAT IN THIS           $
$        COORDINATE SYSTEM THE UPSIDE DOWN AND BACKWARDS STRUC-         $
$        TURE WILL FLY UPSIDE UP AND FORWARD.                           $
$                                                                       $
$       CID     RID     A1      A2      A3      B1      B2      B3
$CORD2R  1               0.      0.      0.      0.      0.      -1.     +C1
$       C1      C2      C3
$+C1     -1.     0.      0.
$
$        THE CAERO1 ENTRY IS USED FOR DOUBLET-LATTICE AERODYNAMICS.     $
$        LISTED ARE ITS PAERO ENTRY ID AND THE COORDINATE SYSTEM        $
$        FOR LOCATING THE INBOARD AND OUTBOARD LEADING EDGE POINTS      $
$        (1 AND 4).  NSPAN AND NCHORD, OR LSPAN AND LCHORD, ARE         $
$        USED TO PARTITION THE WING INTO AERODYNAMIC BOXES, THE         $
$        FORMER FOR UNIFORMLY SPACED BOXES AND THE LATTER FOR           $
$        NON-UNIFORMLY SPACED BOXES.  IGID IS THE ID OF ITS             $
$        ASSOCIATED INTERFERENCE GROUP.  THE CONTINUATION ENTRY         $
$        DEFINES POINTS 1 AND 2, THE ROOT CHORD AND THE TIP CHORD.      $
$        THE BOXES FORMED BY THE GRID LINES WILL BE NUMBERED            $
$        BEGINNING WITH EID, SO A NUMBER SHOULD BE CHOSEN THAT IS       $
$        UNIQUE, AND IS GREATER THAN ALL STRUCTURAL GRID, SCALAR        $
$        AND EXTRA POINT IDS.                                           $
$ RHS
$                                                                 $
$       EID     PID     CP      NSPAN   NCHORD  LSPAN   LCHORD  IGID    +CA
CAERO1  1001    1000    0               5       77              1       +CA1
$       (FWD INBOARD POINT)   ROOTCHORD  (FWD OUTBOARD POINT) TIP CHORD
+CA1    -78.75  0.0     0.0     225.0   -35.0   500.0   0.0     100.0
$
$ LHS
$                                                                   $
CAERO1  2001    1000    0               5       77              1       +CA2
+CA2    -78.75  0.0     0.0     225.0   -35.0   -500.0  0.0     100.0
$
$        THE AEFACT ENTRY IS A UTILITY ENTRY USED TO SPECIFY LISTS OF   $
$        NUMBERS.  THE CAERO1 ENTRY IDENTIFIES THEM BY LSPAN AND LCHORD.$
$        THIS AEFACT ENTRY AND ITS CONTINUATION CARD CONTAIN SIX FIELDS $
```

```
$        WHICH SPECIFY THE STRIP EDGES AS FRACTIONS OF THE SPAN.        $
$                                                                       $
$       SID     D1      D2      D3      ETC
AEFACT  77      .0      .09     .276    .454    .636    .826    1.0
$                                                                       $
$        THE PAERO ENTRY IS REQUIRED EVEN THOUGH IT IT NON-FUNCTIONAL   $
$        (BECAUSE THERE ARE NO ASSOCIATED BODIES IN THIS EXAMPLE).      $
$                                                                       $
PAERO1  1000
$               * * SPLINE FIT ON THE LIFTING SURFACES * *              $
$                                                                       $
$                    * LINEAR SPLINE FIT ON THE WING *                  $
$                                                                       $
$        THE SPLINE2 ENTRY SPECIFIES A BEAM SPLINE FOR INTERPOLAT-      $
$        ION OVER THE REGION OF THE CAERO ENTRY (ID1 AND ID2 ARE        $
$        THE FIRST AND LAST BOXES IN THIS REGION).  SETG REFERS         $
$        TO A SET1 ENTRY WHERE THE STRUCTURAL GRID POINTS ARE           $
$        DEFINED.  DZ AND DTOR ARE SMOOTHING CONSTANTS FOR LINEAR       $
$        ATTACHMENT AND TORSIONAL FLEXIBILITIES.  DTHX AND DTHY         $
$        ARE ROTATIONAL ATTACHMENT FLEXIBILITIES. CID IDENTIFIES        $
$        THE  SPLINE AXIS.                                              $
$                                                                       $
$       EID     CAERO   ID1     ID2     SETG    DZ      DTOR    CID
SPLINE2 100     1001    1001    1030    14      0.0     1.0     0       +SP100
$       DTHX    DTHY
+SP100  -1.0    -1.0
$                                                                       $
SPLINE2 200     2001    2001    2030    914     0.0     1.0     0       +SP200
+SP200  -1.0    -1.0
$
$        THE SET1 ENTRY DEFINES THE SETS OF STRUCTURAL GRID POINTS      $
$        TO BE USED BY THE BEAM SPLINE FOR INTERPOLATION.               $
$                                                                       $
$       SID     G1      G2      G3      G4      G5      G6
SET1    14      1       THRU    11
SET1    914     91      THRU    99      910     911
```

- **Program alterv4.dat**

```
compile  seaero list ref
ALTER 'IF ( EXTRCV=0 ) THEN',''
ALTER 'CALL SESUM '(1,+2),''
ALTER 'IF ( NOT(NOPH2 OR SAVERSTL) ) THEN',''
ALTER 'IF ( FOURIER ) THEN'(1,-3),''(1,-1)
ALTER 'CALL FDRMGEN  USET,VGFD'(1,-1),''
$ALTER 'DELETE /QHH,QHJ,QKH,,',''
ALTER 'TYPE PARM,,I,N,KCNT=1,CNTR=0,NOMKLIST=1,NUMI','' $
TYPE PARM,,I,N,KCNT,CNTR,NOMKLIST,NUMI $
TYPE PARM,,I,N,NSKIPPDF $
TYPE PARM,,I,Y,NSTRIPRM $
ALTER 'IF ( OPPHIB>=0 OR OPPHIPA>=0'
ENDIF $ NOEDTS>0
NSKIPPDF=0 $ INITIALIZE
COPY  AERO/AEROTEMP/ALWAYS/-1 $
COPY  CASES/CASETEMP/ALWAYS/-1 $
DO WHILE (NSKIPPDF<NSTRIPRM ) THEN $
NSKIPPDF=NSKIPPDF+1  $
$    CASE      CASECC,/CASE1/'TRAN'/S,N,NSKIPPDF $
$    PVT       PVT,CASE1//   $
$    PARAML    CASE1//'DTI'/1/1//S,N,SUBID  $
     MESSAGE   //' NSKIPPDF='/NSKIPPDF  $
CNTR=0 $ INITIALIZE
KCNT=1 $ INITIALIZE
```

```
NOMKLIST=1 $ INITIALIZE
DELETE /AERO,CASES,,, $
COPY AEROTEMP/AERO/ALWAYS/-1 $
COPY CASETEMP/CASES/ALWAYS/-1 $
DELETE /QHHL,QHJL,QKHL,, $
DELETE /QHHA,QHJA,QKHA,, $
$DELETE /QHH,QHJ,QKH,, $
DELETE /PPF,FOL,AUPF,AQPF,AQMPF $
DELETE /AUHF,QMGF,QSGF,PHF, $
DELETE /FOL1,PPF1,AULF,PSF1,AUHF1 $
DELETE /IUG1,IQG1,IEF1,IES1,IEE1 $
DELETE /IUG2,IQG2,IEF2,IES2,IEE2  $
ALTER 'CALL SUPER3  CASECC  ,        ,AULF'
ENDDO $ NSKIPPDFX>=0
ALTER 'AMP      AJJ0' $
DMIIN DMI,DMINDX/ISTRIP,,,,,,,,,/ $ USE MATRIX ISTRIP DEFINED IN DMI
MATMOD ISTRIP,,,,,/ISTRIP1COL,/1/NSKIPPDF $ SELECTS THE COLUMN FROM ISTRIP
$                                          $ BY THE INDEX NSTRIPPRM
MATMOD  ISTRIP1COL,,,,,/ISTRIPDIAG,/28 $ DIAGONALIZES THE ABOVE SELECTED COLUMN
$ MPYAD ISTRIP,QHJ,/QHJTEMP/ $ CREATE THE NEW QHJ CORRESPONDING TO THE STRIP
MPYAD ISTRIPDIAG,QHJ,/QHJTEMP/ $ CREATE THE NEW QHJ CORRESPONDING TO THE STRIP
DELETE /QHJ,,,, $
ADD QHJTEMP,/QHJ $
$matprn QHJ// $
ALTER 'MATMOD   AERO,QHHA,,,,/QHHL,/22'(1,-2)
     MESSAGE   //' KCNT='/KCNT/' NOMKLIST='/NOMKLIST/
                '  DOAMP='/ DOAMP  $
ALTER 'DOAMP = (NOQHH','IF ( DOAMP ) THEN'
     MESSAGE   //' NOQHJ='/NOQHJ/' NOQHH='/NOQHH/
                '  GUSTAERO='/ GUSTAERO  $
ALTER ') SDR1     ,,QHJ,,,,,,,,,/,QHJA,/CNTR/'(1,+1),''
endalter $
```

- **Program BAH_strip**

```
$-------$-------$-------$-------$-------$-------$-------$-------$-------
dmi       istrip       0       2       2       2              60      11
$dmi      istrip     col  row st   1.0D0    thru row end
dmi       istrip       1      26   1.0D0    thru      30
dmi       istrip       2      21   1.0D0    thru      25
dmi       istrip       3      16   1.0D0    thru      20
dmi       istrip       4      11   1.0D0    thru      15
dmi       istrip       5       6   1.0D0    thru      10
dmi       istrip       6       1   1.0D0    thru       5      31   1.0D0
            thru      35
dmi       istrip       7      36   1.0D0    thru      40
dmi       istrip       8      41   1.0D0    thru      45
dmi       istrip       9      46   1.0D0    thru      50
dmi       istrip      10      51   1.0D0    thru      55
dmi       istrip      11      56   1.0D0    thru      60
```

APPENDIX G

MATLAB programs used in the frequency response analysis of the BAH wing under two dimensional gust loads

- **Program calc_response.m**

```
function [freq,auto,psd,rms,no] = calc_response
%[FREQUENCY APS CPS,RMS,NO] = CALC_RESPONSE
% Calculates the power spctral density matrix. Each column of the matrix is the PSD of
one response
% quantity as a function of frequency. Case information data should be changed in the
file
%                          'case_info.data'
%
% See also CASE_INFO.DATA

% read case information from file "case_info.data"

fid = fopen('case_info.data');
num_strips = fscanf(fid,'%*s %*s %*s %f',1);
num_frequencies = fscanf(fid,'%*s %*s %*s %f',1);
num_responses = fscanf(fid,'%*s %*s %*s %f',1);
sigmaw = fscanf(fid,'%*s %*s %*s %*s %f',1);
V = fscanf(fid,'%*s %*s %f',1);
L = fscanf(fid,'%*s %*s %*s %f',1);
f06_fname = fscanf(fid,'%*s %*s %*s %*s %s',1);
pch_fname = fscanf(fid,'%*s %*s %*s %*s %s',1);
sep_fname = fscanf(fid,'%*s %*s %*s %*s %s',1);

fclose(fid);
save case_info num_strips num_frequencies  num_responses sigmaw V L f06_fname
pch_fname sep_fname
case_info = load ('case_info.mat')

if strcmp(pch_fname,'none');
  [freq frf] = read_f06(f06_fname,num_strips,num_responses,num_frequencies); %read f06
data
else
  [freq frf] = read_pch(pch_fname,num_strips,num_responses,num_frequencies); %read
punch file data
end

%save 'frfdata' freq frf;
%load frfdata
omega = 2*pi*freq;

% read the coordinates of the centers of the strips

fid = fopen(sep_fname);
y = fscanf(fid,'%*s %*s %*d %f')';
fclose(fid);
%y=1e-9*y;
% calculate the separation distance between the ith and jth strips

for istrip = 1:num_strips
   s(istrip,:) = abs(y(istrip) - y);
end

% For each frequency calculate the PSD of the responces

for ifreq = 1:num_frequencies
   phi = gust_cross_spectra(omega(ifreq),L,V,s,sigmaw);
```

```
   frfi = squeeze(frf(ifreq,:,:));
   psd(ifreq,:,:) = frfi'*phi*frfi;
end
for iresp = 1:num_responses
   auto(:,iresp) = real(psd(:,iresp,iresp));
end
[rms no] = calc_statistics(freq,auto);
```

- **Program calc_statistics.m**

