NASA Contractor Report 2854

A Program for Calculating Load Coefficient Matrices Utilizing the Force Summation Method, L218 (LOADS)

Volume II: Supplemental System Design and Maintenance Document

L. R. Anderson and R. D. Miller

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1.0 SUMMARY

The program L218 (LOADS) is structured as five overlays, one main overlay and four primary overlays. Input into the program is made via cards and magnetic files (tapes or disks). Output from the program consists of printed results and magnetic files containing load coefficient matrices for use in either L219 (EQMOD) or L221 (TEV156).

Although L218 (LOADS) serves as a module of the DYLOFLEX system, it can be operated as a stand alone program. Subroutines used by L218 include routines embedded in the program code and routines obtained from the standard FORTRAN and the DYLOFLEX libraries.

2.0 INTRODUCTION

The computer program L218 (LOADS) was developed for use as either a standalone program or as a module of a program system called DYLOFLEX (see fig. 1) developed for NASA under contract NAS1-13918 (ref. 1). Because of the DYLOFLEX contract requirements defined in reference 2, a program was needed to calculate dynamic load coefficient matrices for use as sensors in active control analyses and/or for use in calculating design loads.

The objective of this volume is to aid those persons who will maintain and/or modify the program in the future. To meet this objective, the following items are defined:

- Program design and structure
- Overlay purpose and description
- Input, output and internal data base descriptions
- Extent of checkout

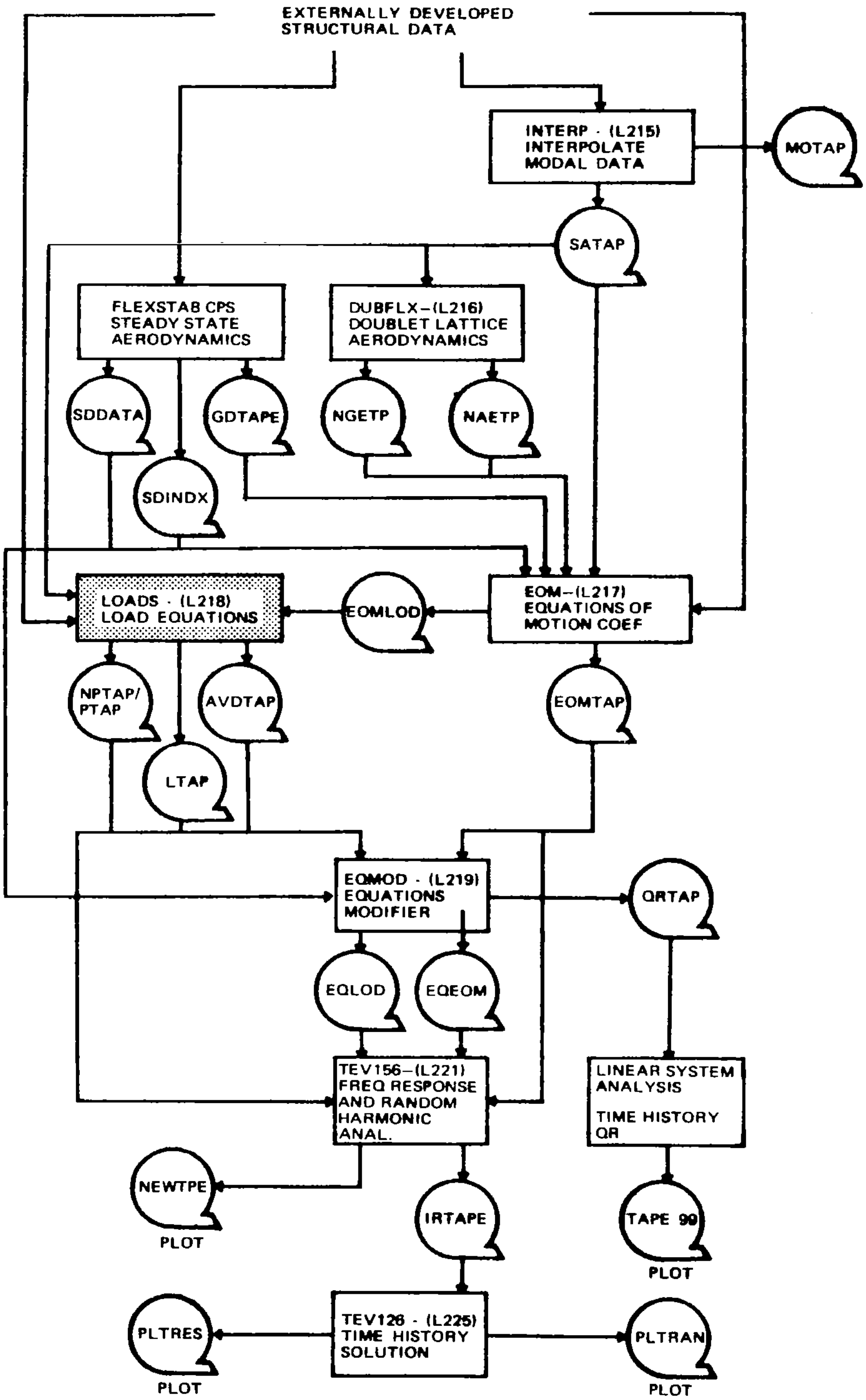


Figure 1. — Dyloflex Flow Chart

3.0 PROGRAM DESIGN AND STRUCTURE

The program is structured as a system of five overlays (fig. 2):

Main overlay (L218,0,0)	L218vc
Primary overlay (L218,1,0)	RGEN
Primary overlay (L218,2,0)	AVD
Primary overlay (L218,3,0)	NPLDS/PLDS
Primary overlay (L218,4,0)	VBMT

The main overlay L218vc controls reading of general data cards by the primary overlay (1,0) RGEN, and calls the proper primary overlay to perform the execution requested. The main overlay does not read input cards.

The (1,0) primary overlay RGEN reads the general input data and the module cards ($AVD, $NPLDS, $PLDS, or $VBMT), which selects the primary overlay for execution.

The (2,0) primary overlay AVD reads the AVD card and tape input data, performs the AVD calculations, and writes the AVDTAP output tape.

The (3,0) primary overlay NPLDS/PLDS reads the NPLDS (or PLDS) card and tape input data, performs the NPLDS (or PLDS) calculations, and writes the NPTAP (or PTAP) output tape.

The (4,0) primary overlay VBMT reads the VBMT card and tape input data, performs the VBMT calculation, and writes the LTAP output tape.

Although L218 serves as a module of the DYLOFLEX system, it can be operated as a standalone program. When the program is run by itself, it becomes the user's responsibility to generate input data in the format required by L218; see figure 3 for the external file requirements and volume I of this document for the file contents and formats.

This program requires subroutines that are not part of the L218 code. Some routines are automatically obtained from the standard FORTRAN library when the program is loaded. Others, however, are stored in the DYLOFLEX alternate subroutine library, which must be declared at the time of loading. Subsequent sections describe each overlay separately and contain tables displaying the routines called and the library in which they are located. All subroutines are single entry point routines.

This volume describes the program in a macro sense. A more detailed discussion appears in the comments contained in the program source code. Each routine contains a preface describing the routine's purpose, author, analytical steps, modification history, input data, output data, glossary of variables, and list of other routines called. Embedded within the executable code are comments labeling each section and explaining logical branches.

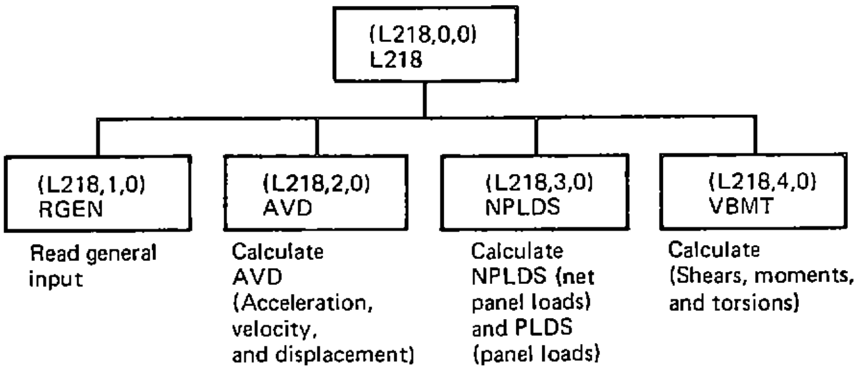


Figure 2. — Overlay Structure of L218 (LOADS)

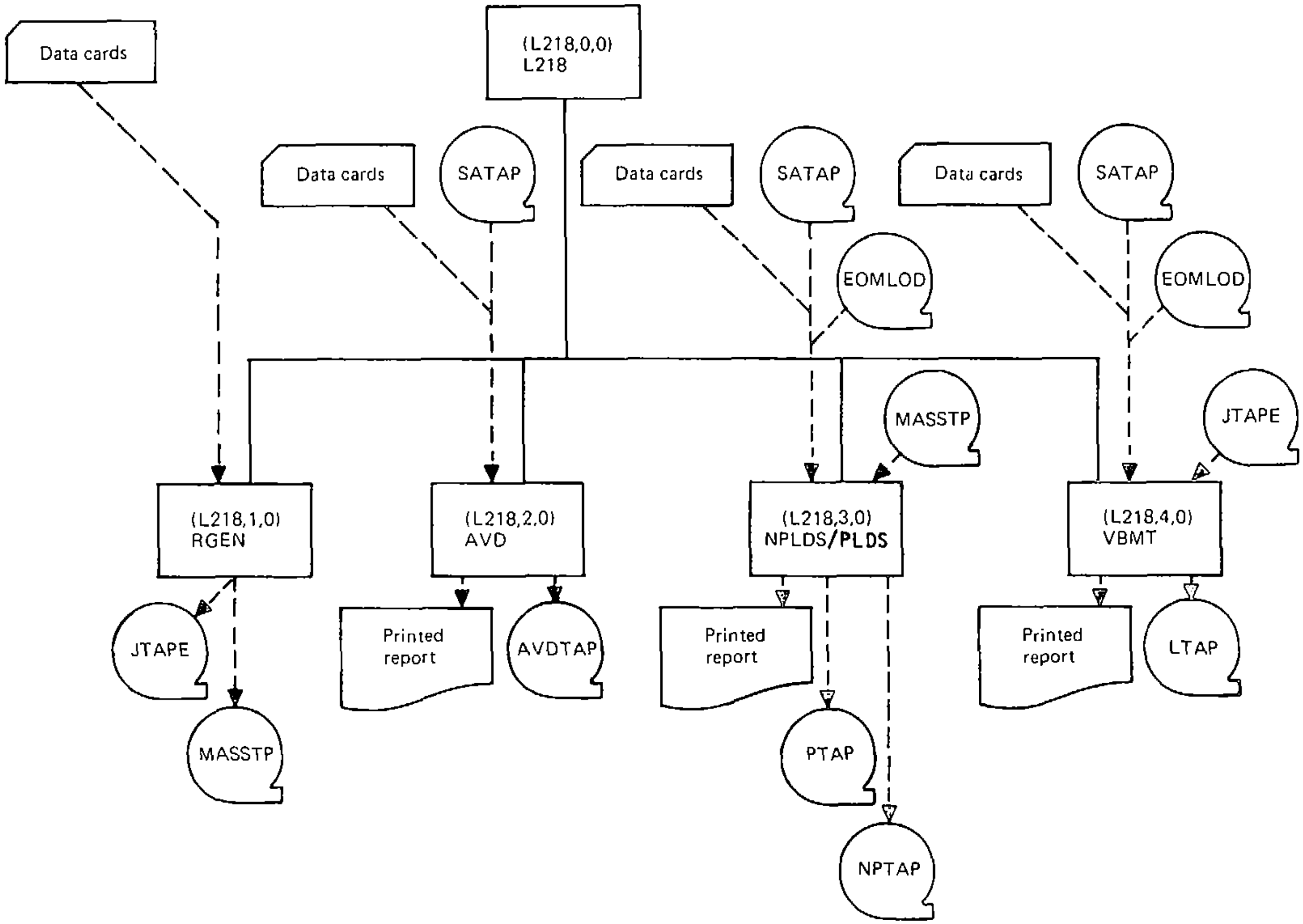


Figure 3. – Input/Output of L218 Overlays

3.1 OVERLAY (218,0,0) - L218vc

The main overlay of L218 is itself named L218vc where v is a letter indicating the program version and c is an integer number indicating the correction number that applies to the v version.

Purpose of L218vc

Overlay L218vc directs the execution of the primary overlays and aids communication between primary overlays via labeled common blocks.

Analytical Steps of L218vc

Overlay L218vc performs its task in the following steps:

1. Overlay (L218,1,0), RGEN, is called to read general input and/or a keyword card $AVD, $NPLDS, $PLDS, or $VBMT.

2. L218 determines the next overlay to call.

   a. If the keyword is $AVD, jump to step 3.

   b. If the keyword is $NPLDS, jump to step 4.

   c. If the keyword is $PLDS, jump to step 4.

   d. If the keyword is $VBMT, jump to step 5.

   e. If the keyword is $QUIT, jump to step 6.

3. Overlay (L218,2,0) is called to read input data and perform calculations for AVD (acceleration, velocity, displacement). When finished, program control returns to step 1.

4. Overlay (L218,3,0) is called to read input data and perform calculations for NPLDS/PLDS (net panel loads or panel loads). When finished, program control returns to step 1.

5. Overlay (L218,4,0) is called to read input data and perform calculations for VBMT (shears, bending moments, and torsions). When finished, program control returns to step 1.

6. L218 program stop.

The macro flow chart of this overlay is shown in figure 4. The subroutines called are displayed in table 1.

I/O Devices of L218vc

There is no I/O performed in the (0,0) overlay. It is all performed in the primary overlays.

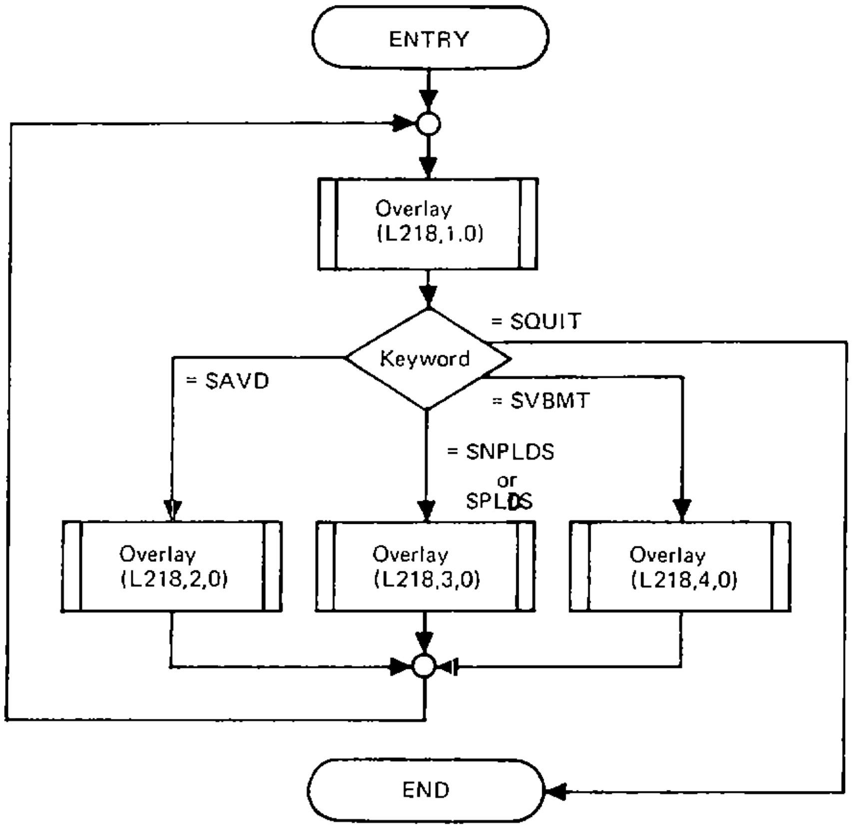


Figure 4. — Macro Flow Chart of Overlay (L218,0,0) L218 vc

Table 1. — Routines Called by L218vc

```
OVERLAY (L218,0,0)

PROGRAM L218vc

---------------------------------------------------------------------

RGEN     OVERLAY (L218,1,0)

AVD      OVERLAY (L218,2,0)

NPLDS    OVERLAY (L218,3,0)

VBMT     OVERLAY (L218,4,0)
```

3.2 PRIMARY OVERLAY (L218,1,0) - RGEN

Purpose of RGEN

The L218 (LOADS) program's first primary overlay is named RGEN. RGEN reads general input data from cards and may write a J-MATRIX and a MASS MATRIX tape. Upon reading a keyword defining the LOADS module to be executed, control is returned to L218vc.

