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EDASP, VERSION 1.1
EQUIPMENT DYNAMIC ANALYSIS SOFTWARE PACKAGE

USERS MANUAL

REVISION 0

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CONTROL COPY NUMBER __

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PART 1

OPERATIONAL OVERVIEW

1.0 INTRODUCTION

This section contains the information necessary to learn the basic operation of Stevenson & Associates' Equipment Dynamic Analysis Software Package (EDASP). The introduction covers the following topics:

1. Capabilities of the Software Package
2. Flowchart of the Software Package
3. Description of the Full Screen Editor

The program main and the primary modules are described in Part 2. Example(s) are used to explain the proper usage of the program for the sake of clarity and the example problem is described at the beginning of the Program Description section, Part 2. Part 3 of the users guide (file register) explains the files developed by the program and their format. The Appendix provides parameter definitions of important terms used in the program.

1.1 CAPABILITIES OF THE SOFTWARE PACKAGE

The package is designed to be an interactive, desktop engineering computer aid in the dynamic analysis of structures and equipment. Given the original modal properties of the structure, this software package allows the user to modify structural properties such as stiffness or mass, and calculate the altered state modal properties. This is done with only the modal data as input. No finite element analytical modeling is involved. This is achieved by working with the equations of motion at the modal coordinate level.

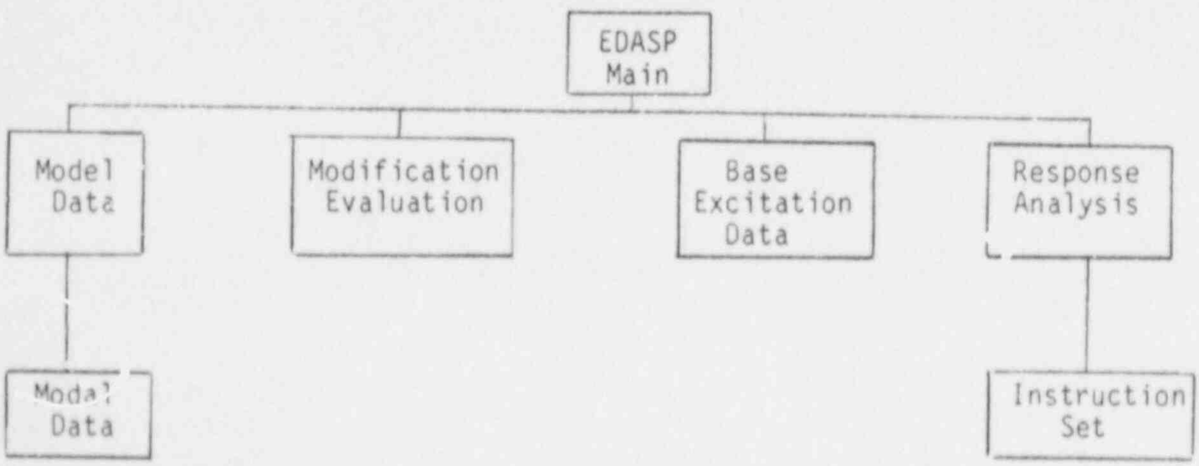
The user can also perform response analyses using the modal properties and a prescribed input (base excitation) motion. The program can accept an input base acceleration history, an acceleration response spectrum or a power spectral density function (PSDF). The response spectrum must be converted to a power spectral density function in order to conduct a response analysis and this can be performed in the base excitation module of the program. The response output, in the form of an amplified response spectrum, can be output at any coordinate point in the grid for which modal information was originally prescribed.

Graphical comparisons may also be made between any two response spectra in the response analysis module. For example, the response spectra at a point on the structure due to a given input forcing function may be compared to a different response spectrum possibly representing the functional threshold of a component located at the point. Alternatively, response spectra at a point for the before and after stage of a structural modification for the same input motion may be compared. These comparisons are controlled by an "instruction set" specified by the user in the response analysis module.

The program is designed such that the user may continually update the database accounting for changes to the structure or equipment which occur over time. This makes the program ideal for equipment or structures which undergo frequent change.

1.2 FLOWCHART OF THE SOFTWARE PACKAGE

The program package comprises the main menu which directs the user to one of four primary modules: the model definition, structural modification, base excitation definition, or the response analysis. The model definition module has a submenu defining the modal data, and the response analysis menu has a submenu defining the instruction set. The basic flowchart is shown below:



1.3 FULL SCREEN EDITOR

The editor allows the user to edit existing files or create new files. The data entry location is shown by a pointer located to the left of the data field, as shown below:

```
\othersub\2C13&15                                          EDASP 1.1
                                                           09-30-1986
                         Model Dimensions

            1. # of nodes          ▶ 50

            2. # of elements         80

            3. # of modes             8

            4. Active DOF's          0   1   0   0   0   0
```

In order to make an entry, the user presses the space bar. The pointer is replaced by a flashing cursor and the original data entry for that field is shifted to the lower left hand corner of the screen, as shown below:

```
\othersub\2C13&15                                          EDASP 1.1
                                                           09-30-1986
                         Model Dimensions

            1. # of nodes          __

            2. # of elements         80

            3. # of modes             8

            4. Active DOF's          0   1   0   0   0   0







 50
```

To make the new entry, the user types the new data value and presses (cr). The pointer reappears and may be repositioned to the next data field to be changed/entered by pressing the function keys to the right of the carriage return. The arrows shown on keys 2, 4, 6, and 8 control the movement of the cursor as indicated.

PART 2

PROGRAM DESCRIPTIONS

2.1 USERS GUIDE MODEL EXAMPLE - 2C13 & 15

The example used in this guide represents a real electrical control cabinet which has been modally tested. The model contains fifty (50) data points or coordinates as shown in Figure 1. The element connectivity is shown in Figure 2. Eighty (80) elements were used to connect the fifty (50) data point coordinates. Each of the coordinates represent a real physical location at which measurements were taken during a modal survey.

In total, eight (8) normal modes were measured in the frequency range of interest. Figures 3 and 4 show the frequency and damping table and the plot of the first mode, respectively.

The modes are displayed as planar panels with the only active degree-of-freedom being the y-direction (out-of-plane with respect to panel face)