```
function [rms,no] = calc_statistics(freq,auto)
% [RMS No] = CALC_STATISTICS(FREQ,AUTO)
% Calculates the root mean square value (RMS) and the zero crossing rate (No)
% of the variables in that have the auto power spectral densities AUTO. Auto is
% arranged in column format (each aps in one column with the elements corresponding
% to the frequencies in FREQ).
% Caculate the rms values
% Generate tow matrices one for aps(j,i) and the other for aps(j,i+1) to take
advantage
% of the vectorization capabilities of Matlab
 [n_frequencies n_vars] = size(auto);
autoi = auto(1:n_frequencies-1,:);
autoip1 = auto(2:n_frequencies,:);
freqmat = repmat(freq,1,n_vars);
freqi = freqmat(1:n_frequencies-1,:);
freqip1 = freqmat(2:n_frequencies,:);
ms = 0.5 * sum(((autoi+autoip1).*(freqip1-freqi)),1);
rms = sqrt(ms);
alpha = 3*freqi.^2 + 2*freqi.*freqip1 + freqip1.^2;
beta = freqi.^2 + 2*freqi.*freqip1 + 3*freqip1.^2;
r = sqrt(sum(((alpha.*autoi+beta.*autoip1).*(freqip1-freqi)),1)/12);
no = r./rms;
```

- **Program read_pch.m**

```
function [frequency,frf] = read_pch(fname,num_strips,num_responses,num_frequencies)
% [FREQUENCY RESP] = READ_PCH(PCH FILE NAME, NUMBER OF STRIPS, NUMBER OF RESPONCES,
NUMBER OF FREQUENCIES)
% Reads the data in the punch file and stores it into a 3-d array with the following
index order
% (frequency index,strip number index, response index)

fp = fopen(fname);

% Loop over the strips

for istrip = 1:num_strips

  % Loop over the responses

  for iresponse = 1:num_responses

    % skip header line that which is not needed

    % read the first string
    string1 = fscanf(fp, '%s',1);

    % identify the response
    acce = '$ACCE';
    if strcmp(string1,acce);
      line = fscanf(fp, '%*d %*d %*d %d',1);
    else
      line = fscanf(fp, '%*s %*d %*d %*d %d',1);
    end
```

```
    % read the real part of the response

    data = fscanf(fp, '%f' , [4 num_frequencies]);

    data1 = data(3,:);

    % Skip header line which is not needed
    % read the first string
    string1 = fscanf(fp, '%s',1);

    % identify the response
    acce = '$ACCE';


    if strcmp(string1,acce);
      line = fscanf(fp, '%*d %*d %*d %d',1);
    else
      line = fscanf(fp, '%*s %*d %*d %*d %d',1);
    end

    % read the imaginary part of the data

    data = fscanf(fp, '%f %f', [4 num_frequencies]);

    % Arrange the data in a 3-d array (frequency index, strip number index, response
index)

    frf(:,istrip,iresponse) = data1 + I*data(3,:);

  % Close looping over the response
  end

% Close looping over the strip number
end

%close the data file
fclose(fp);

% Write the frequency vector

frequency = data(2,:)';
```

- **Program gust_cross_spectra.m**

```
function phi12 = gust_cross_spectra(omega,L,V,s,sigmaw)
% PHI12 = GUST_CROSS_SPECTRA(OMEGA,L,V,S,SIGMAW)
% CALCULATES THE TWO DIMENSIONAL GUST LOAD CROSS SPECTRA BETWEEN TWO
% STRIPS A WITH A SEPARATION DISTANCE S. OMEGA IS THE FREQUENCY, V IS THE VELOCITY,
% L IS THE GUST SCALE OF TURBULANCE, AND SIGMAW IS THE RMS VALUE OF THE GUST VELOSITY.
Sigma = s/L;
r = sigma==0;
sigma = sigma+r;
nu = omega * L / V;
z = sigma .* sqrt(1 + ( 1.339 .* nu ) .^ 2 ) / 1.339;
phi12 = sqrt(2*pi)*sigmaw^2 * 2^(2/3) *L/( V * gamma(1/3) * (1.339) ^ (8/3) ) …
       * (8*1.3339^2 * sigma .^ (5/3) .* besselk((5/6),z) ./ (3 * z .^ (5/6) ) …
       - sigma .^ (11/3) .* besselk((11/6),z) ./ z .^ (11/6) );
phiii = 2 *sigmaw^2 * L/V * ( 1 + 8/3 *( 1.339 * nu ) .^ 2 ) …
        ./ ( 1 + (1.339 * nu ) .^ 2 ) .^ (11/6);
phi12 = phi12 - r.* phi12 + r * phiii;
```

- **Program case_info.data**

```
number of strips            11
number of frequencies       351
number of responses         15
rms of gust velocity        1.000
forward velocity            8360
gust scale length           6000
nastran f06 file name       none
nastran pch file name       /home0/naser/bah/ha146c_full2.pch
strip coordinate file name  /home0/naser/bah/BAH_coor.dat
```

- **Program BAH_coor.dat**

```
strip no.  1    456.5000
strip no.  2    365.5000
strip no.  3    272.5000
strip no.  4    182.2500
strip no.  5     91.2500
strip no.  6          0
strip no.  7    -91.2500
strip no.  8   -182.2500
strip no.  9   -272.5000
strip no. 10   -365.5000
strip no. 11   -456.5000
```

APPENDIX H

MSC/NASTRAN input file used in the Discrete Gust Response Analysis of the Alliance airplane

```
$   TO EXECUTE THIS FILE USE THE FOLLOWING:
$   NAST705  VK01 SCRATCH=YES MEM=12MW NEWS=NO
$
SOL  146  $  AEROELASTIC DYNAMIC RESPONSE
$ DIAG = 8,15   $   MATRIX AND TABLE TRAILERS
TIME 120.0    $  TIME IN MINUTES
$
compile freqrs
alter 241 $
putsys (0, 209) $
alter 242 $
putsys (1, 209) $
CEND
$
TITLE = SEMISPAN MODEL * TRANSIENT ANALYSIS * M=0.090 * H=1000.0 FT.
SUBTITLE = SYMMETRIC RESPONSE FUEL 166.95LB. V=98.3 FT/SEC 8/8cbar
LABEL = 1-COSINE GUST, THIRTY-TWO MODES
$
METHOD = 1  $  SINV EIGENVALUE EXTRACTION METHOD
SPC = 1  $  BOUNDARY CONDITION CONSTRAINTS
SDAMPING = 25  $  MODAL STRUCTURAL DAMPING (TABDMP1)
FREQUENCY = 42  $  SET OF SOLUTION FORCING FREQUENCIES (FREQ1)
TSTEP = 41              $ SOLUTION TIME STEPS (1 PERIOD)
$RANDOM = 111  $  PSD SPECIFICATION (RANDPS)
K2PP = STIFF  $  D.O.F. FOR OUTPUT OF VON KARMAN SPECTRUM (DMIG)
$ ECHO = UNSORT
ECHO = NONE  $  SUPPRESS PRINTOUT OF BULK DATA DECK
$
OUTPUT
$
SET 40 = 9990,101,121,141
$  EXTRA POINT FOR GENERATION OF VON KARMAN PSD
DISPLACEMENT(SORT2,PLOT) = ALL
$SDISPLACEMENT(SORT2) = 40
SDISPLACEMENT(SORT2,PLOT) = ALL
$
SUBCASE  1  $  APPLY 1 - COS GUST
GUST = 1880 $ GUST SELECTION  (GUST)
  DLOAD = 2880            $ REQUIRED
OUTPUT(XYOUT)
XYPUNCH  SDISP RESPONSE/9990(T1)
XYPUNCH  DISP  RESPONSE/101(T3)
XYPUNCH  DISP  RESPONSE/121(T3)
XYPUNCH  DISP  RESPONSE/141(T3)
$$$$$$$$$$$$$$$$$$$$$
  XYPUNCH  ELFORCE RESPONSE / 101(3)
  XYPUNCH  ELFORCE RESPONSE / 101(4)
  XYPUNCH  ELFORCE RESPONSE / 101(5)
  XYPUNCH  ELFORCE RESPONSE / 101(6)
  XYPUNCH  ELFORCE RESPONSE / 101(7)
  XYPUNCH  ELFORCE RESPONSE / 101(8)
  XYPUNCH  ELFORCE RESPONSE / 101(9)
  XYPUNCH  ELFORCE RESPONSE / 121(3)
  XYPUNCH  ELFORCE RESPONSE / 121(4)
  XYPUNCH  ELFORCE RESPONSE / 121(5)
  XYPUNCH  ELFORCE RESPONSE / 121(6)
```

```
  XYPUNCH  ELFORCE RESPONSE / 121(7)
  XYPUNCH  ELFORCE RESPONSE / 121(8)
  XYPUNCH  ELFORCE RESPONSE / 121(9)
  XYPUNCH  ELFORCE RESPONSE / 140(3)
  XYPUNCH  ELFORCE RESPONSE / 140(4)
  XYPUNCH  ELFORCE RESPONSE / 140(5)
  XYPUNCH  ELFORCE RESPONSE / 140(6)
  XYPUNCH  ELFORCE RESPONSE / 140(7)
  XYPUNCH  ELFORCE RESPONSE / 140(8)
  XYPUNCH  ELFORCE RESPONSE / 140(9)
  XYPUNCH  ELFORCE RESPONSE / 217(3)
  XYPUNCH  ELFORCE RESPONSE / 217(4)
  XYPUNCH  ELFORCE RESPONSE / 217(5)
  XYPUNCH  ELFORCE RESPONSE / 217(6)
  XYPUNCH  ELFORCE RESPONSE / 217(7)
  XYPUNCH  ELFORCE RESPONSE / 217(8)
  XYPUNCH  ELFORCE RESPONSE / 217(9)
$$$$$$$$$$$$$$$$$$$$$$
  XYPUNCH  ACCE RESPONSE /  95(T1)
  XYPUNCH  ACCE RESPONSE /  95(T3)
  XYPUNCH  ACCE RESPONSE /  95(R2)
  XYPUNCH  ACCE RESPONSE / 121(T1)
  XYPUNCH  ACCE RESPONSE / 121(T3)
  XYPUNCH  ACCE RESPONSE / 121(R2)
  XYPUNCH  ACCE RESPONSE / 140(T1)
  XYPUNCH  ACCE RESPONSE / 140(T3)
  XYPUNCH  ACCE RESPONSE / 140(R2)
  XYPUNCH  ACCE RESPONSE / 217(T1)
  XYPUNCH  ACCE RESPONSE / 217(T3)
  XYPUNCH  ACCE RESPONSE / 217(R2)
$$$$$$$$$$$$$$$$$$$$$$
$
BEGIN BULK
$
$   INPUT UNITS: ARE INCHES, POUNDS, SECONDS FOR LENGTH, MASS, AND TIME
$
PARAM, POST, 0 $  XDB POST-PROCESSING
$
PARAM, LMODES, 32  $   USE THE 32 LOWEST NORMAL MODES
$
$ PARAM, VREF, 20.2537  $  CONVERT FROM IN/SEC TO KNOTS IN SOL 145
$ PARAM, VREF, 12.0  $  USE VELOCITY UNITS OF FEET/SECOND IN SOL 145
$
$ CHANGES "WEIGHT" INPUT DATA TO "MASS" DATA
PARAM,WTMASS,0.002588
$
$ REQUESTS MASS PROPERTIES SUMMARY
PARAM,GRDPNT,0  $ WITH RESPECT TO ORIGIN OF BASIC C.S.
$
$  DEFINE LOCAL COORDINATE SYSTEMS FOR HORIZONTAL AND VERTICAL TAILS
SPC1, 1, 123456, 30, 40   $   GRIDS 30 AND 40 ONLY USED FOR ORIENTATION
GRID, 30, 0, 379.75, 521.5678, 100.0   $   DEFINES DIRECTION OF Z-AXIS (H-TAIL)
GRID, 40, 0, 410.39, 587.3362, 100.0   $   DEFINES DIRECTION OF Z-AXIS (V-TAIL)
$
$  COORDINATE SYSTEM 12 IS A REFERENCE AXIS SYSTEM FOR STABILITY DERIVATIVES
CORD2R        12       0 156.51    0.0   48.98   156.51   0.0     40.0  +CO12
+CO12      140.0  0.0     48.98
$    LOCAL COORD. SYSTEM FOR HORIZONTAL TAIL
CORD1R, 5, 301, 30, 2301   $   Z-AXIS NORMAL TO PLANE OF HORIZ. TAIL
$    LOCAL COORD. SYSTEM FOR VERTICAL TAIL
CORD1R, 6, 401, 40, 2401   $   Z-AXIS NORMAL TO PLANE OF VERT. TAIL
$
$  LOCAL COORDINATE SYSTEM TO DEFINE Y-AXIS OF RIGHT H-TAIL HINGE LINE
```