Analytical Steps of RGEN

RGEN performs its task in the following steps:

1. If this is not the first call to RGEN, jump to step 4.

2. The header matrix array (IQLTAP) is initialized. The subroutine PRGBEG is called to place the program header on the printed output.

3. A data card is read. It must begin with $LOAD to assure that the card input file is correctly positioned. If it does not contain $LOAD the fatal error counter is incremented and the program tries to process additional cards; however, module execution will not occur.

4. A program directive card is read, printed, interpreted, and acted upon according to the following conditions:

   a. If the keyword is $TITLE, begin step 4 again.

   b. If the keyword is $GEN, jump to step 5.

   c. If the keyword is $AVD, $NPLDS, $PLDS, or $VBMT, jump to step 11.

   d. If the keyword is $END, jump to step 4.

   e. If the keyword is $QUIT, jump to step 11.

5. A general input directive card is read, printed, interpreted, and acted upon as follows:

   a. If the keyword is JMAT, jump to step 6.

   b. If the keyword is MASS, jump to step 7.

   c. If the keyword is TRAN, jump to step 8.

   d. If the keyword is MAXSUR, jump to step 9.

   e. If the keyword is AVDTAP, EOMLOD, JTAPE, LTAPE, MASSTP, NPTAP, IPTAP, or SATAP, jump to step 10.

   f. If the keyword is $----, jump to step 4a.

6. Subroutine RGEN2 is called. This subroutine reads the J-matrix data and writes it on JTAPE. Program control returns to step 5.
7. Subroutine RGEN1 is called. This subroutine reads the MASS matrix data and writes it on MASSTP. Program control returns to step 5.
8. The transformation order is set. Program control returns to step 5.
9. The maximum number of surfaces is set. Program control returns to step 5.
10. The appropriate tape name is changed. Program control returns to step 5.
11. The appropriate keyword code is set. If the keyword was *not* $QUIT, jump to step 13. If it was a $QUIT card, jump to step 12.
12. Copy the final general output from IOUT to IUTFIL. Call PRGEND to place the program termination message on the printed output.
13. Return control to (L218,0,0).

The intended order of card input for RGEN is: $LOAD card, $TITLE card, $GEN card, all GEN input for this execution run, $module card.

The macro flow chart of this overlay is shown in figure 5. The subroutines called are displayed in table 2.

I/O Devices of RGEN

RGEN reads general loads card input and may write the J-matrix (JTAPE) and mass matrix (MASSTP) magnetic files.

3.3 PRIMARY OVERLAY (L218,2,0) - AVD

Purpose of AVD

The L218 (LOADS) program's second primary overlay is named AVD (acceleration, velocity, and displacement). AVD processes modal deflections (ϕ), modal slopes (ϕ_θ), and geometry data (BS, BBL, WL, θ_X, θ_Y, θ_Z) to generate the appropriate coefficient matrices required by L221 (TEV156) to calculate loads. The loads consist of translational and/or angular accelerations, velocities, and displacements at selected points on the structure. The axis system may be either reference or local (that system defined by the angular data (θ_X, θ_Y, θ_Z) in the geometry input , or by (θ_X θ_Y, θ_Z) from card input. The resultant loads matrices are written on tape (AVDTAP).

Analytical Steps of AVD

AVD performs its task in the following steps:

1. It initialize FETS for disk storage files MERGE 1, MERGE 2, and MERGE 3.
2. The subroutine RAVD is called to read the AVD card input.
3. If matrices were card input, jump to step 9.
4. The subroutine DISK is called to read geometry, modes, and SA array from (SATAP).

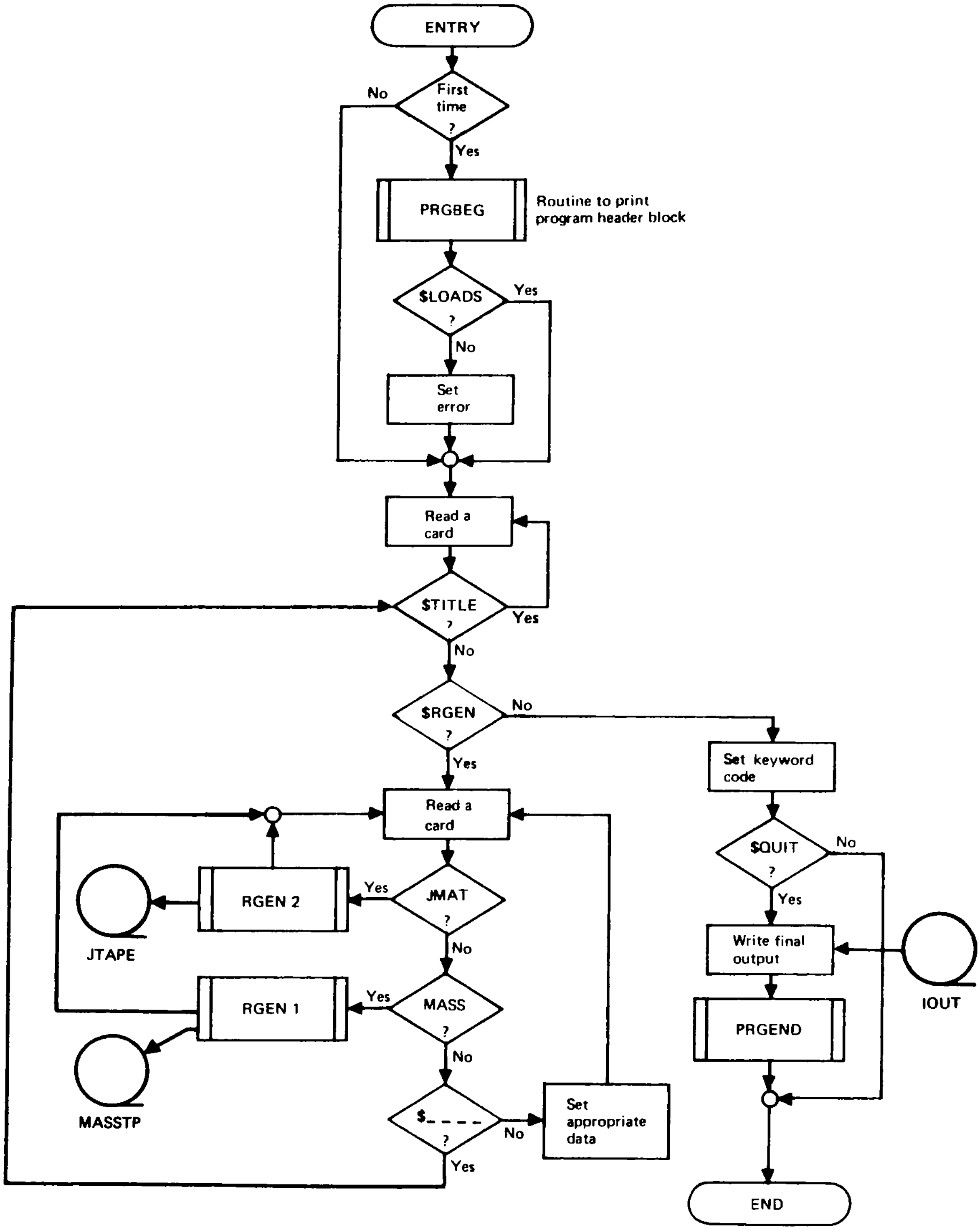


Figure 5. – Macro Flow Chart of Overlay (L218, 1,0) RGEN

Table 2. — Routines Called by RGEN

```
OVERLAY (L218,1,0)
PROGRAM RGEN
------------------------------------------------------------------

FETADD +
FETDEL +
NAMFIL +
PRGBEG +
PRGEND +
RGEN1          WRTETP +
RGEN2          WRTETP +
```

\+ indicates a routine in the DYLOFLEX alternate subroutine library

All others are local to L218(LOADS).

5. If interpolation is required, jump to step 8.

6. If transformation (rotation) is *not* required, jump to step 9.

7. The subroutine ROTATE is called to perform the required axis transformation (rotation); jump to step 9.

8. The subroutine NTERP is called to perform the necessary interpolation.

9. The subroutine MERGE is called to merge the matrices for this surface.

10. If more surfaces are to be processed, jump to step 2.

11. The subroutine AVDTAP is called to write the final tape (AVDTAP).

12. The subroutine RETURNF is called to return all scratch files.

13. Return control to (L218,0,0).

The macro flow chart of this overlay is shown in figure 6. The subroutines called are displayed in table 3.

I/O Devices of AVD

AVD reads card input. Geometry, mode shapes, slopes, and SA arrays are read from SATAP, which is normally written by the DYLOFLEX interpolation program L215 (INTERP), described in reference 3.

Regular and general print options control the printed output.

The coefficient matrices are written on the final output tape (AVDTAP) in a format acceptable to L219 (EQMOD) and L221 (TEV156) (refs. 4 and 5, respectively).

3.3.1 AVD PROGRAMMING SPECIFICATIONS

AVD Modal Data Interpolation Methods

When the interpolation option is selected, axis transformation (rotation) is not allowed. Interpolation is performed in the local axis system to an arbitrary (x,y,z) reference axis coordinate.

There are three interpolation methods available, one method for thin bodies and two methods for slender bodies. Their description is as follows.

1. Interpolation of Thin Bodies (INTER=1): Where $\phi_X = \phi_Y = \phi_{\theta Z} = 0$, $\phi_Z, \phi_{\theta X}$, and $\phi_{\theta Y}$ are obtained by calling AINTG, a subroutine in the DYLOFLEX library, with the appropriate SA array and multiplying the results by -1 to retain the proper sign convention of the modes.

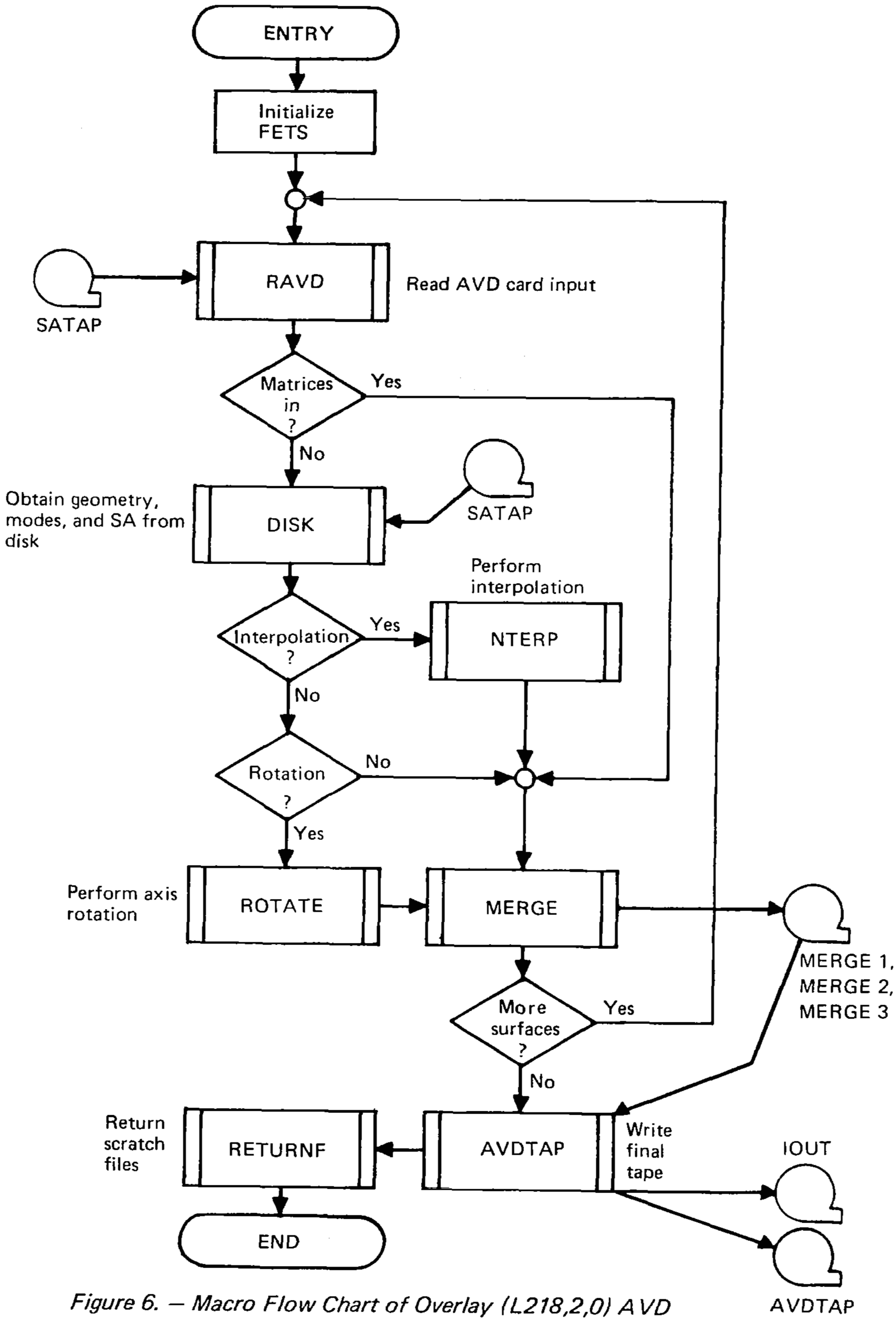


Figure 6. – Macro Flow Chart of Overlay (L218,2,0) AVD

Table 3. — Routines Called by AVD

OVERLAY (L218,2,0)

PROGRAM AVD

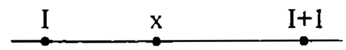
AVDTAP	FETDEL +		
	FETADD +		
	WRTETP+		
DISK	DISK1	DISK5	READTP+
	DISK2	DISK5	READTP+
	DISK5	READTP+	
FETADD+			
MERGE	MERGE1		
NTERP	NTERP1	AINTG+	
	NTERP5		
	NTERP6		
RAVD	RAVD1	RAVD1A	RAVD6
		RAVD6	
	RAVD2	RAVD6	
		KOMSTR+	
		RAVD5B	
	RAVD3	RAVD5B	
		RAVD6	

+ Indicates a routine in the DYLOFLEX alternate subroutine library.

