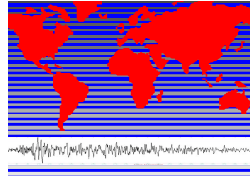


**Consortium of Organizations for Strong-Motion Observation Systems**



**COSMOS**  
**Strong Motion Data Format**

**COSMOS Strong Motion  
Programs Board**

Ver 1.20  
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# **COSMOS Strong Motion Data Format**

## **Introduction**

The COSMOS Strong Motion Data File Format<sup>1</sup> is designed to be a common format that meets current needs by combining:

- similarity with traditional strong motion formats,
- current needs for higher resolution in data and parameters,
- needs for flexibility by networks, and
- user convenience, with a single format structure.

Format flexibility is a key element of the COSMOS approach, allowing strong motion networks to produce data with wide choices. Even with this flexibility, a user can read the full range of variations with a single program as long as the format framework has been maintained.

This format specification builds on earlier formats used by Caltech, USC, USGS, CDMG and others. References for the documentation of the earlier formats are listed below. This format itself is meant to be a growing standard, and the tables with reference codes will be expanded as more networks are established and new instruments and sensors come into use.

## **Purpose**

One of the first goals of the COSMOS consortium was the development of a common strong motion data format. Several factors contributed to the importance of this issue:

- 1) The increasing number of networks collecting and releasing strong motion data led to an increased number and variability of data formats. The lack of commonality impeded application of recovered data by users in studies to increase seismic safety.
- 2) Technological advances, as high-resolution accelerographs introduced in the last decade continue to supplant film record digitization, mean that even existing data formats needed to increase resolution capability. In another advance, increased station location precision, available with GPS, mean more resolution is also required to specify station location.
- 3) The increased number of networks make unique station identification an issue for users, since two networks might each have a station number 1552, for example. COSMOS borrows from the Internet IP protocol model, adding a network number as part of an expanded station number. Thus the full number of the two stations might be 02-1552 and 07-1552, and the uniqueness of the stations is preserved for the user. (The network number is cross-referenced to the IRIS seismic network codes where applicable.)
- 4) The increasing interface with classical seismic networks, associated with increased common goals and the in-common use of seismic instruments, makes the interchange of data for dual use in both earthquake engineering and seismology research an important goal.

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<sup>1</sup> The COSMOS format was developed by a Working Group of the COSMOS Strong Motion Programs Board with participation by N. Abrahamson and W. Savage (PG&E); R. Borchardt, D. Boore, W. Joyner, G. Glassmoyer, C. Stephens and K. Fogelman (USGS); R. Archuleta, A. Tumarkin and M. Squibb (UCSB); R. Ballard and M. Savage (USCOE); C.B. Crouse and R. Graves (URS); M. Huang, V. Graizer, C. Scrivner, and H. Haddadi (CDMG); A. Viksne and C. Wood (USBurRec); W. Lee and D. Dodge; A. Shakal. (Chair).

## Date File Structure

Each data file consists of a header followed by data. More specifically, a file contains a header and data for a single component of motion and for a single type of data (acceleration, velocity, displacement, etc.) (The component files can be easily concatenated to form traditional multi-component files, and some networks may take this step for convenience in distribution.) The data header itself has three sections (text, integer and real), each of which contains information of the corresponding type.

### Header Section:

#### 1. Text Header:

- Provides alphanumeric information, such as the name of the earthquake and station, the location of the sensor (in the case of a structural, geotechnical or other array), and a short description of the site geology.
- Provides convenient, quickly readable information that does not require reference tables to understand. Its purpose is human readability; precise values of parameters should be obtained from the numeric headers.
- The basic text header has 13 lines, but can be longer if a network chooses, provided the first 13 lines follow the format described here.

#### 2. Integer Header:

- The basic integer header includes the specification of a minimum set of parameters.
- A larger number of parameters may be included beyond that set, defined as desired.
- The numeric format that the integer parameters are written in can be chosen by the agency, and is specified in the header itself.

#### 3. Real Header:

- Like the integer header, the basic real header includes the specification of a minimum set of parameters, and a larger number may be included, defined as desired.
- The numeric format for the real parameters is specified in the header itself (either a floating point or exponential format can be used).

### Data Section:

- The first line of the data section includes the type of data (accel., velocity, displ., etc.) and its units, the number of data points, and the format to be used in reading the data. The format will type be for integer or real values, as appropriate; the format for real values can be floating point (e.g., 8f10.5) or exponential (e.g., 5e16.7). Although not required, 80-character line lengths are most convenient for many engineering strong motion data users.
- The first line is followed by as many lines of data as are needed to accommodate the number of points, given the format in which the data values are written.

## Revision Process

This format uses a set of tables (Tables 1 through 12) that contain codes for the variety of necessary metadata information parameters about the data. Some tables, especially those containing information about networks, instruments and sensors, are expected to change and grow with time, and gaps have been left to accommodate this need. COSMOS will introduce new values in these tables as the need develops, and upon input from users (please email [cosmos@eerc.berkeley.edu](mailto:cosmos@eerc.berkeley.edu) with suggestions when a need becomes apparent).

Changes in the 3-digit format version number (e.g., 1.20) will reflect the introduction of changes. Major version changes will be reflected in the first two digits; changes in the minor number (third digit) will indicate that only additional table code values have been defined. This document and the latest versions of the supplemental tables will be available at the COSMOS web site and at the web sites of several of the core members (e.g., <http://nsmg.wr.usgs.gov/> and <ftp://ftp.consrv.ca.gov/pub/dmg/csmip/formats/>). It is planned that machine-readable versions of the tables will be available at these sites so that user programs can automatically look up unknown/new Table entries.

## User Convenience

The COSMOS format strives to achieve flexibility for the data-generating agencies while preserving user convenience by including, in the format prescription, the number of parameters and number of lines to be read. Though reading this format is slightly more complex than reading one of the legacy formats, with this approach a single user program can easily read data files that are quite different in detail.