```
CORD2R        13       0 404.480 525.50  77.360  404.480521.5678 100.0  +CO13
+CO13      450.0531.888378.46955
$  LOCAL COORDINATE SYSTEM TO DEFINE Y-AXIS OF RIGHT V-TAIL HINGE LINE
CORD2R        14       0 433.14  496.50 157.190  433.140614.1537 200.0  +CO14
+CO14      500.0497.3168154.9451
$
$   SELECT THE DESIRED BOUNDARY CONDITIONS
$ Fixed Root
$ SPC            1     101  123456      0.
$
$ Symmetric BC  *  CONSTRAIN GRIDS ON CENTERLINE
SPC            1     101     246     0.0      95     246     0.0
$
$ Antisymmetric BC
$ SPC            1     101  135         0.
$
$    ******************************************************
$      SECTION FOR DYNAMIC RESPONSE TO GUST LOADING
$    ******************************************************
$
PARAM, MACH, 0.090   $ DESIRED MACH NUMBER
PARAM, Q, 0.077444  $   DYNAMIC PRESSURE IN PSI AT 1000 FT. (V=1179.6 IN/SEC)
PARAM, GUSTAERO, -1
$
$   STRUCTURAL MODAL DAMPING = 0.02 IN EACH MODE
TABDMP1       25       G                                                +TDMP1
+TDMP1       0.0    0.02    60.0    0.02    ENDT
$
$    ******************************************************
$      FOLLOWING GROUP OF INPUT IS FOR THE VON KARMAN PSD
$
$RANDPS       111       1       1     1.0     0.0     121
$  VON KARMAN GUST WITH (L/U)=10.1729 SEC., AND WG=1.0 IN/SEC
$TABRNDG      121       1 10.1729     1.0
$   VELOCITY ON 'GUST' MUST BE SAME AS ON 'AERO' INPUT RECORD.
$GUST          36      468.4774-4     0.0  1179.6
$       SID     DLOAD   WG      X0      V
$GUST    1000    2000    23.58   -472.   2360.
$       2       3       4       5       6       7       8       9       1
$234567812345678123456781234567812345678123456781234567812345678123456787
GUST    1180    2180     1.0         0.0  1179.6
GUST    1280    2280     1.0         0.0  1179.6
GUST    1380    2380     1.0         0.0  1179.6
GUST    1480    2480     1.0         0.0  1179.6
GUST    1580    2580     1.0         0.0  1179.6
GUST    1680    2680     1.0         0.0  1179.6
GUST    1780    2780     1.0         0.0  1179.6
GUST    1880    2880     1.0         0.0  1179.6
$
$        TLOAD2 DEFINES A TIME DEPENDENT DYNAMIC LOAD OR ENFORCED MOTION.
$        LISTED ARE THE ID, DAREA ID, DELAY ID, TYPE OF DYNAMIC EXCITATION,
$        AND AN ANALYTICAL FUNCTION.
$
$       2       3       4       5       6       7       8       9       1
$234567812345678123456781234567812345678123456781234567812345678123456787
$       SID     DAREA   DELAY   TYPE    T1      T2      F       P
$ 1d8
tload2  1181    1002                    .2      .335109 0.      0.
        0.      0.
tload2  1182    1002                    .2      .335109 7.4014120.
        0.      0.
dload   2180    0.5     1.      1181    -1.     1182
$ 2d8
```

```
tload2  1281    1002                    .2      .470219 0.      0.
        0.      0.
tload2  1282    1002                    .2      .470219 3.7007060.
        0.      0.
dload   2280    0.5     1.      1281    -1.     1282
$ 3d8
tload2  1381    1002                    .2      .603855 0.      0.
        0.      0.
tload2  1382    1002                    .2      .603855 2.4671370.
        0.      0.
dload   2380    0.5     1.      1381    -1.     1382
$ 4d8
tload2  1481    1002                    .2      .740437 0.      0.
        0.      0.
tload2  1482    1002                    .2      .740437 1.8503530.
        0.      0.
dload   2480    0.5     1.      1481    -1.     1482
$ 5d8
tload2  1581    1002                    .2      .875548 0.      0.
        0.      0.
tload2  1582    1002                    .2      .875548 1.48028 0.
        0.      0.
dload   2580    0.5     1.      1581    -1.     1582
$ 6d8
tload2  1681    1002                    .2      1.01066 0.      0.
        0.      0.
tload2  1682    1002                    .2      1.01066 1.23357 0.
        0.      0.
dload   2680    0.5     1.      1681    -1.     1682
$ 7d8
tload2  1781    1002                    .2      1.14577 0.      0.
        0.      0.
tload2  1782    1002                    .2      1.14577 1.05734 0.
        0.      0.
dload   2780    0.5     1.      1781    -1.     1782
$ 8d8
tload2  1881    1002                    .2      1.28088 0.      0.
        0.      0.
tload2  1882    1002                    .2      1.28088 .925176 0.
        0.      0.
dload   2880    0.5     1.      1881    -1.     1882
$
$RLOAD1        46      56                      66
$   APPLY VON KARMAN GUST TO THE EPOINT FOR SUBSEQUENT OUTPUT
DAREA       1002    9990             1.0
EPOINT      9990
$  TABLED1 PROVIDES FREQUENCY INTERVAL OVER WHICH LOADS ARE GENERATED
$TABLED1       66                                                          +TDVK1
$+TDVK1       0.0     1.0    60.0     1.0    ENDTA
$
$        TSTEP DEFINES TIME STEP INTERVALS AT WHICH THE TRANSIENT
$        RESPONSES ARE DESIRED.  LISTED ARE  THE NUMBER OF STEPS,
$        THE TIME INTERVAL AND SKIP FACTOR FOR OUTPUT.
$       SID     N       DT      NO
TSTEP   41      800     .025    1
$
$
$        FREQ1 DEFINES THE SET OF FREQUENCIES USED TO OBTAIN
$        THE FREQUENCY RESPONSE SOLUTION. LISTED ARE THE STARTING
$        FREQUENCY, FREQUENCY INCREMENT AND NUMBER OF INCREMENTS.
$
$       SID     F1      DF      NDF
$FREQ1   40      0.      .1      100
```

```
FREQ1         42    0.00    0.05     400
$
$  SETS OF FREQUENCIES USED IN SOLUTION OF FREQUENCY RESPONSE PROBLEMS
$FREQ1         41  0.0001  0.0001       9
$FREQ1         41   0.001   0.001       9
$FREQ1         41   0.010   0.010       9
$FREQ1         41    0.10    0.05    1198
$  DMIG DEFINES AN EPOINT USED TO OUTPUT THE VON KARMAN PSD
DMIG       STIFF       0       6       1       0
DMIG       STIFF    9990       0            9990       0     1.0
$
$    ******************************************************
$      END OF SECTION FOR DYNAMIC RESPONSE TO GUST LOADING
$    ******************************************************
$
$ ************************************************************
$    BEGIN AERODYNAMIC FLUTTER CARDS
$ ************************************************************
$
$ VALUE OF FIELD 6 (SYMXZ) IS 1 FOR SYM CASE, -1 FOR ASYM,  0 FOR FIXED
$       2       3       4       5       6       7       8       9       1
$234567812345678123456781234567812345678123456781234567812345678123456787
$   AERO. DENSITY UNITS: LB-SEC**2/IN**4 (SEA-LEVEL)
AERO           0  1179.6   51.001.1463-7       1       0
$
$ Inboard Wing   (RIGHT SIDE)
CAERO1  10001   1       0       17      8                       1       +CA101
+CA101  132.83  0.0     48.98   59.2    134.33  223.5   60.77   54.03
$
$GRID   101     0       156.51    0.00   48.98
$ (156.51-132.83)/59.2=0.40 chord
$
$ Outboard Wing   (RIGHT SIDE)
CAERO1  20001   1       0       23      8                       1       +CA102
+CA102  134.33  223.5   60.77   54.03    138.03  525.5   76.79    41.28
$
$GRID   118     0       155.94  223.50   60.77
$ (155.94-134.33)/54.03=0.40 chord
$
$   RIGHT-SIDE HORIZONTAL TAIL
$   THE H-TAIL PANEL SPANS THE AREA FROM THE LEADING EDGE TO THE HINGE LINE
CAERO1  30001   1       0       20      8                       1       +CA103
+CA103  355.08  525.5   77.36   49.40   366.04  620.5   93.92   24.704
$
$   RIGHT-SIDE CONTROL SURFACE PANEL ON HORIZONTAL TAIL
CAERO1  31001      1      0      20       2                       1      +CA103A
+CA103A 404.480 525.50  77.360  12.35   390.744 620.50  93.920  6.176
$
$GRID   301     0       379.75  525.50   77.36
$ (379.75-355.08)/61.75=0.40 chord
$
$   RIGHT-SIDE VERTICAL TAIL
$ CAERO1  40001   1       0       16      8                       1       +CA104
$ +CA104  390.67  525.5   77.5    49.3    407.54  496.5   157.19  32.00
$
$  REDEFINE POINTS 1 AND 4 FOR VERTICAL TAIL (SWAP POINTS 1 AND 4)
CAERO1  40001   1       0       20      8                       1       +CA104
+CA104  407.54  496.5   157.19  25.60   390.67  525.5   77.5    39.44
$
$  RIGHT-SIDE CONTROL SURFACE PANEL ON VERTICAL TAIL
CAERO1  41001      1       0      20       2                       1     +CA104A
+CA104A 433.140  496.50  157.190  6.40   430.110 525.50  77.50   9.86
$
```

```
$GRID   401     0       410.39  525.50  77.50
$ (410.39-390.67)/49.30=0.40 chord
$
$                       DENS    MACH    VEL     INTERP  MODES   PK TOL (0.001 default)
FLUTTER 30      PK      1       2       4       L       10
FLFACT  1       1.0
FLFACT  2       0.0
$
$  FOR PK METHOD, 'FLFACT 4' IS A VELOCITY TABLE (UNITS IN/SEC)
$  A MINUS SIGN FOR A VELOCITY IS A REQUEST FOR EIGENVALUE OUTPUT
FLFACT  4       176.0   528.0    880.0  1320.0  1760.0  2640.0  3520.0  +FL01
+FL01   4400.0  5280.0  6200.0  7040.0
$
$   TABLES OF MACH NUMBER AND REDUCED FREQUENCY
MKAERO1     0.09                                                        +MK1
+MK1     0.00001   0.005    0.01    0.02    0.04    0.06    0.08     0.1
MKAERO1     0.09                                                        +MK2
+MK2         0.2     0.4     0.6     0.8     1.0     2.0     3.0     4.0
MKAERO1     0.09                                                        +MK3
+MK3         5.0     6.0     7.0     8.0     9.0    10.0
$
PAERO1  1
$
$  TEST USAGE OF SURFACE SPLINES ON ALL LIFTING SURFACES
$   SPLINE1 = 100   RIGHT-SIDE INBOARD WING
$   SPLINE1 = 200   RIGHT-SIDE OUTBOARD WING
$   SPLINE1 = 300   RIGHT-SIDE HORIZONTAL TAIL WITHOUT CONTROL SURFACE
$   SPLINE1 = 305   RIGHT-SIDE CONTROL SURFACE ON HORIZONTAL TAIL
$   SPLINE1 = 400   RIGHT-SIDE VERTICAL TAIL WITHOUT CONTROL SURFACE
$   SPLINE1 = 405   RIGHT-SIDE CONTROL SURFACE ON VERTICAL TAIL
$
SPLINE1 100     10001   10001   10136   100
SPLINE1 200     20001   20001   20184   200
$
SPLINE1 300     30001   30001   30160   300
SPLINE1 400     40001   40001   40160   400
$
SPLINE1 305     31001   31001   31040   305
SPLINE1 405     41001   41001   41040   405
$
$   GRIDS UTILIZED FOR RIGHT SIDE INBOARD WING SURFACE SPLINES
SET1         100     101     102     103     104     105     106     107+IW01
+IW01        108     109     110     111     112     113     114     115+IW02
+IW02        116     117     118    1101    1102    1103    1104    1105+IW03
+IW03       1106    1107    1108    1109    1110    1111    1112    1113+IW04
+IW04       1114    1115    1116    1117    1118    2101    2102    2103+IW05
+IW05       2104    2105    2106    2107    2108    2109    2110    2111+IW06
+IW06       2112    2113    2114    2115    2116    2117    2118
$   GRIDS UTILIZED FOR RIGHT SIDE OUTBOARD WING SURFACE SPLINES
SET1         200     118     119     120     121     122     123     124+OW01
+OW01        125     126     127     128     129     130     131     132+OW02
+OW02        133     134     135     136     137     138     139     140+OW03
+OW03        141    1118    1119    1120    1121    1122    1123    1124+OW04
+OW04       1125    1126    1127    1128    1129    1130    1131    1132+OW05
+OW05       1133    1134    1135    1136    1137    1138    1139    1140+OW06
+OW06       1141    2118    2119    2120    2121    2122    2123    2124+OW07
+OW07       2125    2126    2127    2128    2129    2130    2131    2132+OW08
+OW08       2133    2134    2135    2136    2137    2138    2139    2140+OW09
+OW09       2141
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON H-TAIL
SET1         300     301     302     303     304     305     306     307+HT01
+HT01        308     309     310     311    1301    1302    1303    1304+HT02
+HT02       1305    1306    1307    1308    1309    1310    1311    2501+HT03
```

