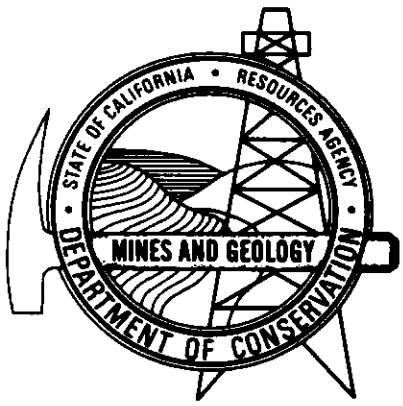
# STANDARD TAPE FORMAT FOR CSMIP STRONG-MOTION DATA TAPES


CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY
OFFICE OF STRONG MOTION STUDIES
REPORT OSMS 85-03

# STANDARD TAPE FORMAT

# FOR CSMIP STRONG-MOTION DATA TAPES

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December 1985

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# INTRODUCTION

Strong-motion accelerograms recorded in structures and at ground-response stations are routinely digitized and processed for subsequent analyses by seismological and engineering researchers. The processed data are distributed on magnetic tapes written in a standard format.

The standard tape format described here is an extension of the format originally used for the accelerogram computer tapes distributed by the California Institute of Technology in the early 1970s (Hudson, Trifunac and Brady, 1970 to 1975). The Caltech format (Trifunac and Lee, 1973) was extended somewhat in a series of tapes distributed by the University of Southern California in the late 1970s (Trifunac and Lee, 1979) primarily through the addition of more variable fields. The major differences between the Caltech/USC format and the format described here result from differences in modern instrumentation practice. For example, an additional field is needed for time-of-triggering, frequently known for contemporary accelerograms. In addition, data from remote-sensor structural accelerograph systems require a field describing the location of the sensor in the structure.

## Components of Processed Data

The digitization and processing of accelerograms involves certain products. The first product is the raw digitized accelerogram, defined by time/acceleration pairs, [t(i),a(i)]. These data have come to be called "Volume 1" data, and more recently, "Phase 1" data.

The second product, called "Volume 2" or "Phase 2", includes the processed acceleration, velocity, and displacement time histories. The processed acceleration is obtained from the raw acceleration through correction for instrument-response and baseline effects, followed by low- and high-pass filtering. The velocity and displacement time histories are subsequently

obtained through numerical integration, with additional filtering as necessary.

The third product, called "Volume 3", is composed of spectral information computed from the accelerogram. The response spectra values are given at up to 91 periods ranging from 0.04 to 15.0 seconds, for five values of damping (0, 2, 5, 10 and 20% of critical). The response spectra computed include PSV, Sa, Sv, and Sd. Besides the spectral values, the times associated with each response spectral maximum are included. Fourier amplitude spectral values are also given at each of the periods.

A computer tape written by CSMIP for distribution typically contains the data and processing results for a set of accelerograms from a particular earthquake. The tape contains the set of Volume 1 files for the accelerograms, followed by the corresponding set of Volume 2 files, followed by the set of Volume 3 files. For example, if 20 accelerograms were digitized for an earthquake, there would be 20 + 20 + 20 = 60 files on the tape.

Each file contains the results for all of the components or channels of an accelerogram (3 for a triaxial recorder, up to 13 for a central recorder). The data for all components for the first accelerogram would be in file numbers 1, 21, and 41. To keep the number of files and the length of the tape manageable, the data may be written onto two tapes, one containing just the Volume 1 data, and the other containing the Volume 2 and 3 data. The table-of-contents provided with the tape as well as the name of the tape will reflect this.

## VOLUME 1 FILE FORMAT

A Volume 1 file contains data for all of the channels on an accelerogram. For each channel, the following information is given:

1. Text header, alphanumeric
2. Integer header
3. Real-value header
4. Digitized data (times and accelerations)
5. End-of-data mark

These five elements (three headers, the data, and an end flag) are then followed by the same five elements for the next channel. The integer header is used to store values which are integers by nature, while the real-value header contains values most appropriately stored as floating-point numbers. The text header contains, in addition to alphabetic information such as names and labels, many of the values contained in the other headers. The text header is thus a relatively complete description of the record characteristics; it is meant to be conveniently readable by an individual as well as a computer.

The contents of the three headers are described on the following pages. A sample program which illustrates reading the headers and the data using standard Fortran is given after the header descriptions. A listing of an actual Vol. 1 header follows the sample program.

VOLUME 1 TEXT HEADER (TXTHDR)

The text header occupies 13 lines of alphanumeric data, which are the first 13 lines of the information for a given channel.

| Line | Column | Description |
|---|---|---|
| 1 | 1-80 | Vol. 1 title line, which includes processing date and directory identifier |
| 2 | 1-40 | Earthquake name (actual no. of characters used in name is element 29 of integer header array, IHDR) |
| 3 | 1-40 | Earthquake date, time (local time) |
| | 41-80 | Origin time (GMT) |
| 4 | 1-24 | Accelerogram identification number |
| | 36-77 | Trigger time for the accelerogram (GMT), if available |
| 5 | 13-17 | Station number |
| | 21-27 | Station latitude; N or S in column 27 |
| | 30-37 | Station longitude; E or W in column 37 |
| | 40-47 | Instrument type (for example, SMA, RFT, CRA, etc.) |
| | 54-57 | Instrument serial number |
| | If other than a single triaxial instrument at this station, then: | |
| | 60-61 | Number of channels on this accelerograph |
| | 71-72 | Total number of channels at station (if different) |
| 6 | 1-40 | Station name (actual no. of characters used in name is element 30 of integer header IHDR). |
| 7 | 6-7 | Accelerogram channel number of this component |
| | 10-13 | If horizontal component, azimuth (0-360, measured clockwise from North, in cols 10-12); if vertical component, 'UP ' or 'DOWN'. (* Also, see note on following page.) |
| | 29-30 | Station channel number, if multi-instrument station |
| | 47-80 | Description of sensor location in structure, when appropriate |
| 8 | 1-80 | Earthquake title line, including name and date (actual no. of characters used in title line is element 31 of IHDR) |
| 9 | 1-45 | Earthquake hypocenter information (latitude, longitude, depth) |
| | 46-80 | Earthquake magnitude information |
| 10 | 15-21 | Transducer natural period (seconds) |
| | 39-43 | Damping (fraction of critical) |
| | 60-64 | Sensitivity (Cols 66-72: units, typically cm/g) |
| 11 | 17-22 | Number of data points in digitized record (Vol. 1 data) |
| | 40-46 | Length in seconds of digitized record |
| 12 | 1-40 | Units of data, typically seconds and g/10 |
| | 51-56 | Maximum acceleration value, Vol. 1 (in g) |
| | 64-70 | Time of maximum value (seconds after trigger) |
| 13 | 31-36 | RMS acceleration of entire digitized record |

