The Society of Exploration Geophysicists

MT / EMAP
Data Interchange Standard

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Introduction

In early 1986, representatives from some of the major users of magnetotelluric (MT) and electromagnetic array profiling (EMAP) data formed an *ad hoc* committee to investigate a standard for the interchange and archiving of data. The original committee consisted of Richard Sigal (Amoco), Truman Holcombe (Standard), Roy Warren (Exxon) and Joe McNutt (Shell).

By June 1986, the committee produced a first draft describing an industry-wide standard for the interchange of MT and EMAP data. Over the course of the next sixteen months, the standard was circulated to a variety of audiences who deal with MT and EMAP data including oil company representatives, contractors, and consultants. A draft was presented to the SEG Technical Standards Committee in November 1986 and copies were circulated to various reviewers. Also during this time, a FORTRAN program for reading and writing data in the standard format was implemented. This proved to be very valuable in uncovering discrepancies, inconsistencies, and implementation problems prior to adoption of the standard.

In August 1987, a meeting of the ad hoc committee was held to resolve the remaining issues and approve a final draft. The resulting draft was forwarded to Mr Ben Thigpen, chairman of the SEG Technical Standards Committee, for consideration at the committee's next meeting. After incorporating minor revisions proposed by the SEG Technical Standards Committee, the standard was presented to the SEG Executive committee and was adopted on December 14, 1987.

I would especially like to recognize Richard Sigal of Amoco and Truman Holcombe of Standard Oil for being major contributors to the MT data standard project. Although many people contributed to this data standard, I would like to thank the following persons for providing valuable comments and criticisms which shaped this document: Karen Christopherson and Ransom Reddig of Standard Oil, Dwight Eggers of Arco, Michael Rudder of Exxon, Bob Anderson of Phoenix Geoscience, Arnold Orange of Emerald Exploration, and Francis Bostick of the University of Texas.

In late 1990, an effort was begun to produce a revised description which was easier to use than the original standard. This document, published in October 1991, is the result of that effort. It is hopefully a clearer, easier to use description of the original standard. There have been no changes to the actual standard from the original description published in December 1987. There have, however, been changes in the description designed to make the the standard easier to use:

1. A table of contents has been added, formatting has been improved, and typographical errors have been corrected.

2. Typical examples (clearly labeled and enclosed in boxes) have been added to each block description. Complete EDI examples for stacked spectra and computed MT parameters have been added as appendices.

3. Hints (clearly labeled and enclosed in boxes) have been added. Although not part of the official standard, they offer recommendations and suggestions regarding use and implementation of the standard.

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1.0 INTRODUCTION

This a description of the proposed data format for electrical geophysical data approved at a recent meeting of representatives from several major oil companies who contract for magnetotelluric (MT) and electromagnetic array profiling (EMAP) data. Its primary purpose is to facilitate data exchange from contractors to clients and among clients. It also serves a very important function as a standard format for archiving data.

The format has been designed to accommodate a wide variety of different field measurement configurations and processing requirements which might arise from special applications or new developments. Although very similar in appearance to some existing formats, it has been slightly modified to be more consistent, unambiguous, extensible, and realizable. A number of refinements have been incorporated as a result of actually implementing the standard.

The format can accommodate any currently used data acquisition configuration, and has the flexibility to handle any reasonable future configuration. Supported configurations include single and multi-station MT, telluric-magnetotelluric (TMT) sounding, EMAP profiling, and combinations of the above. Provisions have been made for interchange of data at various levels of acquisition and processing including time series, power spectra, impedance, and computed parameters including non-standard parameters. The data interchange file is always an ASCII file. However, a provision has been made to store actual data values in a parallel binary data file and reference them through the (ASCII) data interchange file.

A standard file for the interchange of data from MT, EMAP, or similar electrical geophysical techniques is called an Electrical Data Interchange (EDI) file.

2.0 PURPOSE AND SCOPE

This document addresses three separate areas:

(1) The physical format and media for data interchange.
(2) Definitions and conventions for representing electrical geophysical data.
(3) The syntax and semantics of a data interchange file.