Table 3. — (Concluded)

RAVD	RAVD4	RAVD5A
		RAVD5B
	RAVD5	RAVD5A
		RAVD5B
	RAVD5A	
	RAVD6	
	READTP+	
RCTATE	ROTATE1	

2. Interpolation of Slender Bodies (INTER=2). This linear interpolation method between points is suitable for elastic axes that are straight and, preferably, parallel to the reference axis. To interpolate to a point x, given two structural node points I and I+1 and their coordinate locations (BS, BBL, WL):



$$A = (x - BS_I)/(BS_{I+1} - BS_I)$$

$$\phi_{x_x} = \phi_{x_I}$$

$$\phi_{y_x} = A\left(\phi_{y_{I+1}} - \phi_{y_I}\right) + \phi_{y_I} + LTT \;\; \phi\theta_{x_x}$$

$$\phi_{z_x} = A\left(\phi_{z_{I+1}} - \phi_{z_I}\right) + \phi_{z_I} + LT \;\; \phi\theta_{x_x}$$

$$\phi\theta_{x_x} = A\left(\phi\theta_{x_{I+1}} - \phi\theta_{x_I}\right) + \phi\theta_{x_I}$$

$$\phi\theta_{y_x} = A\left(\phi\theta_{y_{I+1}} - \phi\theta_{y_I}\right) + \phi\theta_{y_I}$$

$$\phi\theta_{z_x} = A\left(\phi\theta_{z_{I+1}} - \phi\theta_{z_I}\right) + \phi\theta_{z_I}$$

where:

$LT = BBL_X - BBL_I$

$LTT = WL_X - WL_I$

To interpolate to a point x, given only one structural node point I and its coordinate locations (BS, BBL, WL):

or

then:

$$\phi_{x_x} = \phi_{x_I}$$

$$\phi_{y_x} = \phi_{y_I} - LB \;\; \phi\theta_{z_I} \;\; + LTT \;\; \phi\theta_{x_x}$$

$$\phi_{z_x} = \phi_{z_I} + LB \;\; \phi\theta_{y_I} \;\; + LT \;\; \phi\theta_{x_x}$$

$$\phi\theta_{x_x} = \phi\theta_{x_I}$$

$$\phi\theta_{y_x} = \phi\theta_{y_I}$$

$$\phi\theta_{z_x} = \phi\theta_{z_I}$$

where:

$LB = BS_X - BS_I$

$LT = BBL_X - BBL_I$

$LTT = WL_X - WL_I$

3. Interpolation of Slender Bodies (INTER=4). A linear interpolation method that interpolates to a node using rigid links attached to a reference node. To interpolate to a point x using only one structural reference node I:

$$\phi_{x_x} = \phi_{x_I}$$

$$\phi_{y_x} = \phi_{y_I} - LB\ \phi\theta_{z_I} + LTT\ \phi\theta_{x_I}$$

$$\phi_{z_x} = \phi_{z_I} + LB\ \phi\theta_{y_I} + LT\ \phi\theta_{x_I}$$

$$\phi\theta_{x_x} = \phi\theta_{x_I}$$

$$\phi\theta_{y_x} = \phi\theta_{y_I}$$

$$\phi\theta_{z_x} = \phi\theta_{z_I}$$

where I, LB, LTT, and LT are card input using the relationship defined in method 2.

Transformation of Axis

To transform the modal data from the local axis to the inertia (or arbitrary) axis requires that each mode ϕ_x, ϕ_y, ϕ_z, $\phi_{\theta x}$, $\phi_{\theta y}$, and $\phi_{\theta z}$ at each node for the surface be transformed to the axis defined by θ_x, θ_y, θ_z as follows:

$$\begin{bmatrix} \phi_x \\ \phi_y \\ \phi_z \end{bmatrix} = \begin{bmatrix} T \end{bmatrix} \begin{bmatrix} \phi_x \\ \phi_y \\ \phi_z \end{bmatrix}_{\text{local axis}}$$

and

$$\begin{bmatrix} \phi_{\theta_x} \\ \phi_{\theta_y} \\ \phi_{\theta_z} \end{bmatrix} = \begin{bmatrix} T \end{bmatrix} \begin{bmatrix} \phi_{\theta_x} \\ \phi_{\theta_y} \\ \phi_{\theta_z} \end{bmatrix}_{\text{local axis}}$$

where T is the Euler transformation matrix for $\theta_x, \theta_y, \theta_z$ (see vol. I, sec. 5).

Note: All ϕ's must be present; they are assumed zero if null.

Selection of Modes

In general, ϕ_x, ϕ_y, ϕ_z, ϕ_{θ_x}, ϕ_{θ_y} and ϕ_{θ_z} are available, but for a normal case only some will be selected. Keywords will be input to select the required modes and final $\overline{M}_1$, $\overline{M}_2$, and $\overline{M}_3$ matrices.

For the acceleration matrix ($\overline{M}_3$), either translation (ϕ_x, ϕ_y, ϕ_z) and/or rotation (ϕ_{θ_x}, ϕ_{θ_y}, ϕ_{θ_z}) may be required. Furthermore, any combination of ϕ_x, ϕ_y, and ϕ_z may be required (similarly for ϕ_{θ_x}, ϕ_{θ_y} and ϕ_{θ_z}). The same is also true for the $\overline{M}_2$ and $\overline{M}_1$ matrix.

As an example, if an $\overline{M}_3$ translational matrix for x, y, z is required, then $\overline{M}_{3_x}$, $\overline{M}_{3_y}$, $\overline{M}_{3_z}$ will be selected. If the $\overline{M}_3$ rotational matrix for Z is required, then $\overline{M}_{3_z}$ (rotational) will be selected.

Merging of Matrices

Matrices for a given surface are merged in the order x, y, z translational, x, y, z rotational. Any matrix that is null is omitted. If all of the matrices $\overline{M}_3$ were nonzero for surface IS, $\overline{M}_3$ for surface IS would merge as:

$$\begin{bmatrix} \overline{M}_{3_x} \\ \overline{M}_{3_y} \\ \overline{M}_{3_z} \\ \overline{M}_{3_x} \\ \overline{M}_{3_y} \\ \overline{M}_{3_z} \end{bmatrix} \begin{matrix} \left.\vphantom{\begin{matrix} a \\ a \\ a \end{matrix}}\right\} \text{translational} \\ \left.\vphantom{\begin{matrix} a \\ a \\ a \end{matrix}}\right\} \text{rotational} \end{matrix}$$

and similarly for $\overline{M}_2$ and $\overline{M}_1$. This is further illustrated by the following examples:

Assume the number of modes is three and that nodes 1 and 4 are selected from ϕ_x, ϕ_y, ϕ_x and ϕ_{θ_x}, ϕ_{θ_y}, ϕ_{θ_z} for translational and rotational acceleration mode shapes, respectively.

Then the merged matrix would appear as:

$$\begin{bmatrix} \overline{M}3_x \\ \overline{M}3_y \\ \overline{M}3_z \\ \overline{M}3_x \\ \overline{M}3_y \\ \overline{M}3_z \end{bmatrix} = \begin{bmatrix} \phi_{x_{11}} & \phi_{x_{12}} & \phi_{x_{13}} \\ \phi_{x_{41}} & \phi_{x_{42}} & \phi_{x_{43}} \\ \phi_{y_{11}} & \phi_{y_{12}} & \phi_{y_{13}} \\ \phi_{y_{41}} & \phi_{y_{42}} & \phi_{y_{43}} \\ \phi_{z_{11}} & \phi_{z_{12}} & \phi_{z_{13}} \\ \phi_{z_{41}} & \phi_{z_{42}} & \phi_{z_{43}} \\ \phi\theta_{x_{11}} & \phi\theta_{x_{12}} & \phi\theta_{x_{13}} \\ \phi\theta_{x_{41}} & \phi\theta_{x_{42}} & \phi\theta_{x_{43}} \\ \phi\theta_{y_{11}} & \phi\theta_{y_{12}} & \phi\theta_{y_{13}} \\ \phi\theta_{y_{41}} & \phi\theta_{y_{42}} & \phi\theta_{y_{43}} \\ \phi\theta_{z_{11}} & \phi\theta_{z_{12}} & \phi\theta_{z_{13}} \\ \phi\theta_{z_{41}} & \phi\theta_{z_{42}} & \phi\theta_{z_{43}} \end{bmatrix}$$

If nodes 1 and 4 are selected from ϕ_y and ϕ_z for translational velocity only, $\overline{M}_2$ would merge as:

$$\begin{bmatrix} \overline{M}2_y \\ \overline{M}2_z \end{bmatrix} = \begin{bmatrix} \phi_{y_{11}} & \phi_{y_{12}} & \phi_{y_{13}} \\ \phi_{y_{41}} & \phi_{y_{42}} & \phi_{y_{43}} \\ \phi_{z_{11}} & \phi_{z_{12}} & \phi_{z_{13}} \\ \phi_{z_{41}} & \phi_{z_{42}} & \phi_{z_{43}} \end{bmatrix}$$

AVD's Final Output Tape

After all surfaces have been processed and the matrices merged, the final tape will contain the merged matrices $[\overline{M}_1]$, $]\overline{M}_2]$, and $[\overline{M}_3]$. The maximum size of $[\overline{M}_1]$ is (100 x 70), similarly for $[\overline{M}_2]$ and $[\overline{M}_3]$.

To illustrate the format for final output, consider a load set of one surface with all matrices required (no zero matrices). Then:

$$[\overline{M}_1] = \left[\begin{array}{c} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \overline{M}_{1_x} \\ \overline{M}_{1_y} \\ \overline{M}_{1_z} \\ \overline{M}_{1_x} \\ \overline{M}_{1_y} \\ \overline{M}_{1_z} \end{array}\right] \begin{array}{l} \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \left.\begin{array}{c} \\ \\ \\ \end{array}\right\} \text{translational} \\ \left.\begin{array}{c} \\ \\ \\ \end{array}\right\} \text{rotational} \end{array}$$

$$[\overline{M}_2] = \left[\begin{array}{c} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \overline{M}_{2_x} \\ \overline{M}_{2_y} \\ \overline{M}_{2_z} \\ \overline{M}_{2_x} \\ \overline{M}_{2_y} \\ \overline{M}_{2_z} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array}\right] \begin{array}{l} \\ \\ \\ \\ \\ \\ \left.\begin{array}{c} \\ \\ \\ \end{array}\right\} \text{translational} \\ \left.\begin{array}{c} \\ \\ \\ \end{array}\right\} \text{rotational} \\ \\ \\ \\ \\ \\ \\ \end{array}$$

$$[\overline{M}_3] = \left[\begin{array}{c} \overline{M}_{3_x} \\ \overline{M}_{3_y} \\ \overline{M}_{3_z} \\ \overline{M}_{3_x} \\ \overline{M}_{3_y} \\ \overline{M}_{3_z} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array}\right] \begin{array}{l} \left.\begin{array}{c} \\ \\ \\ \end{array}\right\} \text{translational} \\ \left.\begin{array}{c} \\ \\ \\ \end{array}\right\} \text{rotational} \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \end{array}$$

These matrices would be written on the tape as:

$$\left[\begin{array}{c}\text{Header}\\ \overline{M}_1\\ \overline{M}_2\\ \overline{M}_3\\ \text{EOF}\\ \bullet\\ \bullet\\ \bullet\\ \text{EOF}\end{array}\right]\begin{array}{l}\\ \left.\begin{array}{c}\\ \\ \\ \end{array}\right\}\text{Load set number 1}\\ \\ \left.\begin{array}{c}\\ \\ \\ \\ \end{array}\right\}\text{Load set number 2}\end{array}$$

The physical size of the matrices $\overline{M}_1$, $\overline{M}_2$, and $\overline{M}_3$ are equal and are appropriately loaded with zero rows as follows.

In general there may be several surfaces in a load set. Then:

$$[\overline{M}_1] = \begin{bmatrix} 0 \\ 0 \\ \overline{M}_{1_{\text{surface 1}}} \\ 0 \\ 0 \\ \overline{M}_{1_{\text{surface 2}}} \\ \cdot \\ \cdot \\ \text{etc} \end{bmatrix}, \quad [\overline{M}_2] = \begin{bmatrix} 0 \\ \overline{M}_{2_{\text{surface 1}}} \\ 0 \\ 0 \\ \overline{M}_{2_{\text{surface 2}}} \\ 0 \\ \cdot \\ \cdot \\ \text{etc} \end{bmatrix} \quad [\overline{M}_3] = \begin{bmatrix} \overline{M}_{3_{\text{surface 1}}} \\ 0 \\ 0 \\ \overline{M}_{3_{\text{surface 2}}} \\ 0 \\ 0 \\ \cdot \\ \cdot \\ \text{etc} \end{bmatrix}$$

where zero rows are added as required.

3.4 PRIMARY OVERLAY (L218,3,0) – NPLDS/PLDS

Purpose of NPLDS/PLDS

The L218 (LOADS) third primary overlay, NPLDS/PLDS, reads the specific card input data for net panel loads or panel loads. A net panel loads run will result in loads matrices written on tape NPTAP. A panel loads run will result in loads matrices written on tape PTAP.

Analytical Steps of NPLDS/PLDS

NPLDS/PLDS performs its task in the following steps:

1. It initializes FETS for disk storage.

2. The subroutine OPENMS is called to initialize a random access file, MERGB.

3. The subroutine NPLDA is called to read card input data.

4. The subroutine NPLDB is called to calculate $\overline{M}_3$ and/or read geometry for this surface (PLDS reads geometry but does not calculate $\overline{M}_3$).

5. The subroutine NPLDD is called to calculate $\overline{M}_4$, $\overline{M}_5$, and $\overline{\overline{\phi}}$ for all frequencies.

6. If more surfaces are to be processed, jump to step 3.

7. The subroutine NPLDH is called to merge the matrices and write the final output tape NPTAP or PTAP.

8. The overlay closes all FETS and returns scratch files.

9. Return control to (L218,0,0).

The macro flow chart of this overlay is shown in figure 7. The subroutines called are displayed in table 4.

I/O Devices of NPLDS

NPLDS reads card input. Geometry and modal data is read from tape (SATAP) as provided by L215 (INTERP) (ref. 3). Equations of motion data is read from tape (EOMLOD) as provided by L217 (EOM) (ref. 6). Mass matrix data is read from tape (MASSTP) as provided by (L218,1,0), RGEN.

Note: Both SATAP and EOMLOD are required for either NPLDS or PLDS.

Regular and general print options control the printed output. For net panel loads, the loads matrices are written on tape (NPTAP) in a format acceptable to L219 (EQMOD) (ref. 4) and L221 (TEV156) (ref. 5).

For panel loads, the loads matrices are written on tape PTAP in a format acceptable to L219 (EQMOD) and L221 (TEV156).