VOLUME 1 INTEGER HEADER (IHDR)

The integer-value header is a 100-element integer array, written in lines 14-20 of the header information for a given channel (in format 16I5). Only the first 32 of the array elements are currently used, as described in the following.

| Line | Array Element | Description |
|---|---|---|
| 14 | 1 | Accelerogram channel number |
| | 2 | 1, not used |
| | 3 | Station channel number (same as element 1 if there is only one instrument at the station) |
| | 4 | Number of channels on accelerogram |
| | 5 | Total number of channels at station |
| | 6 | 0, not used |
| | 7 | Shock number (1 unless more than one earthquake per trigger) |
| | 8 | 1 (indicates that a direct-copy negative was the digitized medium, true for the CSMIP system) |
| | 9-16 | 0, not used |
| 15 | 17-26 | 0, not used |
| | 27 | Orientation of sensor for this channel (azimuth clockwise from North, 0-360 for horizontal sensor. For vertical sensor, 500=Up, 600=Down) * |
| | 28 | Number of digitized acceleration data points |
| | 29 | Number of letters in earthquake name (line 2 of TXTHDR) |
| | 30 | Number of letters in station name (line 6 of TXTHDR) |
| | 31 | Number of letters in earthquake title line (line 8 of TXTHDR) |
| | 32 | Azimuth of Reference North of the structure, clockwise from true North; 0, for a free-field record ** |
| 16 | 33-48 | 0, not used |
| 17 | 49-64 | 0, not used |
| 18 | 65-80 | 0, not used |
| 19 | 81-96 | 0, not used |
| 20 | 97-100 | 0, not used |

Notes: * For a structure, sensor azimuth is given relative to the Reference North for the structure. In all cases, the orientation given corresponds to positive (+y) motion on the record.

** For example, if a structure's Reference North is aligned 18 degrees clockwise from (true) North, and a sensor is aligned East with respect to the structure's reference direction, then IHDR(32)=18 and IHDR(27)=90 (though the sensor is oriented at 108 degrees from true North). (This element is not used for records digitized by CSMIP before October, 1985.)

VOLUME 1 REAL-VALUE HEADER (RHDR)

The real-value header is a 50 element array, written in lines 21-27 of the header (in format 8F10.3). Only the first 16 elements of the array are currently used, as described below. (Elements 10-16 in the following are defined specifically for digitization by CSMIP.)

| Line | Array Element | Description |
|---|---|---|
| 21 | 1 | Natural period of transducer (seconds) |
| | 2 | Damping of transducer (fraction of critical) |
| | 3 | Length of digitized record (in seconds) |
| | 4 | RMS value of digitized record (in g) |
| | 5 | Units of digitized acceleration in file (fractions of g), typically 0.10 |
| | 6 | Sensitivity of transducer (cm/g) |
| | 7 | Peak acceleration for this component (in g) |
| | 8 | Time of peak acceleration value (seconds after trigger) |
| 22 | 9 | Natural frequency of transducer (in Hz) |
| | 10 | Digitizer y-step (acceleration) size, in microns (cm/10000) |
| | 11 | Digitizer y-step size, in milli-g |
| | 12 | Digitizer x-step (time) size, in microns (cm/10000) |
| | 13 | Actual average time step of digitized record, in milliseconds |
| | 14 | Standard deviation of time step, in milliseconds |
| | 15 | Minimum time step size, as digitized (milliseconds) |
| | 16 | Maximum time step size, as digitized (milliseconds) |
| 23 | 17-24 | 0.0, not used |
| 24 | 25-32 | 0.0, not used |
| 25 | 33-40 | 0.0, not used |
| 26 | 41-48 | 0.0, not used |
| 27 | 49-50 | 0.0, not used |

SAMPLE FORTRAN CODE FOR READING A VOLUME 1 FILE

A Volume 1 file with its headers and data can be read using the following Fortran code, which is standard Fortran IV. (If Fortran 77 were used the text header could be read into a character variable instead of an integer array, making subsequent character operations easier.)

```
      INTEGER IHDR(100), TXTHDR(40,13), ENDCHN
      REAL RHDR(50), T(5000),A(5000)
      DATA MAXPTS/5000/
C
C  --- READ THE HEADERS: TXTHDR, IHDR AND RHDR ---
      READ(LUVOL1,100) ((TXTHDR(IWRD,LINE), IWRD=1,40), LINE=1,13)
      READ(LUVOL1,200) (IHDR(I), I=1,100)
      READ(LUVOL1,300) (RHDR(I), I=1,50)
  100 FORMAT(40A2)
  200 FORMAT(16I5)
  300 FORMAT(8F10.3)
  400 FORMAT(10F7.3)
C
C  --- READ THE DATA POINTS (TIME AND ACCELERATION) ---
      NPTSV1 = IHDR(28)
      IF(NPTSV1 .GT. MAXPTS) STOP 1
      READ(LUVOL1,400) (T(I),A(I), I=1,NPTSV1)
C
C  --- READ THE END-OF-CHANNEL FLAG ---
      READ(LUVOL1,100) ENDCHN
      IF(ENDCHN .NE. '/&') STOP 2
```