As an example, to read an Integer header which has been written with a specific numeric format (e.g., I10, as in the illustration), the following general coding (in Fortran) can be used:

```
character textstring*80, IhdrFormat*12
integer Ihdr(100)
:
read (iunit, '(a)') textstring
read (textstring,'(i4, t57, a12)') nIhdrValues, IhdrFormat
read (iunit, IhdrFormat) (Ihdr(i), i=1,nIhdrValues)
```

(good practice would monitor read errors, and check that the value of nIhdrValues is in range, of course.) Source code templates in Fortran and other languages will be available from COSMOS.

## Converters for Compatibility with Legacy Formats

Many programs and software packages require input data in a specific format (for example, the Caltech Bluebook format, the CDMG format, one of the USGS formats, etc.). It is the expressed intent of COSMOS that these application programs not be rendered unusable by the new format. Therefore, conversion routines will be available at the COSMOS website that will convert files in this format into one of the traditional formats. The user need only download the executable program, run it on a data file in the COSMOS format, and obtain a file in the legacy format that is readable by the existing application program.

Some users who have used one of the legacy formats for years may feel that this new common format is unnecessarily complex, and involves too many parameters. The complexity and number of parameters is an aspect of bringing together disparate formats, and is necessary for future growth. However, at this time a user need only deal with the subset of parameters they actually use in their work, and the above converters can be used to convert the new format to a file they are accustomed to. Other users may wish to strip off the top header section of the file and save it in a "--.hdr" file in the same folder, and work directly with the data section, referring to the .hdr file as needed for reference.

Additional converters are planned to provide conversion to and from common spreadsheet and application program formats, and seismological network formats such as SEED, thus making "dual use" of the data in earthquake engineering and seismological research very convenient.

## Data File Types

The data file types commonly used in strong motion have their roots in the Caltech Bluebook project and are named Volume 1, 2, etc. (or Phase 1, 2..). They range from very raw files to processed and user-ready product files. They are all ASCII files and so do not have the machine dependency problems of binary files. The Volume 2 product file is used most often in earthquake engineering analysis.

- Volume 0 files have raw data values in digital counts, obtained directly from the native binary files of the recording instrument. (Records obtained by digitizing analog film generally do not have a V0 file.) V0 files may have almost no quality control or checking, and so they may be treated as internal files by networks. V0 files have adequate information in the headers to be converted to files with physical values. There is one component per file, so one record obtained by a triaxial recorder will result in three files.
- Volume 1 files contain raw data, but converted to physical units. V1 files are traditionally referred to as “Uncorrected” acceleration files, primarily because the instrument correction has not been performed. In the V1 file, digital counts (which are dependent on a recorder’s word length and the span and offset of its analog-to-digital converter) have been converted to physical units (e.g., "g") with normal range. No correction for instrument response and no filtering to remove noise is performed. V1 files are often zero-mean; if so the average value that was removed is stored in the real header. V1 files often have the same sampling rate as their V0 files. Again, there will be three files for one record from a triaxial recorder.
- Volume 2 files are time-series product files obtained through signal processing operations on V1 files. The operations generally include correction for the instrument response and digital bandpass filtering and/or base-line correction procedures. The V2 acceleration is obtained from the V1 acceleration through these calculations. The velocity is obtained from the V2 acceleration via numerical integration, and the velocity is integrated to obtain the displacement, each integration possibly accompanied by long-period filtering. Each component yields three files (acceleration, velocity and displacement), so a triaxial record produces 9 files.
- Volume 3 files are spectral product files. Each file includes response spectra (relative displacement, SD, relative velocity, SV, and absolute acceleration, SA) at a fixed set of periods and damping values, which are given in the file. The file will also contain an approximation of the Fourier amplitude spectrum (FS) of the acceleration. (Note that the pseudo relative velocity (PSV) and pseudo absolute acceleration (PSA) spectra are not included since PSV can be obtained as  $\omega \times SD$ , and PSA as  $\omega^2 \times SD$ .) One file is produced per component, so one triaxial record will result in three V3 files.

## Format References

### Background:

Shakal, A.F. and R. D. Borchardt (1999). Toward a common format for strong motion data, in Proceedings, SMIP99 Seminar on Utilization on Strong-Motion Data, Sacramento, CA, p. 121-133.

### Caltech (Bluebook) Format:

Hudson, D.E., A.G. Brady and M.D. Trifunac (1969). Strong-motion earthquake accelerograms, digitized and plotted data, Vol. I, Parts A-Y, Calif. Inst. Technology, EERL Reports.

Hudson, D.E., A.G. Brady, M.D. Trifunac and A. Vijayaraghavan (1971). Strong-motion earthquake accelerograms, Corrected accelerograms and integrated velocity and displacement curves, Vol. II, Parts A-Y, Calif. Inst. Technology, EERL Reports.

Hudson, D.E., M. Trifunac and A.G. Brady (1972). Response spectra, Vol. III, Parts A-Y, Calif. Inst. Technology, EERL Reports.

### USC Format:

Lee, V.W and M.D. Trifunac (1973) Automatic digitization and processing of strong motion accelerograms, Part II: Computer processing of accelerograms, Univ. of Southern Calif., Report 79-15.

### USGS Formats:

- Brady, A., V. Perez, and P. Mork (1980) The Imperial Valley earthquake, October 15, 1979, Digitization and processing of accelerograph records, U.S. Geol. Survey, Seismic Engineering Data Report, Open File Report 80-703.
- SMC-format data files: <http://nsmp.wr.usgs.gov/smcfmt.html>
- CDROM data file format: [http://nsmp.wr.usgs.gov/data2/cdrom\\_sm\\_1933-1986/docfiles/techinfo.txt](http://nsmp.wr.usgs.gov/data2/cdrom_sm_1933-1986/docfiles/techinfo.txt), Appendix B
- BBF-format data files: <http://nsmp.wr.usgs.gov/docs/bbfmt.txt>
- GEOS VFBB format: <http://nsmp.wr.usgs.gov/GEOS/HELP/header.doc>

### CDMG Format:

Shakal, A.F. and M.J. Huang (1985) Standard tape format for CSMIP strong-motion data tapes, CSMIP Report OSMS 85-03, 26p; <ftp://ftp.consrv.ca.gov/pub/dmg/csmip/formats>.