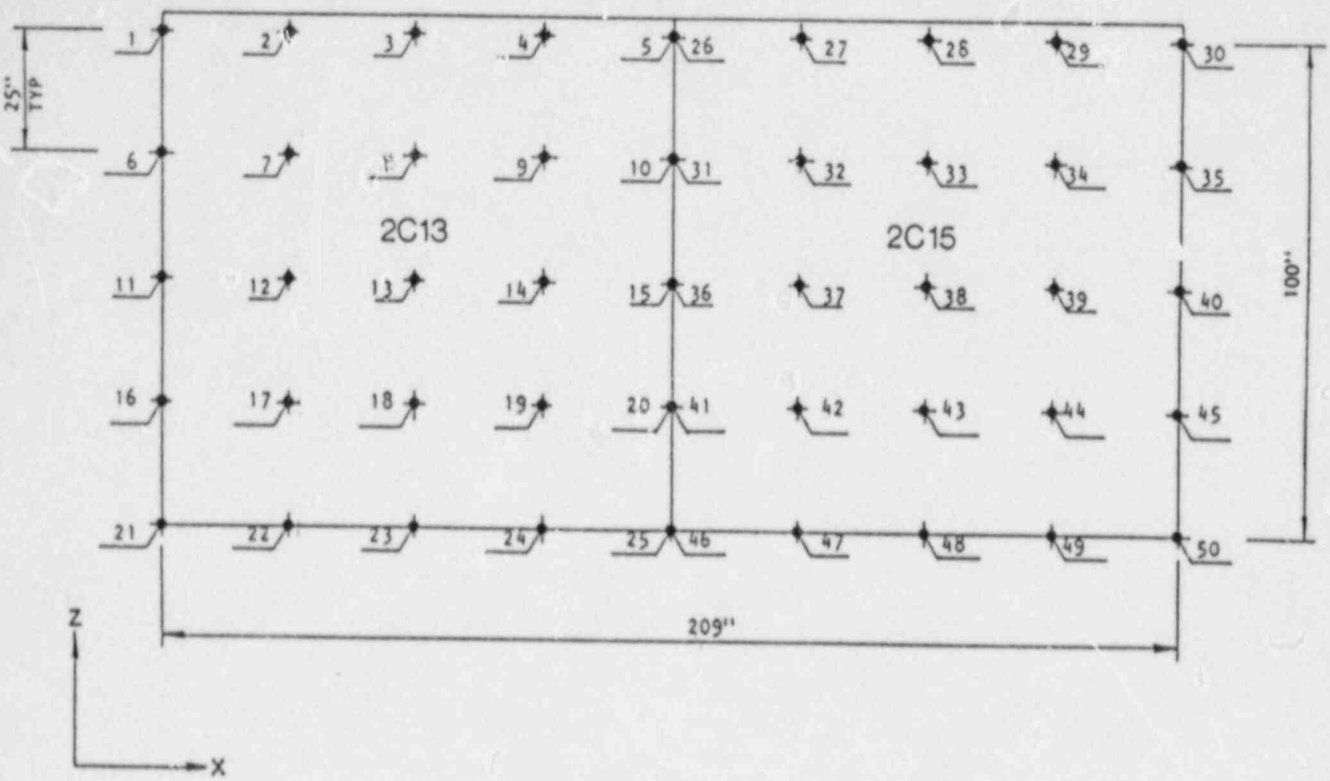


FIGURE 1
MEASUREMENT POINT LOCATIONS
CONTROL PANELS 2C13 AND 2C15

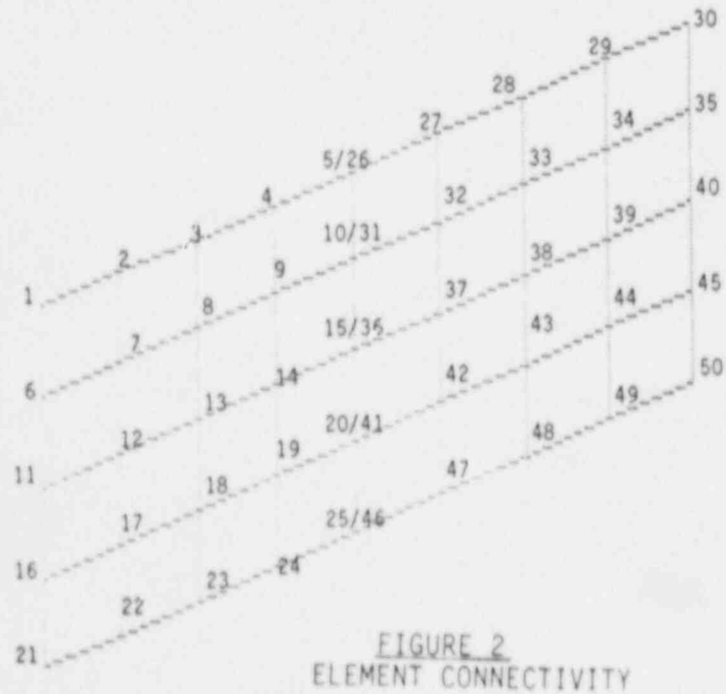


FIGURE 2
ELEMENT CONNECTIVITY

FREQUENCY AND DAMPING

MODE NO.	FREQUENCY HZ	FREQUENCY R/S	DAMPING %	DAMPING HZ	DAMPING R/S
1	8.010	55.981	4.886	435.880 *	2.739
2	11.870	74.580	4.912	583.704 *	3.668
3	16.361	102.801	3.478	569.381 *	3.578
4	18.161	114.109	3.593	653.009 *	4.103
5	19.965	125.443	569.203 *	113.643 *	714.040 *
6	21.688	136.271	730.277 *	158.388 *	995.181 *
7	24.511	154.008	3.520	863.366 *	5.425
8	28.649	180.007	744.318 *	213.248 *	1.340

FIGURE 3

CONTROL PANELS 2C13 AND 2C15
FREQUENCY AND DAMPING OF MODES
BELOW 33 HZ IN THE Y DIRECTION

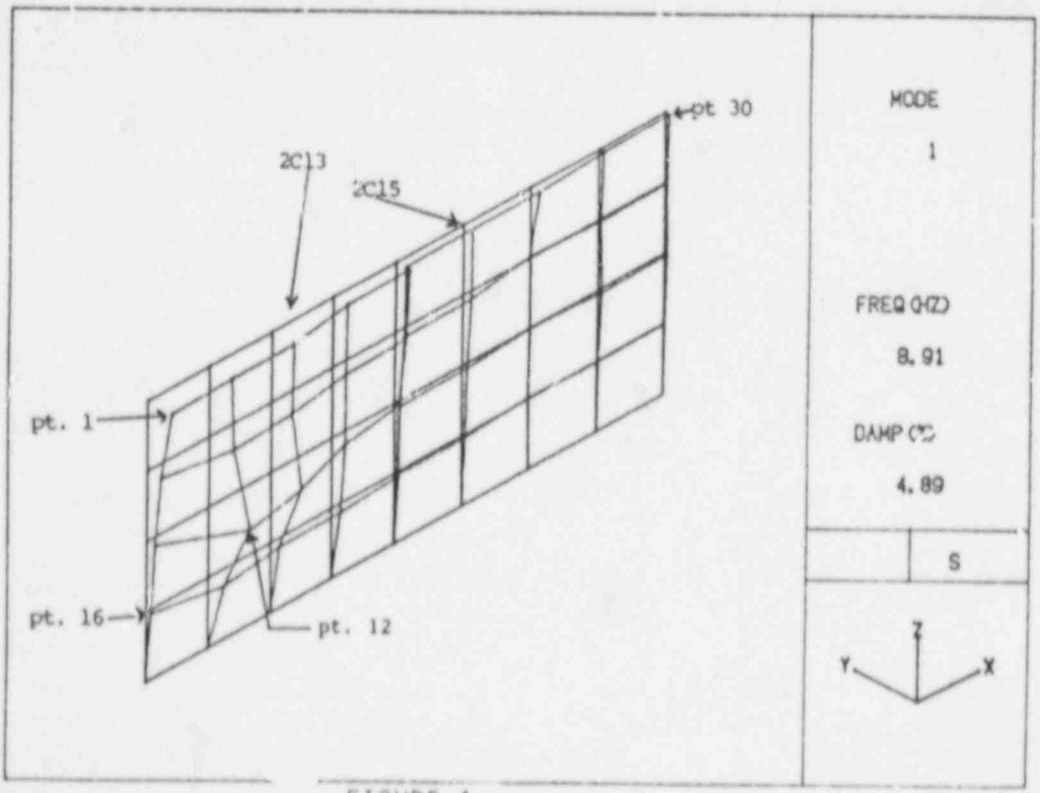


FIGURE 4

CONTROL PANELS 2C13 and 2C15
ILLUSTRATED MODE SHAPE OF MODE 1 TESTED IN THE Y DIRECTION

2.2 MAIN PROGRAM OPERATION OVERVIEW

After the system is booted, the user may call up the compiled software package from disk drive C, also known as the hard disk. The software package executable files should reside under a subdirectory name in disk drive C.

The user may create a subdirectory with the following command:

md c:*filename*

where *filename* is the name chosen by the user as the subdirectory file name.

Once the subdirectory is established, the user should copy the EDASP program files, and may copy any base motion files, any TRS files, and any model data files into the subdirectory from the appropriate disk(s) inserted in disk drive A by the following command :

copy a:edasp.* c:*filename**.*

The above command will copy all EDASP program files into the subdirectory. The same procedure may be repeated for any other files to be established in the subdirectory. The base motion files, TRS files and model data files may, however, reside in any number of other subdirectories created in the same fashion as described above. In other words, these data files may reside in other subdirectories and may be filed in or retrieved from those other subdirectories.

When within the EDASP the user is prompted to supply a data file name, the user must supply the subdirectory name and then the data file name as follows:

*subdirectoryname**filename*

This string is not to exceed 33 characters and the subdirectory name is not to exceed 8 characters. If no subdirectory name is supplied, the program assumes the data is to be retrieved or filed to the default subdirectory on which the EDASP executable files reside. Alternatively, the user may also specify data file retrieval or storage to a disk drive.

To call up the program, the user must first set the subdirectory default name by the following command:

cd c:*filename*

The user then types in the program name:

edasp

This calls up the executable file of the main program. The main menu, allowing the user to access any of the four primary modules, should appear as shown on the next page:

```
                  Equipment Dynamic Analysis Software Package
                            Version 1.1 (Rev. 0)
                            Stevenson & Associates
                            Sept. 1, 1986


                      1. Model Data

                      2. Modification Evaluation

                      3. Base Excitation Data

                      4. Response Analysis

                      5. End

   Enter item #:
```

The user then enters the item number of the module to be accessed and presses carriage return (cr).

If any module other than the excitation module is selected the program then asks for the model name, as shown below, or displays the current name on file. The user then types in the model name (preceded by \subdirectoryname\ if the model does not or will not finally reside in the default subdirectory) and presses (cr) or if the on-file name displayed is correct, simply presses (cr). If the base excitation module is selected, the name of the input motion file is requested only upon entering the base excitation module.

```
                  Equipment Dynamic Analysis Software Package
                            Version 1.1 (Rev. 0)
                            Stevenson & Associates
                            Sept. 1, 1986


                      1. Model Data

                      2. Modification Evaluation

                      3. Base Excitation Data

                      4. Response Analysis

                      5. End

          Model Name: \othersub\2017815
                    (CR): Execute          (ESC): Abort

   Enter item #:
```

To move from one module to another, the program always goes through the main menu. Each of the four primary modules shown above is described in the following sections. When the evaluation is completed and the user is in the system mode, the user may copy selected, or all, data files back onto floppy disk(s) inserted in disk drive A by the following command:

copy c:*filename**othername*.* a:*.*

2.3 MODEL DATA MODULE OPERATION OVERVIEW

When the model data module is selected, the directory shown below is displayed. The disk containing (or if it is a new model, to contain) the model data resides in disk drive C under the subdirectory name. The user may select to enter or edit any of the model data input files by entering its item number and pressing (cr).

```
\othersub\2C13&15                                            EDASP 1.1
                                                             09-30-1986
                         Enter/Edit Model Data

                         1. Model Dimensions

                         2. Node Coordinates

                         3. Masses

                         4. Node Connectivities

                         5. Modal Data

                         6. Plot

                         7. Return to the Main Menu



Enter item #:
```

Each of the input files is described in the remainder of this section.

Model Dimensions

This section defines the size of the model. The model definition for the original model data base has no particular physical meaning since the original stiffness properties of the program are not necessarily known. However, changes in stiffness will be incorporated through the model elements as will be the plotting functions. The model dimension section is shown below:

```
\othersub\2C13&15                                        EDASP 1.1
                                                         09-30-1986
                        Model Dimensions

            1. # of nodes           50

            2. # of elements        80

            3. # of modes            8

            4. Active DOF's          0  1  0  0  0  0
```

The name of the model (2C13 & 15) is displayed in the upper left-hand corner of the screen. The number of nodal coordinates (data points) is fifty (50). Eighty (80) elements are used to connect the fifty (50) coordinates. Eight (8) normal modes are going to be input. The "Active DOF's" line is inactive for a null entry and active if 1 is entered. The six (6) entries represent translational x, y, and z and rotational x, y and z degrees-of-freedom, respectively.

The maximum number of coordinates allowed is two-hundred (200). The maximum number of allowed elements is four-hundred (400). The maximum permissable number of normal modes is twenty (20).

The function keys, located on the left-hand side of the keyboard, control certain activities during each phase of the program as indicated below:

F6 - Refresh Screen
F8 - Print
F10 - Exit: Return to Model Data Menu

Node Coordinates

This section represents the physical location of the nodal coordinates used in the program. Shown below is the display of the first thirty node points for the example model. To enter or edit data, the user utilizes the full screen editor as described in Part 1.