==========

Notes:

```
          LUVOL1 = Fortran logical unit number for the Vol. 1 file,
                   previously opened.
   TXTHDR(40,13) = 13 lines of text header, 40 two-character words
                   each line
       IHDR(100) = 7 lines of integer header values

        RHDR(50) = 7 lines of real header values

 T(5000),A(5000) = digitized times and accelerations.  Dimension of arrays
                   (MAXPTS) must be adequate for number of points
                   (IHDR(28));  alternatively, the program could read
                   in a portion of the data at a time.
          ENDCHN = end-of-channel flag, which follows the data.
```

SAMPLE VOLUME 1 FILE LISTING:

```
UNCORRECTED ACCELEROGRAM DATA                    PROCESSED:  2/25/83, CDMG EQML8015
MAMMOTH LAKES EARTHQUAKE
MAY 27, 1980 07:51 PDT                    (ORIGIN(USGS): 05/27/80, 14:50:57.2 GMT)
54214-S3505-80148.07                    TRIGGER TIME: 05/27/80, 14:51:00.9 GMT
STATION NO. 54214   37.588N, 118.705W     SMA-1  S/N 3505 ( 3 CHNS OF 22 AT STA)
LONG VALLEY DAM (UPPER LEFT ABUT.)
CHAN  1:  90 DEG  (STA CHN: 17)
MAMMOTH LAKES EARTHQUAKE    MAY 27, 1980 07:51 PDT
HYPOCENTER(USGS): 37.506N,118.826W, H=14KM.  ML=6.2(BRK).
INSTR PERIOD =  .0398 SEC,  DAMPING =  .570,  SENSITIVITY = 1.83 CM/G.
NO. OF POINTS =  13001  RECORD LENGTH = 64.997 SEC
UNITS OF UNCOR ACCEL ARE SEC AND G/10.     MAX  =  -.398 G, AT   5.359 SEC.
RMS ACCEL OF COMPLETE RECORD =  .036 G.
    1    1   17    3   22    0    1    1    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0 9013001   24   34   50    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0
      .040       .570     64.997       .036       .100      1.830      -.398      5.359
    25.100     50.000      2.732     50.000      4.999       .069      1.190      5.286
      .000       .000       .000       .000       .000       .000       .000       .000
      .000       .000       .000       .000       .000       .000       .000       .000
      .000       .000       .000       .000       .000       .000       .000       .000
      .000       .000       .000       .000       .000       .000       .000       .000
      .000       .000
   .000  .002   .005   .002   .010   .016   .015   .030   .020   .045
   .025  .045   .030   .045   .035   .047   .040   .060   .045   .061
   .050  .047   .055   .020   .060  -.007   .065  -.034   .070  -.047
          ..
         .... Points of T(i), A(i) ...
          ..
 59.985  -.033 59.990  -.033 59.995  -.019 60.000  -.006 60.005  -.006
/&  ----------  END OF DATA FOR CHANNEL  1  ----------


       ..
       ..
  (Header, etc for next channel)
       ..
       ..
```

## VOLUME 2 FILE FORMAT

A Volume 2 file contains the instrument and base-line corrected data corresponding to the data in a Vol. 1 file. For each of the channels, the file has three headers, followed by the acceleration time series, the velocity time series, and the displacement time series. Specifically, the elements of a Vol. 2 file, for each channel, are:

1. Text header, alphanumeric
2. Integer header
3. Real-value header
4. Acceleration data-start line
5. Acceleration data, equal time spacing
6. Velocity data-start line
7. Velocity data, equi-spaced
8. Displacment data-start line
9. Displacement data, equi-spaced.
10. End-of-data flag

These 10 elements are then repeated for the next channel. Similar to the Vol. 1 headers, the text header contains the most information and is best for scanning by an investigator. Portions of the Vol. 2 headers are the same as the corresponding Vol. 1 headers; thus, complete information about the Vol. 1 processing, etc. can be obtained from the Vol. 2 header without having to read the Vol. 1 file.

Each of the headers is described on the following pages. These descriptions are followed by a sample Fortran program for reading a Volume 2 file, and by an actual listing of a complete header.

VOLUME 2 TEXT HEADER (TXTHDR)

The text header occupies 25 lines of alphanumeric data, which are the first 25 lines of the information for a given channel. The contents of each line are given in the following. (Lines 2 through 11 are identical to lines 1 through 10, respectively, of the Volume 1 text header.)

| Line | Column | Description |
|---|---|---|
| 1 | 1-80 | Vol. 2 title line, which includes record identifier and channel identification |
| 2 | 1-80 | Vol. 1 title line, which includes processing date and directory identifier |
| 3 | 1-40 | Earthquake name (actual number of characters used in name is element 29 of integer header array, IHDR) |
| 4 | 1-40 | Earthquake date, time (local time) |
| | 41-80 | Earthquake origin time (GMT) |
| 5 | 1-24 | Accelerogram identification number |
| | 36-77 | Trigger time (GMT), if available |
| 6 | 13-17 | Station number |
| | 21-27 | Station latitude; N or S in column 27 |
| | 30-37 | Station longitude; E or W in column 37 |
| | 40-47 | Instrument type (e.g., SMA, RFT, CRA) |
| | 54-57 | Instrument serial number |
| If other | | than a single triaxial instrument at this station, then: |
| | 60-61 | Number of channels on this accelerograph |
| | 71-72 | Total number of channels at station (if different) |
| 7 | 1-40 | Station name (actual number of characters used in name is element 30 of integer header IHDR). |
| 8 | 6-7 | Accelerogram channel number of this component |
| | 10-14 | If horizontal component, azimuth (0-360, measured clockwise from North, in cols 10-12); if vertical component, 'UP ' or 'DOWN'. (* Also see note for IHDR(27).) |
| | 29-30 | Station channel number, if multi-instrument station |
| | 47-80 | Description of sensor location in structure, when appropriate |
| 9 | 1-80 | Earthquake title line, including name and date (actual no. of characters used in title line is element 31 of IHDR) |
| 10 | 1-45 | Earthquake hypocenter information (latitude, longitude, depth) |
| | 46-80 | Earthquake magnitude (ML; other magnitudes may also be listed) |
| 11 | 15-21 | Transducer natural period (seconds) |
| | 39-43 | Damping (fraction of critical) |
| | 60-64 | Sensitivity (Cols 66-72: Units, typically cm/g) |
| 12 | 40-46 | Length in seconds of Vol. 2 digitized record |