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Figure 2. Modification for Response Spectrum Files

| Line | Columns   | 11111111111  | 22222222222 | 33333333333 | 44444444444 | 55555555555 | 66666666666 | 77777777777 | 8        |
|------|---|--|-------------|-------------|-------------|-------------|-------------|-------------|----------|
|      |   | 0123456789   | 0123456789  | 0123456789  | 0123456789  | 0123456789  | 0123456789  | 0123456789  | 0        |
| 1    | Response spectra                                  | (Format v01.20 with 13 text lines) Src: 24236a13.evt                   |             |             |             |             |             |             |          |
| 11   | Processed:  | 01/25/1994,09:14:18 PST,CDMG. SaMax= 1.53g at 2.64 sec prd, 5% damping |             |             |             |             |             |             |          |
| 46   | And lines 46 and beyond (in this example) become: |  |             |             |             |             |             |             |          |
| 47   | 5   | damping values for which spectra are computed: .00, .02, .05, .10, .20 |             |             |             |             |             |             |          |
| :    | 91  | periods at which spectra computed, units=sec (01), Format=(8F10.3)     |             |             |             |             |             |             |          |
| :    | :   | .040   | .042        | .044        | .046        | .048        | .050        | .055        | .060     |
| :    | :   | .065   | .070        | .075        | .080        | .085        | .090        | .095        | 1.00     |
| :    | :   | .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      |             |             |             |             |          |
| :    | 91  | values of approx Fourier spectrum, units=in/sec (08), Format=(8E10.3)  |             |             |             |             |             |             |          |
| :    | :   | .201E-01   | .397E+00    | .130E+01    | .285E+00    | .724E+00    | .141E+01    | .908E+00    | .836E+00 |
| :    | :   | .189E+01   | .169E+01    | .318E+01    | .250E+01    | .206E+01    | .105E+02    | .688E+01    | .865E+01 |
| :    | :   | :  | :           | :           | :           | :           | :           | :           | :        |
| :    | 91  | values of Sd for Damping = .00, units=inches (09), Format=(8E10.3)     |             |             |             |             |             |             |          |
| :    | :   | .559E-02   | .667E-02    | .123E-01    | .106E-01    | .153E-01    | .174E-01    | .153E-01    | .170E-01 |
| :    | :   | .301E-01   | .344E-01    | .482E-01    | .521E-01    | .947E-01    | .152E+00    | .158E+00    | .187E+00 |
| :    | :   | :  | :           | :           | :           | :           | :           | :           | :        |
| :    | 91  | values of Sv for Damping = .00, units=in/sec (08), Format=(8E10.3)     |             |             |             |             |             |             |          |
| :    | :   | .287E+00   | .588E+00    | .130E+01    | .685E+00    | .113E+01    | .172E+01    | .124E+01    | .146E+01 |
| :    | :   | .238E+01   | .274E+01    | .340E+01    | .323E+01    | .645E+01    | .105E+02    | .993E+01    | .109E+02 |
| :    | :   | :  | :           | :           | :           | :           | :           | :           | :        |
| :    | 91  | values of Sa for Damping = .00, units=g (02), Format=(8E10.3)          |             |             |             |             |             |             |          |
| :    | :   | .357E+00   | .387E+00    | .650E+00    | .512E+00    | .677E+00    | .713E+00    | .518E+00    | .483E+00 |
| :    | :   | .729E+00   | .717E+00    | .876E+00    | .833E+00    | .134E+01    | .192E+01    | .179E+01    | .191E+01 |
| :    | :   | :  | :           | :           | :           | :           | :           | :           | :        |
| :    | 91  | values of Sd for Damping = .02, units=inches (09), Format=(8E10.3)     |             |             |             |             |             |             |          |
| :    | :   | :  | :           | :           | :           | :           | :           | :           | :        |
| :    | :   | (Sv and Sa included here)  |             |             |             |             |             |             |          |
| :    | :   | :  | :           | :           | :           | :           | :           | :           | :        |
| :    | :   | [repeat pattern for other dampings, as needed]                         |             |             |             |             |             |             |          |
| :    | :   | :  | :           | :           | :           | :           | :           | :           | :        |
| :    | :   | End-of-data for Chan 4 response spectra                                |             |             |             |             |             |             |          |
| 1    | Columns   | 11111111111  | 22222222222 | 33333333333 | 44444444444 | 55555555555 | 66666666666 | 77777777777 | 8        |
|      |   | 0123456789   | 0123456789  | 0123456789  | 0123456789  | 0123456789  | 0123456789  | 0123456789  | 0        |



## HEADER SECTIONS

### I. Text Header

The Text Header provides intrinsically textual information (names, descriptions, etc.) and allows a human-readable quick introduction to the file. Numeric values appearing in the text header are for quick reference and convenience; the actual value of parameters should be obtained from the numeric headers.

The following description assumes nominal header sizes (13 text header lines, 100 integer and real header values, and 3 comment lines); these correspond to the attached illustration (Figure 1).

#### Line Cols

- 1 1-25 Type of physical parameter of the data that follows. Examples:
  - “Corrected acceleration”      “Velocity data”
  - “Uncorrected acceleration”      “Displacement data”
  - “Raw acceleration counts”      “Rel. Displacement data”
  - “Response spectra”      “Pore pressure data”
- 36-40 COSMOS format version number (major.minor).
- 47-48 Number of lines in text header (including this one).
- 62-80 Field reserved for use by preparing agency.