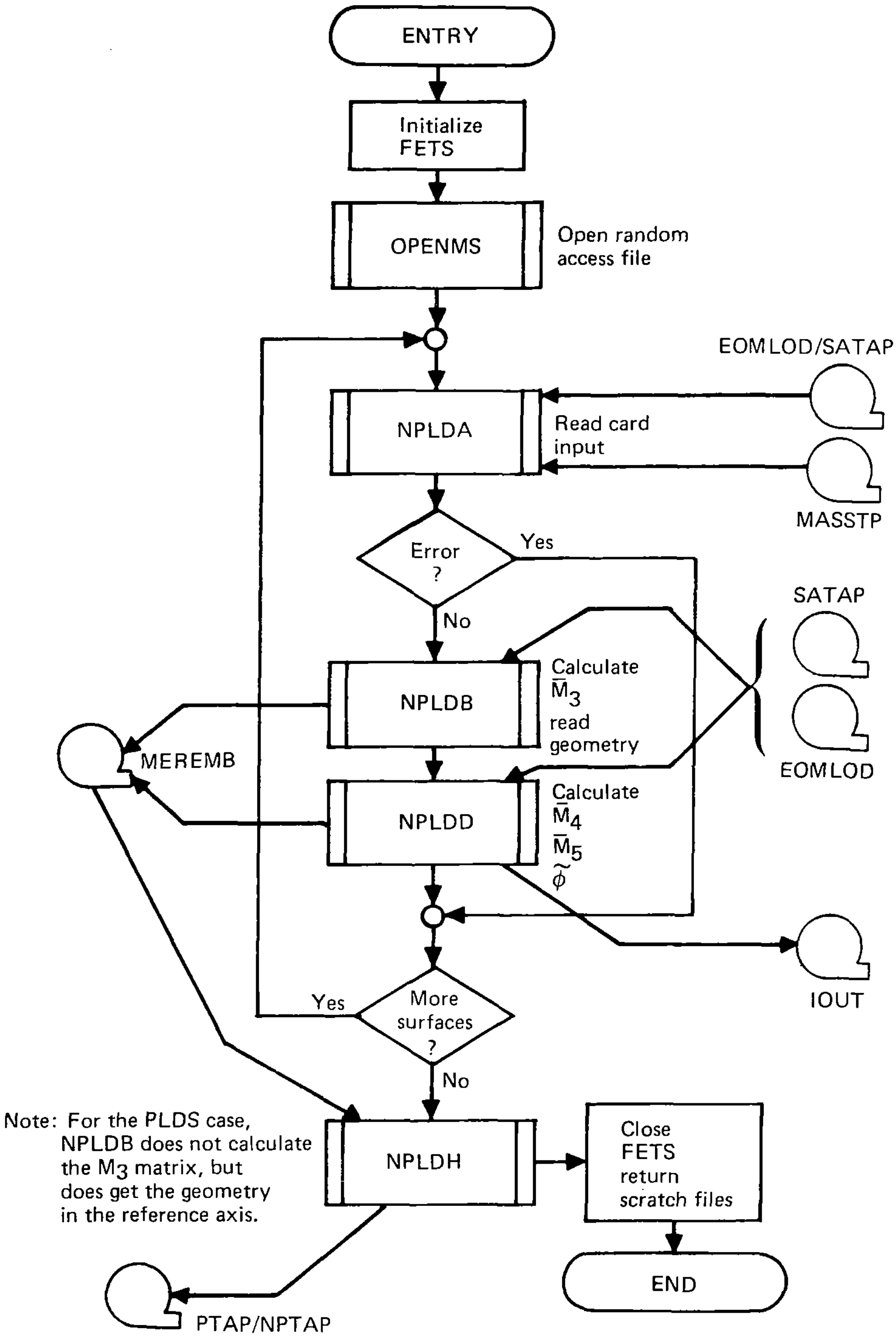


Figure 7. – Macro Flow Chart of Overlay (L218,3,0) NPLDS/PLDS

Table 4. — Routines Called by NPLDS/PLDS

```
OVERLAY (L218,3,0)

PROGRAM NPLDS/PLDS

-----------------------------------------------------------------

FETADD+

FETDEL+

NPLDA           FETADD+

                NPLDA1          KOMSTR+

                                NPLDA6

                NPLDA2          NPLDA6

                                READTP+

                NPLDA3          NPLDA4

                                NPLDA6

                NPLDA6

                READTP+

NPLDB           NPLDB1

                NPLDB2          WRITMS*

                READTP+
```

+ Indicates a routine in the DYLOFLEX alternate subroutine library.

* Indicates a routine in the FORTRAN subroutine library.

Table 4. – (Concluded)

NPLDD	NPLDD1	READTP+	
	NPLDD2		
	NPLDD4	NPLDD1	READTP+
		NPLDD2	
		NPLDD3	AINTG+
			PLATE+
			READTP+
		WRITMS*	
NPLDH	FETDEL+		
	NPLDH1	READMS*	
	WRTETP+		
OPENMS*			
RETURNF+			

3.4.1 NPLDS/PLDS PROGRAMMING SPECIFICATIONS

NPLDS (net panel loads) uses the modal deflection ϕ_Z with the mass matrix to obtain the inertia forces ($\overline{M}_3$ matrix) on each subsurface. It also uses the aerodynamic force matrices generated in the Equations of Motion program from which selected nodes are extracted to form the $\overline{M}_4$, $\overline{M}_5$, and $\tilde{\overline{\phi}}$ matricies. The resulting matrices are in the local axis only. PLDS is identical to NPLDS except that the $[\overline{M}_3]$ matrix is omitted. The following information is useful in understanding the program generation of the required matrices.

For each requested surface and selected nodes:

1. Calculate $[\overline{M}_3]$ and write it on NPTAP.
2. Form $[\overline{M}_4]$, $[\overline{M}_5]$, and $[\tilde{\overline{\phi}}]$ for all frequencies (k) and write them on NPTAP (also on PTAP if requested).

To calculate $\overline{M}_3$:

1. Read the mass matrix.
2. Read scalars for $[\overline{M}_3]$.
3. Read ϕ_Z from disk (also geometry).
4. Read nodes to be used.
5. Calculate:

$$[\overline{M}_3]_z = \text{SCALR1} \begin{bmatrix} m_1\phi_{z_{11}} & \cdots & m_1\phi_{z_{in}} \\ \vdots & & \vdots \\ m_i\phi_{z_{i1}} & \cdots & m_i\phi_{z_{in}} \end{bmatrix}$$

There is no contribution from ϕ_X and ϕ_Y. $\overline{M}_3$ is in the local axis only.

To calculate $[\overline{M}_4]$, $[\overline{M}_5]$, and $[\tilde{\overline{\phi}}]$:

1. Read nodes.
2. Read $F_{PL}(\dot{q})$, $F_{PL}(\ddot{q})$, $F_{PL}(\dot{\alpha}_g)$ from the EOM tape.
3. Read scalars for $[\overline{M}_4]$, $[\overline{M}_5]$, and $[\tilde{\overline{\phi}}]$.

4. If the structural and aero node points are identical:

$$[\overline{M}_4] = \text{SCALR2} \begin{bmatrix} F_{PL_{11}} & \cdots\cdots\cdots & F_{PL_{1n}} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ F_{PL_{i1}} & \cdots\cdots\cdots & F_{PL_{in}} \end{bmatrix}_{\dot{q}}$$

$$[\overline{M}_5] = \text{SCALR2} \begin{bmatrix} F_{PL_{11}} & \cdots\cdots\cdots & F_{PL_{1n}} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ F_{PL_{i1}} & \cdots\cdots\cdots & F_{PL_{in}} \end{bmatrix}_{\ddot{q}}$$

$$[\overline{\overline{\phi}}] = \text{SCALR3} \begin{bmatrix} F_{PL_{11}} & \cdots\cdots\cdots & F_{PL_{1g}} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ F_{PL_{i1}} & \cdots\cdots\cdots & F_{PL_{ig}} \end{bmatrix}_{\dot{\alpha}_g}$$

where g = number of gust zones.

5. If the structural and node points are *not* identical, there are two options available in NPLDS for interpolating the aerodynamic forces from the aerodynamic nodes to the structural nodes.

Option 1: (OPT1)

Required data is as follows:

1. Card input of the force weighting matrix $[P]$ (weighting matrix of aerodynamic forces from aerodynamic nodes to structural nodes).

2. $F_{PL}(\dot{q})$, $F_{PL}(\ddot{q})$, $F_{PL}(\dot{\alpha}_g)$, read from the EOM tape

The program calculates:

$$[\overline{M}_4] = \text{SCALR2}\ [P]\ \left[F_{PL}(\dot{q})\right]$$

$$[\overline{M}_5] = \text{SCALR2}\ [P]\ \left[F_{PL}(\ddot{q})\right]$$

$$[\overline{\overline{\phi}}] = \text{SCALR3}\ [P]\ \left[F_{PL}(\dot{\alpha}_g)\right]$$

where the size of:

$[P]$	is the number structural loads by the number of aerodynamic panels
$[F_{PL}(\dot{q})]$	is the number aerodynamic panels by the number of modes
$[F_{PL}(\ddot{q})]$	is the number aerodynamic panels by the number of modes
$[F_{PL}(\dot{\alpha}_g)]$	is the number aerodynamic panels by the number of gust penetration panels

Limitations:

Number of structural loads $\leqslant$ structural nodes $\leqslant$ 100

Number of aero panels $\leqslant$ 100 $\leqslant$ number structural node

Number of modes $\leqslant$ 70

Number of gust penetration panels $\leqslant$ 35

Number of structural nodes $\leqslant$ 100

Option 2: (OPT2)

Required data is as follows:

1. Read card input structural areas corresponding to structural nodes: $[a_S]$.
2. Read structural $(X, Y, Z)_S$ coordinates from INTERP.
3. Read local aero $(X,Y)_L$ coordinates from EOM.
4. Read local aero areas $[A]_L = \begin{Bmatrix} A_1 \\ \cdot \\ \cdot \\ \cdot \\ A_i \end{Bmatrix}$ from EOM.
5. Read $F_{PL}(\dot{q})$, $F_{PL}(\ddot{q})$, $F_{PL}(\dot{\alpha}_g)$ from EOM.

Program operations are as follows:

1. Calculate:

$$[P]_L = \begin{bmatrix} F_{PL_{11}}/A_1 & \text{-------------} & F_{PL_{1n}}/A_1 \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ F_{PL_{i1}}/A_i & \text{-------------} & F_{PL_{in}}/A_i \end{bmatrix}_{\dot{q},\ddot{q},\dot{\alpha}_g}$$

where:

$F_{in} = F_{PL}(\dot{q}), F_{PL}(\ddot{q}), F_{PL}(\dot{\alpha}_g)$

$[P]_L$ = matrices of aerodynamic pressures at aerodynamic nodes for $\dot{q}$, $\ddot{q}$, and $\dot{\alpha}_g$.

2. Call PLATEI using $[P]_L$ and $(X,Y)_L$.

3. Get SA from INTERP, extract transformation.

4. Insert transformation in SA array from step 2.

5. Call AINTG using (X,Y,Z) to interpolate $[p]_S$ (aerodynamic pressures on structural areas).

6. Calculate aerodynamic force at structural nodes due to $\dot{q}$, $\ddot{q}$, and $\dot{\alpha}_g$ as

$$[F_{PL}(\dot{q})]_S,\ [F_{PL}(\ddot{q})]_S,\quad [F_{PL}(\dot{\alpha}_g)]_S = \begin{bmatrix} a_1 & & \\ & \ddots & \\ & & a_j \end{bmatrix} [p]_S$$

where $[P]_S$ is the aerodynamic pressure due to $\dot{q}$, $\ddot{q}$, and $\dot{\alpha}_g$

7. Then:

$$[\overline{M}_4] = \text{SCALR2}\ [F_{PL}(\dot{q})]_S$$

Similarly

$$[\overline{M}_5] = \text{SCALR2}\ [F_{PL}(\ddot{q})]_S$$

$$[\bar{\tilde{\phi}}] = \text{SCALR3}\ [F_{PL}(\dot{\alpha}_g)]_S$$

*Warning: This option is only valid over regions where $\frac{dp}{dx}$ and $\frac{dp}{dy}$ are equal or approximately equal to constants.

NPTAP and/or PTAP Final Output/LOAD-SET*

$$\left.\begin{array}{l} [\text{Header}] \\ [\overline{M}_3] \\ \left.\begin{array}{l}[\overline{M}_4]\\ [\overline{M}_5]\\ [\tilde{\bar{\phi}}]\end{array}\right\} k=1 \\ \left.\begin{array}{l}[\overline{M}_4]\\ [\overline{M}_5]\\ [\tilde{\bar{\phi}}]\end{array}\right\} k=2 \\ \left.\begin{array}{l}\cdot\\ \cdot\\ \cdot\end{array}\right\} k=Nk \end{array}\right\} \begin{array}{l}\text{Load}\\ \text{set 1}\end{array}$$

$$\overline{\text{EOF}}$$

$$\left.\begin{array}{l} [\text{Header}] \\ [\overline{M}_3] \\ \left.\begin{array}{l}[\overline{M}_4]\\ [\overline{M}_5]\end{array}\right\} k=1 \\ \cdot \\ \cdot \\ \cdot \end{array}\right\} \begin{array}{l}\text{Load}\\ \text{set 2}\end{array}$$

where:

$$[\overline{M}_3] = \begin{array}{cl} \left[\begin{array}{c} \overline{M}_{3_z} \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \cdot \end{array}\right] & \begin{array}{l} \text{Surface 1} \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \text{Surface IS} \end{array} \end{array}$$

$$[\overline{M}_4] = \begin{array}{cl} \left[\begin{array}{c} \overline{M}_4 \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \cdot \end{array}\right] & \begin{array}{l} \text{Surface 1} \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \text{Surface IS} \end{array} \end{array}$$

Similarily for $[\overline{M}_5]$ and $[\tilde{\bar{\phi}}]$ and for all values of k

Maximum size of
$[\overline{M}_3] = [\overline{M}_4] = [\overline{M}_5]$ is 100 x 70
$[\tilde{\bar{\phi}}]$ is 100 x (2) (35)

*A LOAD-SET is a result of processing all surfaces requested following the $NPLDS card, but before the next $ card.

Note: The final output of PLDS is identical to that for NPLDS described above except that $\overline{M}_3$ matrix is omitted.

3.5 PRIMARY OVERLAY (L218,4,0) - VBMT

Purpose of VBMT

The L218 (LOADS) fourth primary overlay is named VBMT. VBMT reads the specific card input data to calculate shears, bending moments, and torsions and writes the load matrices on the magnetic file LTAP.

Analytical Steps of VBMT

VBMT performs its task in the following steps:

1. VBMT initialize FETS for disk storage.
2. The subroutine VBMTA is called to check all data for this load-set.
3. The subroutine OPENMS is called to initialize a random access file.
4. The subroutine VBMTA is called to read data for one load for this surface.
5. The subroutine VBMTC is called to calculate $\overline{M}_3$ for this load.
6. The subroutine VBMTD is called to calculate $\overline{M}_4$, $\overline{M}_5$, and $\overline{\tilde{\phi}}$ for this load.
7. If more loads or surfaces are to be processed, jump to step 4.
8. The subroutine VBMTF is called to merge the matrices and write the final tape LTAP.
9. If another load-set is to be read, jump to step 2.
10. Close all FETS and return scratch files.
11. Return control to (L218,0,0).

The macro flow chart of this overlay is shown in figure 8. The subroutines called are displayed in table 5.

I/O Devices of VBMT

VBMT reads card input. Geometry and modal data is read from tape SATAP as provided by L215 (INTERP) (ref. 3). Equations of Motion data is read from tape EOMLOD as provided by L217 (EOM) (ref. 6). J-matrix data is read from tape JTAPE as provided by (L218,1,0), RGEN.

Note: J-matrix data on JTAPE can also be used by NPLDS, since the mass matrix is the first record of each file.

Regular and general print options control the printed output. Loads matrices are written on tape LTAP in a format acceptable to L219 (EQMOD) (ref. 4) and L221 (TEV156) (ref. 5).

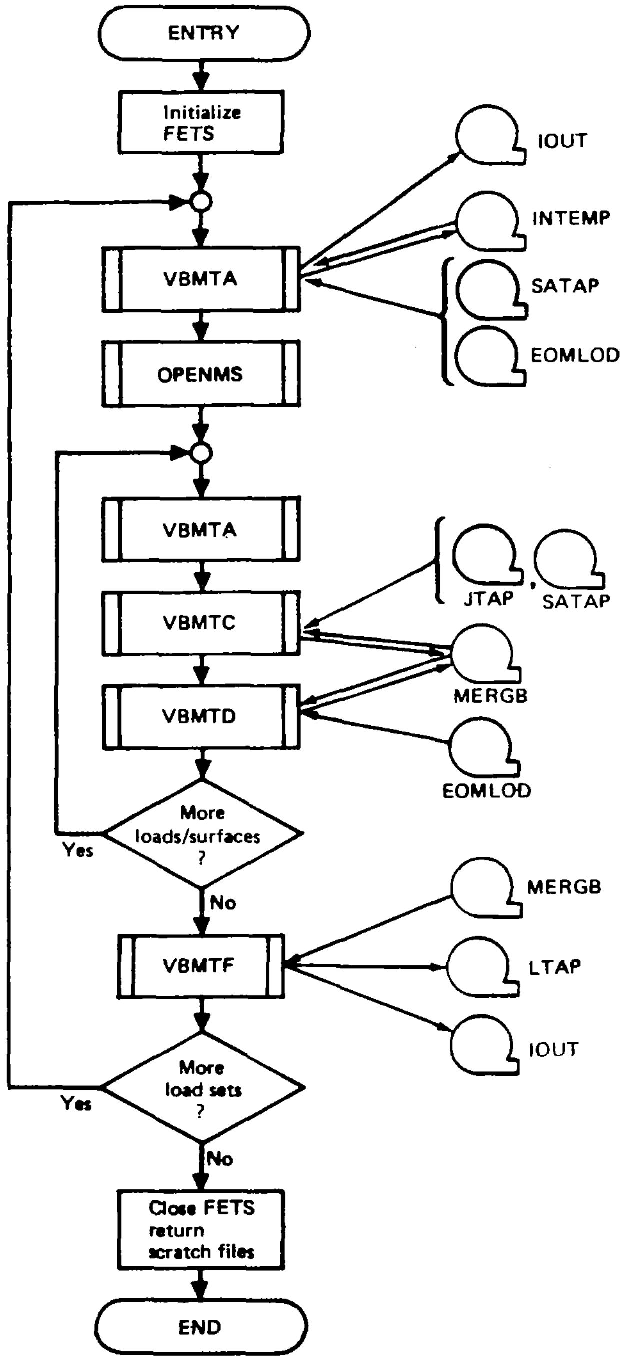


Figure 8. – Macro Flow Chart of Overlay (L218,4,0) VBMT

Table 5. — Routines Called by VBMT

OVERLAY (L218,4,0)

PROGRAM VBMT

FETADD+				
FETDEL+				
OPENMS*				
RETURNF+				
VBMTA	VBMTA1			
	VBMTA2	VBMTA3		LTOGT+
				READTP+
VBMTC	VBMTC1		READTP+	
	VBMTC2		VBMTC3	VBMTC4
			READMS*	
			WRITMS*	

+ Indicates a routine in the DYLOFLEX alternate subroutine library.