| | | |
|---|---|---|
| 13 | 51-55<br>64-70 | Vol. 1 peak acceleration (g)<br>Time of peak acceleration (seconds after triggering) |
| 14 | 31-36 | RMS of Vol. 1 acceleration (g) |
| 15 | 1-80 | Frequency limits used in the band-pass filtering |
| 16 | 1-6 | Number of Vol. 2 acceleration, velocity and displacement points |
| 17 | 1-45 | Time step of Vol. 2 data (equally-spaced) |
| 18 | 1-64 | Value and time of Vol. 2 peak acceleration (time, in seconds after triggering) |
| 19 | 1-64 | Value and time of peak velocity |
| 20 | 1-64 | Value and time of peak displacement |
| 21 | 1-78 | Initial velocity and displacement (computed during processing) |
| 22 | 1-80 | Earthquake name (same as line 9, or line 8 of Vol. 1 header) |
| 23 | - | Blank |
| 24 | 1-80 | Titling line, used for plot titling |
| 25 | - | Blank, or additional plot titling if needed. |

VOLUME 2 INTEGER HEADER (IHDR)

The integer-value header is a 100-element integer array, written in lines 26-32 of the header information for a given channel (in format 16I5). Only the first two-thirds of the array elements are now used, as described in the following. (Elements 1-50 are identical to those of the Volume 1 integer header.)

| Line | Array Element | Description |
|---|---|---|
| 26 | 1 | Accelerogram channel number |
| | 2 | 1, not used |
| | 3 | Station channel number (same as element 1 if there is only one instrument at the station) |
| | 4 | Number of channels on accelerogram |
| | 5 | Total number of channels at station |
| | 6 | 0, not used |
| | 7 | Shock number (1 unless more than one earthquake per trigger) |
| | 8 | 1, indicating that a direct-copy negative was digitized medium |
| | 9-16 | 0, not used |
| 27 | 17-26 | 0, not used |
| | 27 | Orientation of sensor for this channel. For horizontal sensor, value is azimuth, measured clockwise from North, 0-360 degrees. For vertical sensor, 500=Up, 600=Down. (* See note below) |
| | 28 | Number of digitized acceleration data points |
| | 29 | Number of letters in earthquake name (line 3 of TXTHDR) |
| | 30 | Number of letters in station name (line 7 of TXTHDR) |
| | 31 | Number of letters in earthquake title line (line 9 of TXTHDR) |
| | 32 | Azimuth of Reference North of the structure, clockwise from true North; 0, for a free-field accelerogram ** |
| 28 | 33-48 | 0, not used |
| 29 | 49-50 | 0, not used |
| | 51,52 | Number of digitized acceleration data points, same as IHDR(28) |
| | 53 | Number of Vol. 2 acceleration data points |
| | 54 | First decimation factor in processing (typically 4) |
| | 55 | Decimation factor for long-period filtering of accelerations (typically 10) |
| | 56 | Half-length of filter operator in BAS |
| | 57 | 0, not used |
| | 58 | 0, not used |
| | 59 | Number of letters in earthquake title, same as IHDR(31), for plotting |
| | 60 | Number of letters for plotting station name |
| | 61 | Decimation factor for long-period filtering of velocity (typically 10) |
| | 62 | Decimation factor for long-period filtering of displacement (typically 10) |
| | 63 | 0, not used |
| | 64 | Number of velocity points |

| | | |
|---|---|---|
| 30 | 65 | 0, not used |
| | 66 | Number of displacement points |
| | 67-80 | 0, not used |
| 31 | 81-96 | 0, not used |
| 32 | 97-100 | 0, not used |

Notes: * For a structure, sensor azimuth is given relative to Reference North for the structure. In all cases, the orientation given corresponds to positive (+y) motion on the record.

** For example, if a structure's Reference North is aligned 18 degrees clockwise from (true) North, and a sensor is aligned East with respect to the structure's reference, then IHDR(32)=18 and IHDR(27)=90 (though the sensor is oriented at 108 degrees from true North).

VOLUME 2 REAL-VALUE HEADER (RHDR)

The real-value header is a 100-element floating-point array, written in lines 33-45 of the header (in format 8F10.3). Only the first 76 elements of the array are now used, as described in the following. (Elements 1-50 are the same as the corresponding elements in the Vol. 1 header. Elements 10-16 are defined specifically for digitization by CSMIP.)