**Earthquake information** (note that the location and magnitude reflect information available when the file was generated and may be preliminary and subject to revision; the source seismic network should be referred to for the current best estimates of the parameters):

- 2 1-40 Earthquake name (before a name has been assigned, may appear as “Record of”; test records may use “Test Record of”, etc.).
  - 41-80 Earthquake date and time (including time zone).
- 3 12-46 Hypocenter: 12-20 Latitude (positive North); 22-31 Longitude (positive East); and 35-37 Depth (km); 40-46 Source agency for hypocenter information.
  - 47-80 Magnitude(s), including source agency for values (may be entered manually, so spacing may be variable).\*
- 4 9-42 Earthquake origin date and time, in UTC (i.e., GMT), with source agency; 43-80, For use by preparing agency; may include note, e.g., “Preliminary Processing”, etc.

#### **Station information:**

- 5 10-80 Station identification: 10-12 Network number (see Table 4); 14-19 Station number; 26-27 Network code, IRIS (if assigned; see Table 4); 29-34 Station alphanumeric code (left justified); 36-40 Network abbreviation; 41-80 Station name.
- 6 8-16 Station latitude (positive North); 17-26 longitude (positive East); 41-80 Site geology description.

#### **Recorder and sensor information:**

- 7 11-26 Recorder type and serial number.\*
  - 28-29 Number of channels in recorder; 39-41 Number of channels at station.
  - 58-80 Sensor type and serial number.\*

#### **Record information:**

- 8 17-50 Record start time (date and time of first sample; may be approximate - precise value should be obtained from real header) and time quality (0 through 5 correspond to lowest through highest quality).
  - 59-80 Record identification, assigned by preparing agency.
- 9 9-20 Station channel number for this sensor, and sensing direction (azimuth or word; refer to code in Ihdr(54) and Table 11).
  - 33-35 Recorder channel number, if different.
  - 47-80 Location of sensor (for structural or other arrays).

- 10 20-27 Length of raw record, as recorded (seconds); 45-54 Maximum of raw (uncorrected) record in g (or other units);\* 60-67 Time max occurs in raw record (secs after start).\*
- 11 11-40 Processing/release date, time and agency.  
48-80 Maximum of data series in file, units, and time of maximum (seconds after start).\*
- 12 22-27 Filter band used in processing: Low frequency 3 dB corner frequency, in Hz; in 45-50, expressed as period, in seconds; 68-72 High frequency 3 dB corner frequency, in Hz.
- 13 65-80 Value used in file to indicate a parameter or data value is unknown or not specified: 65-71, value for integers; 73-80, value for reals.

\* Note: Because of the variability of the information, these fields may not be parsable strictly by column position. The most reliable way to access the information is through the parameters in the Integer or Real headers.

## II. Integer Header

- 14 1 - 4 Number of values in Integer Header.  
38-40 Number of lines of Integer Header values that follow.  
57-80 Format by which the Integer Header values are written.
- 15 - 24: Lines with Integer header values (actual number of lines, and line numbers in rest of header, depend on number of elements in the header and the format).

## III. Real Header

- 25 1 - 4 Number of values in Real Header.  
35-37 Number of lines of Real Header values that follow.  
54-80 Format by which the Real Header values are written.
- 26 - 42: Lines with Real header values (actual line numbers will vary).

## IV. Comments

- 43 1 - 4 Number of comment lines that follow, each starting with “[”]; may be zero. Comment lines contain special information about the record (e.g., problem with timing, gain, orientation, or processing issues such as filtering, noise, etc.)

## DATA VALUES SECTION

### Line Cols

- 1<sup>st</sup> 1 - 8 Number of data points following; 10-21 Physical parameter of the data.  
35-38 Approximate length of record (rounded to nearest sec; see Rhdr(66) for precise value).  
52-58 Units of the data values (e.g., cm/sec<sup>2</sup>); 60-61 Index code for units (see Table 2).  
71-80 Format of the data values written on the following lines.

N lines: Data values.

### **End-of-Data Flag Line:**

- N+1 1 -11 End of data flag string, “End-of-data for..”.  
21-36 Station channel number and physical parameter of data (a checksum may optionally be included on the remainder of this line).

## RESPONSE SPECTRUM FILES

Response spectrum files follow the pattern of the time-history files. Differences include:

- 11 48 -80 Maximum of Sa and period of max.

Lines 46 and beyond follow the header-line-plus-data pattern of the Data Values section for each of the spectra (see Figure 2).