* Indicates a routine in the FORTRAN subroutine library.

Table 5. — (Concluded)

VBMTD	VBMTD1	READTP+		
	VBMTD2			
	VBMTD3	VBMTD1	READTP+	
		VBMTD4	READMS*	
			WRITMS*	
			VBMTC3	VBMTC4
		WRITMS*		
VBMTF	FETDEL+			
	VBMTF1	READMS*		
	RETURNF+			
	WRTETP+			

3.5.1 VBMT PROGRAMMING SPECIFICATIONS

To calculate $[\overline{M}_3]$ for a given surface number (IS), the inertia forces at the structural nodes and in local axis are:

$$\left[F_{x_i}\right]_{\text{local axis}} = \lceil m_i \rfloor [\phi_x] - \lceil m_i z_i \rfloor \left[\phi_{\theta_y}\right] - \lceil m_i y_i \rfloor \left[\phi_{\theta_z}\right]$$

$$\left[F_{y_i}\right]_{\text{local axis}} = \lceil m_i \rfloor [\phi_y] + \lceil m_i z_i \rfloor \left[\phi_{\theta_x}\right] - \lceil m_i x_i \rfloor \left[\phi_{\theta_z}\right]$$

$$\left[F_{z_i}\right]_{\text{local axis}} = \lceil m_i \rfloor [\phi_z] + \lceil m_i y_i \rfloor \left[\phi_{\theta_x}\right] + \lceil m_i x_i \rfloor \left[\phi_{\theta_y}\right]$$

where $[F_{x_i}]$, $[F_{y_i}]$, and $[F_{z_i}]$ are the matrices of inertia forces in the x, y, and z directions. ϕ_x, ϕ_y, ϕ_z, ϕ_{θ_x}, ϕ_{θ_y} and ϕ_{θ_z} are obtained from the INTERP tape (SATAP) and m_i, $m_i x_i$, $m_i y_i$, and $m_i z_i$ are obtained from the J-matrix (general card input or tape). These local axis forces are transformed to the inertia axis by:

$$\begin{bmatrix} F_x \\ F_y \\ F_z \end{bmatrix}_{\substack{\text{inertia} \\ \text{axis}}} = \text{SCALS}\,[T] \begin{bmatrix} F_x \\ F_y \\ F_z \end{bmatrix}_{\substack{\text{local} \\ \text{axis}}}$$

where:

$$[F_x] = \begin{bmatrix} F_{x_{11}} & \text{----------} & F_{x_{1n}} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ F_{x_{i1}} & \text{----------} & F_{x_{in}} \end{bmatrix}$$

n = number of modes
i = number of nodes

$[F_y]$ and $[F_z]$ are similar to $[F_x]$. $[T]$ = the coordinate transformation matrix using θ_x, θ_y, θ_z from the geometry data provided by INTERP.

The matrix is formed using the Euler transformation triad $[X]$ $[Y]$ $[Z]$ or some other combination, where $[X]$, $[Y]$, $[Z]$ are the individual axis transformation matrices making up the triad (see sec. 4.0, vol. I).

SCALS = 1.0 or SCALE from card 6.9.3 (sec. 6.3, vol. I) for the specific structural panels.

The forces in the inertia axis are summed at all required nodes to calculate shears at point A (load station or dummy load station).

$$v_{x_A} = SCALE1\, \Sigma_i\, F_{x_i} + \Sigma_j\, SCALED_j\, F_{x_{D_j}}$$

$$v_{y_A} = SCALE1\, \Sigma_i\, F_{x_i} + \Sigma_j\, SCALED_j\, F_{x_{D_j}}$$

$$v_{z_A} = SCALE1\, \Sigma_i\, F_{x_i} + \Sigma_j\, SCALED_j\, F_{x_{D_j}}$$

where:

i = required structural node numbers.

j = required dummy node numbers

SCALE 1 is from card set 6.0 (sec. 6.3, vol. I)

and

$$\left.\begin{array}{l} F_{x_{D_j}} = V_{x_{D_j}} = SCALE1\, \Sigma_i\, F_{x_i} \\ F_{y_{D_j}} = V_{y_{D_j}} = SCALE1\, \Sigma_i\, F_{y_i} \\ F_{z_{D_j}} = V_{z_{D_j}} = SCALE1\, \Sigma_i\, F_{z_i} \end{array}\right\} \text{dummy node forces at dummy node j}$$

Note: If $SCALED_j = +2.0$ (see vol. 1, sec. 6.3, card 6.9),

$$F_{y_{D_j}} = M_{x_{D_j}} = M_{z_{D_j}} = \Delta_y \text{ is set} = 0$$

If $SCALED_j = -2.0$,

$$F_{x_{D_j}} = F_{z_{D_j}} = M_{y_{D_j}} \text{ is set} = 0$$

and $SCALED_j = |-2.0|$.

The moments at the structural nodes are obtained by $[J]\ [\phi]$ (local axis) as follows:

$$[M_{x_i}] = \lceil m_i z_i \rfloor [\phi_y] + \lceil m_i y_i \rfloor [\phi_z] + \lceil Ixx_i \rfloor [\phi_{\theta_x}] + \lceil m_i x_i y_i \rfloor [\phi_{\theta_y}] - \lceil m_i x_i z_i \rfloor [\phi_{\theta_z}]$$

$$[M_{y_i}] = -\lceil m_i z_i \rfloor [\phi_x] + \lceil m_i x_i \rfloor [\phi_z] + \lceil m_i x_i y_i \rfloor [\phi_{\theta_x}] + \lceil Iyy_i \rfloor [\phi_{\theta_y}] + \lceil m_i y_i z_i \rfloor [\phi_{\theta_z}]$$

$$[M_{z_i}] = -\lceil m_i y_i \rfloor [\phi_x] - \lceil m_i x_i \rfloor [\phi_y] - \lceil m_i x_i z_i \rfloor [\phi_{\theta_x}] + \lceil m_i y_i z_i \rfloor [\phi_{\theta_y}] + \lceil Izz_i \rfloor [\phi_{\theta_z}]$$

These moments are transformed to the inertia axis system by:

$$\begin{bmatrix} M_{x_i} \\ M_{y_i} \\ M_{z_i} \end{bmatrix}_{\substack{\text{inertia} \\ \text{axis}}} = \text{SCALS}\ [T] \begin{bmatrix} M_x \\ M_y \\ M_z \end{bmatrix}_{\substack{\text{local} \\ \text{axis}}}$$

The bending moments at point A (load station or dummy load station) are now obtained by summing over all required nodes.

$$M_{x_A} = \text{SCALE1} \sum_i (\Delta_{y_i} F_{z_i} + \Delta_{z_i} F_{y_i} + M_{x_i}) + \sum_j MX_j$$

$$M_{y_A} = \text{SCALE1} \sum_i (\Delta_{x_i} F_{z_i} - \Delta_{z_i} F_{x_i} + M_{y_i}) + \sum_j MY_j$$

$$M_{z_A} = \text{SCALE1} \sum_i (-\Delta_{y_i} F_{x_i} - \Delta_{x_i} F_{y_i} + M_{z_i}) + \sum_j MZ_i$$

where:

$$\Delta_{x_i} = BS_i - BS_A$$

$$\Delta_{y_i} = BBL_i - BBL_A$$

$$\Delta_{z_i} = WL_i - WL_A$$

$$MS_j = \text{SCALED}_j\ (\Delta_{y_{D_j}} F_{z_{D_j}} + \Delta_{z_{D_j}} F_{y_{D_j}} + M_{x_{D_j}})$$

$$MY_j = \text{SCALED}_j\ (\Delta_{x_{D_j}} F_{z_{D_j}} - \Delta_{z_{D_j}} F_{x_{D_j}} + M_{y_{D_j}})$$

$$MZ_j = \text{SCALED}_j\ (-\Delta_{y_{D_j}} F_{x_{D_j}} - \Delta_{x_{D_j}} F_{y_{D_j}} + M_{z_{D_j}})$$

$$\Delta_{x_{D_j}} = BS_{D_j} - BS_A$$

$$\Delta_{y_{D_i}} = BBL_{D_j} - BBL_A$$

$$\Delta_{z_{D_i}} = WL_{D_j} - WL_A$$

D_j is the j^{th} dummy node

Note: See the previous note on $SCALED_i$.

The dummy node forces and moments at each dummy load station are saved for future use.

For load stations, the shears and moments are now transformed to the requested orientation. The angles θ_x, θ_y, and θ_z used to calculate $[T^{-1}]$ for the transformation are obtained from card input (see card 6.7, sec. 6.3, vol. I).

$$\begin{bmatrix} V_x \\ V_y \\ V_z \end{bmatrix}_{\substack{\text{Point A} \\ \text{requested axis}}} = [T^{-1}] \begin{bmatrix} V_x \\ V_y \\ V_z \end{bmatrix}_{\substack{\text{Point A} \\ \text{inertia axis}}}$$

and:

$$\begin{bmatrix} M_x \\ M_y \\ M_z \end{bmatrix}_{A} = [T^{-1}] \begin{bmatrix} M_x \\ M_y \\ M_z \end{bmatrix}_{A,\ \text{inertia axis}}$$

Thus, we have $\overline{M}_3$ at point A:

$$[\overline{M}_3] = \begin{bmatrix} V_x \\ V_y \\ V_z \\ M_x \\ M_y \\ M_z \end{bmatrix} = \begin{bmatrix} V_{x_1} & \cdots & V_{x_n} \\ \vdots & & \vdots \\ M_{z_1} & & M_{z_n} \end{bmatrix}$$

For a surface with two load points (A and B), and with all components (V_x, V_y, V_z, M_x, M_y, and M_z), the structure of $[\overline{M}_3]$ as placed on LTAP would be:

$$[\overline{M}_3] = \left[\begin{array}{c} V_{x_A} \\ V_{x_B} \\ V_{y_A} \\ V_{y_B} \\ V_{z_A} \\ V_{z_B} \\ M_{x_A} \\ M_{x_B} \\ M_{y_A} \\ M_{y_B} \\ M_{z_A} \\ M_{z_B} \\ \vdots \end{array}\right] \begin{array}{l} \left.\begin{array}{c} \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \end{array}\right\} \text{Surface I} \\ \left.\begin{array}{c} \\ \end{array}\right\} \text{Surface N} \end{array}$$

If one or more component is missing, the matrix would close up; also, each surface is treated separately and is merged onto the preceding surface.

To calculate $[\overline{M}_4]$, $[\overline{M}_5]$, and $\{\overline{\overline{\phi}}\}$, obtain the aero force coefficient matrices $F_{PL}(\dot{q})$, $F_{PL}(\ddot{q})$, $F_{PL}(\dot{\alpha}_g)$ from the Equations of Motion tape and transform the forces into the matrix axis system. Then:

$$\begin{bmatrix} F_{x_i}(\dot{q},\ddot{q},\dot{\alpha}_g) \\ F_{y_i}(\dot{q},\ddot{q},\dot{\alpha}_g) \\ F_{z_i}(\dot{q},\ddot{q},\dot{\alpha}_g) \end{bmatrix}_{\substack{\text{inertia} \\ \text{axis}}} = \text{SCALA}_i \begin{Bmatrix} T_1 \end{Bmatrix} [F_{PL_i}(\dot{q},\ddot{q},\dot{\alpha}_g)]_{\substack{\text{local} \\ \text{axis}}}$$

where $\{T_1\}$ is the transpose of the third row of $[T]$ with $\theta_z = 0$, or:

$$F_{x_i}(\dot{q},\ddot{q},\dot{\alpha}_g) = \text{SCALA}_i\, T(3,1)\, F_{PL_i}(\dot{q},\ddot{q},\dot{\alpha}_g)$$

$$F_{y_i}(\dot{q},\ddot{q},\dot{\alpha}_g) = -\,\text{SCALA}_i\, T(3,2)\, F_{PL_i}(\dot{q},\ddot{q},\dot{\alpha}_g)$$

$$F_{z_i}(\dot{q},\ddot{q},\dot{\alpha}_g) = \text{SCALA}_i\, T(3,3)\, F_{PL_i}(\dot{q},\ddot{q},\dot{\alpha}_g)$$

SCALA_i = 1.0 or SCALE from card 6.93 (section 6.3, volume 1) for the specific aerodynamic panels.

The aero forces in the inertia axis are summed at all required nodes to calculate shears at point A (load station or dummy load station, inertia axis):

$$V_{x_A} = \text{SCALE} \sum_i F_{x_i} + \sum_j \text{SCALED}_j F_{x_{D_j}}$$

$$V_{y_A} = \text{SCALE} \sum_i F_{y_i} + \sum_j \text{SCALED}_j F_{y_{D_j}}$$

$$V_{z_A} = \text{SCALE} \sum_i F_{z_i} + \sum_j \text{SCALED}_j F_{z_{D_j}}$$

where:

i = required aerodynamic node numbers

j = required dummy node numbers

SCALE = SCALE2 for $\overline{M}_4$ and $\overline{M}_5$

= SCALE3 for $\tilde{\overline{\phi}}$

and

$$\left.\begin{aligned} F_{x_{D_j}} &= V_{x_{D_j}} = \text{SCALE}\Sigma_i\ F_{x_i} \\ F_{y_{D_j}} &= V_{y_{D_j}} = \text{SCALE}\Sigma_i\ F_{y_i} \\ F_{z_{D_i}} &= V_{z_{D_i}} = \text{SCALE}\Sigma_i\ F_{z_i} \end{aligned}\right\} \begin{array}{l}\text{dummy node forces} \\ \text{at dummy node j}\end{array}$$

Note: See the previous note on SCALED_j.

For slender bodies (Z bodies) where the force is in the Z direction:

$$F_{x_{\text{inertia axis}}} = 0$$

$$F_{y_{\text{inertia axis}}} = 0$$

$$F_{z_{\text{inertia axis}}} = F_{z_{\text{aero local axis}}}$$

For slender bodies (Y bodies) where the force is in the Y direction:

$$F_{x_{\text{inertia axis}}} = 0$$

$$F_{y_{\text{inertia axis}}} = -F_{y_{\text{aero local axis}}}$$

$$F_{z_{\text{inertia axis}}} = 0$$

The force coefficient matrices from EOM are partitioned for slender bodies to contain F_y and F_z. For example, $F_{PL}(\dot{q})$ for a slender body with y and z forces would appear as follows:

$$[F_{PL}(\dot{q})] = \begin{bmatrix} F_{PL}(\dot{q})_y \\ \cdot \\ \cdot \\ \hline F_{PL}(\dot{q})_z \\ \cdot \\ \cdot \end{bmatrix}$$

Note: F_y or F_z may be zero, but both F_y and F_z will be on the magnetic file.