| Line | Array Element | Description |
|---|---|---|
| 33 | 1 | Natural period of transducer (seconds) |
| | 2 | Damping of transducer (fraction of critical) |
| | 3 | Length of digitized record (in seconds) |
| | 4 | RMS value of digitized record (in g) |
| | 5 | Units of digitized acceleration in file (fractions of g, typically 0.10) |
| | 6 | Sensitivity of transducer (cm/g) |
| | 7 | Peak acceleration (Vol.1) for this component (in g) |
| | 8 | Time of peak acceleration value (seconds after trigger) |
| 34 | 9 | Natural frequency of transducer (in Hz) |
| | 10 | Digitizer y-step (acceleration) size, in microns (cm/10000) |
| | 11 | Digitizer y-step size, in milli-g |
| | 12 | Digitizer x-step (time) size, in microns (cm/10000) |
| | 13 | Actual average time step of digitized record, in milliseconds |
| | 14 | Standard deviation of time step, in milliseconds |
| | 15 | Minimum time step size, as digitized (milliseconds) |
| | 16 | Maximum time step size, as digitized (milliseconds) |
| 35 | 17-24 | 0.0, not used |
| 36 | 25-32 | 0.0, not used |
| 37 | 33-40 | 0.0, not used |
| 38 | 41-48 | 0.0, not used |
| 39 | 49-51 | 0.0, not used |
| | 52 | Scaling factor for converting acceleration from g/10 to cm/sec/sec (98.0665) |
| | 53 | Time step of Vol. 2 equally-spaced interpolation (sec) |
| | 54 | Length of interpolated Vol. 2 acceleration (secs) |
| | 55 | Natural frequency of transducer (radians/sec) |
| | 56 | 0.0, not used |
| 40 | 57 | 0.0, not used |
| | 58 | Terminal frequency of high-frequency filter (Hz) |
| | 59 | Roll-off width of high-frequency filter (Hz) |
| | 60 | Length of Vol. 2 output after resampling to sampling interval given in RHDR(53) |
| | 61 | Time step of Vol. 2 output (sec) |
| | 62 | Roll-off corner frequency of long-period filter (Hz) |
| | 63 | Roll-off width of long-period filter (Hz) |
| | 64 | 0.0, not used |

| | | |
|---|---|---|
| 41 | 65 | Time of peak acceleration (Vol. 2), seconds |
| | 66 | Peak acceleration value (Vol. 2), cm/sec/sec |
| | 67 | Time of peak velocity (sec) |
| | 68 | Peak velocity (cm/sec) |
| | 69 | Time of peak displacement (sec) |
| | 70 | Peak displacement (cm) |
| | 71 | Initial velocity value (cm/sec) |
| | 72 | Same as RHDR(62) |
| 42 | 73 | Roll-off corner frequency of high-frequency filter (Hz) |
| | 74 | Velocity time step (sec) |
| | 75 | Displacement time step (sec) |
| | 76 | Initial displacement (cm) |
| | 77-80 | 0.0, not used |
| 43-45 | 81-100 | 0.0, not used |

EXAMPLE FORTRAN CODE FOR READING A VOLUME 2 FILE

A file can be read as follows (an example using Fortran IV):

```
      INTEGER IHDR(100), TXTHDR(40,25), ENDCHN
      REAL RHDR(100), A(3000), V(3000), D(3000)
C
C  --- READ HEADERS ---
      READ(LUVOL2,100) ((TXTHDR(IWRD,LINE), IWRD=1,40), LINE=1,25)
      READ(LUVOL2,200) (IHDR(I), I=1,100)
      READ(LUVOL2,300) (RHDR(I), I=1,100)
  100 FORMAT(40A2)
  200 FORMAT(16I5)
  300 FORMAT(8F10.3)
  400 FORMAT(I5)
C
C  --- READ THE ACCELERATION, VELOCITY AND DISPLACEMENT ---
      READ(LUVOL2,400) NPTSA
      READ(LUVOL2,300) (A(I), I=1,NPTSA)
C
      READ(LUVOL2,400) NPTSV
      READ(LUVOL2,300) (V(I), I=1,NPTSV)
C
      READ(LUVOL2,400) NPTSD
      READ(LUVOL2,300) (D(I), I=1,NPTSD)
C
C  --- READ THE END-OF-DATA FLAG FOR THIS CHANNEL, WHICH SHOULD BE HERE ---
      READ(LUVOL2,100) ENDCHN
      IF(ENDCHN .NE. '/&') STOP 1
```

==========

Notes:

LUVOL2 = FORTRAN logical unit number for the Vol. 2 file, assumed to be previously opened

TXTHDR(40,25) = 25 lines of text headers, 40 2-character words per line

IHDR(100) = 7 lines of integer headers

RHDR(100) = 13 lines of real-value headers

NPTSA,NPTSV,NPTSD = number of acceleration, velocity, displacement data points (these values could also be obtained from IHDR array: NPTSA=IHDR(53), NPTSV=IHDR(64), and NPTSD=IHDR(66))

A(3000),V(3000),D(3000) = arrays for Vol. 2 acceleration, velocity, and displacement. Dimensions of these arrays have to be sufficient for the actual number of data points.

ENDCHN = End-of-data mark for this channel (a "/&" flag is used)