```
+HT03       2502    2503    2504    2505    2506    2507    2508    2509+HT04
+HT04       2510    2511
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON H-TAIL CONTROL SURFACE
SET1         305    2501    2502    2503    2504    2505    2506    2507+HC01
+HC01       2508    2509    2510    2511    2301    2302    2303    2304+HC02
+HC02       2305    2306    2307    2308    2309    2310    2311
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON V-TAIL
SET1         400     401     402     403     404     405     406     407+VT01
+VT01        408     409     410     411    1401    1402    1403    1404+VT02
+VT02       1405    1406    1407    1408    1409    1410    1411    2601+VT03
+VT03       2602    2603    2604    2605    2606    2607    2608    2609+VT04
+VT04       2610    2611
$   GRIDS UTILIZED FOR RIGHT SIDE SURFACE SPLINE ON V-TAIL CONTROL SURFACE
SET1         405    2601    2602    2603    2604    2605    2606    2607+VC01
+VC01       2608    2609    2610    2611    2401    2402    2403    2404+VC02
+VC02       2405    2406    2407    2408    2409    2410    2411
$
$ *****  END OF AERODYNAMIC FLUTTER INPUTS  *****
$
EIGR           1    SINV     0.0    60.0              40
$
$   CREATE A NEW GRID POINT AT THE C.G. FOR THE CURRENT FUEL MASS CONDITION
$   USE A CBEAM TO CONNECT THIS NEW GRID TO GRID 101
GRID          95       0160.9484     0.077.08521       0
CBEAM         95      95     101      95     1.0     0.0     0.0
PBEAM         95       1   100.0  1000.0  1000.0     0.0  1000.0
$
$   GRID 100 REPRESENTS PROPULSION SYSTEM
RBE2         504     101  123456     100
$  CONNECTIONS TO WING-TIP BOOM, HORIZONTAL AND VERTICAL TAILS
$
RBE2         501     141  123456     216
RBE2         502     238  123456     301
RBE2         503     240  123456     401
$
GRID         100       0   125.8     0.0    86.1       0
$
$  GRIDS FOR RIGHT WING BEAM
$
GRID         101       0  156.51    0.00   48.98       0
GRID         102       0  156.48   13.15   49.67       0
GRID         103       0  156.45   26.29   50.37       0
GRID         104       0  156.41   39.44   51.06       0
GRID         105       0  156.38   52.59   51.75       0
GRID         106       0  156.34   65.74   52.45       0
GRID         107       0  156.31   78.88   53.14       0
GRID         108       0  156.28   92.03   53.83       0
GRID         109       0  156.24  105.18   54.53       0
GRID         110       0  156.21  118.32   55.22       0
GRID         111       0  156.18  131.47   55.91       0
GRID         112       0  156.14  144.62   56.61       0
GRID         113       0  156.11  157.76   57.30       0
GRID         114       0  156.08  170.91   57.99       0
GRID         115       0  156.04  184.06   58.69       0
GRID         116       0  156.01  197.21   59.38       0
GRID         117       0  155.98  210.35   60.07       0
GRID         118       0  155.94  223.50   60.77       0
GRID         119       0  155.88  236.63   61.46       0
GRID         120       0  155.82  249.76   62.16       0
GRID         121       0  155.76  262.89   62.86       0
GRID         122       0  155.70  276.02   63.55       0
GRID         123       0  155.64  289.15   64.25       0
GRID         124       0  155.58  302.28   64.95       0
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GRID         125       0  155.52  315.41   65.64       0
GRID         126       0  155.46  328.54   66.34       0
GRID         127       0  155.39  341.67   67.04       0
GRID         128       0  155.33  354.80   67.73       0
GRID         129       0  155.27  367.93   68.43       0
GRID         130       0  155.21  381.07   69.13       0
GRID         131       0  155.15  394.20   69.82       0
GRID         132       0  155.09  407.33   70.52       0
GRID         133       0  155.03  420.46   71.22       0
GRID         134       0  154.97  433.59   71.91       0
GRID         135       0  154.91  446.72   72.61       0
GRID         136       0  154.85  459.85   73.31       0
GRID         137       0  154.79  472.98   74.00       0
GRID         138       0  154.72  486.11   74.70       0
GRID         139       0  154.66  499.24   75.40       0
GRID         140       0  154.60  512.37   76.09       0
GRID         141       0  154.54  525.50   76.79       0
$
$ RIGHT SIDE WING SURFACE LEADING-EDGE GRID POINTS
$
GRID        1101       0  132.83    0.00   48.98       0
GRID        1102       0  132.92   13.15   49.67       0
GRID        1103       0  133.01   26.29   50.37       0
GRID        1104       0  133.10   39.44   51.06       0
GRID        1105       0  133.18   52.59   51.75       0
GRID        1106       0  133.27   65.74   52.45       0
GRID        1107       0  133.36   78.88   53.14       0
GRID        1108       0  133.45   92.03   53.83       0
GRID        1109       0  133.54  105.18   54.53       0
GRID        1110       0  133.63  118.32   55.22       0
GRID        1111       0  133.71  131.47   55.91       0
GRID        1112       0  133.80  144.62   56.61       0
GRID        1113       0  133.89  157.76   57.30       0
GRID        1114       0  133.98  170.91   57.99       0
GRID        1115       0  134.07  184.06   58.69       0
GRID        1116       0  134.16  197.21   59.38       0
GRID        1117       0  134.24  210.35   60.07       0
GRID        1118       0  134.33  223.50   60.77       0
GRID        1119       0  134.49  236.63   61.46       0
GRID        1120       0  134.65  249.76   62.16       0
GRID        1121       0  134.81  262.89   62.86       0
GRID        1122       0  134.97  276.02   63.55       0
GRID        1123       0  135.14  289.15   64.25       0
GRID        1124       0  135.30  302.28   64.95       0
GRID        1125       0  135.46  315.41   65.64       0
GRID        1126       0  135.62  328.54   66.34       0
GRID        1127       0  135.78  341.67   67.04       0
GRID        1128       0  135.94  354.80   67.73       0
GRID        1129       0  136.10  367.93   68.43       0
GRID        1130       0  136.26  381.07   69.13       0
GRID        1131       0  136.42  394.20   69.82       0
GRID        1132       0  136.58  407.33   70.52       0
GRID        1133       0  136.74  420.46   71.22       0
GRID        1134       0  136.90  433.59   71.91       0
GRID        1135       0  137.06  446.72   72.61       0
GRID        1136       0  137.22  459.85   73.31       0
GRID        1137       0  137.38  472.98   74.00       0
GRID        1138       0  137.55  486.11   74.70       0
GRID        1139       0  137.71  499.24   75.40       0
GRID        1140       0  137.87  512.37   76.09       0
GRID        1141       0  138.03  525.50   76.79       0
$
$ RIGHT SIDE WING SURFACE TRAILING-EDGE GRID POINTS
```