The first area defines the physical format and media on which data interchange files may reside. Although the only media currently specified by the standard is magnetic tape, there are discussions of the use of non-standard media and data communication channels for data interchange.

Although the syntax and semantics define the set of characters and bytes which comprise the data, they do not, for example, define the units for power spectra or the quadrants for apparent resistivity phase. The use of a unique data block name for each defined data type assures no misunderstandings as to the meaning of a given data block. Provisions have been made for the addition of new data types and for the restricted use of non-standard data types.

The syntax and semantics of an electrical data interchange (EDI) file are completely specified by this document in the same way that a computer language is specified by its manual. In fact, a data interchange file may be thought of as a program written in a “data interchange programming language” as defined in this document. A program which reads data interchange files and converts the data into a usable form is very analogous to a compiler.

3.0 ORGANIZATION OF STANDARD

Section 4 defines the physical format and media on which EDI files may reside. Specifically, it defines the use of magnetic tape, the only currently standardized media. It also discusses the use of non-standard media and data communication channels.

In Section 5 units and conventions are defined for the geophysical quantities which may be represented within an EDI file.

Section 6 first introduces the concept of a context-free grammar and the BNF (Backus-Naur form) notation. This notation will be used in later sections to define the syntax of an EDI file. The section then uses this notation to define a series of constructs which will be the basic constituents of our syntactic definition.

Section 7 provides a high level syntactic and semantic overview of an EDI file. First, it introduces the concepts of data blocks and data sections. Then, it briefly discusses how an EDI file is made up of a Head block, an Info block, a measurement definition section, one or more data sections, and an end block.

Sections 8-20 of the standard provide detailed descriptions of all of the types of data blocks from which EDI files are made. The definitions for data blocks are grouped such that several blocks all having the same characteristics are defined in one place. Each definition includes (1) a list of the data blocks and a brief description of each, (2) a description of the restrictions regarding where in an EDI file the block(s) may appear, (3) a list of options which may be used with the block(s), (4) restrictions on the data set which may be part of the data block, and (5) any other notes regarding the use of the block(s).

Section 21 describes the mechanism for orderly evolution of this standard.

Appendix 1 contains a list of terms and definitions used within this document. Many terms used throughout this document are explained here. It is recommended that this list be read prior to reading the main text of the standard.

Appendix 2 contains a complete summary of the syntax for an EDI file using BNF notation.

Appendix 3 is a diagram summarizing the ordering of data blocks within an EDI file.

Appendices 4 and 5 contain complete example files for MT computed parameters and stacked spectra respectively.

The Reference section lists the sources for the geophysical conventions embraced by this standard.

4.0 PHYSICAL FORMAT AND MEDIA

4.1 Magnetic Tape and Tape Cartridges

At the present time, the only universal media is still 9 track 1/2" magnetic tape. This is the only standard media for electrical data interchange. Tapes must meet the specifications set forth in ANSI standard for unrecorded information interchange X3.40-1976.

The IBM 3480 tape cartridge is rapidly gaining acceptance as a standard media. Therefore, it is also acceptable as an an interchange media. If this media is used, it is to be organized in the same manner as a magnetic tape.

The preferred and recommended media and format for the interchange and archival of electrical geophysical data is:

(1) 1/2" magnetic tape recorded at 1600 characters per inch (CPI) using phase encoding (PE) as specified by ANSI X3.39-1973

The standard, however, allows use of the following alternative media and formats if they are more appropriate:

(2) 1/2" magnetic tape recorded at 800 characters per inch (CPI) using non-return-to-zero inverted (NRZI) encoding as specified by ANSI X3.22-1973.

(3) 1/2" magnetic tape recorded at 6250 characters per inch (CPI) using group -coding as specified by ANSI X3.54-1976.

(4) IBM 3480 compatible 1/2" tape cartridge recorded as specified by ANSII X3B5 (Draft 7 or later) “Proposed Standard for Recorded Magnetic Tape and Cartridge for Information Interchange”.