SAMPLE VOLUME 2 FILE LISTING

```
CORRECTED ACCELEROGRAM   54214-S3505-80148.07       CHAN  1:  90 DEG     FROM
UNCORRECTED ACCELEROGRAM DATA                  PROCESSED:  2/25/83, CDMG EQML8015
MAMMOTH LAKES EARTHQUAKE
MAY 27, 1980 07:51 PDT                    (ORIGIN(USGS): 05/27/80, 14:50:57.2 GMT)
54214-S3505-80148.07                   TRIGGER TIME: 05/27/80, 14:51:00.9 GMT
STATION NO. 54214   37.588N, 118.705W     SMA-1  S/N 3505 ( 3 CHNS OF 22 AT STA)
LONG VALLEY DAM (UPPER LEFT ABUT.)
CHAN  1:  90 DEG  (STA CHN: 17)
MAMMOTH LAKES EARTHQUAKE    MAY 27, 1980 07:51 PDT
HYPOCENTER(USGS): 37.506N,118.826W, H=14KM.  ML=6.2(BRK).
INSTR PERIOD =  .0398 SEC,  DAMPING =  .570,  SENSITIVITY = 1.83 CM/G.
                        RECORD LENGTH = 64.980 SEC.
                                      UNCOR MAX  =  -.398 G, AT   5.359 SEC.
RMS ACCEL OF (UNCOR) RECORD  =  .036 G.
ACCELEROGRAM BANDPASS FILTERED WITH RAMPS AT  .100- .250 AND 23.00-25.00 CYC/SEC
  3250 POINTS OF INSTRUMENT- AND BASELINE-CORRECTED ACCEL, VELOC AND DISPL DATA
AT EQUALLY-SPACED INTERVALS OF    .020  SEC.
PEAK ACCELERATION =   342.365    CM/SEC/SEC  AT    4.980   SEC.
PEAK   VELOCITY   =   -34.189      CM/SEC    AT    5.560   SEC.
PEAK DISPLACEMENT =     6.177        CM      AT    5.340   SEC.
INITIAL VELOCITY  =      .323   CM/SEC;   INITIAL DISPLACEMENT =    -.195   CM
MAMMOTH LAKES EARTHQUAKE    MAY 27, 1980 07:51 PDT

54214-S3505-80148.07      LONG VALLEY DAM (UPPER LEFT ABUT.)    CHAN  1:  90 DEG

    1    1   17    3   22    0    1    1    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0 9013001   24   34   50    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    01300113001 3250    4   10   10    0    0   50   80   10   10    0 3250
    0 3250    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0
      .040      .570    64.997      .036      .100     1.830     -.398     5.359
    25.100    50.000     2.732    50.000     4.999      .069     1.190     5.286
      .000      .000      .000      .000      .000      .000      .000      .000
      .000      .000      .000      .000      .000      .000      .000      .000
      .000      .000      .000      .000      .000      .000      .000      .000
      .000      .000      .000      .000      .000      .000      .000      .000
      .000      .000      .000    98.067      .005    64.997   157.708      .000
      .000    25.000     2.000    64.980      .020      .250      .150      .000
     4.980   342.365     5.560   -34.189     5.340     6.177      .323      .250
    23.000      .200      .200     -.195      .000      .000      .000      .000
      .000      .000      .000      .000      .000      .000      .000      .000
      .000      .000      .000      .000      .000      .000      .000      .000
      .000      .000      .000      .000
 3250 POINTS OF ACCEL DATA EQUALLY SPACED AT  .020 SEC.  (UNITS: CM/SEC/SEC)
    1.664     4.091     3.611    -3.899    -3.014      .124    -1.680    -3.747
    -.907     2.963     2.145     3.725     1.622    -1.756    -2.826    -2.877
   -3.316     1.428     6.525     2.831     -.428    -4.606    -6.571    -5.195
       ..
      .... (Remainder of acceleration data ) ....
       ..
 3250 POINTS OF VELOC DATA EQUALLY SPACED AT  .020 SEC.  (UNITS: CM/SEC)
```

```
          ..
         .... (Velocity data) ....
          ..
 3250 POINTS OF DISPL DATA EQUALLY SPACED AT  .020 SEC.  (UNITS: CM)
          ..
         .... (Displacement data) ....
          ..
/&  ----------  END OF DATA FOR CHANNEL  1  ----------
          ..
         .... (Header, etc for next channel) ....
          ..
          ..
```

## VOLUME 3 FILE FORMAT

A Volume 3 file is composed of spectral information. For each of the channels, the file hase three headers, spectral parameters, and values of the Fourier amplitude spectra and four response spectra at each of up to 91 periods. Specifically, the elements of a Vol. 3 file, for each channel, are:

1. Text header, alphanumeric
2. Integer header
3. Real-value header
4. Damping values for response spectra
5. Periods at which the spectra are computed
6. Fourier amplitude spectrum values
7. Relative displacement, relative velocity, absolute acceleration and pseudo-velocity response spectrum values
8. Times of maximum spectral responses
9. End-of-data flag for this channel

These nine elements are then repeated for the next channel. The text header is very similar to the Vol. 2 text header. The integer header is the same as that of the Vol. 2 file except for three elements. The real-value header is identical to that of the Vol. 2 file.

The headers and file contents are described on the following pages. These descriptions are followed by a sample Fortran program for reading a Vol. 3 file, and by an actual listing, in summary form, of a Vol. 3 file.

## VOLUME 3 TEXT HEADER (TXTHDR)

The text header occupies 30 lines of alphanumeric text, which are lines 1-30 of the information for a given channel. This text header is nearly identical to the text header for the corresponding Vol. 2 file.

| Line | Column | Description |
|---|---|---|
| 1 | 1-80 | Vol. 3 title line |
| 2-16 | - | Same as lines 1-15 of Vol. 2 text header |
| 17 | 9-26 | Descriptive text |
| 18-22 | - | Blank |
| 23-26 | - | Same as lines 22-25 of Vol. 2 text header |
| 27-28 | - | Same as lines 25 and 26 |
| 29-30 | - | Units of spectra |

## VOLUME 3 INTEGER HEADER (IHDR)

The integer-value header is a 100-element array, written in lines 31-37 of the header, in format 16I5. It is identical to the integer array for the Vol. 2 file, except for elements 67-69.

| Line | Array Element | Description |
|---|---|---|
| 31-37 | 1-100 | Same as elements 1-100 of Vol. 2 integer header, except:<br>67: No. of letters for plotting station name (IHDR(60)+1)<br>68: No. of periods for which spectral values are computed<br>69: No. of damping values for which response spectral values are computed (typically 5) |

## VOLUME 3 REAL-VALUE HEADER (RHDR)

The real-value header is a 100-element floating-point array, written in lines 38-50 of the header, in format 8F10.3. The header is identical to the corresponding header for a Vol. 2 file.

| Line | Array Element | Description |
|---|---|---|
| 38-50 | 1-100 | Same as elements 1-100 of Vol. 2 real-value header |