```
$
GRID        2101       0  192.03    0.00   48.98       0
GRID        2102       0  191.82   13.15   49.67       0
GRID        2103       0  191.60   26.29   50.37       0
GRID        2104       0  191.39   39.44   51.06       0
GRID        2105       0  191.17   52.59   51.75       0
GRID        2106       0  190.95   65.74   52.45       0
GRID        2107       0  190.74   78.88   53.14       0
GRID        2108       0  190.52   92.03   53.83       0
GRID        2109       0  190.30  105.18   54.53       0
GRID        2110       0  190.09  118.32   55.22       0
GRID        2111       0  189.87  131.47   55.91       0
GRID        2112       0  189.66  144.62   56.61       0
GRID        2113       0  189.44  157.76   57.30       0
GRID        2114       0  189.22  170.91   57.99       0
GRID        2115       0  189.01  184.06   58.69       0
GRID        2116       0  188.79  197.21   59.38       0
GRID        2117       0  188.58  210.35   60.07       0
GRID        2118       0  188.36  223.50   60.77       0
GRID        2119       0  187.97  236.63   61.46       0
GRID        2120       0  187.57  249.76   62.16       0
GRID        2121       0  187.18  262.89   62.86       0
GRID        2122       0  186.79  276.02   63.55       0
GRID        2123       0  186.39  289.15   64.25       0
GRID        2124       0  186.00  302.28   64.95       0
GRID        2125       0  185.61  315.41   65.64       0
GRID        2126       0  185.21  328.54   66.34       0
GRID        2127       0  184.82  341.67   67.04       0
GRID        2128       0  184.43  354.80   67.73       0
GRID        2129       0  184.03  367.93   68.43       0
GRID        2130       0  183.64  381.07   69.13       0
GRID        2131       0  183.25  394.20   69.82       0
GRID        2132       0  182.85  407.33   70.52       0
GRID        2133       0  182.46  420.46   71.22       0
GRID        2134       0  182.07  433.59   71.91       0
GRID        2135       0  181.67  446.72   72.61       0
GRID        2136       0  181.28  459.85   73.31       0
GRID        2137       0  180.89  472.98   74.00       0
GRID        2138       0  180.49  486.11   74.70       0
GRID        2139       0  180.10  499.24   75.40       0
GRID        2140       0  179.71  512.37   76.09       0
GRID        2141       0  179.31  525.50   76.79       0
$
$  RIGHT WING * LEADING AND TRAILING EDGE GRIDS ARE DEPENDENT ON MAIN BEAM
$
RBE2        1201     101  123456    1101    2101
RBE2        1202     102  123456    1102    2102
RBE2        1203     103  123456    1103    2103
RBE2        1204     104  123456    1104    2104
RBE2        1205     105  123456    1105    2105
RBE2        1206     106  123456    1106    2106
RBE2        1207     107  123456    1107    2107
RBE2        1208     108  123456    1108    2108
RBE2        1209     109  123456    1109    2109
RBE2        1210     110  123456    1110    2110
RBE2        1211     111  123456    1111    2111
RBE2        1212     112  123456    1112    2112
RBE2        1213     113  123456    1113    2113
RBE2        1214     114  123456    1114    2114
RBE2        1215     115  123456    1115    2115
RBE2        1216     116  123456    1116    2116
RBE2        1217     117  123456    1117    2117
RBE2        1218     118  123456    1118    2118
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RBE2        1219     119  123456    1119    2119
RBE2        1220     120  123456    1120    2120
RBE2        1221     121  123456    1121    2121
RBE2        1222     122  123456    1122    2122
RBE2        1223     123  123456    1123    2123
RBE2        1224     124  123456    1124    2124
RBE2        1225     125  123456    1125    2125
RBE2        1226     126  123456    1126    2126
RBE2        1227     127  123456    1127    2127
RBE2        1228     128  123456    1128    2128
RBE2        1229     129  123456    1129    2129
RBE2        1230     130  123456    1130    2130
RBE2        1231     131  123456    1131    2131
RBE2        1232     132  123456    1132    2132
RBE2        1233     133  123456    1133    2133
RBE2        1234     134  123456    1134    2134
RBE2        1235     135  123456    1135    2135
RBE2        1236     136  123456    1136    2136
RBE2        1237     137  123456    1137    2137
RBE2        1238     138  123456    1138    2138
RBE2        1239     139  123456    1139    2139
RBE2        1240     140  123456    1140    2140
RBE2        1241     141  123456    1141    2141
$
$  GRIDS FOR RIGHT SIDE WING-TIP BOOM
$
GRID         201       0     25.   525.5    77.5       0
GRID         202       0 33.6111   525.5    77.5       0
GRID         203       0 42.2222   525.5    77.5       0
GRID         204       0 50.8333   525.5    77.5       0
GRID         205       0 59.4444   525.5    77.5       0
GRID         206       0 68.0556   525.5    77.5       0
GRID         207       0 76.6667   525.5    77.5       0
GRID         208       0 85.2778   525.5    77.5       0
GRID         209       0 93.8889   525.5    77.5       0
GRID         210       0   102.5   525.5    77.5       0
GRID         211       0 111.111   525.5    77.5       0
GRID         212       0 119.722   525.5    77.5       0
GRID         213       0 128.333   525.5    77.5       0
GRID         214       0 136.944   525.5    77.5       0
GRID         215       0 145.556   525.5    77.5       0
GRID         216       0 154.167   525.5    77.5       0
GRID         217       0 162.778   525.5    77.5       0
GRID         218       0 171.389   525.5    77.5       0
GRID         219       0    180.   525.5    77.5       0
GRID         220       0    190.   525.5    77.5       0
GRID         221       0    200.   525.5    77.5       0
GRID         222       0    210.   525.5    77.5       0
GRID         223       0    220.   525.5    77.5       0
GRID         224       0    230.   525.5    77.5       0
GRID         225       0    240.   525.5    77.5       0
GRID         226       0    250.   525.5    77.5       0
GRID         227       0    260.   525.5    77.5       0
GRID         228       0    270.   525.5    77.5       0
GRID         229       0    280.   525.5    77.5       0
GRID         230       0    290.   525.5    77.5       0
GRID         231       0    300.   525.5    77.5       0
GRID         232       0    310.   525.5    77.5       0
GRID         233       0    320.   525.5    77.5       0
GRID         234       0    330.   525.5    77.5       0
GRID         235       0    340.   525.5    77.5       0
GRID         236       0    350.   525.5    77.5       0
GRID         237       0    360.   525.5    77.5       0
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GRID         238       0    370.   525.5    77.5       0
GRID         239       0    380.   525.5    77.5       0
GRID         240       0    390.   525.5    77.5       0
GRID         241       0    400.   525.5    77.5       0
GRID         242       0    410.   525.5    77.5       0
GRID         243       0    420.   525.5    77.5       0
$
$   ***********************************************
$      RIGHT SIDE HORIZONTAL TAIL DEFINITION
$   ***********************************************
$  GRIDS FOR RIGHT SIDE HORIZONTAL TAIL BEAM
$
GRID         301       0  379.75  525.50   77.36       0
GRID         302       0  379.61  535.00   79.01       0
GRID         303       0  379.47  544.50   80.67       0
GRID         304       0  379.34  554.00   82.33       0
GRID         305       0  379.20  563.50   83.98       0
GRID         306       0  379.06  573.00   85.64       0
GRID         307       0  378.92  582.50   87.30       0
GRID         308       0  378.79  592.00   88.95       0
GRID         309       0  378.65  601.50   90.61       0
GRID         310       0  378.51  611.00   92.27       0
GRID         311       0  378.37  620.50   93.92       0
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL MAIN BEAM
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 5
GRID         331       0  379.75  525.50   77.36       5
GRID         332       0  379.61  535.00   79.01       5
GRID         333       0  379.47  544.50   80.67       5
GRID         334       0  379.34  554.00   82.33       5
GRID         335       0  379.20  563.50   83.98       5
GRID         336       0  379.06  573.00   85.64       5
GRID         337       0  378.92  582.50   87.30       5
GRID         338       0  378.79  592.00   88.95       5
GRID         339       0  378.65  601.50   90.61       5
GRID         340       0  378.51  611.00   92.27       5
GRID         341       0  378.37  620.50   93.92       5
$   DUPLICATE GRIDS ON H-TAIL ARE DEPENDENT ON ELASTIC AXIS BEAM
RBE2         521     301  123456     331
RBE2         522     302  123456     332
RBE2         523     303  123456     333
RBE2         524     304  123456     334
RBE2         525     305  123456     335
RBE2         526     306  123456     336
RBE2         527     307  123456     337
RBE2         528     308  123456     338
RBE2         529     309  123456     339
RBE2         530     310  123456     340
RBE2         531     311  123456     341
$
$  RIGHT SIDE HORIZONTAL TAIL LEADING EDGE
$
GRID        1301       0  355.08  525.50   77.36       0
GRID        1302       0  356.17  535.00   79.01       0
GRID        1303       0  357.27  544.50   80.67       0
GRID        1304       0  358.36  554.00   82.33       0
GRID        1305       0  359.46  563.50   83.98       0
GRID        1306       0  360.56  573.00   85.64       0
GRID        1307       0  361.65  582.50   87.30       0
GRID        1308       0  362.75  592.00   88.95       0
GRID        1309       0  363.85  601.50   90.61       0
GRID        1310       0  364.94  611.00   92.27       0
GRID        1311       0  366.04  620.50   93.92       0
$
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$  DISPLACEMENT OF H-TAIL L.E. IS DEPENDENT ON ELASTIC AXIS
RBE2        1251     301  123456    1301
RBE2        1252     302  123456    1302
RBE2        1253     303  123456    1303
RBE2        1254     304  123456    1304
RBE2        1255     305  123456    1305
RBE2        1256     306  123456    1306
RBE2        1257     307  123456    1307
RBE2        1258     308  123456    1308
RBE2        1259     309  123456    1309
RBE2        1260     310  123456    1310
RBE2        1261     311  123456    1311
$
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL LEADING EDGE
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 5
GRID        1331       0  355.08  525.50   77.36       5
GRID        1332       0  356.17  535.00   79.01       5
GRID        1333       0  357.27  544.50   80.67       5
GRID        1334       0  358.36  554.00   82.33       5
GRID        1335       0  359.46  563.50   83.98       5
GRID        1336       0  360.56  573.00   85.64       5
GRID        1337       0  361.65  582.50   87.30       5
GRID        1338       0  362.75  592.00   88.95       5
GRID        1339       0  363.85  601.50   90.61       5
GRID        1340       0  364.94  611.00   92.27       5
GRID        1341       0  366.04  620.50   93.92       5
$  DUPLICATE GRIDS ON H-TAIL LEADING EDGE ARE DEPENDENT ON ELASTIC AXIS
RBE2         541     301  123456    1331
RBE2         542     302  123456    1332
RBE2         543     303  123456    1333
RBE2         544     304  123456    1334
RBE2         545     305  123456    1335
RBE2         546     306  123456    1336
RBE2         547     307  123456    1337
RBE2         548     308  123456    1338
RBE2         549     309  123456    1339
RBE2         550     310  123456    1340
RBE2         551     311  123456    1341
$
$  RIGHT SIDE HORIZONTAL TAIL TRAILING EDGE
$
GRID        2301       0  416.83  525.50   77.36       0
GRID        2302       0  414.84  535.00   79.01       0
GRID        2303       0  412.85  544.50   80.67       0
GRID        2304       0  410.86  554.00   82.33       0
GRID        2305       0  408.87  563.50   83.98       0
GRID        2306       0  406.88  573.00   85.64       0
GRID        2307       0  404.88  582.50   87.30       0
GRID        2308       0  402.89  592.00   88.95       0
GRID        2309       0  400.90  601.50   90.61       0
GRID        2310       0  398.91  611.00   92.27       0
GRID        2311       0  396.92  620.50   93.92       0
$  DUPLICATE GRIDS FOR HORIZONTAL TAIL TRAILING EDGE
$  THE OUTPUT FOR THESE GRIDS WILL BE IN COORD. SYST. 5
GRID        2331       0  416.83  525.50   77.36       5
GRID        2332       0  414.84  535.00   79.01       5
GRID        2333       0  412.85  544.50   80.67       5
GRID        2334       0  410.86  554.00   82.33       5
GRID        2335       0  408.87  563.50   83.98       5
GRID        2336       0  406.88  573.00   85.64       5
GRID        2337       0  404.88  582.50   87.30       5
GRID        2338       0  402.89  592.00   88.95       5
GRID        2339       0  400.90  601.50   90.61       5
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GRID        2340       0  398.91  611.00   92.27       5
GRID        2341       0  396.92  620.50   93.92       5
$  DUPLICATE H-TAIL T.E. GRIDS ARE DEPENDENT ON ORIGINAL T.E. GRIDS
RBE2         561    2301  123456    2331
RBE2         562    2302  123456    2332
RBE2         563    2303  123456    2333
RBE2         564    2304  123456    2334
RBE2         565    2305  123456    2335
RBE2         566    2306  123456    2336
RBE2         567    2307  123456    2337
RBE2         568    2308  123456    2338
RBE2         569    2309  123456    2339
RBE2         570    2310  123456    2340
RBE2         571    2311  123456    2341
$
$  GRIDS AT 80% CHORD HINGE-LINE OF RIGHT SIDE HORIZONTAL TAIL
GRID        2501       0 404.480 525.500  77.360       0
GRID        2502       0 403.106 535.000  79.010       0
GRID        2503       0 401.734 544.500  80.670       0
GRID        2504       0 400.360 554.000  82.330       0
GRID        2505       0 398.988 563.500  83.980       0
GRID        2506       0 397.616 573.000  85.640       0
GRID        2507       0 396.234 582.500  87.300       0
GRID        2508       0 394.862 592.000  88.950       0
GRID        2509       0 393.490 601.500  90.610       0
GRID        2510       0 392.116 611.000  92.270       0
GRID        2511       0 390.744 620.500  93.920       0
$
$    ******************************************************
$    END OF RIGHT SIDE HORIZONTAL TAIL DEFINITION
$    ******************************************************
$
$    ******************************************************
$    RIGHT SIDE VERTICAL TAIL DEFINITION
$    ******************************************************
$
$  GRIDS FOR RIGHT SIDE VERTICAL TAIL BEAM
GRID         401       0  410.39  525.50   77.50       0
GRID         402       0  411.39  522.60   85.47       0
GRID         403       0  412.38  519.70   93.44       0
GRID         404       0  413.38  516.80  101.41       0
GRID         405       0  414.37  513.90  109.38       0
GRID         406       0  415.37  511.00  117.34       0
GRID         407       0  416.36  508.10  125.31       0
GRID         408       0  417.36  505.20  133.28       0
GRID         409       0  418.35  502.30  141.25       0
GRID         410       0  419.35  499.40  149.22       0
GRID         411       0  420.34  496.50  157.19       0
$   THIS GROUP OF GRIDS GENERATES OUTPUT IN COORD. SYSTEM 6
$   THE Z-AXIS FOR COORD. SYS. 5 IS NORMAL TO PLANE OF V-TAIL
GRID         431       0  410.39  525.50   77.50       6
GRID         432       0  411.39  522.60   85.47       6
GRID         433       0  412.38  519.70   93.44       6
GRID         434       0  413.38  516.80  101.41       6
GRID         435       0  414.37  513.90  109.38       6
GRID         436       0  415.37  511.00  117.34       6
GRID         437       0  416.36  508.10  125.31       6
GRID         438       0  417.36  505.20  133.28       6
GRID         439       0  418.35  502.30  141.25       6
GRID         440       0  419.35  499.40  149.22       6
GRID         441       0  420.34  496.50  157.19       6
$  DUPLICATE GRIDS OF MAIN V-TAIL ARE DEPENDENT ON ELASTIC AXIS GRIDS
RBE2         581     401  123456     431
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```
RBE2         582     402  123456     432
RBE2         583     403  123456     433
RBE2         584     404  123456     434
RBE2         585     405  123456     435
RBE2         586     406  123456     436
RBE2         587     407  123456     437
RBE2         588     408  123456     438
RBE2         589     409  123456     439
RBE2         590     410  123456     440
RBE2         591     411  123456     441
$
$  RIGHT SIDE VERTICAL TAIL LEADING EDGE
$
GRID        1401       0  390.67  525.50   77.50       0
GRID        1402       0  392.36  522.60   85.47       0
GRID        1403       0  394.05  519.70   93.44       0
GRID        1404       0  395.73  516.80  101.41       0
GRID        1405       0  397.42  513.90  109.38       0
GRID        1406       0  399.11  511.00  117.34       0
GRID        1407       0  400.79  508.10  125.31       0
GRID        1408       0  402.48  505.20  133.28       0
GRID        1409       0  404.17  502.30  141.25       0
GRID        1410       0  405.85  499.40  149.22       0
GRID        1411       0  407.54  496.50  157.19       0
$
$  LEADING EDGE V-TAIL GRIDS ARE DEPENDENT ON ELASTIC AXIS
RBE2        1271     401  123456    1401
RBE2        1272     402  123456    1402
RBE2        1273     403  123456    1403
RBE2        1274     404  123456    1404
RBE2        1275     405  123456    1405
RBE2        1276     406  123456    1406
RBE2        1277     407  123456    1407
RBE2        1278     408  123456    1408
RBE2        1279     409  123456    1409
RBE2        1280     410  123456    1410
RBE2        1281     411  123456    1411
$
$  DUPLICATE GRIDS FOR VERTICAL TAIL LEADING EDGE
$  THE OUTPUT OF THESE GRIDS WILL BE IN COORD. SYST. 6
GRID        1431       0  390.67  525.50   77.50       6
GRID        1432       0  392.36  522.60   85.47       6
GRID        1433       0  394.05  519.70   93.44       6
GRID        1434       0  395.73  516.80  101.41       6
GRID        1435       0  397.42  513.90  109.38       6
GRID        1436       0  399.11  511.00  117.34       6
GRID        1437       0  400.79  508.10  125.31       6
GRID        1438       0  402.48  505.20  133.28       6
GRID        1439       0  404.17  502.30  141.25       6
GRID        1440       0  405.85  499.40  149.22       6
GRID        1441       0  407.54  496.50  157.19       6
$  V-TAIL LEADING EDGE DUPLICATE GRIDS ARE DEPENDENT ON ELASTIC AXIS GRIDS
RBE2         601     401  123456    1431
RBE2         602     402  123456    1432
RBE2         603     403  123456    1433
RBE2         604     404  123456    1434
RBE2         605     405  123456    1435
RBE2         606     406  123456    1436
RBE2         607     407  123456    1437
RBE2         608     408  123456    1438
RBE2         609     409  123456    1439
RBE2         610     410  123456    1440
RBE2         611     411  123456    1441
```