Whichever format and media are used, they must comply with the corresponding ANSI standard and must be clearly labeled as to which recording format was used for recording. These are standard formats and drivers for reading and writing tapes in these formats are provided on most computer systems. Copies of the ANSI standards cited above are available from:

American National Standards Institute
1430 Broadway
New York, N.Y. 10018

Many computer systems support a flexible record structure and method of writing labels and organizing data on magnetic tapes. Many are unique to a particular computer system. The most available system independent format is the ANSI Standard for Magnetic Tape Labels and File Structure for Information Interchange (X3.27-1978). Although such tape organizations are more versatile, they are not necessary for the exchange of EDI data.

This data interchange standard requires only the following very simple, “least common denominator” record structure and data organization. Tapes written in the following manner can be read or written by almost any computer system. Such tapes are often referred to as “unlabeled tapes”. Most computer systems will provide a “Read/Write Foreign Tape” utility which can read and write tapes in the above format. If such a utility is not available, its simple structure allows a special driver to be written with a minimal effort.

Logical records must always be exactly 80 bytes in length. Space characters (ASCII 32) should be used to pad records. No explicit delimiters such as carriage returns or linefeeds are to be used. Physical records (or blocks) are to always be exactly 2000 bytes. Tapes may be 600, 1200 or 2400 feet as appropriate for the data set.

The first file on the tape, immediately after the beginning of tape (BOT) mark, will be a tape header file. This will be followed by one or more EDI files. There will be exactly one end-of-file mark <EOF> between files and two end-of-file <EOF> marks after the last data interchange file on the tape. The overall tape layout is as follows:

Leader
<BOT>
Tape Header File
<EOF>
Electrical Data Interchange File 1
<EOF>
Electrical Data Interchange File 2
<EOF>
...
Electrical Data Interchange File
<EOF>
<EOF>
Unused tape
<EOT>
Trailer

The contents of the tape header file are not in a fixed format. The header must contain legal ASCII characters (see Sections 6.21, 6.22) which convey all of the following information in a form which is clear and understandable to a person who does not have prior knowledge of the contents of the tape.

(1) Name and address of the creator of the tape.
(2) Date tape was generated.
(3) Computer system on which tape was generated and format information.
(4) Description of data on the tape.
(5) List of file numbers with a brief description of the contents of that file.
(6) If parallel binary data files are included (see Section 6.23), appropriate information must be included to uniquely associate each binary file with the corresponding EDI file.

Example Tape Header File:

Tape Created by: BIG OIL Geophysics
8108 Mesa Drive
Austin, Texas

Tape Creation Date: March 19, 1987

Tape Created Using: Hewlett-Packard 9000/320 computer
Hewlett-Packard 7974A tape drive
1600 BPI PE. Rec size = 2000 bytes

This tape contains MT data for the BLEAK prospect in Nolan County, Texas. The data was acquired by Big Oil Geophysics from August 1-Sept 15, 1986. The MT survey consists of 3 lines of MT sites - A, B, and C. For each line, there is an EDI file containing stacked spectra and a separate EDI file containing computed MT parameters.

This tape contains 7 files as follows:

File Number	Description
1	This tape directory file
2	Stacked Spectra - Line A (21 sites)
3	MT Parameters - Line A (21 sites)
4	Stacked Spectra - Line B (15 sites)

5	MT Parameters- Line B (15 sites)
6	Stacked Spectra - Line C (28 sites)
7	MT Parameters - Line C (28 sites)

4.2 File on Other Media

Even though magnetic tape and IBM 3480 compatible tape cartridges are the only media specified in this standard, many contractors and oil companies have computer systems which can exchange files using other media. Often the use of other media is more efficient than the use of magnetic tape. By mutual agreement, other media may freely be used for the exchange of EDI files. The device drivers which read and write logical records must, of course, use the same conventions for separation of records. Regardless of the media, the size of a logical record is not to exceed 128 bytes.

Once again, we point out that an EDI file is analogous to the source code file for a program. Its contents do not depend on the physical media or any file system organization on which it resides. Its meaning depends only upon the characters within the file which are organized according to a fixed set of rules.

For archival purposes, however, 9 track 1/2" magnetic tape recorded at 1600 BPI is the only allowed media.