\othersub\2C13&15

EDASP 1.1
09-30-1986

Node Coordinates

	X	Y	Z		X	Y	Z
1.	0.00E+00	0.00E+00	0.00E+00	16.	0.00E+00	0.00E+00	7.50E+01
2.	2.50E+01	0.00E+00	0.00E+00	17.	2.50E+01	0.00E+00	7.50E+01
3.	5.00E+01	0.00E+00	0.00E+00	18.	5.00E+01	0.00E+00	7.50E+01
4.	7.50E+01	0.00E+00	0.00E+00	19.	7.50E+01	0.00E+00	7.50E+01
5.	1.00E+02	0.00E+00	0.00E+00	20.	1.00E+02	0.00E+00	7.50E+01
6.	0.00E+00	0.00E+00	2.50E+01	21.	0.00E+00	0.00E+00	1.00E+02
7.	2.50E+01	0.00E+00	2.50E+01	22.	2.50E+01	0.00E+00	1.00E+02
8.	5.00E+01	0.00E+00	2.50E+01	23.	5.00E+01	0.00E+00	1.00E+02
9.	7.50E+01	0.00E+00	2.50E+01	24.	7.50E+01	0.00E+00	1.00E+02
10.	1.00E+02	0.00E+00	2.50E+01	25.	1.00E+02	0.00E+00	1.00E+02
11.	0.00E+00	0.00E+00	5.00E+01	26.	1.00E+02	0.00E+00	0.00E+00
12.	2.50E+01	0.00E+00	5.00E+01	27.	1.27E+02	0.00E+00	0.00E+00
13.	5.00E+01	0.00E+00	5.00E+01	28.	1.54E+02	0.00E+00	0.00E+00
14.	7.50E+01	0.00E+00	5.00E+01	29.	1.81E+02	0.00E+00	0.00E+00
15.	1.00E+02	0.00E+00	5.00E+01	30.	2.08E+02	0.00E+00	0.00E+00

1 / 2

The other twenty (20) coordinates are located on screen 2 of 2. The screen number is shown in the lower right-hand corner.

The function keys control the following activities as described:

F2 - Next Screen
F4 - Previous Screen
F6 - Refresh Screen
F8 - Print
F10 - Exit: Return to Model Data Menu

Masses

A value of mass may be assigned to each nodal coordinate. Values less than zero are not allowed. The display below represents the masses for the example:

```
\othersub\2C13&15                                                  EDASP 1.1
                                                                   09-30-1986

                               Mass Values

               Y                  Y                  Y                  Y

    1.   2.00E+00    16.   2.00E+00    31.   2.00E+00    46.   2.00E+00
    2.   2.00E+00    17.   2.00E+00    32.   2.00E+00    47.   2.00E+00
    3.   2.00E+00    18.   2.00E+00    33.   2.00E+00    48.   2.00E+00
    4.   2.00E+00    19.   2.00E+00    34.   2.00E+00    49.   2.00E+00
    5.   2.00E+00    20.   2.00E+00    35.   2.00E+00    50.   2.00E+00
    6.   2.00E+00    21.   2.00E+00    36.   2.00E+00
    7.   2.00E+00    22.   2.00E+00    37.   2.00E+00
    8.   2.00E+00    23.   2.00E+00    38.   2.00E+00
    9.   2.00E+00    24.   2.00E+00    39.   2.00E+00
   10.   2.00E+00    25.   2.00E+00    40.   2.00E+00
   11.   2.00E+00    26.   2.00E+00    41.   2.00E+00
   12.   2.00E+00    27.   2.00E+00    42.   2.00E+00
   13.   2.00E+00    28.   2.00E+00    43.   2.00E+00
   14.   2.00E+00    29.   2.00E+00    44.   2.00E+00
   15.   2.00E+00    30.   2.00E+00    45.   2.00E+00

                                                                     1 / 1
```

The function keys control the following activities:

F2 - Next Screen
F4 - Previous Screen
F6 - Refresh Screen
F8 - Print
F10 - Exit: Return to Model Data Menu

Element Connectivity

The element connectivities represent the physical display of the model. The input convention is the element number and the two end point nodes (i-j) between which the element spans. The display shown below shows the first forty-five (45) elements on screen 1 of 2:

\othersub\2C13&15 EDASP 1.1
09-30-1986

Node Connectivities

	Node #1	Node #2		Node #1	Node #2		Node #1	Node #2
1.	1	2	16.	19	20	31.	13	18
2.	2	3	17.	21	22	32.	18	23
3.	3	4	18.	22	23	33.	4	9
4.	4	5	19.	23	24	34.	9	14
5.	6	7	20.	24	25	35.	14	19
6.	7	8	21.	1	6	36.	19	24
7.	8	9	22.	6	11	37.	5	10
8.	9	10	23.	11	16	38.	10	15
9.	11	12	24.	16	21	39.	15	20
10.	12	13	25.	2	7	40.	20	25
11.	13	14	26.	7	12	41.	26	27
12.	14	15	27.	12	17	42.	27	28
13.	16	17	28.	17	22	43.	28	29
14.	17	18	29.	3	8	44.	29	30
15.	18	19	30.	8	13	45.	31	32

1 / 2

The function keys control the following activities:

- F2 - Next Screen
- F4 - Previous Screen
- F6 - Refresh Screen
- F8 - Print
- F10 - Exit: Return to Model Data Menu

Modal Data

The frequency and modeshape information is input or edited in this section. The user may also enter/edit the values of generalized mass or modal participation factors; however, the program automatically calculates these parameters each time the modal data submodule (Item 5) is accessed based on the frequencies, modeshapes and previously supplied mass distribution. The modal data directory is shown below:

```
\othersub\2C13&15                                                  EDASP 1.1
                                                                   09-30-1986
                         Enter/Edit Modal Data

              1. Frequency, Generalized Mass, & Participation Factors

              2. Mode Shapes

              3. Generalized Mass Matrix (display only)

              4. Return to the Enter/Edit Model Data menu.
```

The frequency submodule is accessed by typing 1 and pressing (cr). The frequencies are required input whereas the generalized mass and participation factors are optional since the program calculates them automatically. The display for the frequency information is shown below for the example:

```
\othersub\2C13&15                                                  EDASP 1.1
                                                                   09-30-1986

                         Modal Properties

              Freq. (Hz.)      Gen. Mass      Par. Fac. - y

      1.       8.91E+00        1.08E+05        1.98E-02
      2.       1.19E+01        1.34E+05        2.23E-03
      3.       1.64E+01        3.43E+04        9.25E-03
      4.       1.82E+01        7.31E+04        6.43E-03
      5.       2.00E+01        7.81E+05        2.68E-03
      6.       2.17E+01        8.54E+03       -1.93E-02
      7.       2.45E+01        2.06E+05       -1.77E-03
      8.       2.86E+01        5.75E+04        1.16E-03
```

The active function keys for the frequency submodule are shown below:

F2	-	Next Screen
F4	-	Previous Screen
F6	-	Refresh Screen
F8	-	Print
F10	-	Exit: Return to Modal Submodule

After exiting the frequency submodule (by pressing F10), the modeshape information submodule is accessed by entering 2 and pressing (cr). Each nodal coordinate should have a modal amplitude. The display for mode #1 is shown below for the example problem:

```
\other#ub\2C13&15                                              EDASP 1.1
                                                               09-30-1986

                          Mode Shape #1

          Y                  Y                  Y                  Y

 1.  6.56E+01   16.  1.08E+01   31.  2.24E+01   46.  0.00E+00
 2.  6.12E+01   17.  4.33E+01   32.  2.10E+01   47.  0.00E+00
 3.  6.05E+01   18.  2.25E+01   33. -3.70E+00   48.  0.00E+00
 4.  3.82E+01   19.  2.30E+01   34.  7.70E+00   49.  0.00E+00
 5.  3.61E+01   20.  1.08E+01   35.  5.90E+00   50.  0.00E+00
 6.  3.63E+01   21.  0.00E+00   36.  1.40E+01
 7.  6.82E+01   22.  0.00E+00   37.  1.26E+01
 8.  5.74E+01   23.  0.00E+00   38.  1.00E+00
 9.  3.60E+01   24.  0.00E+00   39.  1.05E+01
10.  2.96E+01   25.  0.00E+00   40.  8.70E+00
11.  2.03E+01   26.  2.57E+01   41.  7.30E+00
12.  1.12E+02   27.  2.22E+01   42.  8.60E+00
13.  8.47E+01   28.  2.42E+01   43. -4.00E+00
14.  3.47E+01   29.  1.18E+01   44.  3.40E+00
15.  1.04E+01   30.  1.05E+01   45.  1.50E+00

                                                               1 / 1
```

The active function keys for this section are:

F1 - Next Modeshape
F2 - Next Screen
F3 - Previous Modeshape
F4 - Previous Screen
F6 - Refresh Screen
F8 - Print
F10 - Exit: Return to Modal Submenu

The user may display the generalized mass matrix by typing 3 and pressing (cr). This is a "display only" function and no editing is permitted. The active function keys are:

F2 - Next Screen
F4 - Previous Screen
F6 - Refresh Screen
F8 - Print
F10 - Exit: Return to Modal Submodule

When all of the data entry/edit is complete for the modal data, type 4 and press (cr) to return to the model data module.

Model Graphics Module

The graphics routine is accessed from the model data module by entering the number 6 and pressing (cr). Note that in order to printer plot the graphics, it will be necessary to have executed the DOS command, GRAPHICS, while in the system mode. The undeformed shape of the model, based on previously supplied nodal coordinates and element connectivity, appears on the screen in the x-y plane. The graphics routine may be commanded by using the function keys or by mnemonic commands. The mnemonic command structure is always active.

The basic functions which may be accomplished are model rotation, viewing position or angle, moving the model on the screen, zooming the model, annotation, retrieval and animation of mode shapes, and printer plotting of the model and mode shapes. The default states for all features of this routine are shown in the data blocks to the right of the display.

Model Rotation

This subroutine allows the user to rotate the model about any axis of choice. The commands in the brackets below are the corresponding mnemonic command specification. Note that the user does not have to be in the rotation subroutine, which is activated by originally pressing F5 function key, in order to execute the mnemonic commands. The coordinate axes are shown in the lower right-hand corner. All rotations are defined by the right-hand rule.

The rotation angular increment default is 15°. The step angle adjustment command allows any angular increment between 0° and 360° by entering the desired angular increment followed immediately by r [#r]; or x [#x], y [#y], or z [#z]. The rotation axis vector command simply allows the user to define an axis of rotation defined by a line from the origin through the x,y,z coordinate of choice by entering the x,y,z coordinate followed immediately by r [#,#,#r]. The rotation command, activated by pressing r [r], executes the rotation about the axis of rotation using the specified angular increment. To rotate the model about the coordinate axes, simply press X [X] to rotate in the positive X direction or x [x] to rotate in the negative X direction; similarly for rotations about the Y- and Z-axes.