VOLUME 3 SPECTRAL PARAMETERS

| Line | Parameter | Description |
|---|---|---|
| 51 | DMPNG(I), I=1,5 | Five damping values (fraction of critical, typically 0.00, 0.02, 0.05, 0.10 and 0.20) |
| 52-64 | PD(I), I=1,100 | Periods at which the spectra are computed (typical values are: .04, .042, .044, .046, .048, .05, .055, .06, .065, .07, .075, .08, .085, .09, .095, .10, .11, .12, .13, .14, .15, .16, .17, .18, .19, .20, .22, .24, .26, .28, .30, .32, .34, .36, .38, .40, .42, .44, .46, .48, .50, .55, .60, .65, .70, .75, .80, .85, .90, .95, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.2, 2.4, 2.6, 2.8, 3.0, 3.2, 3.4, 3.6, 3.8, 4.0, 4.2, 4.4, 4.6, 4.8, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10., 11., 12., 13., 14., and 15. seconds. These are 91 periods; the remaining 9 array elements are set to 0.0). |
| 65 | - - | Label and unit of Fourier amplitude spectral values |
| 66-78 | FS(I), I=1,100 | Fourier amplitude spectral values at periods PD(I). |

SAMPLE CODE PROGRAM FOR READING A VOLUME 3 FILE

A Volume 3 file can be read as follows (standard Fortran IV):

```
      INTEGER TXTHDR(40,30), IHDR(100), ENDCHN, LABLFS
      REAL RHDR(100),DMPNG(5),PD(100),FS(100),PSSV(100,5),SD(100,5),
     &     SV(100,5),SA(100,5),TTSD(100,5),TTSV(100,5),TTSA(100,5)
C
C  --- READ HEADERS ---
      READ(LUVOL3,100) ((TXTHDR(IWRD,LINE), IWRD=1,40), LINE=1,30)
      READ(LUVOL3,200) (IHDR(I), I=1,100)
      READ(LUVOL3,300) (RHDR(I), I=1,100)
  100 FORMAT(40A2)
  200 FORMAT(16I5)
  300 FORMAT(8F10.3)
  400 FORMAT(8E10.3)
  500 FORMAT(9X,F5.2)
C
C  --- READ SPECTRAL PARAMETERS ---
      READ(LUVOL3,300) (DMPNG(I), I=1,5)
      READ(LUVOL3,300) (PD(I), I=1,100)
      READ(LUVOL3,100) LABLFS
      READ(LUVOL3,400) (FS(I), I=1,100)
      NDMPNG = IHDR(69)
      DO 20 IDMPNG = 1,NDMPNG
         READ(LUVOL3,500) DAMPNG
C          --- READ RESPONSE SPECTRA FOR EACH DAMPING ---
         READ(LUVOL3,400) (SD(IPRD,IDMPNG), IPRD=1,100)
         READ(LUVOL3,400) (SV(IPRD,IDMPNG), IPRD=1,100)
         READ(LUVOL3,400) (SA(IPRD,IDMPNG), IPRD=1,100)
         READ(LUVOL3,400) (PSSV(IPRD,IDMPNG), IPRD=1,100)
C          --- READ TIMES OF MAXIMUM RESPONSES ---
         READ(LUVOL3,400) (TTSD(IPRD,IDMPNG), IPRD=1,100)
         READ(LUVOL3,400) (TTSV(IPRD,IDMPNG), IPRD=1,100)
         READ(LUVOL3,400) (TTSA(IPRD,IDMPNG), IPRD=1,100)
   20 CONTINUE
C        --- CHECK FOR END-OF-DATA FOR THIS CHANNEL ---
      READ(LUVOL3,100) ENDCHN
      IF(ENDCHN .NE. '/&') STOP 1
```

Notes:

LUVOL3 = FORTRAN logical unit number for the Vol. 3 file

TXTHDR(40,30) = 30 lines of text headers

IHDR(100) = 7 lines of integer headers

RHDR(100) = 13 lines of real-value headers

DMPNG(5) = damping values of the oscillator whose response is computed (typically 0.0, 0.02, 0.05, 0.10 and 0.20)

PD(100) = periods of the oscillator whose response is computed; actual number of periods computed is in IHDR(68)

SD(100,5), SV(100,5), SA(100,5), PSSV(100,5) = relative displacement, relative velocity, absolute acceleration, and pseudo-velocity response spectrum values

TTSD(100,5), TTSV(100,5), TTSA(100,5) = times of maximum spectral response for each period and damping