## Contents of Integer and Real Headers

| Param.No.   |           | Parameter Description   | First |
|---|-----------|---|-------|
| I   | R         |   | Used  |
| <b><u>Data/File Parameters</u></b>  |           |   |       |
| 1   |           | Processing stage index of data in this file (0,1,2,3 for v0 through v3)   | 0     |
| 2   |           | Physical parameter of data in this file (1,2,3..=acceleration, velocity, displ., etc; see Table 1)  | 0     |
| 3   |           | Units of data following this header (1,2,etc; see Table 2)  | 0     |
| 4   |           | COSMOS format version number (major.minor x 100)  | 0     |
| 5   |           | Type of record (1 for seismically triggered; other values for other record types in Table 3)  | 0     |
| <b><u>Station parameters</u></b>  |           |   |       |
| 8   |           | Station number (as assigned by operating network)   | 0     |
| 9   |           | Secondary station number (assigned by secondary network, if any)  | 0     |
|   |           | Network number for station (see Table 4)  |       |
| 11  |           | Network number of operating network   | 0     |
| 12  |           | Network number of network/agency owning this station  | 0     |
| 13  |           | Network number of secondary network with previous or secondary responsibility for this station (if any)   | 0     |
| 14  |           | Network number of network/agency that processed this record   | 0     |
|   | <b>1</b>  | Latitude of station (decimal degrees, North positive)   | 0     |
|   | <b>2</b>  | Longitude of station (decimal degrees, East positive)   | 0     |
|   | <b>3</b>  | Elevation of station above sea level (m)  | 0     |
| 16  |           | Reference datum for station coordinates (see Table 5)   | 0     |
|   | <b>4</b>  | Site geology parameter V30 (km/s)   | 0     |
| 18  |           | Code for site geology at station (assigned by agency)   | 0     |
| 19  |           | Station type (freefield, small bldg; instrumented bldg, bridge, or dam, etc; see Table 6)   | 0     |
|   |           | Instrumentation orientation direction at station  |       |
| 20  |           | - For freefield/triaxial stations: Connector Reference Orientation (azimuth of accelerograph connector, accelerometer connector in the case of an external biaxial or triaxial pkg); 1-360 deg, CW from North | 0     |
| 21  |           | - For structural stations or arrays: Structure/Array Reference Orientation (azimuth of Structure/Array "Reference North" relative to True North); 1-360, CW from North  | 0     |
| 22  |           | Number of recorders in system at station  | 0     |
| 23  |           | Total number of channels in recording system at station   | 0     |
| <b><u>Earthquake Parameters</u></b> (location and magnitudes may be preliminary, and subject to revision) |           |   |       |
|   | <b>10</b> | Earthquake latitude (decimal degrees, North positive)   | 0     |
|   | <b>11</b> | Earthquake longitude (decimal degrees, East positive)   | 0     |
|   | <b>12</b> | Earthquake depth (km).  | 0     |
| 25  |           | Reference for location and depth determination (see Table 7)  | 0     |
|   | <b>13</b> | Moment magnitude, M.  | 0     |
|   | <b>14</b> | Surface-wave magnitude, MS.   | 0     |
|   | <b>15</b> | Local magnitude, ML.  | 0     |
| 26  |           | Reference for Moment magnitude (see Table 7)  | 0     |
| 27  |           | Reference for Surface-wave magnitude (see Table 7)  | 0     |
| 28  |           | Reference for Local magnitude (see Table 7)   | 0     |
|   | <b>16</b> | Other magnitude (see comments, if used)   | 0     |
|   | <b>17</b> | Epicentral distance to station (km).  | 0     |
|   | <b>18</b> | Epicenter-to-station azimuth (CW from north)  | 0     |
| <b><u>Recorder/Datalogger parameters</u></b>  |           |   |       |
| 30  |           | Recorder type code (see Table 9)  | 0     |
| 31  |           | Recording medium (1=film, 2=tape, 3=solid state)  | 0     |
| 32  |           | Recorder serial number (if non-numeric, given by text string in Text Header, line 7)  | 0     |
| 33  |           | Number of channels in recorder  | 0     |
| 34  |           | Number of channels in recorder that were recorded (may be same as above)  | 0     |
|   | <b>22</b> | Recorder least significant bit (LSB) in micro-volts (i.e., uv/count)  | 0     |
|   | <b>23</b> | Recorder full-scale input (volts)   | 0     |
| 35  |           | Sample word length as originally recorded (i.e., number of bits; so full scale counts = $\pm 2^{**}(\text{nbits}-1)$ )  | 0     |
| 36  |           | Effective number of bits (may be the same as above)   | 0     |
|   | <b>24</b> | Pre-trigger memory recording time (secs)  | 0     |
|   | <b>25</b> | Post-detrigger recording time (secs)  | 0     |

## Contents of Integer and Real Headers

| Param.No. |           | Parameter Description   | First |
|-----------|-----------|---|-------|
| I         | R         |   | Used  |
|           | <b>26</b> | Corner frequency of anti-alias filter (Hz)  | 0     |
|           | <b>27</b> | Decay of anti-alias filter (dB/octave)  | 0     |
|           | <b>28</b> | If film record, size of digitizer y-step (acceleration) of digitizer used, in microns (i.e., cm/10000)  | 0     |
|           |           | <b><u>Record parameters</u></b>   |       |
| 38        |           | Trigger number of this record in the recorder (if applicable)   | 0     |
| 39        |           | Shock number in this trigger; normally 1  | 0     |
|           |           | Start time of record (time of first sample, UTC (i.e., GMT))  |       |
| 40        |           | Year (4 digit)  | 0     |
| 41        |           | Julian day  | 0     |
| 42        |           | Month   | 0     |
| 43        |           | Day of month  | 0     |
| 44        |           | Hour  | 0     |
| 45        |           | Minute  | 0     |
|           | <b>30</b> | Seconds (with fractional part)  | 0     |
| 46        |           | Time quality indicator (0-5 = poorest to best)  | 0     |
| 47        |           | Time source (see Table 8).  | 0     |
|           | <b>31</b> | Correction applied to recorder clock time (if applicable, e.g., for Time source=1 or 2) to obtain above start time (secs); i.e., Tstart = Trecorder + Tcorrection | 0     |
|           | <b>32</b> | Offset of local time zone from UTC (i.e., GMT); i.e., Offset (hrs) = UTC - local time   | 0     |
|           | <b>34</b> | Data sample interval (sec) in original (v0) record  | 0     |
|           | <b>35</b> | Length of raw (v0) record (secs)  | 0     |
|           | <b>36</b> | Mean value removed to make V1 time series zero-mean (if any); in units of V1 data   | 1     |
|           |           | <b><u>Sensor/channel parameters</u></b>   |       |
| 50        |           | Station channel number.   | 0     |
| 51        |           | Recorder channel number (if analog, counted downward from top of film)  | 0     |
| 52        |           | Sensor type code (FBA, etc; see Table 10; -1 if no sensor attached)   | 0     |
| 53        |           | Sensor serial number (if non-numeric, given by text string in text header, line 7)  | 0     |
|           | <b>40</b> | Sensor natural frequency (Hz)   | 0     |
|           | <b>41</b> | Sensor damping (fraction of critical)   | 0     |
|           | <b>42</b> | Sensor sensitivity (for accelerometer, in volts/g (cm/g if film record); for other sensors, in volts per motion unit given in Ihdr(3)).                           | 0     |
|           | <b>43</b> | Full scale output of sensor (volts)   | 0     |
|           | <b>44</b> | Full scale sensing capability of sensor (in g for accelerometer; in units given by Ihdr(3) for other sensors)   | 0     |
|           | <b>45</b> | Sensor low-frequency corner (Hz; 0 for traditional FBA)   | 0     |
|           | <b>46</b> | Sensor low-frequency decay (dB/octave; n/a for traditional FBA)   | 0     |
|           | <b>47</b> | Gain applied to sensor output prior to recording (1.0 if no amplification; 2.0 for doubling, etc.   | 0     |
|           |           | Azimuth of sensor (i.e., direction of motion corresponding to positive-going data values  |       |
| 54        |           | - Azimuth of sensor relative to True North (1-360 deg; see Table 11 for other values  | 0     |
| 55        |           | - Azimuth of sensor relative to Reference Orientation, if any (1-360 deg; see Table 11 for other values   | 0     |
| 56        |           | Location Index of sensor site at station, in the case of a multi-site array   | 0     |
|           | <b>50</b> | North offset of sensor site from station location reference, if array (m)   | 0     |
|           | <b>51</b> | East offset of sensor site (m)  | 0     |
|           | <b>52</b> | Vertical offset of sensor site (m; up positive)   | 0     |
|           |           | <b><u>Filtering/Processing parameters</u></b>   |       |
| 60        |           | Processing stage (1-3 = preliminary, intermediate, final)   | 1     |
| 61        |           | Low-frequency filter type used in vol2 processing (see Table 12)  | 2     |
|           | <b>54</b> | Corner frequency of low-frequency filter (Hz)   | 2     |
|           | <b>55</b> | Decay of low-frequency filter (dB/octave)   | 2     |
|           | <b>56</b> | Roll-off width of low-frequency filter (Hz), if applicable (e.g., Ormsby)   | 2     |
| 62        |           | High-frequency filter type used in vol2 processing (see Table 12)   | 2     |
|           | <b>57</b> | Corner frequency of high-frequency filter (Hz)  | 2     |
|           | <b>58</b> | Decay of high-frequency filter (dB/octave)  | 2     |
|           | <b>59</b> | Roll-off width of high-frequency filter (Hz), if applicable (e.g., Ormsby)  | 2     |