If the function key mode is desired, press F5 for which the following function keys are activated:

- F1 - Positive (+) Rotation About X-Axis [X (shift x)]
- F2 - Negative (-) Rotation About X-Axis [x]
- F3 - Positive (+) Rotation About Y-Axis [Y]
- F4 - Negative (-) Rotation About Y-Axis [y]
- F5 - Positive (+) Rotation About Z-Axis [Z]
- F6 - Negative (-) Rotation About Z-Axis [z]
- F7 - Step Angle Adjustment [#r or #x or #y or #z]
- F8 - Rotation Axis Vector [#,#,#r]
- F9 - Rotation Activator [r]
- F10 - Return

Move Model
The model may be moved up or down and left or right on the display screen by pressing the appropriate "arrow" keys on the right-hand key pad. The default number of steps moved are 10. This may be adjusted by simply by entering the new, desired step number followed immediately by any arrow [#↑].

If the function key mode is desired, press F2 for which the commands are as follows:

↑ - up [↑]
↓ - down [↓]
→ - right [→]
← - left [←]
F9 - move step adjustment [#↑] (any arrow)
F10 - Return

Zoom Model
To zoom in or out of the model, simply enter E [E] to zoom in or e [e] to zoom out. The zoom occurs from the middle of the display screen space; therefore, to zoom and view a specific section of the model, that section must be moved to the center of the display screen space. The default increment is 1.2 (or 20%) enlarging or diminishing. The rate of zoom may be adjusted by entering the desired new increment followed immediately by e (or E) in the mnemonic mode [#E].

If the function key mode is desired, press F3 for which the following keys are activated:

F1 - Zoom In [E]
F2 - Zoom Out [e]
F9 - Adjust Zoom Increment [#e]
F10 - Return

Model Viewing Angle
The model may be viewed from any point in space normalized to the unit vector. In the mnemonic mode, the command is simply the x,y,z coordinate followed by v [#,#,#v]. Additionally, any of the three axes can be designated as "up" as follows: 1u for the x-axis as up [1u], 2u for the y-axis as up [2u] or 3u for the z-axis as up [3u]. The view routine may also be accessed by pressing F3 in which case the following function keys are activated:

F1 - +X Axis View [1,0,0v]
F2 - -X Axis View [-1,0,0v]
F3 - +Y Axis View [0,1,0v]
F4 - -Y Axis View [0,-1,0v]
F5 - +Z Axis View [0,0,1v]
F6 - -Z Axis View [0,0,-1v]
F7 - Orthographic View [1,1,1v]
F8 - Axis Up Command [#u]
F9 - Set Any View Angle [#,#,#v]
F10 - Return

Mode Shape Display and Animation

To view the mode shapes, simply enter the mode number followed immediately by m [#m]. The amplitude, and for animation the number of frames and pause between frames, if any, may be specified by the following command [#,#,#a]. The default values are (.2,3,0a). The amplitude must be greater than 0 and less than 1. The number of frames may vary from 1 to 6 and a pause between frames, if desired, may be up to .99 seconds. By pressing a [a], the mode shape is animated. It may be stopped by striking any key and single-stepped by pressing s [s].

If the user desires function keys, press F6 for which the following keys are activated:

F1 - Mode # [#m]
F3 - Amplitude Adjustment [#,,a]
F5 - Number of Frames Adjustment [,#,a]
F7 - Pause Command [,,#a]
F8 - Single-Step (Frame-by-Frame) Mode Shape [s]
F9 - Animate Mode Shape [a]
F10 - Return

Model Annotation

To annotate the model, the mnemonic command is simply the beginning node number to end node number desired followed immediately by n [#,#n]. To view the next node number, enter [N]; and conversely, to view the preceding node number enter [n]. To erase the node numbers or annotation, enter [On]. If the function key mode is desired, press F7 and the following function keys will be activated:

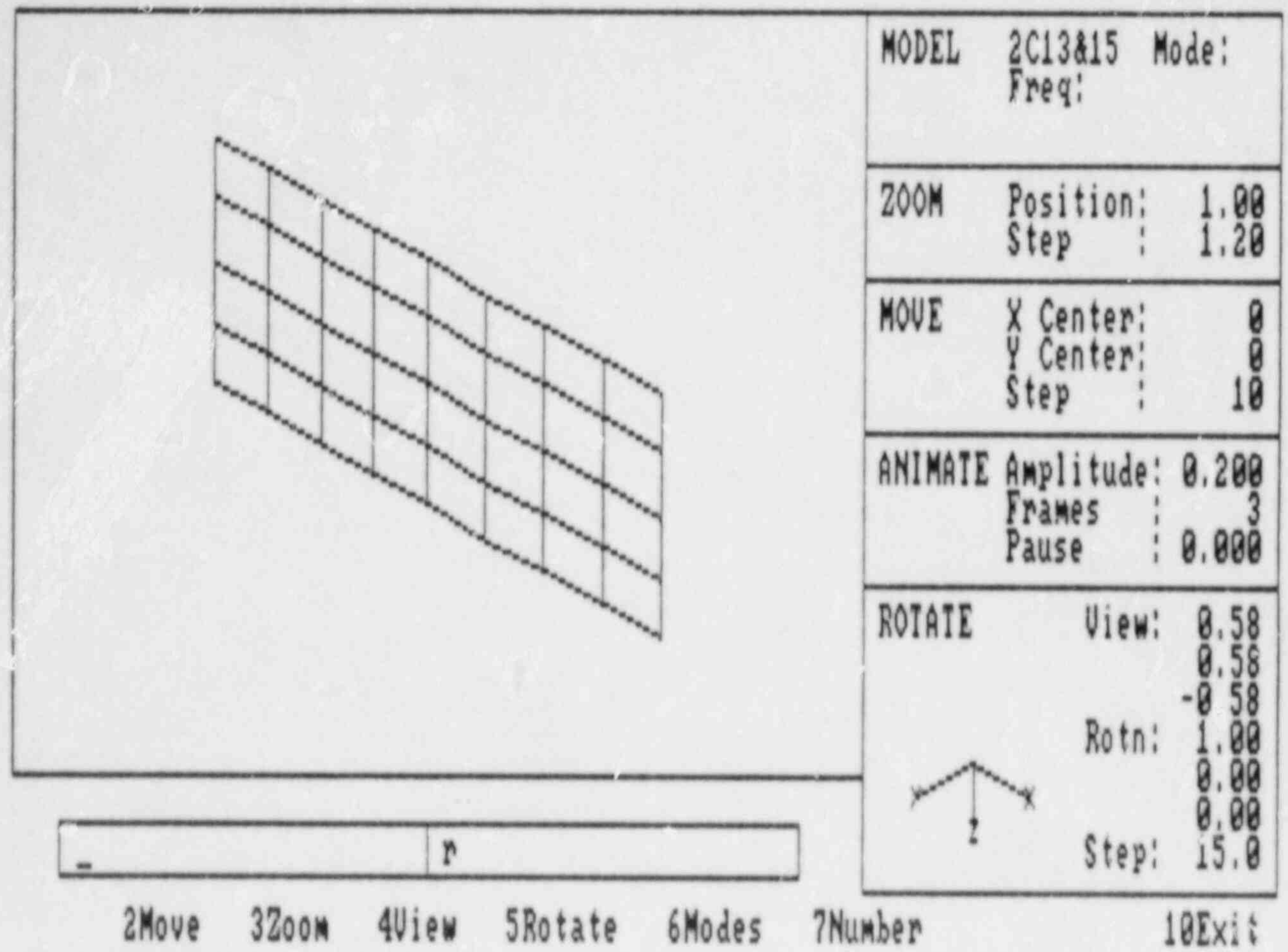
F1 - Nodes To be Annotated [#,#n]
F3 - Next Node Number [N]
F5 - Preceding Node Number [n]
F9 - Erase Annotation [On]