Hints:

1. *DOS format floppies have become widely accepted for the exchange of EDI data. A single high-density 3 1/2" floppy disk can hold an EDI file containing stacked spectra or computed parameters for several sites. Another widely accepted media is the quarter inch data tape cartridge written in one of the QIC standard formats. The use of such media for the exchange of data is acceptable so long as both parties agree on the format.*

2. *Note that the directory structure required for 1/2" nine-track magnetic tape is not required when the media format supports its own directory structure. It is recommended, however, that such media include a README file describing the files on the media.*

3. *Note also that all of the 2000 byte blocks, blank padding, etc. specified for 1/2" nine-track magnetic tape do not apply to other media. These media simply use text files to hold the data.*

3. *Although the standard allows record (line) lengths up to 128 characters, it is highly recommended that line lengths be limited to 80 characters so they can be easily viewed and edited on all PC's and terminals.*

4. *For MT data, the recommended deliverable is one EDI file containing a spectra section (>=SPECTRASECT) with stacked spectra for each site in the survey, and a second EDI file containing an MT section (>=MTSECT) for each site in the survey. In this case, the head, info, and measurement definition sections would be identical for the two EDI files.*

5 *If the survey is greater than 25 or 30 sites, it is appropriate to break these into multiple EDI files, for example one for each line. If multiple EDI files are used to hold all of the sites in a survey, the site id's and measurement id's should be unique across all of the EDI files for the survey.*

6. *Sometimes the contractor delivers EDI files to the customer on a daily basis as data is acquired. In this case, each EDI file may contain stacked spectra or computed parameters for only the sites in that day's run. In this case, the site id's and measurement id's should be unique across all of the EDI files for the survey.*

4.3 Data Communications Channel

The exchange of EDI files need not be limited to physical media. Most computer systems now support the exchange of files over data communication links. EDI files can be transmitted from one computer to another using a mutually agreed upon protocol. It is highly recommended that any protocol used for the transmission of EDI files include a mechanism for error checking. As with physical media, the logical record length is not to exceed 128 bytes.

5.0 GEOPHYSICAL DEFINITIONS, CONVENTIONS, AND UNITS

5.1 Angles, Distances, and Locations

All azimuthal angular measurements are in degrees. Absolute angles, such as those in the measurement definition section, are relative to true north. Positive angles represent clockwise rotation and negative angles represent counterclockwise rotation. Angles are always to be reduced to the range of -180 degrees to +180 degrees. Note that impedance phase angles (see Section 5.5), however, are always measured counterclockwise in the complex plane.

The default units for lengths and distances are meters. However, any data block which specifies lengths or distances will include a UNITS= option. Use of the UNITS=FT option indicates that lengths and distances within that block are in feet rather than meters.

Absolute locations are expressed in terms of latitude, longitude, elevation, and (optionally) a brief textual description. Latitudes and longitudes are expressed as DEG:MIN:SEC. North and East are considered positive and South and West are considered negative. Elevations are relative to sea level with positive being upward. Unless the UNITS=FT option is specified, elevations are in meters. The recommended accuracy for latitudes and longitudes (for typical latitudes) is .01 seconds. Textual descriptions might refer to an intersection of two roads, or some other landmark.

5.2 Time Series Data

Because of the system dependent nature of data acquisition, there are no standard units for time series data. Generally, units are integers representing raw data before system response has been removed. If time series data sections are included within an EDI file, a full explanation of the nature of the data MUST be included within the >INFO section. This explanation should adequately describe the response of the measurement and recording system used for acquiring the data.

Because of the tremendous data volume, and its system dependent nature, time series data are not usually included with delivered data. It is only delivered when special reprocessing requirements preclude the use of another form of the data such as power spectra.

Hints:

1. *Although this standard provides a framework for the delivery of time series data in a standard format, the standard is not sufficiently specific to assure data interchangability.*
2. *For data interchange of time series data, it is necessary that both contractor and customer agree on the specifications for the data to be delivered.*
3. *For data archive of time series data, the INFO section must completely and accurately describe the data being delivered.*

5.3 Power Spectra

Average power spectra estimates are often used to represent "raw" MT or EMAP data. Because most processing is done in the frequency domain, they are a convenient representation, and are much more compact than time series.