## Contents of Integer and Real Headers

| Param.No. |            | Parameter Description  | First |
|-----------|------------|--|-------|
| I         | R          |  | Used  |
| 64        | <b>60</b>  | Filtering domain flag (1 if filter applied in time domain, 2 if applied in frequency domain) | 2     |
|           |            | Length of filter operator (secs), if time domain filtering                                   | 2     |
| 65        |            | Special-processing flag (0=normal; 1=special, described in comment lines)                    | 2     |
|           |            | <b><u>Time History Parameters</u></b>  |       |
|           | <b>62</b>  | Sample interval of time series in file (dt, in msec)   |       |
|           | <b>63</b>  | Length of time series in file (i.e., npts*dt)  |       |
|           | <b>64</b>  | Maximum value of time series in file   | 0     |
|           | <b>65</b>  | Time at which maximum value occurs (secs after start)  | 0     |
|           | <b>66</b>  | Average value of time series   |       |
|           |            | <b>Initial values associated with numerical integration (if applicable)</b>                  |       |
|           | <b>68</b>  | Initial velocity value (cm/sec)  | 2     |
|           | <b>69</b>  | Initial displacement value (cm).   | 2     |
|           |            | <b><u>Response Spectrum Parameters</u></b>   |       |
| 70        |            | Number of periods for which response spectra are computed                                    | 3     |
| 71        |            | Number of damping values for which response spectra are computed (typically 5)               | 3     |
|           |            | Sa spectrum values for 5% damping:   |       |
|           | <b>70</b>  | Value of Sa at 0.2 seconds period (g).   | 3     |
|           | <b>71</b>  | Value of Sa at 0.3 seconds period (g).   | 3     |
|           | <b>72</b>  | Value of Sa at 1.0 second period (g)   | 3     |
|           | <b>73</b>  | Value of Sa at 3.0 seconds period (g).   | 3     |
|           | <b>74</b>  | Maximum value of Sa spectrum (g).  | 3     |
|           | <b>75</b>  | Period at which maximum Sa occurs (secs)   | 3     |
|           | <b>76</b>  | Time in record at which above maximum occurs (secs)  | 3     |
|           |            | <b><u>Computed Parameters</u></b>  |       |
|           | <b>80</b>  | Duration, bracketed (secs over 5% g)   | 2     |
|           | <b>81</b>  | Duration, interval (5-75%, in secs).   | 2     |
|           | <b>82</b>  | RMS of channel.  | 2     |
|           | <b>83</b>  | Cumulative absolute velocity (m/s)   | 2     |
|           | <b>84</b>  | Housner Intensity (SI).  | 2     |
|           | <b>85</b>  | Arias Intensity.   | 2     |
|           |            | <b><u>Miscellaneous</u></b>  |       |
|           | <b>88</b>  | Scaling factor used to convert Vol1 units (g) to cm/s <sup>2</sup> (e.g., 980.665)           | 2     |
| 75        |            | Nominal-constants indicator (1 if nominal sensor constants used in processing)               | 1     |
| 76        |            | Record problem indicator (0 = No problem; 1=fixed, 2=unfixed problem; see comments)          | 0     |
| 77        |            | Instance code/processing index number  |       |
|           |            | <b><u>Auxiliary internal parameters used by networks</u></b>                                 |       |
| 80 -      | <b>90-</b> | Parameters assigned and used in internal processing and quality-control                      |       |
| 100       | <b>100</b> | procedures by individual networks  |       |

### Notes:

- 1) For a V3 (response spectrum) file, parameters such as Ihdr(2), etc. are not applicable and may be set to zero.
- 2) If the frequency response of a sensor is given in terms of poles and zero rather than simply by natural frequency and damping (i.e., Rhdr(40) and Rhdr(41)), those parameters can be set to the null/unspecified value (given on line 13 in the Text header) and the poles and zeroes be stored in the supplemental parameters, with a note to that effect stored in the

## Reference Tables

**Table 1. Data Physical  
Parameter Codes**

| <u>Code</u> | <u>Parameter</u>          |
|-------------|---------------------------|
| 01          | Acceleration              |
| 02          | Velocity                  |
| 03          | Displacment (absolute)    |
| 04          | Displacment (relative)    |
| :           |                           |
| 10          | Angular acceleration      |
| 11          | Angular velocity          |
| 12          | Angular displacement      |
| :           |                           |
| 20          | Pressure, absolute        |
| 21          | Pressure, relative (gage) |
| :           |                           |
| 30          | Volumetric strain         |
| 31          | Linear strain             |
| :           |                           |