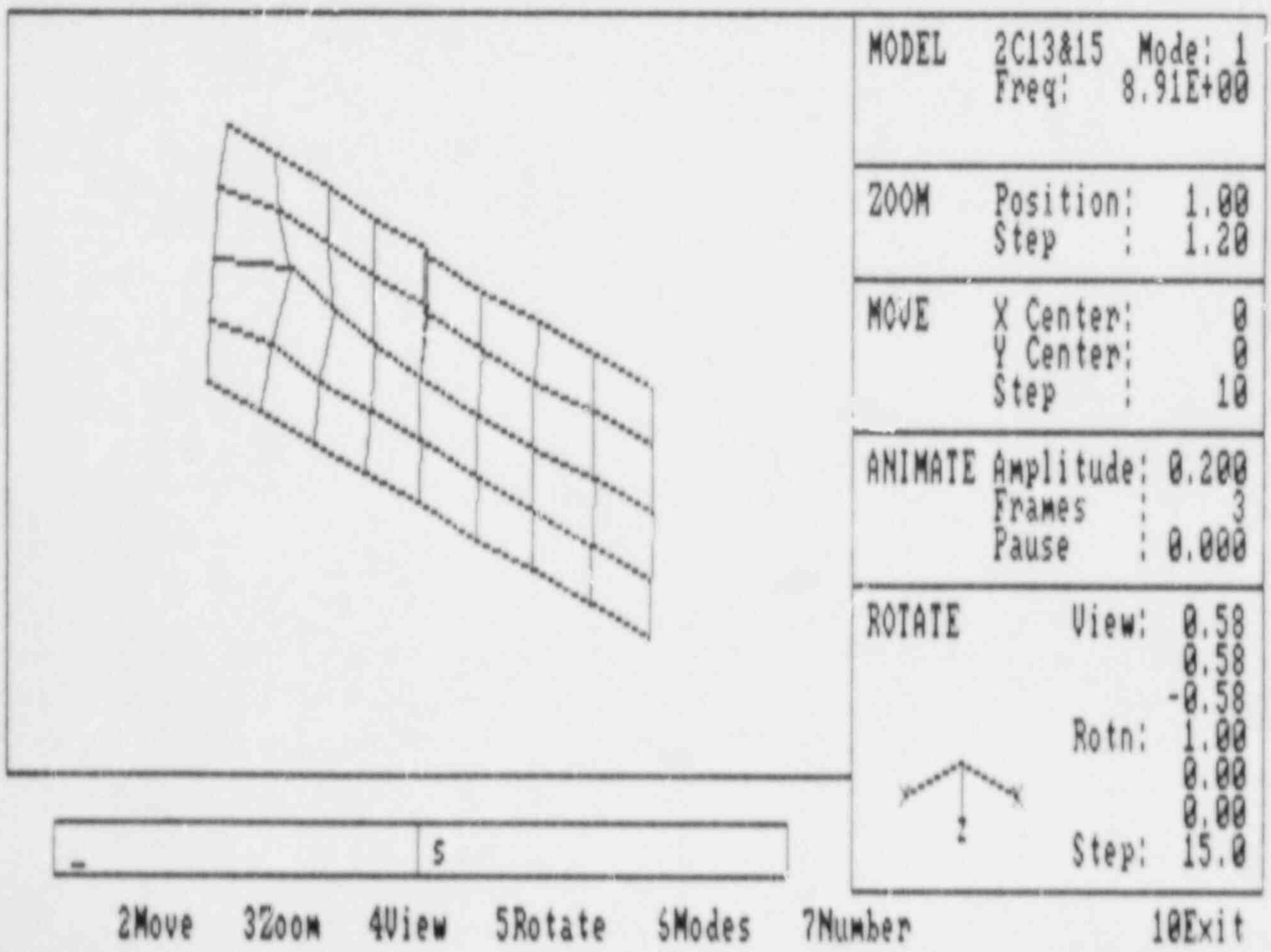
Plotting

To plot the display, whether the undeformed shape or a mode shape, simply press [Shift Print Screen]. In order to printer plot, the GRAPHICS capability of the system must be enabled as mentioned at the beginning of this section.

The plot of the undeformed shape and first mode shape of 2C13&15 is shown on the following page. The coordinate axes are rotated with the model to guide the user in choosing the best orientation.

To exit the graphics routine, press F10. To exit the model data module and return to the main program, enter 7 and press (cr).


MODEL 2C13&15 Mode:
Freq:
ZOOM Position: 1.00
Step : 1.20
MOVE X Center: 0
Y Center: 0
Step : 10
ANIMATE Amplitude: 0.200
Frames : 3
Pause : 0.000
ROTATE View: 0.58
0.58
-0.58
Rotn: 1.00
0.00
0.00
Step: 15.0
r
2Move 3Zoom 4View 5Rotate 6Modes 7Number 10Exit


MODEL 2C13&15 Mode: 1
Freq: 8.91E+00
ZOOM Position: 1.00
Step : 1.20
MOVE X Center: 0
Y Center: 0
Step : 10
ANIMATE Amplitude: 0.200
Frames : 3
Pause : 0.000
ROTATE View: 0.58
0.58
-0.58
Rotn: 1.00
0.00
0.00
Step: 15.0
s
2Move 3Zoom 4View 5Rotate 6Modes 7Number 10Exit

2.4 MODIFICATION EVALUATION OPERATIONAL OVERVIEW

The modification evaluation module is accessed by entering the number 2 and pressing (cr). The program then asks the user for the new model name. The new model data will be written on disk drive C in the designated or default subdirectory. The user can postulate mass and/or stiffness modifications, and perform a new modal analysis as shown on the menu below:

```
\othersub\2C13&15                                              EDASP 1.1
                                                               10-03-1986

                   Modification Evaluation Menu

             1. Enter/Edit Mass Modifications

             2. Enter/Edit Stiffness Modifications

             3. Perform the Modification Evaluation

             4. Return to the Main Menu

   New Model Name: \othersub\NEW2C13&15
                   <CR>: Execute          <ESC>: Abort
```

Mass Modifications

The user enters the number 1 and presses (cr) to conduct a mass modification. The program then asks for the number of mass modifications to be performed. The user enters the number of individual changes and the program constructs a menu as shown below:

```
\othersub\2C13&15                                              EDASP 1.1
                                                               09-30-1986

                        Mass Modifications

                 Node #   Dof #   Change in Mass

          1.       4        2        2.00E+00
          2.       5        2        2.00E+00
          3.       7        2        2.00E+00
```

For this example, three changes were entered. The user enters the node number, directional degree of freedom number, and the change in mass (+ or -). If a negative value greater in absolute value then the existing mass is entered, the program changes the user entry to a negative value equal to the existing mass at that node, in effect making the total mass value at that node zero. If the user leaves a node number as zero, the program discards the data for that entry and reduces the number of mass modifications previously entered by one. If the user enters data for the same node and DOF twice, the program accepts the latest data, discards the previous entry for that node, and reduces the number of mass modifications by one.

The active function keys are:

- F2 - Next Screen
- F4 - Previous Screen
- F6 - Refresh Screen
- F8 - Print Screen
- F10 - Exit: Return To Modification Evaluation Menu

Stiffness Modification

To conduct a stiffness modification, the user enters the model name again, the number 2 and presses (cr). The program asks for the number of stiffness modifications. The user must enter the total number of modifications and press (cr) twice. The software constructs a menu as shown below in this example for two stiffness changes:

```
\othersub\2C13&15                                              EDASP 1.1
                                                               09-30-1986

                        Stiffness Modifications

             Node #   Dof #   Node #   Dof #   Change in Stiffness

         1.    5        2       5        2          1.00E+02
         2.    7        2       7        2          1.00E+02
```

For each change, the user must enter the two node numbers (i-j) between which the spring is attached and the directional degrees of freedom associated with the change. For example, for a spring to ground, the change is on the diagonal of the stiffness matrix and the same node number is entered for the i-term and j-term. A spring to ground is <u>one</u> stiffness modification (one term on the diagonal is changed). An axial spring between two nodes (truss element) is <u>three</u> changes (two diagonal terms are changed and only one off diagonal term is required since the stiffness matrix is symmetric).

The active function keys are:

- F2 - Next Screen
- F4 - Previous Screen
- F6 - Refresh Screen
- F8 - Print Screen
- F10 - Exit: Return To Modification Evaluation Menu

Modification Evaluation

After all changes have been entered, the user enters the model name again, the number 3, and presses (cr). The program asks for the iteration limit (default is 15) and the convergence tolerance for the eigenvalue extraction (default is 1.0 E-5). The program then conducts the eigenvalue extraction. When the program completes the extraction, it writes the new modal data to the disk in the subdirectory specified or the default subdirectory if none is specified, or to a specified disk drive. The new frequencies and original model frequencies are tabulated upon pressing (cr) as shown below:

EDASP 1.1
09-30-1986

Frequencies (Hz.)

Mode	\othersub\2C13&15	\othersub\mod
1	8.910E+00	8.348E+00
2	1.187E+01	1.154E+01
3	1.636E+01	1.613E+01
4	1.816E+01	1.760E+01
5	1.997E+01	1.991E+01
6	2.169E+01	2.160E+01
7	2.451E+01	2.451E+01
8	2.865E+01	2.856E+01

In addition, the original model's instruction set is copied to disk under the new model name. It is pointed out that all modifications made while in the modification module remain in effect, even if the model name is changed. Unwanted modifications may be nulled out if the user reenters the mass or stiffness changes. It is, therefore, recommended that the user review all mass and stiffness changes before executing the eigenvalue extraction. To return to the modification evaluation menu, the user presses F10. To return to the main menu, the user must enter the model name again, the number 4, and press (cr).

2.5 BASE EXCITATION DATA MODULE OPERATIONAL OVERVIEW

The base excitation module is accessed from the EDASP main module by typing 3 and pressing (cr). The name of the base excitation is supplied by the user upon accessing the base excitation module.

```
              Equipment Dynamic Analysis Software Package
                       Version 1.1 (Rev. 0)
                       Stevenson & Associates
                       Sept. 1, 1986

                       1. Model Data

                       2. Modification Evaluation

                       3. Base Excitation Data

                       4. Response Analysis

                       5. End


  Enter item #:
```

The directory for the base excitation module is shown below:

```
                     DEFINE BASE EXCITATION

               1. Enter/Edit Time History

               2. Enter/Edit Response Spectrum

               3. Enter/Edit PSD

               4. PSD to RS Conversion

               5. RS to PSD Conversion

               6. Broaden Response Spectrum

               7. Return to the Main Menu

          Excitation Name: \othersub\nrc160v
                         <CR>: Execute        <ESC>: Abort

  Enter item # : 2
```

Defining a Time History, Response Spectrum or PSD

The input motion may be defined either as an acceleration history (Item 1) response spectrum (Item 2) or power spectral density (PSD) function (Item 3). The motions may be defined either by using the line editor, while in the system mode, or by utilizing the EDASP editor active in the base excitation module. In defining or editing a motion, the program first asks for the number of points. In the case of the time history, the time step is also requested. In the case of response spectra, the damping value(s) is also requested. Finally, in the case of the PSD, the probability of exceedence and duration are requested.

The active function keys are:

F6 - Refresh Screen
F8 - Print Screen
F10 - Advance to Next Screen

After pressing the F10 key, the motion data screen(s) appear. For new motions, the data fields are null and the user must supply the data entries desired using the editor. For existing motions, the data screens display the present entries and the editor is active so that the user may alter any entries. If the user changed the number of points for any motion on the previous screen, this will be reflected in the data base. Specifically, if the number of points were reduced, the data entries will have been truncated. If the number of points were increased, they will be shown at the end of the data string with null values and may be edited to reflect the desired values.