```
$
$  RIGHT SIDE VERTICAL TAIL TRAILING EDGE
$
GRID        2401       0  439.97  525.50   77.50       0
GRID        2402       0  439.93  522.60   85.47       0
GRID        2403       0  439.89  519.70   93.44       0
GRID        2404       0  439.84  516.80  101.41       0
GRID        2405       0  439.80  513.90  109.38       0
GRID        2406       0  439.76  511.00  117.34       0
GRID        2407       0  439.71  508.10  125.31       0
GRID        2408       0  439.67  505.20  133.28       0
GRID        2409       0  439.63  502.30  141.25       0
GRID        2410       0  439.58  499.40  149.22       0
GRID        2411       0  439.54  496.50  157.19       0
$  DUPLICATE GRIDS FOR VERTICAL TAIL TRAILING EDGE
$  THE OUTPUT FOR THESE GRIDS WILL BE IN COORD. SYST. 6
GRID        2431       0  439.97  525.50   77.50       6
GRID        2432       0  439.93  522.60   85.47       6
GRID        2433       0  439.89  519.70   93.44       6
GRID        2434       0  439.84  516.80  101.41       6
GRID        2435       0  439.80  513.90  109.38       6
GRID        2436       0  439.76  511.00  117.34       6
GRID        2437       0  439.71  508.10  125.31       6
GRID        2438       0  439.67  505.20  133.28       6
GRID        2439       0  439.63  502.30  141.25       6
GRID        2440       0  439.58  499.40  149.22       6
GRID        2441       0  439.54  496.50  157.19       6
$  DUPLICATE V-TAIL T.E. GRIDS ARE DEPENDENT ON ORIGINAL GRIDS
RBE2         621    2401  123456    2431
RBE2         622    2402  123456    2432
RBE2         623    2403  123456    2433
RBE2         624    2404  123456    2434
RBE2         625    2405  123456    2435
RBE2         626    2406  123456    2436
RBE2         627    2407  123456    2437
RBE2         628    2408  123456    2438
RBE2         629    2409  123456    2439
RBE2         630    2410  123456    2440
RBE2         631    2411  123456    2441
$
$  GRIDS AT 80% CHORD HINGE-LINE OF RIGHT SIDE VERTICAL TAIL
GRID        2601       0 430.110 525.500  77.500       0
GRID        2602       0 430.416 522.600  85.470       0
GRID        2603       0 430.722 519.700  93.440       0
GRID        2604       0 431.018 516.800 101.410       0
GRID        2605       0 431.324 513.900 109.380       0
GRID        2606       0 431.630 511.000 117.340       0
GRID        2607       0 431.926 508.100 125.310       0
GRID        2608       0 432.232 505.200 133.280       0
GRID        2609       0 432.538 502.300 141.250       0
GRID        2610       0 432.834 499.400 149.220       0
GRID        2611       0 433.140 496.500 157.190       0
$
$    ****************************************************
$      END OF RIGHT SIDE VERTICAL TAIL DEFINITION
$    ****************************************************
$
$   MAIN BEAMS FOR RIGHT WING
CBEAM        101     101     101     102     -1.      0.      0.
CBEAM        102     102     102     103     -1.      0.      0.
CBEAM        103     103     103     104     -1.      0.      0.
CBEAM        104     104     104     105     -1.      0.      0.
CBEAM        105     105     105     106     -1.      0.      0.
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CBEAM        106     106     106     107     -1.      0.      0.
CBEAM        107     107     107     108     -1.      0.      0.
CBEAM        108     108     108     109     -1.      0.      0.
CBEAM        109     109     109     110     -1.      0.      0.
CBEAM        110     110     110     111     -1.      0.      0.
CBEAM        111     111     111     112     -1.      0.      0.
CBEAM        112     112     112     113     -1.      0.      0.
CBEAM        113     113     113     114     -1.      0.      0.
CBEAM        114     114     114     115     -1.      0.      0.
CBEAM        115     115     115     116     -1.      0.      0.
CBEAM        116     116     116     117     -1.      0.      0.
CBEAM        117     117     117     118     -1.      0.      0.
CBEAM        118     118     118     119     -1.      0.      0.
CBEAM        119     119     119     120     -1.      0.      0.
CBEAM        120     120     120     121     -1.      0.      0.
CBEAM        121     121     121     122     -1.      0.      0.
CBEAM        122     122     122     123     -1.      0.      0.
CBEAM        123     123     123     124     -1.      0.      0.
CBEAM        124     124     124     125     -1.      0.      0.
CBEAM        125     125     125     126     -1.      0.      0.
CBEAM        126     126     126     127     -1.      0.      0.
CBEAM        127     127     127     128     -1.      0.      0.
CBEAM        128     128     128     129     -1.      0.      0.
CBEAM        129     129     129     130     -1.      0.      0.
CBEAM        130     130     130     131     -1.      0.      0.
CBEAM        131     131     131     132     -1.      0.      0.
CBEAM        132     132     132     133     -1.      0.      0.
CBEAM        133     133     133     134     -1.      0.      0.
CBEAM        134     134     134     135     -1.      0.      0.
CBEAM        135     135     135     136     -1.      0.      0.
CBEAM        136     136     136     137     -1.      0.      0.
CBEAM        137     137     137     138     -1.      0.      0.
CBEAM        138     138     138     139     -1.      0.      0.
CBEAM        139     139     139     140     -1.      0.      0.
CBEAM        140     140     140     141     -1.      0.      0.
$   BEAMS FOR RIGHT WING TIP BOOM
CBEAM        201     201     201     202      0.      1.      0.
CBEAM        202     202     202     203      0.      1.      0.
CBEAM        203     203     203     204      0.      1.      0.
CBEAM        204     204     204     205      0.      1.      0.
CBEAM        205     205     205     206      0.      1.      0.
CBEAM        206     206     206     207      0.      1.      0.
CBEAM        207     207     207     208      0.      1.      0.
CBEAM        208     208     208     209      0.      1.      0.
CBEAM        209     209     209     210      0.      1.      0.
CBEAM        210     210     210     211      0.      1.      0.
CBEAM        211     211     211     212      0.      1.      0.
CBEAM        212     212     212     213      0.      1.      0.
CBEAM        213     213     213     214      0.      1.      0.
CBEAM        214     214     214     215      0.      1.      0.
CBEAM        215     215     215     216      0.      1.      0.
CBEAM        216     216     216     217      0.      1.      0.
CBEAM        217     217     217     218      0.      1.      0.
CBEAM        218     218     218     219      0.      1.      0.
CBEAM        219     219     219     220      0.      1.      0.
CBEAM        220     220     220     221      0.      1.      0.
CBEAM        221     221     221     222      0.      1.      0.
CBEAM        222     222     222     223      0.      1.      0.
CBEAM        223     223     223     224      0.      1.      0.
CBEAM        224     224     224     225      0.      1.      0.
CBEAM        225     225     225     226      0.      1.      0.
CBEAM        226     226     226     227      0.      1.      0.
CBEAM        227     227     227     228      0.      1.      0.
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CBEAM        228     228     228     229      0.      1.      0.
CBEAM        229     229     229     230      0.      1.      0.
CBEAM        230     230     230     231      0.      1.      0.
CBEAM        231     231     231     232      0.      1.      0.
CBEAM        232     232     232     233      0.      1.      0.
CBEAM        233     233     233     234      0.      1.      0.
CBEAM        234     234     234     235      0.      1.      0.
CBEAM        235     235     235     236      0.      1.      0.
CBEAM        236     236     236     237      0.      1.      0.
CBEAM        237     237     237     238      0.      1.      0.
CBEAM        238     238     238     239      0.      1.      0.
CBEAM        239     239     239     240      0.      1.      0.
CBEAM        240     240     240     241      0.      1.      0.
CBEAM        241     241     241     242      0.      1.      0.
CBEAM        242     242     242     243      0.      1.      0.
$   RIGHT SIDE HORIZONTAL TAIL BEAMS
CBEAM        301     301     301     302     -1.      0.      0.
CBEAM        302     302     302     303     -1.      0.      0.
CBEAM        303     303     303     304     -1.      0.      0.
CBEAM        304     304     304     305     -1.      0.      0.
CBEAM        305     305     305     306     -1.      0.      0.
CBEAM        306     306     306     307     -1.      0.      0.
CBEAM        307     307     307     308     -1.      0.      0.
CBEAM        308     308     308     309     -1.      0.      0.
CBEAM        309     309     309     310     -1.      0.      0.
CBEAM        310     310     310     311     -1.      0.      0.
$   RIGHT SIDE VERTICAL TAIL BEAMS
CBEAM        401     401     401     402      1.      0.      0.
CBEAM        402     402     402     403      1.      0.      0.
CBEAM        403     403     403     404      1.      0.      0.
CBEAM        404     404     404     405      1.      0.      0.
CBEAM        405     405     405     406      1.      0.      0.
CBEAM        406     406     406     407      1.      0.      0.
CBEAM        407     407     407     408      1.      0.      0.
CBEAM        408     408     408     409      1.      0.      0.
CBEAM        409     409     409     410      1.      0.      0.
CBEAM        410     410     410     411      1.      0.      0.
$
$   BEAM PROPERTIES FOR RIGHT WING ELASTIC AXIS
PBEAM        101       1   1000.   1021.   247.3      0.   174.3      0.
PBEAM        102       1   1000.   1005.   227.7      0.   171.5      0.
PBEAM        103       1   1000.   989.3   208.8      0.   168.7      0.
PBEAM        104       1   1000.    974.   190.5      0.    166.      0.
PBEAM        105       1   1000.   958.7    173.      0.   163.3      0.
PBEAM        106       1   1000.   943.7   156.2      0.   160.6      0.
PBEAM        107       1   1000.   928.8   140.2      0.   157.9      0.
PBEAM        108       1   1000.    914.   124.8      0.   155.3      0.
PBEAM        109       1   1000.   899.4   110.3      0.   152.7      0.
PBEAM        110       1   1000.    885.   96.95      0.   150.1      0.
PBEAM        111       1   1000.   870.7   92.06      0.   147.6      0.
PBEAM        112       1   1000.   856.6   86.48      0.   145.1      0.
PBEAM        113       1   1000.   842.6   79.99      0.   142.6      0.
PBEAM        114       1   1000.   828.8   75.44      0.   140.1      0.
PBEAM        115       1   1000.   815.2   71.21      0.   137.7      0.
PBEAM        116       1   1000.   801.6   68.65      0.   135.3      0.
PBEAM        117       1   1000.   788.3   67.96      0.    133.      0.
PBEAM        118       1   1000.   769.7   66.91      0.   129.7      0.
PBEAM        119       1   1000.   746.1   65.52      0.   125.5      0.
PBEAM        120       1   1000.   723.1   64.11      0.   121.4      0.
PBEAM        121       1   1000.   700.5   62.75      0.   117.4      0.
PBEAM        122       1   1000.   678.4   61.39      0.   113.5      0.
PBEAM        123       1   1000.   656.7   60.02      0.   109.7      0.
PBEAM        124       1   1000.   635.5   58.67      0.    106.      0.
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PBEAM        125       1   1000.   614.8   57.33      0.   102.3      0.
PBEAM        126       1   1000.   594.6   56.01      0.   98.78      0.
PBEAM        127       1   1000.   574.8    54.7      0.    95.3      0.
PBEAM        128       1   1000.   555.4    53.4      0.   91.91      0.
PBEAM        129       1   1000.   536.5   52.12      0.    88.6      0.
PBEAM        130       1   1000.    518.   50.86      0.   85.37      0.
PBEAM        131       1   1000.   499.9   49.61      0.   82.22      0.
PBEAM        132       1   1000.   482.3   48.37      0.   79.15      0.
PBEAM        133       1   1000.   465.1   47.15      0.   76.15      0.
PBEAM        134       1   1000.   448.3   45.95      0.   73.23      0.
PBEAM        135       1   1000.   431.9   44.76      0.   70.39      0.
PBEAM        136       1   1000.   415.9   43.58      0.   67.62      0.
PBEAM        137       1   1000.   400.3   42.42      0.   64.93      0.
PBEAM        138       1   1000.   385.1   41.27      0.    62.3      0.
PBEAM        139       1   1000.   370.3   40.14      0.   59.75      0.
PBEAM        140       1   1000.   355.9   39.03      0.   57.27      0.
$   BEAM PROPERTIES FOR RIGHT WING TIP BOOM
PBEAM        201       2   1000.   83.46   90.29      0.   238.6      0.
PBEAM        202       2   1000.   132.9   146.5      0.   238.6      0.
PBEAM        203       2   1000.   182.3   202.8      0.   238.6      0.
PBEAM        204       2   1000.   231.8   259.1      0.   238.6      0.
PBEAM        205       2   1000.   281.2   315.3      0.   238.6      0.
PBEAM        206       2   1000.   330.7   371.6      0.   238.6      0.
PBEAM        207       2   1000.   380.1   427.8      0.   238.6      0.
PBEAM        208       2   1000.   429.5   484.1      0.   238.6      0.
PBEAM        209       2   1000.    479.   540.4      0.   238.6      0.
PBEAM        210       2   1000.   528.4   596.6      0.   238.6      0.
PBEAM        211       2   1000.   577.8   652.9      0.   238.6      0.
PBEAM        212       2   1000.   627.3   709.1      0.   238.6      0.
PBEAM        213       2   1000.   676.7   765.4      0.   238.6      0.
PBEAM        214       2   1000.   726.2   821.7      0.   238.6      0.
PBEAM        215       2   1000.   704.4   793.9      0.   238.6      0.
PBEAM        216       2   1000.   682.7   766.2      0.   238.6      0.
PBEAM        217       2   1000.    661.   738.4      0.   238.6      0.
PBEAM        218       2   1000.   639.3   710.7      0.   238.6      0.
PBEAM        219       2   1000.    597.   659.8      0.   221.1      0.
PBEAM        220       2   1000.   556.2   610.7      0.   204.5      0.
PBEAM        221       2   1000.   516.7   563.3      0.   188.8      0.
PBEAM        222       2   1000.   478.6   517.7      0.   173.9      0.
PBEAM        223       2   1000.   441.9   473.7      0.   159.8      0.
PBEAM        224       2   1000.   406.6   431.5      0.   146.5      0.
PBEAM        225       2   1000.   372.6   391.1      0.    134.      0.
PBEAM        226       2   1000.    340.   352.3      0.   122.1      0.
PBEAM        227       2   1000.   308.8   315.3      0.    111.      0.
PBEAM        228       2   1000.   278.9   279.9      0.   100.6      0.
PBEAM        229       2   1000.   253.6   249.5      0.   113.6      0.
PBEAM        230       2   1000.   226.1   217.3      0.   102.3      0.
PBEAM        231       2   1000.    200.   186.8      0.   91.71      0.
PBEAM        232       2   1000.   177.6   160.2      0.   98.27      0.
PBEAM        233       2   1000.   153.9   132.9      0.   87.36      0.
PBEAM        234       2   1000.   131.7   107.3      0.   77.29      0.
PBEAM        235       2   1000.   112.4   85.01      0.   79.37      0.
PBEAM        236       2   1000.   94.08   64.02      0.   79.38      0.
PBEAM        237       2   1000.    75.6   43.23      0.   69.04      0.
PBEAM        238       2   1000.   59.53    25.2      0.    67.1      0.
PBEAM        239       2   1000.   44.55   8.614      0.   63.92      0.
PBEAM        240       2   1000.    30.7   8.007      0.   59.78      0.
PBEAM        241       2   1000.   14.37   3.655      0.   27.47      0.
PBEAM        242       2   1000.   3.024   3.024      0.    22.9      0.
$   BEAM PROPERTIES FOR RIGHT SIDE HORIZONTAL TAIL
PBEAM        301       3   1000.   1047.   54.91      0.    179.      0.
PBEAM        302       3   1000.   894.1    41.7      0.   151.7      0.
PBEAM        303       3   1000.   756.8   30.83      0.   127.4      0.
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PBEAM        304       3   1000.   634.3   22.05      0.   105.8      0.
PBEAM        305       3   1000.   525.8   15.11      0.   86.74      0.
PBEAM        306       3   1000.   430.5   9.772      0.   70.15      0.
PBEAM        307       3   1000.   347.4   5.823      0.   55.82      0.
PBEAM        308       3   1000.   275.8   3.046      0.   43.59      0.
PBEAM        309       3   1000.   214.8   1.241      0.   33.28      0.
PBEAM        310       3   1000.   163.5  0.2188      0.   24.75      0.
$   BEAM PROPERTIES FOR RIGHT SIDE VERTICAL TAIL
PBEAM        401       4   1000.   542.6   24.42      0.   73.63      0.
PBEAM        402       4   1000.   486.7   18.52      0.   66.03      0.
PBEAM        403       4   1000.   434.7   13.68      0.   58.98      0.
PBEAM        404       4   1000.   386.6   9.785      0.   52.45      0.
PBEAM        405       4   1000.   342.1   6.712      0.   46.42      0.
PBEAM        406       4   1000.   301.3    4.35      0.   40.87      0.
PBEAM        407       4   1000.   263.8   2.599      0.   35.79      0.
PBEAM        408       4   1000.   229.5   1.365      0.   31.14      0.
PBEAM        409       4   1000.   198.4  0.5584      0.   26.91      0.
PBEAM        410       4   1000.   170.2 0.09922      0.   23.09      0.
$
$       MATERIAL  PROPERTIES
$ FEMAP Material 1 : Generic - WING AND CHORDWISE SPINES
MAT1           11000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - BOOM
MAT1           21000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - HORIZONTAL
MAT1           31000000.1000000.     0.3      0.      0.      0.
$
$ FEMAP Material 1 : Generic - VERTICAL
MAT1           41000000.1000000.     0.3      0.      0.      0.
$
$     LUMPED  MASSES
$ Fuselage Rigid Body Mass (50% for 1/2 symm model)
$
CONM2        601     100      -1   446.1  125.80    0.00    86.1       0 MASS601
+MASS601  2.64E5       0  8.90E5       0       0  6.95E5
$
$ ***************************************
$ LUMPED MASSES FOR RIGHT-WING
$ ***************************************
$   RIGHT WING
CONM2        602     102      -1    7.91  157.54    6.57   49.16       0 MASS602
CONM2        603     103      -1    7.75  157.67   19.72   49.83       0 MASS603
CONM2        604     104      -1    7.60  157.80   32.87   50.50       0 MASS604
CONM2        605     105      -1    7.45  157.92   46.01   51.17       0 MASS605
CONM2        606     106      -1    7.30  158.05   59.16   51.84       0 MASS606
CONM2        607     107      -1    7.16  158.17   72.31   52.51       0 MASS607
CONM2        608     108      -1    7.03  158.30   85.46   53.17       0 MASS608
CONM2        609     109      -1    6.90  158.42   98.60   53.84       0 MASS609
CONM2        610     110      -1    6.77  158.54  111.75   54.51       0 MASS610
CONM2        611     111      -1    6.66  158.65  124.90   55.18       0 MASS611
CONM2        612     112      -1    6.57  158.71  138.04   55.86       0 MASS612
CONM2        613     113      -1    6.49  158.77  151.19   56.54       0 MASS613
CONM2        614     114      -1    6.41  158.82  164.34   57.22       0 MASS614
CONM2        615     115      -1    6.35  158.83  177.49   57.91       0 MASS615
CONM2        616     116      -1    6.30  158.82  190.63   58.60       0 MASS616
CONM2        617     117      -1    6.26  158.79  203.78   59.29       0 MASS617
CONM2        618     118      -1    6.24  158.74  216.93   59.99       0 MASS618
CONM2        619     119      -1    6.19  158.66  230.07   60.69       0 MASS619
$
+MASS602   114.0       0  2357.1       0       0  2471.1
+MASS603   111.7       0  2285.6       0       0  2397.2
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```
+MASS604   109.4       0  2216.7       0       0  2326.1
+MASS605   107.3       0  2150.3       0       0  2257.6
+MASS606   105.2       0  2086.5       0       0  2191.6
+MASS607   103.2       0  2025.0       0       0  2128.2
+MASS608   101.2       0  1966.0       0       0  2067.2
+MASS609    99.4       0  1909.2       0       0  2008.6
+MASS610    97.6       0  1854.7       0       0  1952.3
+MASS611    95.9       0  1802.8       0       0  1898.7
+MASS612    94.6       0  1760.2       0       0  1854.9
+MASS613    93.4       0  1719.1       0       0  1812.6
+MASS614    92.3       0  1679.5       0       0  1771.8
+MASS615    91.5       0  1646.6       0       0  1738.0
+MASS616    90.7       0  1615.4       0       0  1706.1
+MASS617    90.2       0  1587.8       0       0  1678.0
+MASS618    89.8       0  1563.6       0       0  1653.4
+MASS619    88.9       0  1527.9       0       0  1616.9
$
$   ***************************************************************
$      BEGIN FUEL STATIONS
$   ***************************************************************
$
$ No Fuel
$
$CONM2        620     120      -1    6.14  158.56  243.20   61.53       0 MASS620
$CONM2        621     121      -1    6.10  158.46  256.33   62.23       0 MASS621
$CONM2        622     122      -1    6.05  158.36  269.46   62.93       0 MASS622
$CONM2        623     123      -1    6.00  158.26  282.59   63.63       0 MASS623
$CONM2        624     124      -1    5.95  158.16  295.72   64.33       0 MASS624
$CONM2        625     125      -1    5.91  158.06  308.85   65.03       0 MASS625
$CONM2        626     126      -1    5.86  157.96  321.98   65.73       0 MASS626
$
$ No Fuel
$
$+MASS620    88.3       0  1485.1       0       0  1573.4
$+MASS621    87.6       0  1443.1       0       0  1530.7
$+MASS622    86.9       0  1402.0       0       0  1488.9
$+MASS623    86.2       0  1361.5       0       0  1447.8
$+MASS624    85.5       0  1321.9       0       0  1407.5
$+MASS625    84.9       0  1283.1       0       0  1367.9
$+MASS626    84.2       0  1245.0       0       0  1329.1
$
$ WITH FUEL AT AN ALTITUDE OF 1000 FEET (10/15/98)
$
CONM2        620     120      -1  25.379  157.65  243.20   61.53       0 MASS620
CONM2        621     121      -1  24.861  157.57  256.33   62.23       0 MASS621
CONM2        622     122      -1  24.348  157.49  269.46   62.93       0 MASS622
CONM2        623     123      -1  23.839  157.41  282.59   63.63       0 MASS623
CONM2        624     124      -1  23.335  157.33  295.72   64.33       0 MASS624
CONM2        625     125      -1  22.839  157.25  308.85   65.03       0 MASS625
CONM2        626     126      -1  22.348  157.17  321.98   65.73       0 MASS626
$
$ WITH FUEL AT AN ALTITUDE OF 1000 FEET (10/15/98)
$
+MASS620  364.62       0 3931.34       0       0 4090.73
+MASS621  357.16       0 3774.54       0       0 3930.40
+MASS622  349.80       0 3622.52       0       0 3774.90
+MASS623  342.48       0 3475.13       0       0 3624.12
+MASS624  335.29       0 3332.35       0       0 3477.95
+MASS625  328.15       0 3194.03       0       0 3336.28
+MASS626  321.10       0 3060.12       0       0 3199.03
$
$ With Fuel
$
```