**Table 2. Data Units Codes**

| <u>Code</u> | <u>Units</u> | <u>Code</u> | <u>Units</u> |
|-------------|--------------|-------------|--------------|
| 01          | sec          | 50          | counts       |
| 02          | g            | 51          | volts        |
| 03          | secs & g     | 52          | mvolts       |
| 04          | cm/sec/sec   | :           |              |
| 05          | cm/sec       | 60          | psi          |
| 06          | cm           | 61          |              |
| 07          | in/sec/sec   | :           |              |
| 08          | in/sec       | 80          | μstrain      |
| 09          | in.          | :           |              |
| 10          | gal          |             |              |
| 11          | mg           |             |              |
| 12          | μg           |             |              |
| :           |              |             |              |
| 23          | deg/sec/sec  |             |              |
| 24          | deg/sec      |             |              |
| 25          | deg          |             |              |
| :           |              |             |              |

**Table 3. Record Types**

| <u>Code</u> | <u>Record type</u>    |
|-------------|-----------------------|
| 1           | Seismic trigger       |
| 2           | Remote trigger        |
| 3           | Preset trigger        |
| 4           | Manual trigger        |
| 5           | Function test         |
| :           |                       |
| 10          | Sensor calibration    |
| 11          | Amplifier calibration |
| 12          | Recorder calibration  |
| 13          | Other calibration     |
| :           |                       |

**Table 4. Strong Motion Network Codes**

| <u>Code</u> | <u>Agency</u>                      | <u>Abbrev.<br/>(4-ltr)</u> | <u>IRIS<br/>Code</u> |
|-------------|------------------------------------|----------------------------|----------------------|
| 1           | U.S. Coast and Geodetic Survey     | C&GS                       | --                   |
| 2           | U.S. Geological Survey             | USGS                       | NP                   |
| 3           | U.S. Bureau of Reclamation         | USBR                       | RE                   |
| 4           | U.S. Army Corps of Engineers       | ACOE                       | --                   |
| 5           | Calif. Div. of Mines and Geology   | CDMG                       | CE                   |
| 6           | Calif. Institute of Technology     | CIT                        | CI                   |
| 7           | UC Berkeley                        | UCB                        | BK                   |
| 8           | ...                                | ..                         | ..                   |
| :           |                                    |                            |                      |
| 100         | CWB, Taiwan Central Weather Bureau | CWB                        | TW                   |
| :           |                                    |                            |                      |

**Table 5. Latitude/Longitude  
Datum Codes**

| <u>Code</u> | <u>Datum</u> |
|-------------|--------------|
| 1           | WGS84        |
| 2           | NAD83        |
| 3           | NAD27        |
| 4           | WGS72        |
| :           |              |

**Table 6. Station Type**

| <u>Code</u> | <u>Freefield, Ground Response or Reference Stations</u>                                |                       |
|-------------|--|-----------------------|
| 1           | Small, fiberglass shelter (typically 1 m x 1 m x 1 m; e.g., T-hut).                    |                       |
| 2           | Small, prefabricated metal building (typically 1-2 m x 1-2 m x 2 m high; e.g., Armco). |                       |
| 3           | Sensors buried/set in ground (shallow, near surface).                                  |                       |
| 4           | Reference station (1-2 story, small, light building).                                  |                       |
| 5           | Base of building larger than above.  |                       |
| :           |  |                       |
|             | <u>Instrumented Structures or Arrays</u>   |                       |
| 10          | Building   | 50 Geotechnical array |
| 11          | Bridge   | 51 Other array        |
| 12          | Dam  | :                     |
| 20          | Other structure  |                       |
| :           |  |                       |

**Table 7. Earthquake Parameter  
Information Sources**

| <u>Code</u> | <u>Agency</u>           |
|-------------|-------------------------|
| 1           | USGS                    |
| 2           | NEIC, Golden, Colo.     |
| 3           | UC Berkeley             |
| 4           | Caltech, Pasadena       |
| 5           | NCSN, Northern Calif.   |
| 6           | SCSN, Pasadena, Calif.  |
| 7           | UCSD, San Diego, Calif. |
| 8           | UNR, Reno, Nevada       |
| 9           | USCGS                   |
| :           |                         |
| 100         | CWB, Taiwan             |
| :           |                         |
| 200         | Other                   |

**Table 8. Recorder Timing Type**

| <u>Code</u> | <u>Time source for record</u>               |
|-------------|---|
| 0           | None  |
| 1           | Recorder clock                              |
| 2           | Auxiliary clock (e.g., TCG)                 |
| 3           | Radio time signal (e.g., WWVB, WWVH)        |
| 4           | Clock that tracks radio signal (WWVB, etc.) |
| 5           | GPS signal                                  |
| :           |   |
| 20          | Other                                       |
| :           |   |