The active function keys for the editing/observing of the acceleration history are:

F2 - Next Screen
F4 - Previous Screen
F6 - Refresh Screen
F8 - Print (digitized data)
F10 - Exit: Return to Base Excitation Directory

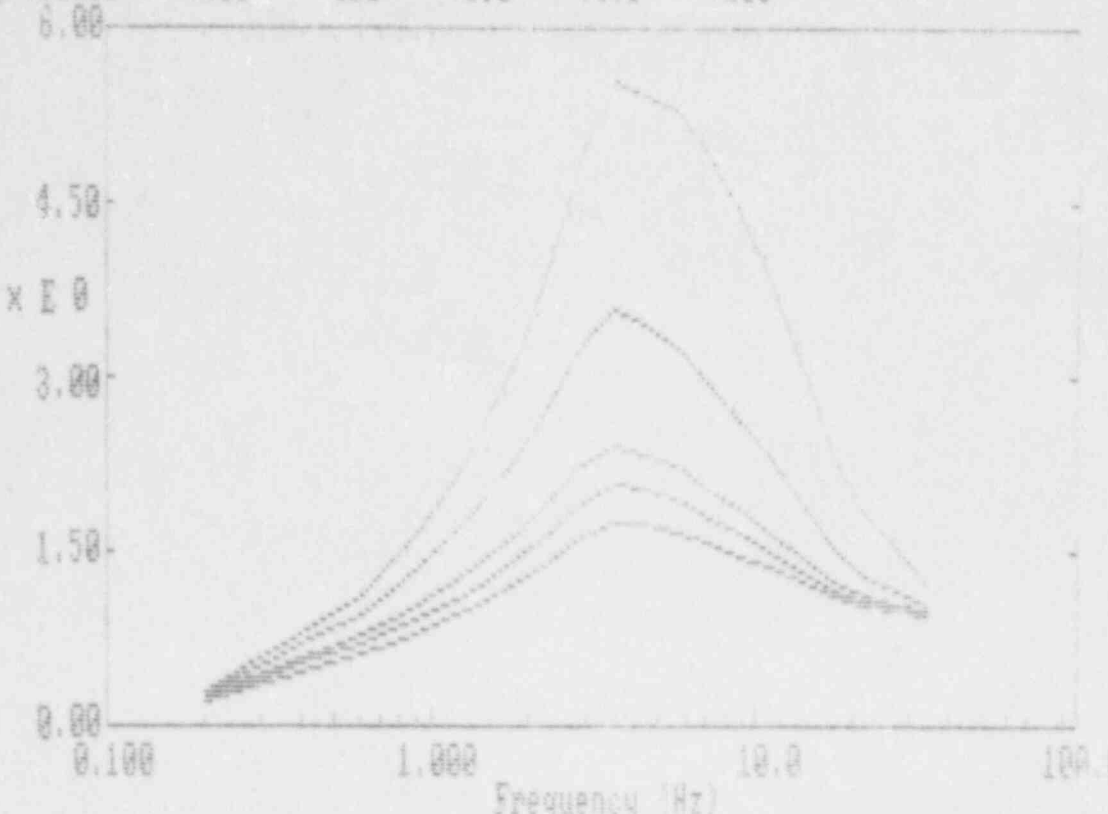
The active function keys for the editing/observing of the acceleration response spectrum and power spectral density functions are:

F2 - Next Screen
F4 - Previous Screen
F6 - Refresh Screen
F7 - View Plotted Data
F8 - Print Screen
F10 - Finished Viewing Plot - Return to Digitized Data Display, or Exit: Return to Base Excitation Directory

The plots on the following page show the plots of the acceleration response spectra and PSD input motion for the example problem.

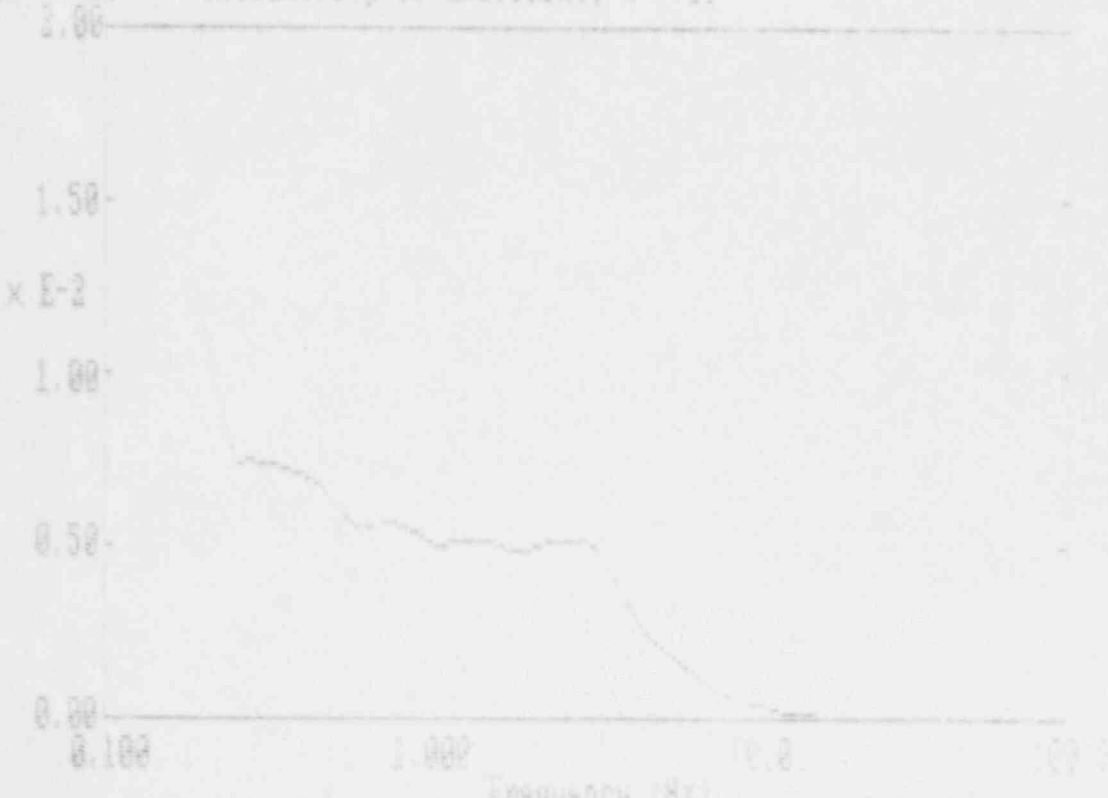
\othersub\nrc160v
Response Spectra (g)
Damping Values : .005 .020 .050 .070 .100

EDASP 1.1
09-30-1986



\othersub\nrc160v
Power Spectral Density (g**2/Hz)
Duration = 15 Probability of Exceedence = .15

EDASP 1.1
09-30-1986



Converting PSD to RS

Item numbers 4 and 5 represent conversion of PSD to response spectra (RS) and RS to PSD, respectively. As an example, it is possible to take a 5% damped acceleration response spectrum, convert it to a PSD (which is damping independent), and then convert it back to an acceleration response spectrum (or spectra) of any other damping value(s).

If the user wishes convert a PSD to a RS, type the number 4 and press (cr). The program will read the PSD from a disk file located in the designated or default subdirectory in disk drive C or any other drive designated. The program asks for the number of damping curves and sets up an instruction set such as the one shown below:

```
\othersub\nrc160v                                              EDASP 1.1
 0
                                    Converting PSD to RS
09-30-1986


        1. # of Curves           5

        2. Dampings           .005  .020  .050  .070  .100

        3. Division/Octave     16.0

        4. Prob Exceedance     0.150

        5. Duration            15.00
```

The number of damping curves has now been set by the user. Any of the other values may be changed by the user. The damping values represent the values of damping for the response spectra curves to be developed. The divisions per octave represent the discretization of the calculation. The probability of exceedance represents the possibility that an acceleration value may exceed the peak acceleration. For a random process, including an earthquake, 15% (0.15) has been found to be a reasonable value. The duration is the length of time in seconds of the input motion process.

The active function keys are as follows:

- F6 - Refresh Screen
- F8 - Print
- F10 - Start Calculation, then Return to Base Excitation Directory

The program plots the curves and asks the user whether to store the results on disk (a yes/no decision point).

Converting RS to PSD

The user must type 5 and enter (cr) in order to access this phase of the program. Converting a response spectrum to a PSD is an iterative process. The program reads the response spectra and chooses the first curve on the disk file in the designated or default subdirectory in disk drive C or designated disk drive. Another damping curve may be used by simply changing the damping value in Item 1 as shown below:

```
\othersub\nrc160v                                              EDASP 1.1
 0
                                  Converting RS to PSD
09-30-1986          1. Damping                 0.005

                    2. Division/Octave          16.0

                    3. Prob Exceedance         0.150

                    4. Duration                15.00

                    5. # of Iterations             5

                    6. Conv Tolerance          0.050

                    7. Cut-off Frequency       34.00

                    8. Rate of Decay            4.00
```

The number of frequency points is limited to ND*NO being less than 140, where ND is the number of divisions per octave and NO is the number of octaves of the frequency range, if only core memory is utilized. The probability of exceedance and duration are dictated by the same considerations previously discussed in the PSD to RS conversion.

Items 5 and 6 control the number of iterations and convergence tolerance with 0.05 representing 5%, for example. The iteration scheme does not guarantee convergence or numerical stability. As a recommendation, the user should not use too many iteration cycles or too small of a convergence factor.

The active function keys are:

- F6 - Refresh Screen
- F8 - Print
- F10 - Start Calculation, then Return to Base Excitation Directory