This is possible since the maximum possible number of nodes for slender bodies is less than 50. Thus, the maximum number of nodes for $[F_y$ and $F_z]$ would be less than 100.

The bending moments at point A (load station or dummy load station) are obtained by summing over all required nodes:

$$M_{x_A} = \text{SCALE} \sum_i (\Delta_{y_i} F_{z_i} + \Delta_{z_i} F_{y_i}) + \sum_j MX_j$$

$$M_{y_A} = \text{SCALE} \sum_i (\Delta_{x_i} F_{z_i} - \Delta_{z_i} F_{x_i}) + \sum_j MY_j$$

$$M_{z_A} = \text{SCALE} \sum_i (-\Delta_{y_i} F_{x_i} - \Delta_{x_i}) F_{y_i} + \sum_j MZ_j$$

where:

$$\Delta_{x_i} = BS_i - BS_A$$

$$\Delta_{y_i} = BBL_i - BBL_A$$

$$\Delta_{z_i} = WL_i - WL_A$$

$$M_{x_j} = \text{SCALED}_j\,(\Delta y_{D_j} F_{z D_j} + \Delta_{z D_j} F_{y D_j} + M_{x D_j})$$
$$M_{y_j} = \text{SCALED}_j\,(\Delta_{x D_j} F_{z D_j} - \Delta_{z D_j} F_{x D_j} + M_{y D_j})$$
$$M_{z_j} = \text{SCALED}_j\,(-\Delta_{y D_j} F_{x D_j} - \Delta_{x D_j} F_{y D_j} + M_{z D_j})$$

$$\Delta x_{D_j} = BS_{D_j} - BS_A$$

$$\Delta y_{D_j} = BBL_{D_j} - BBL_A$$

$$\Delta z_{D_j} = WL_{D_j} - WL_A$$

D_j is the j^{th} dummy node

$$\text{SCALE} = \text{SCALE2 for } \overline{M}_4 \text{ and } \overline{M}_5$$
$$= \text{SCALE3 for } \tilde{\tilde{\phi}}$$

Note: See the previous note on SCALEDj.

The dummy node forces and moments at each dummy load station are saved for future use. For load stations, the shears and moments are then transformed to the requested orientation (for a dummy load there is no transformation). The angles θ_x, θ_y, and θ_z are obtained from card input (see card set 6.0, sec. 6.3, vol. I).

$$\begin{bmatrix} V_x \\ V_y \\ V_z \end{bmatrix}_{\substack{A,\text{ requested}\\ \text{axis}}} = [T^{-1}] \begin{bmatrix} V_x \\ V_y \\ V_z \end{bmatrix}_{\substack{A,\text{ inertia}\\ \text{axis}}}$$

and:

$$\begin{bmatrix} M_x \\ M_y \\ M_z \end{bmatrix}_{\substack{A,\text{ requested}\\ \text{axis}}} = [T^{-1}] \begin{bmatrix} M_x \\ M_y \\ M_x \end{bmatrix}_{\substack{A,\text{ inertia}\\ \text{axis}}}$$

Thus:

$$[\overline{M}_4]_A = \begin{bmatrix} V_x \\ V_y \\ V_z \\ M_x \\ M_y \\ M_z \end{bmatrix}_A = \begin{bmatrix} V_x & \text{———} & V_{x_n} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ M_{z_1} & & M_{z_n} \end{bmatrix}_A$$

where n = number of modes. Similarly for $\overline{M}_5$:

$$[\tilde{\tilde{\phi}}]_A = \begin{bmatrix} V_x \\ V_y \\ V_z \\ M_x \\ M_z \end{bmatrix}_A = \begin{bmatrix} V_{x_1} & \text{———} & V_{x_g} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ M_{z_1} & \text{———} & M_{z_g} \end{bmatrix}$$

where g = number of gust zones.

VBMT Output TAPE (LTAP)

Note: A load set is the result of processing all surfaces requested following the LOAD-SET card, but before the next LOAD-SET or $ card.

$$
\begin{array}{l}
[\text{Header}] \\
\left.\begin{array}{l}
[\bar{M}_3] \\
\left.\begin{array}{l}[\bar{M}_4]\\ [\bar{M}_5]\\ [\bar{\tilde{\phi}}\ ]\end{array}\right\} k=1 \\
\vdots \\
\left.\begin{array}{l}[\bar{M}_4]\\ [\bar{M}_5]\\ [\bar{\tilde{\phi}}\ ]\end{array}\right\} k=Nk
\end{array}\right\} \text{Load set 1} \\
\text{EOF} \\
[\text{Header}] \\
\left.\begin{array}{l}
\left.\begin{array}{l}[\bar{M}_3]\\ [\bar{M}_4]\\ \vdots\end{array}\right\} k=1
\end{array}\right\} \text{Load set 2}
\end{array}
$$

Maximum size of $[\bar{M}_3] = [\bar{M}_4] = [\bar{M}_5]$ is 100 x 70; of $[\bar{\tilde{\phi}}]$ is 100 x 2(35).

Expansion of $[\bar{M}_3]$ on LTAP (the first output on LTAP):

$$
[\bar{M}_3] = \left[\begin{array}{c}
V_{x_1}\\ \vdots\\ V_{x_m}\\ \vdots\\ M_{z_1}\\ \vdots\\ M_{z_m}\\ V_{x_1}\\ \vdots\\ M_{z_n}\\ \vdots
\end{array}\right]
\begin{array}{l}
\left.\begin{array}{l}\text{point 1}\\ \vdots\\ \text{point m}\\ \vdots\\ \text{point 1}\\ \vdots\\ \text{point m}\end{array}\right\} \text{Surface 1}\\
\left.\begin{array}{l}\text{point 1}\\ \vdots\\ \text{point n}\end{array}\right\} \text{Surface 2}\\
\left.\begin{array}{l}\vdots\end{array}\right\} \text{Surface 1}
\end{array}
$$

Similarly for $[\bar{M}_4]$, $[\bar{M}_5]$, and $[\bar{\tilde{\phi}}]$ and for all values of k.

Local to Reference Coordinates

The coordinate locations (X,Y,Z) of the loads from card 6.9.2 (sec. 6.3, vol. I) are always in reference coordinates. Thus it can be directly compared with the reference coordinates from INTERP to determine the structural nodes to be included in the summation for $[\overline{M}_3]$.

However, the coordinates (X,Y) associated with the aero data (from the EOM tape) are in local coordinates. They must be changed back to structural coordinates before being compared to load coordinate locations (X,Y,Z) in the selection of the aero nodes to get summation for $[\overline{M}_4]$, $[\overline{M}_5]$, and $[\tilde{\phi}]$.

This is accomplished by LTOGT from the DYLOFLEX library. CALL LTOGT (X,Y,Z, NPTS, R,T), where (X,Y,Z) input is (X,Y) from EOM with Z being zero, and R and T are from the SA array from INTERP (rotation and transformation). LTOG will then return (X,Y,Z) in structural coordinates. (LTOGT is an entry point in AINTT).

For slender bodies, the Z coordinate in (X,Y,Z) from LTOGT may be replaced by the Z from input card 6.6.

3.6 DATA BASES

L218 (LOADS) data bases include input and output files plus internal scratch files and common block storage.

3.6.1 INPUT DATA

The input data is from two sources, cards and magnetic files.

Card Input Data

For a complete description of all the card input formats, see section 6.3 in volume I of this document.

Tape Input Data

For a complete description of the tape input data see section 6.4 in volume I of this document.

3.6.2 OUTPUT DATA

The output data may be of two types, printed and magnetic files.

Printed Output Data

For a complete description of the printed output data, see section 6.5.1 in volume I of this document.

Magnetic Files (Tape or Disk)

For a complete description of the magnetic file output data, see section 6.5.2 in volume I of this document.

3.6.3 INTERNAL DATA

Common blocks and blank common (dynamic storage) are used to pass data from one routine to another within an overlay. Temporary (scratch) disk files are used in (L218,2,0), AVD. Random access disk files are used in (L218,3,0), NPLDS, and (L218,4,0), VBMT.

AVD Internal (Temporary) Disk Storage

FETADD is used to initialize buffer storage. FETDEL and RETURNF are called to delete the files after they are no longer needed. Three files are used:

- o IFM_1 contains merged $\overline{M}_1$ data.
- o IFM_2 contains merged $\overline{M}_2$ data.
- o IFM_3 contains merged $\overline{M}_3$ data.

These data are written on these three files in subroutine MERGE with FORTRAN write statements and read in subroutine AVDTAP. The files are initialized and deleted in AVD. The record structure (fig. 9) for IFM_1, IFM_2, and IFM_3 is identical.

NPLDS/PLDS Internal (Temporary) Disk Storage

All temporary disk storage in this overlay is accomplished on the file MERGMB using random access methods. The file MERGMB is initialized and deleted in NPLDS. The subroutines that call WRITEMS to write on MERGMB are NPLDB2 and NPLDD4. NPLDB2 writes the matrix $\overline{M}_3$, and NPLDD4 writes the matrice $\overline{M}_4$, $\overline{M}_5$, and $\overline{\tilde{\phi}}$. The subroutine that calls READMS from MERGMB is NPLDH1.

The matrices or records are indexed with the following numbers:

Matrix	Random access key	
$\overline{M}_3$	1	to ISMAX
$\overline{M}_4$	ISMAX + 1	to 21(ISMAX)
$\overline{M}_5$	21(ISMAX) + 1	to 41(ISMAX)
$\overline{\tilde{\phi}}$	41(ISMAX) + 1	to 61(ISMAX)

where ISMAX is the maximum number of surfaces.

The read/write activity on MERGMB in NPLDS/PLDS is displayed in figure 10.

<u>Size</u>		<u>IFM$_3$</u>
NROWS$_1$	X MODES	$[\overline{M}_3]_1$
NROWS$_2$	X MODES	$[\overline{M}_3]_2$
	•	•
	•	•
	•	•
NROWS$_i$	X MODES	$[\overline{M}_3]_i$
	•	•
	•	•
	•	•
NROWS$_{NSURF}$	X MODES	$[\overline{M}_3]_{NSURF}$

where $[\overline{M}_3]$ is the $[\overleftarrow{M}_3]$ for surface i

NSURF is the last surface

MODES is the number of modes

NROWS is dependent on the number of selected nodes, and the selected matrix components.

Figure 9. — Record Structure of IFM_1, IFM_2, and IFM_3

Record No.	Record Size	Written In	Read In	Contents
1	NODES(MXMODE+1)	NPLDB2	NPLDH1	$\overline{M}_3$ - Surface 1
⋮				⋮
ISMAX				$\overline{M}_3$ - Surface ISMAX
ISMAX+1		NPLDD4		$\overline{M}_4$ - Surface 1, freq 1
+2				freq 2
⋮				⋮ ⋮
+20				freq 20
+21				Surface 2, freq 1
⋮				⋮
21(ISMAX)+1				$\overline{M}_5$ - Surface 1, freq 1
⋮				⋮
41(ISMAX)+1	NODES(COL+1)			$\overline{\Phi}$ - Surface 1, freq 1
⋮				⋮
61(ISMAX)				$\overline{\Phi}$ - Surface ISMAX, freq 20

Figure 10. – Read/Write Activity on MERGMB in NPLDS/PLDS

VBMT Internal (Temporary) Disk Storage

All temporary disk storage in this overlay is accomplished on the file MERGMB using random access methods. MERGMB is initialized and deleted in VBMT. The subroutines that call WRITEMS to write on MERGMB are VBMTC2, VBMTD3, and VBMTD4. The subroutines that call READMS to read from MERGMB are VBMTC2, VBMTD4, and VBMTF1. The read/write activity on the file MERGMB in VBMT is displayed in figure 11.

Common Blocks

Table 6 displays the common blocks used in the program and the overlays in which they are used.

The LABELED common blocks are used for communication between the main and primary overlays, and for communication between routines in a primary overlay. The block names and contents are described in table 7. The "T" heading in table 7 refers to variable type. The codes used are as follows:

I Integer

R Real

C Complex

L Logical

H Hollerith

Blank common is used in the primary overlays as a variable length working storage area. The length of required arrays is calculated, and the first word address and variable dimension of the array is passed through the subroutine calling sequence for those routines which require it.

Record No.	Record Size	Written In	Read In	Contents
1	IROW(MXMODE+2)	VBMTC2	NPLDH1	$\overline{M}_3$ for load No. 1
⋮				⋮
MXLOAD				
MXLOAD+1				$\overline{M}_4$ for load No. 1, freq 1
⋮				⋮
MXLOAD(1+NK)+1				$\overline{M}_5$ for load No. 1, freq 1
⋮				⋮
MXLOAD(2+NK)+1				$\overline{\phi}$ for load No. 1, freq 1
⋮				⋮
MXLOAD(3+NK)+1				Dummy load No. 1
⋮				⋮
LAST				

where

MXLOAD	is the number of loads for this load set
NK	is the number of frequencies
IROW	is the number of rows in this matrix
MXMODE	is the number of modes
LAST	= MXLOAD(3+NK)+MXDUM(1+NK)
MXDUM	is maximum number of dummy loads

Figure 11. – Read/Write Activity on MERGMB in VBMT

Table 6. – Common Blocks in Each Overlay

OVERLAY \ COMMON BLOCK	CGEN	CGEN1	CGEN2	RWBUFF	CAVD	CLOC	CITMRM	CMAT	CARRAY	Q3	CNPLD1	CNPLD2	CVBMT1	CVBMT2	CVBMTF1	BLANK
(L218,0,0) L218	X	X		X												
(L218,1,0) RGEN	X	X	X	X												X
(L218,2,0) AVD	X	X	X	X	X	X	X	X	X	X						X
(L218,3,0) NPLDS	X	X	X	X							X	X				X
(L218,4,0) VBMT	X	X		X									X	X	X	X

Table 7. — Contents of Common Blocks

BLANK COMMON: AVD Dynamic Storage

DESCRIPTION: Variably dimensioned arrays

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	INODE	I	100	i	Contain selected nodes
2	LFM1	I	LBUF		FET buffer for IFM1
3	LFM2	I	LBUF		FET buffer for IFM2
4	LFM3	I	LBUF		FET buffer for IFM3
5	LARRAY	I	LBUF		FET buffer for IDISK
6	XYZCOR	R	3*NODES	BS_X, BBL_X, WL_X	(X,Y,Z) coordinates for surface IS (card input)
7	ALB	R	NODES	LB	(LB) interpolation coefficient
8	ALT	R	NODES	LT	(LT) interpolation coefficient
9	ALTT	R	NODES	LTT	(LTT) interpolation coefficient
10	ISUB	I	NODES		Requested nodes
11	GEOM	R	3*NODES	BS_I, BBL_I, WL_I	(X,Y,Z) coordinates from INTERP
12	BS2	R	NODES	BS_{i+1}	X coordinate from INTERP for the (I+1) node
13	THXYZ	R	3*NODES	$\theta_x, \theta_y, \theta_z$	$\theta_x, \theta_y, \theta_z$ for surface IS
14	PX	R	NODES* MXMODE	ϕ_{x_i}	ϕ_x
15	PX2	R	NODES* MXMODE	$\phi_{x_{i+1}}$	ϕ_x for (I+1) node
16	PY	R	NODES* MXMODE	ϕ_{y_i}	ϕ_y
17	PY2	R	NODES* MXMODE	$\phi_{y_{i+1}}$	ϕ_y for (I+1) node
18	PZ	R	NODES* MXMODE	ϕ_{z_i}	ϕ_z
19	PZ2	R	NODES* MXMODE	$\phi_{z_{i+1}}$	ϕ_z for (I+1) node
20	PPX	R	NODES* MXMODE	$\phi_{\theta x_i}$	$\phi_{\theta x}$

Table 7. — (Continued)

BLANK COMMON: AVD Dynamic Storage (continued)

DESCRIPTION:

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
21	PPX2	R	NODES* MXMODE	$\phi_{\theta x_{i+1}}$	$\phi_{\theta x}$ for (I+1) node
22	PPY	R	NODES* MXMODE	$\phi_{\theta y_i}$	$\phi_{\theta y}$
23	PPY2	R	NODES* MXMODE	$\phi_{\theta y_{i+1}}$	$\phi_{\theta y}$ for (I+1) node
24	PPZ	R	NODES* MXMODE	$\phi_{\theta z_i}$	$\phi_{\theta z}$
25	PPZ2	R	NODES* MXMODE	$\phi_{\theta z_{i+1}}$	$\phi_{\theta z}$ for (I+1) node
26	SA	R		SA	SA array from INTERP

Table 7. — (Continued)

LABELED COMMON NAME: CGEN

DESCRIPTION: Contains general data required by all overlays.