```
$ CONM2        620     120      -1   56.86  157.65  243.20   61.53       0 MASS620
$ CONM2        621     121      -1   55.70  157.57  256.33   62.23       0 MASS621
$ CONM2        622     122      -1   54.55  157.49  269.46   62.93       0 MASS622
$ CONM2        623     123      -1   53.41  157.41  282.59   63.63       0 MASS623
$ CONM2        624     124      -1   52.28  157.33  295.72   64.33       0 MASS624
$ CONM2        625     125      -1   51.17  157.25  308.85   65.03       0 MASS625
$ CONM2        626     126      -1   50.07  157.17  321.98   65.73       0 MASS626
$
$ With Fuel
$
$ +MASS620   816.9       0  8807.9       0       0  9165.0
$ +MASS621   800.2       0  8456.6       0       0  8805.8
$ +MASS622   783.7       0  8116.0       0       0  8457.4
$ +MASS623   767.3       0  7785.8       0       0  8119.6
$ +MASS624   751.2       0  7465.9       0       0  7792.1
$ +MASS625   735.2       0  7156.0       0       0  7474.7
$ +MASS626   719.4       0  6856.0       0       0  7167.2
$
$   ****************************************************************
$      END FUEL STATIONS
$   ****************************************************************
$
CONM2        627     127      -1    5.81  157.86  335.11   66.31       0 MASS627
CONM2        628     128      -1    5.76  157.76  348.24   67.01       0 MASS628
CONM2        629     129      -1    5.72  157.66  361.37   67.71       0 MASS629
CONM2        630     130      -1    5.67  157.56  374.50   68.42       0 MASS630
CONM2        631     131      -1    5.62  157.46  387.63   69.12       0 MASS631
CONM2        632     132      -1    5.58  157.37  400.76   69.82       0 MASS632
CONM2        633     133      -1    5.53  157.27  413.89   70.52       0 MASS633
CONM2        634     134      -1    5.48  157.17  427.02   71.23       0 MASS634
CONM2        635     135      -1    5.43  157.07  440.15   71.93       0 MASS635
CONM2        636     136      -1   12.39  155.86  453.28   72.81       0 MASS636
CONM2        637     137      -1    5.34  156.87  466.41   73.33       0 MASS637
CONM2        638     138      -1   12.29  155.76  479.54   74.19       0 MASS638
CONM2        639     139      -1    5.24  156.67  492.67   74.74       0 MASS639
CONM2        640     140      -1   12.20  155.67  505.80   75.58       0 MASS640
CONM2        641     141      -1    5.15  156.47  518.93   76.14       0 MASS641
$
+MASS627    83.5       0  1207.6       0       0  1291.1
+MASS628    82.8       0  1171.0       0       0  1253.8
+MASS629    82.1       0  1135.2       0       0  1217.3
+MASS630    81.5       0  1100.0       0       0  1181.5
+MASS631    80.8       0  1065.6       0       0  1146.4
+MASS632    80.1       0  1031.9       0       0  1112.0
+MASS633    79.4       0   999.0       0       0  1078.4
+MASS634    78.7       0   966.7       0       0  1045.4
+MASS635    78.1       0   935.1       0       0  1013.2
+MASS636    77.4       0   974.4       0       0   974.4
+MASS637    76.7       0   874.0       0       0   950.7
+MASS638    76.0       0   912.3       0       0   912.3
+MASS639    75.3       0   815.6       0       0   890.9
+MASS640    74.7       0   853.1       0       0   853.1
+MASS641    74.0       0   759.8       0       0   833.8
$
$   LUMPED MASSES ON RIGHT WING-TIP BOOM
CONM2        702     202      -1   11.25   33.61  525.50   77.50       0 MASS702
CONM2        703     203      -1   16.33   42.22  525.50   77.50       0 MASS703
CONM2        704     204      -1   16.41   50.83  525.50   77.50       0 MASS704
CONM2        705     205      -1   11.48   59.44  525.50   77.50       0 MASS705
CONM2        706     206      -1    1.56   68.06  525.50   77.50       0 MASS706
CONM2        707     207      -1    1.64   76.67  525.50   77.50       0 MASS707
CONM2        708     208      -1    1.72   85.28  525.50   77.50       0 MASS708
CONM2        709     209      -1    1.79   93.89  525.50   77.50       0 MASS709
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CONM2        710     210      -1    1.87  102.50  525.50   77.50        0 MASS710
CONM2        711     211      -1    1.95  111.11  525.50   77.50        0 MASS711
CONM2        712     212      -1    2.02  119.72  525.50   77.50        0 MASS712
CONM2        713     213      -1    2.10  128.33  525.50   77.50        0 MASS713
CONM2        714     214      -1    2.18  136.94  525.50   77.50        0 MASS714
CONM2        715     215      -1    2.25  145.56  525.50   77.50        0 MASS715
CONM2        716     216      -1    2.22  154.17  525.50   77.50        0 MASS716
CONM2        717     217      -1    2.18  162.78  525.50   77.50        0 MASS717
CONM2        718     218      -1    5.65  171.39  525.50   77.50        0 MASS718
CONM2        719     219      -1    2.11  180.00  525.50   77.50        0 MASS719
CONM2        720     220      -1    2.41  190.00  525.50   77.50        0 MASS720
CONM2        721     221      -1    2.35  200.00  525.50   77.50        0 MASS721
CONM2        722     222      -1    2.30  210.00  525.50   77.50        0 MASS722
CONM2        723     223      -1    2.24  220.00  525.50   77.50        0 MASS723
CONM2        724     224      -1    2.17  230.00  525.50   77.50        0 MASS724
CONM2        725     225      -1    2.11  240.00  525.50   77.50        0 MASS725
CONM2        726     226      -1    2.05  250.00  525.50   77.50        0 MASS726
CONM2        727     227      -1    1.98  260.00  525.50   77.50        0 MASS727
CONM2        728     228      -1    1.91  270.00  525.50   77.50        0 MASS728
CONM2        729     229      -1    1.84  280.00  525.50   77.50        0 MASS729
CONM2        730     230      -1    1.89  290.00  525.50   77.50        0 MASS730
CONM2        731     231      -1    1.81  300.00  525.50   77.50        0 MASS731
CONM2        732     232      -1    1.73  310.00  525.50   77.50        0 MASS732
CONM2        733     233      -1    1.76  320.00  525.50   77.50        0 MASS733
CONM2        734     234      -1    1.66  330.00  525.50   77.50        0 MASS734
CONM2        735     235      -1    1.56  340.00  525.50   77.50        0 MASS735
CONM2        736     236      -1    1.56  350.00  525.50   77.50        0 MASS736
CONM2        737     237      -1    1.54  360.00  525.50   77.50        0 MASS737
CONM2        738     238      -1    1.42  370.00  525.50   77.50        0 MASS738
CONM2        739     239      -1    1.37  380.00  525.50   77.50        0 MASS739
CONM2        740     240      -1    1.31  390.00  525.50   77.50        0 MASS740
CONM2        741     241      -1    1.29  400.00  525.50   77.50        0 MASS741
CONM2        742     242      -1    0.80  410.00  525.50   77.50        0 MASS742
CONM2        743     243      -1    0.71  420.00  525.50   77.50        0 MASS743
$
$
+MASS702   316.5       0   126.6       0       0   126.6
+MASS703   459.3       0   330.6       0       0   330.6
+MASS704   461.5       0   332.1       0       0   332.1
+MASS705   323.0       0   232.5       0       0   232.5
+MASS706    87.8       0    53.6       0       0    53.6
+MASS707    92.2       0    56.2       0       0    56.2
+MASS708    96.5       0    58.8       0       0    58.8
+MASS709   100.8       0    61.5       0       0    61.5
+MASS710   105.1       0    64.1       0       0    64.1
+MASS711   109.5       0    66.8       0       0    66.8
+MASS712   113.8       0    69.4       0       0    69.4
+MASS713   118.1       0    72.0       0       0    72.0
+MASS714   122.5       0    74.7       0       0    74.7
+MASS715   126.8       0    77.3       0       0    77.3
+MASS716   124.8       0    76.1       0       0    76.1
+MASS717   122.7       0    74.9       0       0    74.9
+MASS718   158.8       0   114.3       0       0   114.3
+MASS719   118.7       0    72.4       0       0    72.4
+MASS720   128.9       0    84.6       0       0    84.6
+MASS721   119.5       0    79.4       0       0    79.4
+MASS722   110.5       0    74.4       0       0    74.4
+MASS723   101.8       0    69.6       0       0    69.6
+MASS724    93.6       0    64.9       0       0    64.9
+MASS725    85.8       0    60.5       0       0    60.5
+MASS726    78.3       0    56.2       0       0    56.2
+MASS727    71.3       0    52.1       0       0    52.1
+MASS728    64.5       0    48.2       0       0    48.2
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+MASS729    58.2       0    44.4       0       0    44.4
+MASS730    56.0       0    43.8       0       0    43.8
+MASS731    50.0       0    40.1       0       0    40.1
+MASS732    44.3       0    36.6       0       0    36.6
+MASS733    41.8       0    35.5       0       0    35.5
+MASS734    36.5       0    32.1       0       0    32.1
+MASS735    31.6       0    28.8       0       0    28.8
+MASS736    29.0       0    27.5       0       0    27.5
+MASS737    26.2       0    26.0       0       0    26.0
+MASS738    21.9       0    22.8       0       0    22.8
+MASS739    19.3       0    21.1       0       0    21.1
+MASS740    16.6       0    19.2       0       0    19.2
+MASS741    14.7       0    18.1       0       0    18.1
+MASS742     8.1       0    10.7       0       0    10.7
+MASS743     6.4       0     9.1       0       0     9.1
$   LUMPED MASSES FOR RIGHT SIDE HORIZONTAL TAIL
CONM2        802     302      -1    4.97  387.10  530.25   77.80       0 MASS802
CONM2        803     303      -1    4.73  386.66  539.75   79.47       0 MASS803
CONM2        804     304      -1    7.69  387.79  549.25   81.06       0 MASS804
CONM2        805     305      -1    4.26  385.75  558.75   82.82       0 MASS805
CONM2        806     306      -1    4.03  385.29  568.25   84.49       0 MASS806
CONM2        807     307      -1    7.00  387.18  577.75   86.04       0 MASS807
CONM2        808     308      -1    3.58  384.33  587.25   87.84       0 MASS808
CONM2        809     309      -1    3.35  383.83  596.75   89.51       0 MASS809
CONM2        810     310      -1    6.34  386.70  606.25   91.01       0 MASS810
CONM2        811     311      -1    2.92  382.81  615.75   92.87       0 MASS811
$
+MASS802    37.4       0  1504.7       0       0  1542.1
+MASS803    35.6       0  1289.2       0       0  1324.7
+MASS804    33.8       0  1149.5       0       0  1149.5
+MASS805    32.0       0   923.6       0       0   955.6
+MASS806    30.3       0   770.9       0       0   801.2
+MASS807    28.6       0   710.0       0       0   710.0
+MASS808    26.9       0   519.2       0       0   546.1
+MASS809    25.2       0   417.6       0       0   442.8
+MASS810    23.6       0   427.7       0       0   427.7
+MASS811    22.0       0   256.7       0       0   278.7
$   LUMPED MASSES FOR RIGHT SIDE VERTICAL TAIL
CONM2        902     402      -1    3.06  413.63  524.05   81.48       0 MASS902
CONM2        903     403      -1    2.91  414.65  521.15   89.45       0 MASS903
CONM2        904     404      -1    5.97  418.34  518.25   97.42       0 MASS904
CONM2        905     405      -1    2.63  416.67  515.35  105.39       0 MASS905
CONM2        906     406      -1    2.49  417.67  512.45  113.36       0 MASS906
CONM2        907     407      -1    2.36  418.66  509.55  121.33       0 MASS907
CONM2        908     408      -1    5.43  422.59  506.65  129.30       0 MASS908
CONM2        909     409      -1     2.1  420.61  503.75  137.27       0 MASS909
CONM2        910     410      -1    1.98  421.57  500.85  145.23       0 MASS910
CONM2        911     411      -1    1.86  422.50  497.95  153.20       0 MASS911
$
+MASS902    18.3       0   616.3       0       0   597.9
+MASS903    17.5       0   547.1       0       0   529.7
+MASS904    16.6       0   483.7       0       0   467.1
+MASS905    15.8       0   425.8       0       0   410.0
+MASS906    14.9       0   373.1       0       0   358.2
+MASS907    14.1       0   325.3       0       0   311.2
+MASS908    13.3       0   282.3       0       0   269.0
+MASS909    12.6       0   243.7       0       0   231.1
+MASS910    11.8       0   209.3       0       0   197.5
+MASS911    11.1       0   178.9       0       0   167.8
$
$
PBEAM       2301       1   100.    1000.  1000.       0.  1000.
PBEAM       2401       1   100.    1000.  1000.       0.  1000.
```