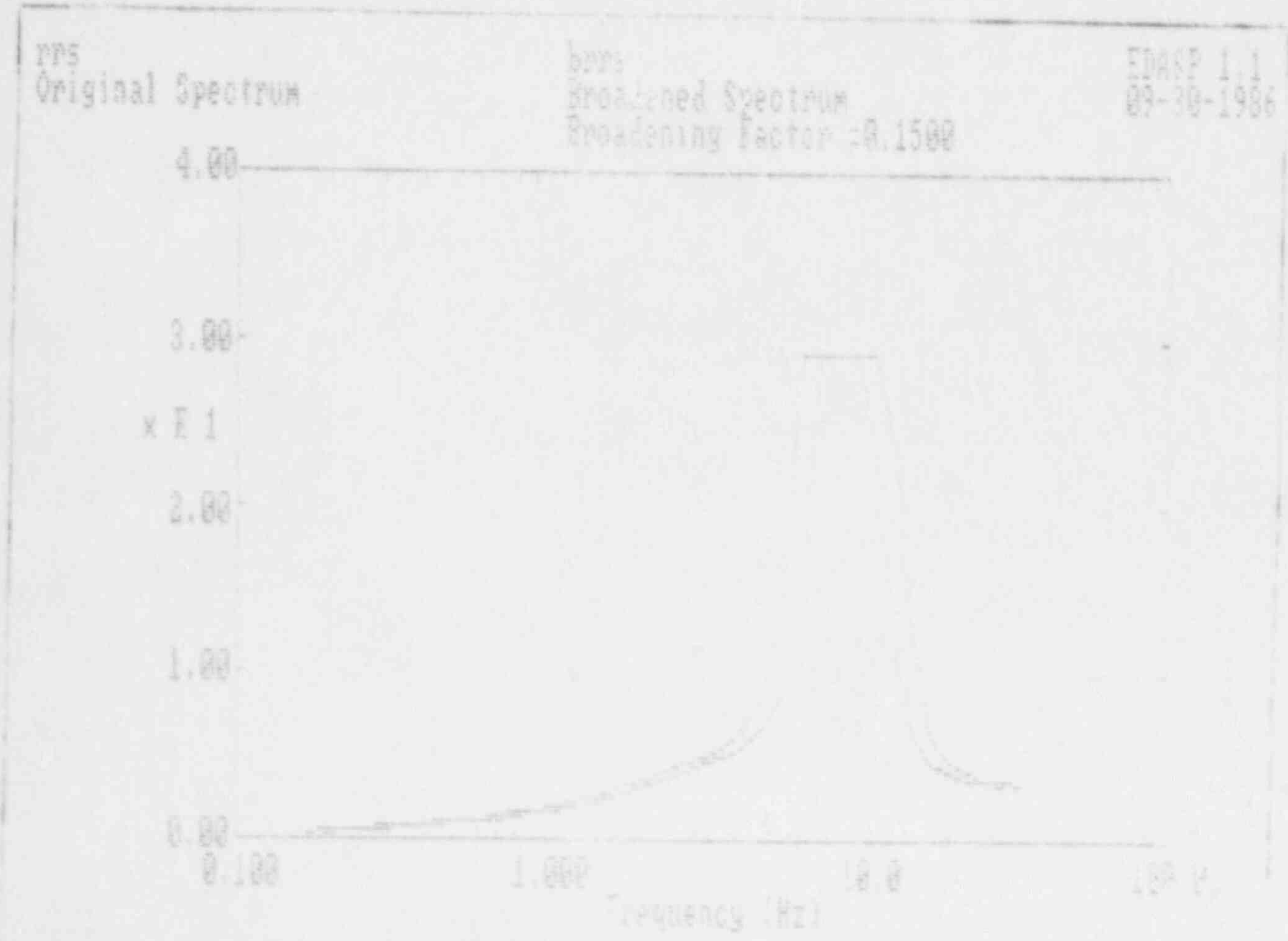
The program plots the curves and allows the user to store the results.

Spectrum Broadening

To broaden a response spectrum, enter 6 and press (cr). The name of the file to contain the broadened response spectrum is asked for. If the existing file name is supplied again, the file will be overwritten with the broadened spectrum and the original raw spectrum will be lost. After the file name for the broadened spectrum is entered, the broadening factor is asked for. The factor must be in digital form (less than 1.0). The broadening will be the same (+ and -) percentage for each data point. The raw and enveloping broadened spectrum will then be plotted on the screen as shown below for the example problem. The active function keys are:

F8 - Print Screen
F10 - Exit: Return To Base Excitation Menu

When all desired operations are completed in the base excitation module, type 7 and press (cr) to return to the main EDASP module.



Instruction Set

The instruction set directs the program as to what to do in performing the response analysis. Before any analysis is conducted, the instructions must be supplied by the user. Typing 1 and pressing (cr) will access the instruction set menu as shown below:

```
\othersub\2C13&15                                          EDASP 1.1
                                                           09-30-1986

                        Instruction Set Menu




                  1. General Parameters

                  2. ARS Frequency Points

                  3. Case Specific Parameters

                  4. Print Summary Table

                  5. Return to the Response Analysis Menu
```

The general parameters (select 1, press (cr)) are shown below:

```
\othersub\2C13&15                                          EDASP 1.1
                          General Parameters               09-30-1986


              1. X Excitation        none

              2. Y Excitation        \othersub\orc160v

              3. Z Excitation        none

              4. Damping             0.050

              5. # of ARS points       16

              6. # of Cases             3
```

2.6 RESPONSE ANALYSIS MODULE OPERATIONAL OVERVIEW

The response analysis module is accessed from the main EDASP module by typing 4 and pressing (cr). The name of the model must then be supplied. This module allows the user to "drive" the structure, that is, to conduct a response analysis of the item to a prescribed input motion.

The directory for the response analysis module is shown below:

```
\othersub\2C13615                                        EDASP 1.1
                                                         09-30-1986

                      Response Analysis Menu

                      1. Instruction Set

                      2. Time History Analysis

                      3. PSD Analysis

                      4. ARS/TRS Comparison

                      5. Return to the Main Menu




Enter Item #:
```

Items 1, 2, and 3 cover the input base excitation in the x, y, and z direction, respectively. The name of the motion file is supplied for each direction. The motion may be an acceleration history (time history) or PSD. The damping value represents the structural damping (same for all modes) for the structure. Item #5 pertains to the number of frequencies at which a response will be calculated over the frequency spectrum for the development of the acceleration response spectrum (maximum of 75 frequency points). The output motion at any point on the structure is limited to response spectrum. Output (amplified) PSD's can be obtained according to the procedure outlined on the following page. If the number zero is provided for Item 5, the seventy-five (75) recommended frequency points in accordance with USNRC Regulatory Guide 1.122 are used. Item 6, the number of cases, pertains to the total number of output spectra (discrete locations) desired. The active function keys are:

F6 - Refresh Screen
F8 - Print
F10 - Exit: Return to Instruction Set Menu

Returning to the instruction set menu (after pressing F10), the ARS Frequency Points (Item 2) pertain to the frequencies at which the response will be calculated for determining the output response spectrum. The user must supply these. If the number zero is supplied for Item 5 in the general parameters section, the seventy-five (75) recommended frequencies given in USNRC Regulatory Guide 1.122 will appear. The active function keys are:

F2 - Next Screen
F4 - Previous Screen
F6 - Refresh Screen
F8 - Print
F10 - Exit: Return to Instruction Set Menu

The number of cases (Item 3) in the instruction menu specifies for which locations (node coordinates) on the structure the response spectra will be output. The display is shown below for case No. 1:

```
[illegible]                                              EDASP 1.1
                         Case # 1                        09-30-1986


          1. ARS Name            rrs

          2. TRS Name            trs

          3. Damping             0.020

          4. Broadn'g Factor     0.150

          5. # of DOFs               2
```

The ARS name is the name the user wants to give to this output, amplified response spectrum. The TRS name is the name of an existing response spectra to which the ARS can be compared. This could be a test response spectrum for an electrical device to which the ARS being computed will be compared. The damping value is the damping of a response oscillator, not the structure damping. The broadening factor is the percentage broadening, plus and minus, of the raw response spectrum. Item 5 represents the number of points and their directional degrees-of-freedom to be enveloped. The software can envelope any, up to all, node coordinate responses and directions.

In order to specifiy the points and their associated degrees-of-freedom to be enveloped, the user must press the function key, F9. For the example problem, the responses at nodes 13 and 3 will be enveloped in their two (2) degree-of-freedom direction (y-direction) as shown below:

```
\othersub\2C13&15                                          EDASP 1.1
                          Case # 1 - DOF List              09-30-1986



                              Node #  DOF #

                          1.    13      2
                          2.     3      2
```

If the DOF # is preceded by a negative sign, this triggers a feature in the program to save the output (amplified) PSD's and copy the data to the subdirectory in disk drive C. This feature is described further in the "PSD Analysis" section. Pressing F10 will return the user to the case register main display.

The active function keys are:

F1	-	Next Case
F3	-	Previous Case
F6	-	Refresh Screen
F8	-	Print
F9	-	DOF List
F10	-	Return to Case Register Display or Exit: Return to Instruction Set Menu

After having returned to the Instruction Set Menu, the user may display and print a summary of the instruction set, as shown on the next page, by typing 4 and pressing (cr). Typing 5 and pressing (cr) returns the user to the Response Analysis Directory.

```
\othersub\2C13k15                                              EDASP 1.1
                            INSTRUCTION SET                     09-30-1986


Model damping:  .05


Base excitations:

    X Direction: none
    Y Direction: \othersub\nrc160x
    Z Direction: none


ARS frequency set (Hz.):

    0.20   0.30   0.50   0.70   0.90   1.10   1.30   1.50
    1.70   2.00   2.30   2.60   3.00   3.30   3.60   4.00
    4.40   4.80   5.25   5.75   6.25   6.75   7.25   7.75
    8.50   9.50  10.50  11.50  12.50  13.50  14.50  16.00
   18.00  22.00  28.00  31.00

Case                                          DOFs Enveloped  (Node/DOF)

   1 ARS: rrs                                 13/ 1    3/ 2
     TRS: trs
     Damping    Factor: 0.020
     Broadening Factor: 0.150


   2 ARS: rrs2                                13/ 2
     TRS: trs
     Damping    Factor: 0.020
     Broadening Factor: 0.150


   3 ARS: rrs3                                 5/ 2
     TRS: trs
     Damping    Factor: 0.020
     Broadening Factor: 0.150
```

Time History Analysis

By selecting Item 2, the program conducts an acceleration time history analysis per the instructions specified in the instruction set. The program reads the model data and the time history (input motion) data from disk drive C. The amplified (output) time histories are calculated, converted to acceleration response spectra which are stored in disk in the designated or default subdirectory or drive, and discarded. The amplified response spectra may be viewed graphically by typing 4 and pressing (cr), (ARS/TRS Comparison).

PSD Analysis

By selecting Item 3, the program conducts a psd analysis per the instructions specified in the instruction set. The program reads the model data and the input psd from disk drive C. The amplified (output) PSD's are calculated, converted to acceleration response spectra which are stored in disk in the designated or default subdirectory or drive, and discarded. As described previously in the instruction set section, if a negative sign precedes the DOF # in the DOF List, it triggers the option to save the amplified psd. This data is for each node and each directional degree of freedom which has been preceded by a negative sign only. The filenames for the output PSD's are arsname.-n, where n is the sequential order of the DOF's in the case register. These files must be renamed with an extension of .rs to be viewed. The response spectra may be viewed graphically by typing 4 and pressing (cr), (ARS/TRS comparison).