LABLFS = label for Fourier amplitude spectrum

ENDCHN = end-of-data mark for this channel

SAMPLE VOLUME 3 FILE LISTING

```
RESPONSE AND FOURIER AMPLITUDE SPECTRA (91 PERIODS,  .04 - 15.0 SEC)  FOR
CORRECTED ACCELEROGRAM  54214-S3505-80148.07       CHAN  1:  90 DEG     FROM
UNCORRECTED ACCELEROGRAM DATA                PROCESSED:  2/25/83, CDMG EQML8015
MAMMOTH LAKES EARTHQUAKE
MAY 27, 1980 07:51 PDT                    (ORIGIN(USGS): 05/27/80, 14:50:57.2 GMT)
54214-S3505-80148.07                  TRIGGER TIME: 05/27/80, 14:51:00.9 GMT
STATION NO. 54214   37.588N, 118.705W     SMA-1  S/N 3505 ( 3 CHNS OF 22 AT STA)
LONG VALLEY DAM (UPPER LEFT ABUT.)
CHAN  1:  90 DEG  (STA CHN: 17)
MAMMOTH LAKES EARTHQUAKE    MAY 27, 1980 07:51 PDT
HYPOCENTER(USGS): 37.506N,118.826W, H=14KM.  ML=6.2(BRK).
INSTR PERIOD =  .0398 SEC,  DAMPING =  .570,  SENSITIVITY = 1.83 CM/G.
                        RECORD LENGTH = 64.980 SEC.
                                      UNCOR MAX  =  -.398 G, AT   5.359 SEC.
RMS ACCEL OF (UNCOR) RECORD  =  .036 G.
ACCELEROGRAM BANDPASS FILTERED WITH RAMPS AT  .050- .070 AND 23.00-25.00 CYC/SEC
                INSTRUMENT- AND BASELINE-CORRECTED



MAMMOTH LAKES EARTHQUAKE    MAY 27, 1980 07:51 PDT

54214-S3505-80148.07      LONG VALLEY DAM (UPPER LEFT ABUT.)    CHAN  1:  90 DEG

54214-S3505-80148.07      LONG VALLEY DAM (UPPER LEFT ABUT.)    CHAN  1:  90 DEG

UNITS FOR SPECTRA ARE INCHES AND SEC, EXCEPT SA IS IN FRACTION OF G.

    1    1   17    3   22    0    1    1    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0 9013001   24   34   50    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    01300113001 3250    4   10   10    0    0   50   80   10   10    0 3250
    0 3250   81   91    5    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0
      .040      .570    64.997      .036      .100     1.830     -.398     5.359
    25.100    50.000     2.732    50.000     4.999      .069     1.190     5.286
      .000      .000      .000      .000      .000      .000      .000      .000
      .000      .000      .000      .000      .000      .000      .000      .000
      .000      .000      .000      .000      .000      .000      .000      .000
      .000      .000      .000      .000      .000      .000      .000      .000
      .000      .000      .000    98.067      .005    64.997   157.708      .000
      .000    25.000     2.000    64.980      .020      .070      .020      .000
     4.980   340.992     5.560   -34.037     5.340     9.127    -1.472      .070
    23.000      .200      .200     -.507      .000      .000      .000      .000
      .000      .000      .000      .000      .000      .000      .000      .000
      .000      .000      .000      .000      .000      .000      .000      .000
      .000      .000      .000      .000
      .000      .020      .050      .100      .200
      .040      .042      .044      .046      .048      .050      .055      .060
      .065      .070      .075      .080      .085      .090      .095      .100
```

```
      .110      .120      .130      .140      .150      .160      .170      .180
      .190      .200      .220      .240      .260      .280      .300      .320
      .340      .360      .380      .400      .420      .440      .460      .480
      .500      .550      .600      .650      .700      .750      .800      .850
      .900      .950     1.000     1.100     1.200     1.300     1.400     1.500
     1.600     1.700     1.800     1.900     2.000     2.200     2.400     2.600
     2.800     3.000     3.200     3.400     3.600     3.800     4.000     4.200
     4.400     4.600     4.800     5.000     5.500     6.000     6.500     7.000
     7.500     8.000     8.500     9.000     9.500    10.000    11.000    12.000
    13.000    14.000    15.000      .000      .000      .000      .000      .000
      .000      .000      .000      .000
FOURIER AMPLITUDE SPECTRA IN IN/SEC.
  .799E-02  .237E-01  .183E-01  .299E-01  .256E-01  .438E-01  .810E-01  .765E-01
       ...
       ...
DAMPING =  .00. DATA OF SD,SV,SA,PSSV,TTSD,TTSV,TTSA :
  .173E-02  .196E-02  .208E-02  .233E-02  .252E-02  .302E-02  .434E-02  .456E-02
       .. (SD, relative displacement response spectrum)
       ..
  .498E-01  .695E-01  .812E-01  .862E-01  .832E-01  .104E 00  .181E 00  .232E 00
       .. (SV, relative velocity response spectrum)
       ..
  .111E 00  .114E 00  .110E 00  .113E 00  .112E 00  .124E 00  .147E 00  .129E 00
       .. (SA, absolute acceleration response spectrum)
       ..
  .272E 00  .294E 00  .297E 00  .318E 00  .330E 00  .380E 00  .495E 00  .477E 00
       .. (PSSV, pseudo-velocity spectrum)
       ..
  .656E 01  .658E 01  .659E 01  .658E 01  .658E 01  .656E 01  .656E 01  .659E 01
       .. (TTSD, times of maximum response SD)
       ..
  .654E 01  .653E 01  .654E 01  .653E 01  .653E 01  .677E 01  .674E 01  .652E 01
       .. (TTSV, times of maximum response SV)
       ..
  .656E 01  .658E 01  .659E 01  .658E 01  .658E 01  .656E 01  .656E 01  .659E 01
       .. (TTSA, times of maximum response SA)
       ..
DAMPING =  .02. DATA OF SD,SV,SA,PSSV,TTSD,TTSV,TTSA :
       ..
       ..
       ..
DAMPING =  .05. DATA OF SD,SV,SA,PSSV,TTSD,TTSV,TTSA :
       ..
       ..
       ..
DAMPING =  .10. DATA OF SD,SV,SA,PSSV,TTSD,TTSV,TTSA :
       ..
       ..
       ..
DAMPING =  .20. DATA OF SD,SV,SA,PSSV,TTSD,TTSV,TTSA :
       ..
       ..
       ..
/&   ----------  END OF SPECTRAL DATA FOR CHANNEL  1  ----------
       ..
       ..
```

(Header, etc for next channel)

..

..

## REFERENCES

Hudson, D.E., M.D. Trifunac and A.G. Brady (1970 to 1975) Analysis of Strong-Motion Accelerograms, Vol. I through Vol. IV, Parts A through Y, Earthquake Engineering Laboratory, California Institute of Technology, Pasadena, California.

Trifunac, M.D. and V.W. Lee (1973) Routine Computer Processing of Strong-Motion Accelerograms, Report EERL 73-03, Earthquake Engineering Laboratory, California Institute of Technology, Pasadena, California.

Trifunac, M.D. and V.W. Lee (1979) Automatic Digitization and Processing of Strong Motion Accelerograms, Part I: Automatic Digitization, and Part II: Computer Processing of Accelerograms (by V.W. Lee and M.D. Trifunac), Report No. 79-15, University of Southern California, Los Angeles, California.