**Table 9. Recorder/Datalogger Codes**

| <u>Code</u>              | <u>Recorder/Datalogger</u>  |
|--------------------------|-----------------------------|
| <b>Analog Recorders</b>  |                             |
| 1                        | C&GS Standard, USC&GS       |
| 2                        | AR-240, Teledyne            |
| 3                        | RFT-250, Teledyne           |
| 4                        | RFT-350, Teledyne           |
| 5                        | MO-2 (New Zealand)          |
| 6                        | RMT-280                     |
| 7                        | SMA-1, Kinematics           |
| 8                        | SMA-2, Kinematics           |
| 9                        | SMA-3, Kinematics           |
| 10                       | CRA-1, Kinematics           |
| :                        |                             |
| <b>Digital Recorders</b> |                             |
| 100                      | DSA-1, Kinematics           |
| 101                      | DSA-3, Kinematics           |
| 102                      | PDR-1, Kinematics           |
| 103                      | PDR-2, Kinematics           |
| 104                      | SSA-1, Kinematics           |
| 105                      | SSA-2, Kinematics           |
| 106                      | SSA-16, Kinematics          |
| 107                      | SSR-1, Kinematics           |
| 108                      | K2, Kinematics              |
| 109                      | Etna, Kinematics            |
| 110                      | Mt Whitney, Kinematics      |
| 111                      | Everest, Kinematics         |
| :                        |                             |
| 200                      | DR-100, Sprengnether        |
| 201                      | DR-200, Sprengnether        |
| 202                      | DR-300, Sprengnether        |
| 202                      | DR-3016, Sprengnether       |
| 203                      | DR-3024, Sprengnether       |
| :                        |                             |
| 300                      | DCA-300, Terratech          |
| 301                      | DCA-310, Terratech          |
| 302                      | DCA-333, Terratech          |
| 310                      | IDS-3602, Terratech (IDS)   |
| 311                      | IDS-3602A, Terratech (IDSA) |
| :                        |                             |
| 400                      | A700, Geotech               |
| 401                      | A800, Geotech               |
| 402                      | A900, Geotech               |
| 403                      | A900A, Geotech              |
| :                        |                             |
| 500                      | GEOS, US Geological Survey  |
| :                        |                             |
| 600                      | Q4120, Quanterra            |
| 601                      | Q4128a, Quanterra           |
| 602                      | Q730, Quanterra             |
| 603                      | Q736, Quanterra             |
| 604                      | Q980, Quanterra             |
| :                        |                             |
| 700                      | 72A, RefTek                 |
| :                        |                             |
| 1000                     | Other                       |
| :                        |                             |

**Table 10. Sensor Codes**

| <u>Code</u>                          | <u>Sensor</u>                    |
|--------------------------------------|----------------------------------|
| <b>Accelerometers</b>                |                                  |
| 1                                    | Optical-mechanical (SMA,RFT,etc) |
| 2                                    | FBA-1, Kinematics                |
| 3                                    | FBA-3, Kinematics                |
| 4                                    | FBA-11, Kinematics               |
| 5                                    | FBA-13, Kinematics               |
| 6                                    | FBA-13DH, Kinematics             |
| 7                                    | FBA-23, Kinematics               |
| 8                                    | FBA-23DH, Kinematics             |
| 20                                   | Episensor, Kinematics            |
| 21                                   | Episensor ES-U, Kinematics       |
| :                                    |                                  |
| 50                                   | FBX-23, Sprengnether             |
| 51                                   | FBX-26, Sprengnether             |
| :                                    |                                  |
| 100                                  | SSA 120, Terratech               |
| 101                                  | SSA 220, Terratech               |
| 102                                  | SSA 320, Terratech               |
| :                                    |                                  |
| 150                                  | 731A, Wilcoxon                   |
| :                                    |                                  |
| 200                                  | CMG-5, Guralp                    |
| :                                    |                                  |
| 900                                  | Other accelerometer              |
| <b>Velocity Sensors/Seismometers</b> |                                  |
| 1001                                 | SS-1 Ranger, Kinematics          |
| :                                    |                                  |
| 1050                                 | S-3000, Sprengnether             |
| :                                    |                                  |
| 1201                                 | CMG-1, Guralp                    |
| 1202                                 | CMG-3T, Guralp                   |
| 1203                                 | CMG-3ESP, Guralp                 |
| 1204                                 | CMG-40, Guralp                   |
| :                                    |                                  |
| 1250                                 | STS-1, Strecheisen               |
| 1251                                 | STS-2, Strecheisen               |
| :                                    |                                  |
| 1300                                 | L4, Mark Products                |
| 1301                                 | L22D, Mark Products              |
| :                                    |                                  |
| 1900                                 | Other seismometer                |
| <b>Other Sensors</b>                 |                                  |
| 3000                                 | Pressure series                  |
| 3000                                 | Pressure series                  |
| :                                    |                                  |
| 3500                                 | Dilatometer series               |
| :                                    |                                  |
| 4000                                 | Relative displacement series     |
| :                                    |                                  |
| 4500                                 | Rotational series                |
| :                                    |                                  |
| 9000                                 | Other sensor                     |



**Table 11. Sensor Direction Codes\***

| <u>Value</u>  | <u>Orientation</u>  | <u>Abbrev.<br/>(4-ltr)</u> |
|---------------|---|----------------------------|
| 1-360         | Horizontal azimuth, clockwise (east) from North   | n/a                        |
| 400           | Up  | Up                         |
| 401           | Down  | Down                       |
| 402           | Vertical, sense not indicated   | Vert                       |
| :             |   |                            |
| 500           | Radial, inward (-500 for outward)   | Radl                       |
| 501           | Transverse, 90 deg CW from radial comp. (-501<br>for CCW from radial comp.)   | Tran                       |
| :             |   |                            |
| :             |   |                            |
| 600           | Longitudinal (relative to structure)  | Long                       |
| 601           | Tangential (relative to structure)  | Tang                       |
| :             |   |                            |
| 700           | H1 (horiz. sensor, azimuth unknown)   | H1                         |
| 701           | H2 (horiz. sensor, azimuth unknown)   | H2                         |
| :             |   |                            |
| 1001-<br>1360 | Horizontal azimuth relative to Chn 1, if absolute<br>not known (e.g., Chn 2 is 1090 if it is 90 deg<br>east of Chn 1) | n/a                        |
| :             |   |                            |
| 2000          | Other (described in comments)   | Othr                       |

\*Note: The direction specified is the direction of motion of the ground (or the structural element the sensor is attached to) that corresponds to upward motion of the trace.

**Table 12. Codes for Filter Types  
used in Processing**

| <u>Code</u> | <u>Filter type</u>                      |
|-------------|---|
| 0           | None                                    |
| 1           | Rectangular                             |
| 2           | Cosine bell                             |
| 3           | Ormsby                                  |
| 4           | Butterworth, single direction (causal)  |
| 5           | Butterworth, bi-directional (noncausal) |
| 6           | Bessel                                  |
| :           |   |