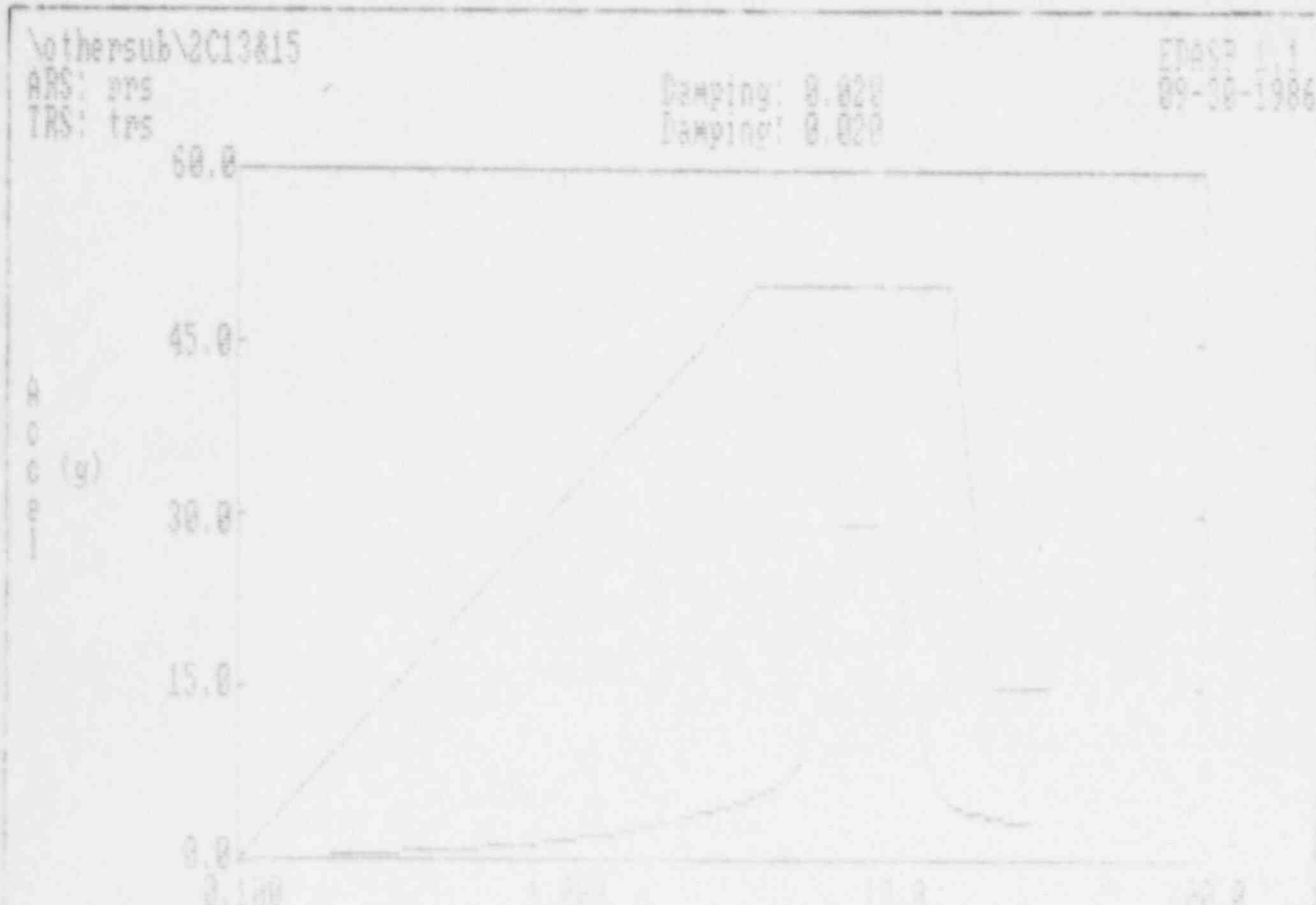
ARS/TRS Comparison

By selecting Item 4, the program will compare the amplified response spectra calculated in the previous sections to the TRS names specified in the instruction set. The software reads the ARS data and the TRS data from the designated disk or subdirectory. If the user just wants to view the ARS's, name the TRS's with the ARS names. An ARS/TRS comparison for the example problem is shown below.

The active function keys are:

- F1 - Next Comparison Case
- F3 - Previous Comparison Case
- F8 - Print Screen
- F10 - Exit: Return To Response Analysis Menu

Entering 5 and pressing (cr) returns the user to the main menu.



PART 3

FILE REGISTER

3.0 INTRODUCTION

The software creates, reads and edits six files specific to the model. They contain the dimensions of the model, coordinate geometry, lumped mass distribution, elemental connectivity, modal data and the instruction set. They are referred to as the model files. The first five are created by the Model Data Module. The instruction set file is created by the Response Analysis Module.

The base excitation data, in the form of acceleration time histories or RS/PSD are created externally. They are used by the Response Analysis Module in conducting the response analysis and they may be viewed, plotted, printed digitally and edited in the Excitation Module.

The general structure of the files is discussed in the next section. Creating/Editing a file external to the program is also discussed in this part. Finally, the specific structure of each file created and used by the program is presented.

3.1 GENERAL FILE STRUCTURE

All data files are formatted in free format. The data is written and read consecutively (that is, in order). Individual data is separated either by a comma, space, or carraige return. Data may be entered using all of a line or one entry per line.

3.2 CREATING/EDITING A FILE

The model data files, including the instruction set, are created by the software package. The base excitation files must be created initially by the user externally. All files may be edited through the software package.

The base excitation files may be created when the microcomputer is in the system mode by calling up the line editor. The user types in edlin, one space, and the file name of the excitation file. The data required may then be entered in free format in accordance with the file structure specified format.

For more information on the use of the line editor, refer to the computer system instruction manual.

3.3 EDASP FILE FORMATS

The following files represent all of the files created and used by the EDASP program.

Variable Name Key

NNODE = no. of nodes
NELM = no. of elements
NMODE = no. of modes
DOFX = degree of freedom in X-translational direction
DOFY = degree of freedom in Y-translational direction
DOFZ = degree of freedom in Z-translational direction
DOFRX = rotational degree of freedom about X-axis
DOFRY = rotational degree of freedom about Y-axis
DOFRZ = rotational degree of freedom about Z-axis
X = geometric X-coordinate value
Y = geometric Y-coordinate value
Z = geometric Z-coordinate value
MASSX = mass value in X-translational direction
MASSY = mass value in Y-translational direction
MASSZ = mass value in Z-translational direction
MASSRX = rotational mass value about X-axis
MASSRY = rotational mass value about Y-axis
MASSRZ = rotational mass value about Z-axis
NODEI = i-node of element
NODEJ = j-node of element
F = frequency value in Hz
GM = generalized mass value
PF = participation factor value
MS = mode shape amplitude
MD = model damping
NRS = no. of points in response spectrum
NC = no. of cases
OD = oscillator damping
BF = broadening factor
NDOF = no. of degrees of freedom to be enveloped
NN = node no.
DOF = directional degree of freedom
NTH = no. of points in a time history
T = time step
NPSD = no. of points in a PSD
NDC = no. of damping cases
D = damping
RS = response spectrum amplitude
DU = duration
PEX = probability of exceedance
PSD = psd value

Model Files

modelname.DIM

NNODE, NELM, dummy value, NMODE, DOFX, DOFY, DOFZ, DOFRX, DOFRY, DOFRZ

A zero entry signifies an inactive DOF and an entry of 1 signifies the DOF is active.

modelname.CRD

NNODE,
[X(I), Y(I), Z(I), I = 1 to NNODE]

modelname.MAS

NNODE,
[MASSX(I), MASSY(I), MASSZ(I), MASSRX(I), MASSRY(I), MASSRZ(I),
I = 1 to NNODE]

If the degree of freedom is inactive, the program does not expect to read any data entry for this degree of freedom. In other words, if only two degrees of freedom are active, the program expects to read two data entries per coordinate point.

modelname.ELM

NELM,
[NODEI(I), NODEJ(I), I = 1 to NELM]

modelname.MOD

NMODE, NNODE, DOFX, DOFY, DOFZ, DOFRX, DOFRY, DOFRZ,
[F(I), I = 1 to NMODE]
[GM(I), I = 1 to NMODE]
[[PF(I,J), J=1 to DOF],I=1 to NMODE]
[[[MS(I,J,K),K=1 to DOF], J=1 to NNODE], I=1 to NMODE]

Note: DOF *is the no. of* ***translational*** *degrees of freedom that are active.*

APPENDIX

PARAMETER DEFINITIONS

Parameter Definitions

This section provides a description of some of the terms used in the program and general terms with which the user should be familiar.

Floor Acceleration. The acceleration of a particular building floor (or equipment mounting) resulting from the motion of a given earthquake or other forcing function. The maximum floor acceleration is the ZPA of the floor response spectrum.

Fourier Spectrum. The Fourier spectrum is a complex valued function that results from the Fourier transform of a time domain waveform.

Natural Modeshape. The extremum of each point on the structure in harmonic motion at the same instant of time at the characteristic frequency.

Natural Frequency. The frequency or frequencies at which a body vibrates due to its own physical characteristics (mass and stiffness) brought into play when the body is distorted in a specific direction and then released.

Octave. The interval between two frequencies which have a frequency ratio of two.

Power Spectral Density (PSD). The mean squared acceleration per unit frequency of a waveform. PSD is usually expressed in g squared per hertz vs frequency.

Required Response Spectrum (RRS). The required response spectrum or amplified response spectrum is the output (demand) response spectrum at a point on the structure.

Response Spectrum. A plot of the maximum response, as a function of oscillator frequency, of an array of single-degree-of-freedom (SDOF) damped oscillators subjected to the same base excitation.

Test Response Spectrum (TRS). The response spectrum that is constructed using response spectrum analysis equipment from the actual time history of the shake table. It generally represents the actual functional threshold of a device or component.

NOTE: When qualifying devices in a panel, the device is qualified by utilizing response spectra, the TRS is to be compared to the RRS.

Transfer Function. The transfer function is a complex frequency response function which defines the dynamic characteristics of a constant parameter linear system. For an ideal system, the transfer function is simply the ratio of an output to a given input. When the output-input ratio is dimensionless, this particular frequency response function is often called a transmissibility function.

Zero Period Acceleration. The high frequency acceleration level of the non-amplified portion of the response spectrum is referred to as Zero Period Acceleration, or generally called ZPA. The acceleration corresponds to the maximum peak acceleration of the time history used to derive the spectrum.