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	TDUM	H	8		Temporary input array
2	INFIL	I	1		Name of card input file (=5)
3	IUTFIL	I	1		Name of card output file (=6)
4	IGPRNT	I	1		General print control
5	KMOD	I	1		Module option control (AVD=1, NPLDS=2, PLDS=3, VBMT=4)
6	IOUT	I	1		Name of temporary general output file.
7	IGS	I	1		Load-Set counter
8	NERROR	I	1		Fatal Error Counter
9	ISMAX	I	1		Maximum Number of surfaces for this load-set
10	WAR	H	3		Warning Message
11	FAT	H	3		Fatal Error Message
12	LBUF	I	1		Dimension value for OUTBUF-buf-fer length.
13	IAVD1	H	1		AVD output tape name
14	NPTAP	H	1		NPLDS output tape name
15	IPTAP	H	1		PLDS output tape name
16	LTAP	H	1		VBMT output tape name
17	IEOMLD	H	1		File name for EOM tape from L217(EOM)
18	IDISK	H	1		File name for interpolation tape from L215(INTERP)
19	MASSTP	H	1		File name for mass tape
20	JTAPE	H	1		File name for the J-Matrix tape
21	IXYZ	I	1		Indicator defining transforma-tion order
22	LC	I	1		Line Count for FETADD

Table 7. – (Continued)

LABELED COMMON NAME: CARRAY

DESCRIPTION: AVD subroutine file names and buffer lengths

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	IFM1	I	1		File name for $\overline{M_1}$ merged
2	IFM2	I	1		File name for $\overline{M_2}$ merged
3	IFM3	I	1		File name for $\overline{M_3}$ merged
4	LFM1	I	1		Buffer length for IFM1
5	LFM2	I	1		Buffer length for IFM2
6	LFM3	I	1		Buffer length for IFM3
7	LARRAY	I	1		Buffer length for IDISK

Table 7. – (Continued)

LABELED COMMON NAME: CAVD

DESCRIPTION: AVD subroutine options and scale factors

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	ICARD	I	1		=1 for matrix input by card; =0 otherwise
2	IIS	I	1		=1 if another surface is to be input; =0 otherwise
3	INTER	I	1		Interpolation control
4	IPRINT	I	1		Print control
5	IROT	I	1		=1 for rotation; =0 otherwise
6	IS	I	1		Current surface number
7	IUNIT	I	1		=1 for Metric; =2 for English
8	NIS	I	1		Not used
9	NRR	I	1		Diagnostic error variable
10	SCALR1	R	1		Matrix scale factor
11	SCALR2	R	1		Matrix scale factor
12	SCALR3	R	1		Matrix scale factor
13	IANGLE	I	1		Theta input control
14	ISP	I	1		Previous surface number

Table 7. – (Continued)

LABELED COMMON NAME: CGEN1

DESCRIPTION: Required in each overlay. Contains the header matrix data for final tape output.

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	IQLTAP		30		Matrix for the first record of output to tapes IAVD1, NPTAP, IPTAP and LTAP.

Table 7. – (Continued)

LABELED COMMON NAME: CGEN2

DESCRIPTION: Contains file count variables

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	IFILEA	I	1		Loadset file count for AVD
2	IFILEP	I	1		Loadset file count for PLDS
3	IFILENP	I	1		Loadset file count for NPLDS

Table 7. – (Continued)

LABELED COMMON NAME: CITMRN

DESCRIPTION: AVD subroutine translation and rotation directives.

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	ITM3X	I	1		Code for translational matrix
2	ITM2X	I	1		Code for translational matrix
3	ITM1X	I	1		Code for translational matrix
4	ITM3Y	I	1		Code for translational matrix
5	ITM2Y	I	1		Code for translational matrix
6	ITM1Y	I	1		Code for translational matrix
7	ITM3Z	I	1		Code for translational matrix
8	ITM2Z	I	1		Code for translational matrix
9	ITM1Z	I	1		Code for translational matrix
10	IRM3X	I	1		Code for rotational matrix
11	IRM2X	I	1		Code for rotational matrix
12	IRM1X	I	1		Code for rotational matrix
13	IRM3Y	I	1		Code for rotational matrix
14	IRM2Y	I	1		Code for rotational matrix
15	IRM1Y	I	1		Code for rotational matrix
16	IRM3Z	I	1		Code for rotational matrix
17	IRM2Z	I	1		Code for rotational matrix
18	IRM1Z	I	1		Code for rotational matrix

Table 7. — (Continued)

LABELED COMMON NAME: CLOC

DESCRIPTION: AVD subroutine matrix sizes and locations

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	NODES	I	1		Number of nodes requested
2	MXNODE	I	1		Total number of nodes
3	MXMODE	I	1		Total number of modes
4	LXYZ	I	1		Dynamic storage location for XYZCOR
5	LLB	I	1		Dynamic storage location for ALB
6	LLT	I	1		Dynamic storage location for ALT
7	LLTT	I	1		Dynamic storage location for ALTT
8	LCODE	I	1		Not Used
9	LISUB	I	1		Dynamic storage location for ISUB
10	LGEOM	I	1		Dynamic storage location for GEOM
11	LBS2	I	1		Dynamic storage location for BS2
12	LTH	I	1		Dynamic storage location for THXYZ
13	LPX	I	1		Dynamic storage location for PX
14	LPX2	I	1		Dynamic storage location for PX2
15	LPY	I	1		Dynamic storage location for PY
16	LPY2	I	1		Dynamic storage location for PY2
17	LPZ	I	1		Dynamic storage location for PZ
18	LPZ2	I	1		Dynamic storage location for PZ2

Table 7. — (Continued)

LABELED COMMON NAME: CLOC (continued)

DESCRIPTION:

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
19	LLPX	I	1		Dynamic storage location for PPX
20	LLPX2	I	1		Dynamic storage location for PPX2
21	LLPY	I	1		Dynamic storage location for PPY
22	LLPY2	I	1		Dynamic storage location for PPY2
23	LLPZ	I	1		Dynamic storage location for PPZ
24	LLPZ2	I	1		Dynamic storage location for PPZ2
25	LTM3X	I	1		Not used
26	LTM2X	I	1		Not used
27	LTM1X	I	1		Not used
28	LTM3Y	I	1		Not used
29	LTM2Y	I	1		Not used
30	LTM1Y	I	1		Not used
31	LTM3Z	I	1		Not used
32	LTM2Z	I	1		Not used
33	LTM1Z	I	1		Not used
34	LRM3X	I	1		Not used
35	LRM2X	I	1		Not used
36	LRM1X	I	1		Not used
37	LRM3Y	I	1		Not used
38	LRM2Y	I	1		Not used
39	LRM1Y	I	1		Not used
40	LRM3Z	I	1		Not used
41	LRM2Z	I	1		Not used
42	LRM1Z	I	1		Not used

Table 7. – (Continued)

LABELED COMMON NAME: CLOC (concluded)

DESCRIPTION:

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
43	LSA	I	1		Dynamic storage location for SA
44	LAST	I	1		Last location of dynamic storage

Table 7. — (Continued)

LABELED COMMON NAME: CMAT

DESCRIPTION: AVD subroutine problem size.

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	ITOTAL	I	1		Total number of rows for this load-set.
2	ITOTIS	I	1		Total number of rows for surface IS.
3	ISTOT	I	1		Current number of surfaces for this load-set.
4	ISM3	I	100		Total rows written on FM3 per surface
5	ISM2	I	100		Total rows written on FM2 per surface
6	ISM1	I	100		Total rows written on FM1 per surface

Table 7. — (Continued)

LABELED COMMON NAME: CNPLD1

DESCRIPTION: NPLDS/PLDS subroutine array sizes, location and scale factors.

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	NODES	I	1		Number of nodes requested
2	MXNODE	I	1		Total number of nodes
3	MXMODE	I	1		Total number of modes
4	LNM3	I	1		Dynamic storage location for NM3
5	LNM4	I	1		Dynamic storage location for NM4
6	LNM5	I	1		Dynamic storage location for NM5
7	LNC3	I	1		Dynamic storage location for NC3
8	LIEOM	I	1		Buffer location for IEOMLD
9	LIDISK	I	1		Buffer location for IDISK
10	LNPTAP	I	1		Buffer location for NPTAP
11	LMERG	I	1		Buffer location for OPENMS
12	LMASS	I	1		Buffer location for MASSTP
13	LPTAP	I	1		Buffer location for IPTAP
14	LINODE	I	1		Dynamic storage location for INODE
15	LXMASS	I	1		Dynamic storage location for XMASS
16	LAREA	I	1		Dynamic storage location for AREA
17	LPMAT	I	1		Dynamic storage location for PMAT
18	LGEOM	I	1		Dynamic storage location for GEOM
19	LPZ	I	1		Dynamic storage location for PZ
20	LXYL	I	1		Dynamic storage location for XYL

Table 7. — (Continued)

LABELED COMMON NAME: CNPLD1 (continued)

DESCRIPTION:

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
21	LAREAL	I	1		Dynamic storage location for AREAL
22	LXKVAL	I	1		Dynamic storage location for XKVAL
23	LFPL	I	1		Dynamic storage location for FPL
24	LSA	I	1		Dynamic storage location for SA
25	LAST	I	1		Last location of dynamic storage
26	NK	I	1	NK	Number of frequencies
27	NAERO	I	1		Number of aeropanels
28	NLOAD	I	1		Number of structural loads
29	ICARD	I	1		=1 for matrix input by cards; =0 for matrix input by tape.
30	IIS	I	1		=1 for another surface; =0 otherwise
31	IOPT	I	1		Option control
32	IPRINT	I	1		Print control
33	IS	I	1		Current surface number
34	ISP	I	1		Previous surface number
35	ISTOT	I	1		Number of surfaces for this load-set
36	ITOTAL	I	1		Total number of rows for this load-set
37	IUNIT	I	1		=1 for Metric; =2 for English
38	IM3	I	1		Random Access Key Number - $\overline{M}_3$
39	IM4	I	1		Random Access Key Number - $\overline{M}_4$
40	IM5	I	1		Random Access Key Number - $\overline{M}_5$
41	IC3	I	1		Random Access Key Number - $\overline{\Phi}$
42	NGUST	I	1	g	Number of gust panels

Table 7. — (Continued)

LABELED COMMON NAME: CNPLD1 (concluded)

DESCRIPTION:

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
43	LROW	I	1		Dynamic storage location for NROW
44	MERGMB	I	1		Random Access File
45	SCALR1	R	1	SCALR1	Scale factor for $\overline{M}_3$
46	SCALR2	R	1	SCALR2	Scale factor for $\overline{M}_4$ and $\overline{M}_5$
47	SCALR3	R	1	SCALR3	Scale factor for $\overline{\Phi}$
48	UNIT	H	1		Metric or English units

Table 7. – (Continued)

LABELED COMMON NAME: CNPLD2

DESCRIPTION: NPLDS/PLDS subroutine linkage (temporary storage)

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	Q3	R	10000		Temporary storage

Table 7. – (Continued)

LABELED COMMON NAME: CVBMT1

DESCRIPTION: VBMT subroutine option, array sizes, and locations.

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	ICOMP	I	1		Current component number
2	IC3	I	1		Random Access Key - $\bar{\Phi}$
3	IIS	I	1		Type of input indicator
4	IL	I	1		Current sequencial load number
5	ILD	I	1		Current sequencial dummy load number
6	ILDS	I	1		Number of Dummy Nodes to sum to this surface
7	ILDT	I	1		=0 for Dummy Load; =1 otherwise
8	ILL	I	1		Current load number (not sequencial
9	ILS	I	1		Load-Set number
10	IMD	I	1		Random Access Key - Dummy Loads
11	IMXX	I	1		=1 for MX comp; =0 otherwise
12	IMYY	I	1		=1 for MY comp; =0 otherwise
13	IMZZ	I	1		=1 for MZ comp; =0 otherwise
14	IM3	I	1		Random Access Key - $\overline{M_3}$
15	IM4	I	1		Random Access Key - $\overline{M_4}$
16	INTMP	I	1		Temporary input file
17	IM5	I	1		Random Access Key - $\overline{M_5}$
18	IPRINT	I	1		Print control
19	IR	I	1		Error indicator
20	IRR	I	1		Error indicator
21	IS	I	1		Current surface number
22	ISLEND	I	1		=1 for a slender body; =0 otherwise
23	ISP	I	1		Previous surface number
24	ISTOT	I	1		Number surfaces for this load-set

Table 7. — (Continued)

LABELED COMMON NAME: CVBMT1(continued)

DESCRIPTION:

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
25	ITOTAL	I	1		Total number rows on final matrix
26	IUNIT	I	1		=1 for Metric; =2 for English
27	IVBMTA	I	1		=1 to check data for load-set =2 to read a load
28	IVX	I	1		=1 for VX computed; =0 otherwise
29	IVY	I	1		=1 for VY computed; =0 otherwise
30	IVZ	I	1		=1 for VZ computed; =0 otherwise
31	IZ	I	1		Number Z override coordinate
32	LAST	I	1		Last location of dynamic storage
33	LAXYZ	I	1		Dynamic storage location for AXYZ
34	LDAX	I	1		Dynamic storage location for DAX
35	LDAY	I	1		Dynamic storage location for DAY
36	LDAZ	I	1		Dynamic storage location for DAZ
37	LFPL	I	1		Dynamic storage location for FPL
38	LGEOM	I	1		Dynamic storage location for GEOM
39	LICOM	I	1		Dynamic storage location for ICOM
40	LIDISK	I	1		Buffer storage for IDISK
41	LIDNOD	I	1		Dynamic storage location for IDNOD
42	LIEOM	I	1		Buffer storage for IEOMLD
43	LIIZ	I	1		Dynamic storage location for IIZ

Table 7. – (Continued)

LABELED COMMON NAME: CVBMT1(continued)

DESCRIPTION:

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
44	LILSEQ	I	1		Dynamic storage location for ILSEQ
45	LINODA	I	1		Dynamic storage location for INODA
46	LINODS	I	1		Dynamic storage location for INODS
47	LINTMP	I	1		Buffer storage location for INTMP
48	LISEQ	I	1		Dynamic storage location for ISEQ
49	LISLOD	I	1		Dynamic storage location for ISLOAD
50	LJTAPE	I	1		Dynamic storage location for JTAPE Buffer
51	LLNODD	I	1		Dynamic storage location for LNODD
52	LLNODE	I	1		Dynamic storage location for LNODE
53	LLTAP	I	1		Dynamic storage location for LTAP Buffer
54	LMASST	I	1		Dynamic storage location for MASSTP Buffer
55	LMERG	I	1		Dynamic storage location for MERGMB Index
56	LMMXX	I	1		Dynamic storage location for MMXX
57	LMMYY	I	1		Dynamic storage location for MMYY
58	LMMZZ	I	1		Dynamic storage location for MMZZ
59	LMVX	I	1		Dynamic storage location for MVX
60	LMVY	I	1		Dynamic storage location for MVY