```
$
$   RIGHT SIDE BEAMS FROM H-TAIL MAIN BEAM TO HINGE LINE
CBEAM       2301    2301    301     2501     302
CBEAM       2302    2301    302     2502     301
CBEAM       2303    2301    303     2503     301
CBEAM       2304    2301    304     2504     301
CBEAM       2305    2301    305     2505     301
CBEAM       2306    2301    306     2506     301
CBEAM       2307    2301    307     2507     301
CBEAM       2308    2301    308     2508     301
CBEAM       2309    2301    309     2509     301
CBEAM       2310    2301    310     2510     301
CBEAM       2311    2301    311     2511     301
$
$   RIGHT SIDE BEAMS FROM H-TAIL HINGE LINE TO H-TAIL TRAILING EDGE
CBEAM       2321    2301    2501    2301    2502
CBEAM       2322    2301    2502    2302    2501
CBEAM       2323    2301    2503    2303    2501
CBEAM       2324    2301    2504    2304    2501
CBEAM       2325    2301    2505    2305    2501
CBEAM       2326    2301    2506    2306    2501
CBEAM       2327    2301    2507    2307    2501
CBEAM       2328    2301    2508    2308    2501
CBEAM       2329    2301    2509    2309    2501
CBEAM       2330    2301    2510    2310    2501
CBEAM       2331    2301    2511    2311    2501
$   RIGHT SIDE BEAMS FROM V-TAIL MAIN BEAM TO HINGE LINE
CBEAM       2401    2401    401     2601     402
CBEAM       2402    2401    402     2602     401
CBEAM       2403    2401    403     2603     401
CBEAM       2404    2401    404     2604     401
CBEAM       2405    2401    405     2605     401
CBEAM       2406    2401    406     2606     401
CBEAM       2407    2401    407     2607     401
CBEAM       2408    2401    408     2608     401
CBEAM       2409    2401    409     2609     401
CBEAM       2410    2401    410     2610     401
CBEAM       2411    2401    411     2611     401
$
$   RIGHT SIDE BEAMS FROM V-TAIL HINGE LINE TO V-TAIL TRAILING EDGE
CBEAM       2421    2401    2601    2401    2602
CBEAM       2422    2401    2602    2402    2601
CBEAM       2423    2401    2603    2403    2601
CBEAM       2424    2401    2604    2404    2601
CBEAM       2425    2401    2605    2405    2601
CBEAM       2426    2401    2606    2406    2601
CBEAM       2427    2401    2607    2407    2601
CBEAM       2428    2401    2608    2408    2601
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13. ABSTRACT *(Maximum 200 words)*
This report presents the work performed by Lockheed Martin's Langley Program Office in support of NASA's Environmental Research Aircraft and Sensor Technology (ERAST) program. The primary purpose of this work was to develop and demonstrate a gust analysis method which accounts for the span-wise variation of gust velocity. This is important because these unmanned aircraft having high aspect ratios and low wing loading are very flexible, and fly at low speeds. The main focus of the work was therefore to perform a two-dimensional Power Spectrum Density (PSD) analysis of the Alliance 1 Proof-of-Concept Unmanned Aircraft. As of this writing, none of the aircraft described in this report have been constructed. They are concepts represented by analytical models. The process first involved the development of suitable structural and aeroelastic Finite Element Models (FEM). This was followed by development of a one-dimensional PSD gust analysis, and then the two-dimensional (PSD) analysis of the Alliance 1. For further validation and comparison, two additional analyses were performed. A two-dimensional PSD gust analysis was performed on a simplet MSC/NASTRAN example problem. Finally a one-dimensional discrete gust analysis was performed on Alliance 1. This report describes this process, shows the relevant comparisons between analytical methods, and discusses the physical meanings of the results.

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