Table 7. — (Continued)

LABELED COMMON NAME: CVBMT1(continued)

DESCRIPTION:

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
61	LMVZ	I	1		Dynamic storage location for MVZ
62	LNC3	I	1		Dynamic storage location for NC3
63	LNMD	I	1		Dynamic storage location for NMD
64	LNM3	I	1		Dynamic storage location for NM3
65	LNM4	I	1		Dynamic storage location for NM4
66	LNM5	I	1		Dynamic storage location for NM5
67	LNODEZ	I	1		Dynamic storage location for NODEZ
68	LPPX	I	1		Dynamic storage location for PPX
69	LPPY	I	1		Dynamic storage location for PPY
70	LPPZ	I	1		Dynamic storage location for PPZ
71	LPX	I	1		Dynamic storage location for PX
72	LPY	I	1		Dynamic storage location for PY
73	LPZ	I	1		Dynamic storage location for PZ
74	LROW	I	1		Dynamic storage location for NROW
75	LSAX	I	1		Dynamic storage location for SAX
76	LSAY	I	1		Dynamic storage location for SAY
77	LSAZ	I	1		Dynamic storage location for SAZ

Table 7. — (Continued)

LABELED COMMON NAME: CVBMT1(continued)

DESCRIPTION:

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
78	LSCALA	I	1		Dynamic storage location for SCALA
79	LSCALD	I	1		Dynamic storage location for SCALD
80	LSCALS	I	1		Dynamic storage location for SCALS
81	LTHEX	I	1		Dynamic storage location for THEX
82	LTHEY	I	1		Dynamic storage location for THEY
83	LTHEZ	I	1		Dynamic storage location for THEZ
84	LXIXX	I	1		Dynamic storage location for XIXX
85	LXIYY	I	1		Dynamic storage location for XIYY
86	LXIZZ	I	1		Dynamic storage location for XIZZ
87	LXKVAL	I	1		Dynamic storage location for XKVAL
88	LXMA	I	1		Dynamic storage location for XMA
89	LXMX	I	1		Dynamic storage location for XMX
90	LXMXY	I	1		Dynamic storage location for XMXY
91	LXMXZ	I	1		Dynamic storage location for XMXZ
92	LXMY	I	1		Dynamic storage location for XMY
93	LXMYZ	I	1		Dynamic storage location for XMYZ
94	LXMZ	I	1		Dynamic storage location for XMZ

Table 7. — (Continued)

LABELED COMMON NAME: CVBMT1

DESCRIPTION:

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
95	LZ	I	1		Dynamic storage location for Z
96	MERGMB	I	1		Random Access File
97	MXAERO	I	1		Maximum nodes from EOM
98	MXCOMP	I	1		Maximum Load Components for this surface
99	MXDUM	I	1		Maximum number of dummy loads
100	MXLOAD	I	1		Number of loads for this load-set
101	MXMODE	I	1		Number of modes
102	MXNODE	I	1		Maximum number of nodes from INTERP
103	NAERO	I	1		Number of aero nodes requested
104	NGUST	I	1		Number of gust panels
105	NK	I	1		Number of frequencies
106	NODES	I	1		Number of structural nodes requested
107	SCALE1	R	1	SCALE1	Scale factor for $\overline{M_3}$
108	SCALE2	R	1	SCALE2	Scale factor for $\overline{M_4}$ and $\overline{M_5}$
109	SCALE3	R	1	SCALE3	Scale factor for $\overline{\Phi}$
110	T	R	(3,4)		Transformation and rotation matrix from SA array

Table 7. --(Continued)

LABELED COMMON NAME: CVBMTF1

DESCRIPTION: Maximum, first and last surface numbers

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	ISMAXX	I	1		Maximum surface number in ISEQ
2	ISMAX1	I	1		ISEQ subscript, first surface for this load-set
3	ISMAX2	I	1		Total number of surfaces calculated thus far.

Table 7. — (Continued)

LABELED COMMON NAME: CVBMT2

DESCRIPTION: VBMT subroutine linkage (temporary storage)

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	Q3	R	10000		Temporary storage

Table 7. – (Continued)

BLANK COMMON: NPLDS/PLDS Dynamic Storage

DESCRIPTION: Variably dimensioned arrays

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	NM3	I	ISMAX		Random Access Key for $\overline{M_3}$
2	NM4	I	20*ISMAX		Random Access Key for $\overline{M_4}$
3	NM5	I	20*ISMAX		Random Access Key for $\overline{M_5}$
4	NC3	I	20*ISMAX		Random Access Key for $\overline{\Phi}$
5	LIEOM	R	LBUF		Buffer for IEOMLD
6	LIDISK	R	LBUF		Buffer for IDISK
7	LNPTAP	R	LBUF		Buffer for NPTAP
8	MERG	R	LBUF		Buffer for MERGMB
9	LMERG	R	LBUF		Random Access Index for MERGMB
10	LMASS	R	LBUF		Buffer for MASSTP
11	INODE	I	NODES		Requested nodes
12	XMASS	R	NODES	m_i	Mass matrix
13	AREA	R	NODES	$[a_s]$	Structural node areas
14	PMAT	R	NLOAD* NAERO	P	P - matrix
15	GEOM	R	3*NODES	$(X,Y,Z)_s$	Structural Geometry
16	PZ	R	NODES* MXMODE	ϕ_z	ϕ_z of requested nodes
17	XYL	R	2*NAERO	$(X,Y)_L$	Local (X,Y) coordinates
18	AREAL	R	NAERO	$[A]_L$	Local aero panel areas
19	XKVAL	R	NK	K	Frequencies
20	FPL	R	NAERO* MXMODE	$[F_{pL}]$	Force coefficient matrix

Table 7. – (Continued)

LABELED COMMON NAME: Q3

DESCRIPTION: AVD subroutine linkeage (temporary storage)

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	Q3	R	7100		Temporary storage

Table 7. — (Continued)

LABELED COMMON NAME: RWBUFF

DESCRIPTION: READTP/WRTETP Buffer Area

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	IQ1	H	1		Code to change buffer size in READTP/WRTETP
2	IQ2	I	1		New buffer size
3	XRWB		7000		Buffer array for READTP/WRTETP

Table 7. — (Continued)

BLANK COMMON: VBMT Dynamic Storage

DESCRIPTION: Variably dimensioned arrays

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
1	LJTAPE	R	LBUF		FET buffer for JTAPE
2	LIEOM	R	LBUF		FET buffer for IEOMLD
3	LIDISK	R	LBUF		FET buffer for IDISK
4	LLTAP	R	LBUF		FET buffer for LTAP
5	MERG	R	LBUF		FET buffer for MERGMB
6	LINTMP	R	LBUF		FET buffer for INTMP
7	ISEQ	I	ISMAX		Sequential order of surface numbers
8	MVX	I	ISMAX		Number of VX components for surface IS
9	MVY	I	ISMAX		Number of VY components for surface IS
10	MVZ	I	ISMAX		Number of VZ components for surface IS
11	MMXX	I	ISMAX		Number of MXX components for surface IS
12	MMYY	I	ISMAX		Number of MYY components for surface IS
13	MMZZ	I	ISMAX		Number of MZZ components for surface IS
14	ISLOAD	I	ISMAX		Sequential number of the first load for surface IS
15	LNODD	I	MXDUM		Load number of defined dummy node (not the sequential number)
16	SCALD	R	MXDUM	$SCALED_i$	Scale factor on dummy node
17	IDNOD	I	MXDUM		Dummy nodes to sum to current surface
18	DAX	R	MXDUM	BS_D	X coordinate of dummy node
19	DAY	R	MXDUM	BBL_D	Y coordinate of dummy node
20	DAZ	R	MXDUM	WL_D	Z coordinate of dummy node

Table 7. — (Continued)

BLANK COMMON: VBMT Dynamic Storage (continued)

DESCRIPTION: Variably dimensioned arrays

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
21	Z	R	IZ		Z override coordinates
22	NODEZ	I	IZ		Node number for Z override coordinate
23	LMERG	I	(MXDUM+ MXLOAD) * (1+3NK)		MERGMB INDEX
24	NM3	I	MXLOAD		Random access key number for $\overline{M}_3$
25	NM4	I	NK*MXLOAD		Random access key number for $\overline{M}_4$
26	NM5	I	NK*MXLOAD		Random access key number for $\overline{M}_5$
27	NC3	I	NK*MXLOAD		Random access key number for $\bar{\Phi}$
28	NMD	I	MXDUM* (1+3NK)		Random access key number for dummy nodes
29	XKVAL	R	NK	K	Frequencies
30	NROW	I	MXLOAD		Number of rows in the matrix for this LOAD
31	THETX	R	MXLOAD	θ_x	THETAX associated with IL
32	THETY	R	MXLOAD	θ_y	THETAY associated with IL
33	THETZ	R	MXLOAD	θ_z	THETAZ associated with IL
34	SAX	R	MXLOAD	BS_A	X coordinate associated with LNODD
35	SAY	R	MXLOAD	BBL_A	Y coordinate associated with LNODD
36	SAZ	R	MXLOAD	WL_A	Z coordinate associated with LNODD
37	INODS	I	NODES	i	Structural nodes for this surface
38	SCALS	R	NODES	SCALES	Scale factor for structural nodes
39	GEOM	R	6 * NODES		$x, y, z, \theta_x, \theta_y, \theta_z$ of structural nodes
40	INODA	I	NAERO		Aero nodes for this surface

Table 7. — (Continued)

BLANK COMMON: VBMT Dynamic Storage (continued)

DESCRIPTION: Variably dimensioned arrays

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
41	SCALA	R	NAERO	SCALEA	Scale factor for aero nodes
42	AXYZ	R	3*NAERO	BS_i, BBL_i, WL_i	X,Y,Z in the inertia axis for aero nodes (transformed from local X,Y coordinates)
43	XMA	R	NODES (or zero)	m_i	M from the J-MATRIX
44	XMX	R	NODES (or zero)	$m_i x_i$	MX from the J-MATRIX
45	XMY	R	NODES (or zero)	$m_i y_i$	MY from the J-MATRIX
46	XMZ	R	NODES (or zero)	$m_i z_i$	MZ from the J-MATRIX
47	XIXX	R	NODES (or zero)	I_{xxi}	IXX from the J-MATRIX
48	XIYY	R	NODES (or zero)	I_{yyi}	IYY from the J-MATRIX
49	XIZZ	R	NODES (or zero)	I_{zzi}	IZZ from the J-MATRIX
50	XMXY	R	NODES (or zero)	$m_i x_i y_i$	MXY from the J-MATRIX
51	XMXZ	R	NODES (or zero)	$m_i x_i z_i$	MXZ from the J-MATRIX
52	XMYZ	R	NODES (or zero)	$m_i y_i z_i$	MYZ from the J-MATRIX
53	PX	R	NODES* MXMODE	ϕ_x	ϕ_x from INTERP
54	PY	R	NODES* MXMODE	ϕ_y	ϕ_y from INTERP
55	PZ	R	NODES* MXMODE	ϕ_z	ϕ_z from INTERP
56	PPX	R	NODES* MXMODE	$\phi_{\theta x}$	ϕ_{θ_x} from INTERP

Table 7. — (Concluded)

BLANK COMMON: VBMT Dynamic Storage

DESCRIPTION: Variably dimensioned arrays

NO.	VARIABLE	T	DIM.	ENG. NOM.	DESCRIPTION
57	PPY	R	NODES* MXMODE	ϕ_{θ_y}	ϕ_{θ_y} from INTERP
58	PPZ	R	NODES* MXMODE	ϕ_{θ_z}	ϕ_{θ_z} from INTERP
59	FPL	R	2*NAERO* MXLOAD	F_{PL}	Force coefficient matrix from EOM

4.0 EXTENT OF CHECKOUT

Each module of L218 (AVD, NPLDS/PLDS, and VBMT) was checked out with preliminary standalone data and then final verification test data, exercising the options indicated in tables 8 through 10.

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Table 8. – AVD Checkout Summary

Variable or Option \ Data Case No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
$LOAD																								
$AVD	X				X				X				X					X		X		X		
Surface No.	1	2	1	2	1	2	1	2	1	1	1	1	1	1	1	1	1	2	1	2	1	1	1	1
Trans. Matrix																								
M1X																								
M1Y												X				X								
M1Z											X				X		X							
M2X																								
M2Y		X					X													X			X	
M2Z			X	X			X	X												X	X		X	
M3X			X				X		X				X							X				
M3Y	X		X		X		X											X		X		X	X	
M3Z	X	X	X		X	X	X			X				X				X	X	X		X	X	X
Rot. Matrix																								
M1X																								
M1Y																								
M1Z																								
M2X																						X	X	
M2Y																		X	X			X	X	X
M2Z																		X						
M3X																								
M3Y																								
M3Z																								
NODE-ALL	X			X				X		X								X			X			
NODE		X	X		X	X	X				X								X	X				
LOCAL	X	X	X	X	X	X	X	X										X	X	X	X			
ANGLES										X	X													
INERT																								
COORD									X			X	X	X	X	X	X					X	X	X
INTER									1			1	2	2	2	4	5					5	2	4
SCALR1	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	*	•	1.
SCALR2	1.	1.	1.	1.	1.	1.	1.	4.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	2.	1.
SCALR3	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	2.	1.	1.

• = .0259

Table 9. — NPLDS/PLDS Checkout Summary

Variable or Option \ Data Case No.	1	2	3	4	5	6	7	8	9
$LOADS									
$NPLDS	X				X			X	
$PLDS									
Surface No.	1	1	1	1	1	1	1	1	2
CARDS	X			X					
TAPE		X	X						X
NODE-ALL			X	X			X	X	X
NODE	X	X			X	X			
OPT1	X	X						X	
OPT2					X				
PLDS			X						
(blank)				X		X	X		
SCALR1	*	*	1.	1.	.002	1.	1.	1.	1.
SCALR2	1.	1.	1.	1.	1.	1.	.1	1.	1.
SCALR3	.1	.1	1.	1.	.1	.1	1.	1.	1.

Table 10. — VBMT Checkout Summary

Data case No. / Variable or Option	1		2		3		4		5			6		7		8		9		
$LOADS	X											X								
$VBMT	X											X								
Load Set No.	1											1								
Surface No.	1		2		4		5		3			1		2		4		3		
SCALE1	*		*		*		*		*			*		*		*		*		
SCALE2	1.		1.		1.		1.		1.			1.		1.		1.		1.		
SCALE3	1.		1.		1.		1.		1.			1.		1.		1.		1.		
ZCOORD																		X		
LOAD No.	1		2	3	4		5		6	7	8	1		2	3	4		5	6	7
VX	X		X							X		X		X	X	X		X		
VY	X						X		X	X	X	X		X	X	X			X	
VZ	X		X	X	X				X		X	X		X	X	X		X	X	X
MX	X		X	X	X		X		X	X	X	X		X	X	X			X	
MY	X		X	X	X					X	X	X		X	X	X		X	X	X
MZ	X						X		X	X	X	X		X	X	X		X		
DLOAD No.		1				2		3					1				2			
ALL	X	X			X	X	X	X				X	X			X	X			
"C.F."			X	X					X	X	X			X	X			X	X	X
STRUCTUREP				X						X					X				X	
AEROP				X						X					X				X	
ADD LOAD				X			X			X	X				X				X	X
$QUIT											X									X

* = .0259

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16. Abstract

The LOADS computer program L218 calculates dynamic load coefficient matrices utilizing the force summation method. The load equations are derived for a flight vehicle in straight and level flight and excited by gusts and/or control motions. In addition, sensor equations are calculated for use with an active control system.

The load coefficient matrices are calculated for the following types of loads:

- Translational and rotational accelerations, velocities, and displacements
- Panel aerodynamic forces
- Net panel forces
- Shears, bending moments, and torsions

Program usage and a brief description of the analysis used are presented in volume I of this document. Volume II contains a description of the design and structure of the program to aid those persons who will maintain and/or modify the program in the future.

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