Power spectra are to be expressed in terms of standard units. Auto and cross power spectra for two electric field measurements are to be in units of $\frac{\left(\frac{mV}{km}\right)^2}{Hz}$. Auto and cross power spectra for two magnetic field measurements are to be in units of $\frac{nT^2}{Hz}$. Cross power spectra for mixed measurements are to be in units of $\frac{nT\left(\frac{mV}{km}\right)}{Hz}$. All spectra are to be normalized for system response and number of samples. Unless specified otherwise by the ROT option, they are assumed to correspond to the measurement directions as defined in the >DEFINEMEAS section.

A >SPECTRA data block contains estimates of all the auto and cross power spectra for a set of measurements for a given frequency and bandwidth. These average spectra estimates are the result of averaging a number of independent spectra estimates. They may be independent in time (e.g. cascade decimation), or in frequency (e.g. FFT), or a combination. These data blocks usually represent the final averages, although the SEGNUM option allows delivery of smaller segments also.

Hints:

1. *Stacked spectra are a good way to deliver "raw" data which may be reprocessed at a later time using alternative processing algorithms. Even if computed parameters are delivered, it may be a good idea to also deliver spectra. Because stacked spectra are a compact representation of the "raw" data, they are often the preferred way of delivering unprocessed data.*
2. *It may be desirable to also have the individual spectra segments prior to stacking. This allows re-stacking of the data at a later time, perhaps resulting in higher data quality. If spectra segments are delivered, it is recommended that they be in addition to final stacked spectra and that they be delivered in a separate EDI file.*

5.4 Impedances

For tensor MT the surface impedance tensor has four components: Z_{xx} , Z_{xy} , Z_{yx} , and Z_{yy} which satisfy the impedance relations:

$$E_x = Z_{xx} H_x + Z_{xy} H_y$$
$$E_y = Z_{yx} H_x + Z_{yy} H_y$$

For EMAP, where only one component of the electric field is measured, it has only two: Z_{xx} and Z_{xy} which satisfy the impedance relation:

$$E_x = Z_{xx} H_x + Z_{xy} H_y$$

It is possible to compute the 4 MT impedance tensor estimates (Z_{xx} , Z_{xy} , Z_{yx} , Z_{yy}) from a set of spectra (in a least-squares sense), in a number of ways depending upon the reference fields used. The reference measurements (R_x , R_y) may be local or remote. For EMAP, impedances may be computed using the H component parallel to the line (Z_{xx}) and using the H component perpendicular to the line (Z_{xy}). For synthetic modeling applications, only Zxy may be required. However, in field acquisition where the line is not completely straight, both impedances must be provided.

For both MT and EMAP data, the option list for the data section will give the electric and magnetic field measurements from which the impedances were computed along with the reference measurements used. Impedances are normally assumed to be least-squares estimates using either local or remote reference measurements. In this case, 6 measurement ID's - Ex, Ey, Hx, Hy, Rx, and Ry must be specified. If another estimation technique has been used (such as L1 norm or averaging several least-squares estimates) it should be indicated using the TYPE option.

Unless specified otherwise by the ROT option, the impedances are assumed to be computed for the measurements in the measurement directions as defined in the >DEFINEMEAS section.

To allow reprocessing of tensor MT data from impedance estimates, the real and imaginary parts of all four impedances should be delivered. Although they may be provided in the measurement directions, it is often more convenient to rotate all of the impedances to either true north or to the strike angle. In the first case the ROT option should specify ROT=NORTH. Alternatively, a >ZROT data block may be included which indicates the rotation angle for each frequency relative to true north, and the ROT option should specify ROT=ZROT.

For EMAP data, the real and imaginary parts for the in-line and perpendicular impedances: ZXX and ZXY, should always be delivered. The spatially filtered impedances, FZXX and FZXY, should also be delivered. Because EMAP impedances are assumed to correspond to the measurement directions, the default ROT option (ROT=NONE) should always be used.

In order to provide rigorous error estimates for the surface impedance tensor elements, one must calculate the variance for the real part, the variance for the imaginary part, and a covariance. This is done in the usual manner for a finite number of estimates of the real and imaginary parts, which are clearly independent functions. This defines an error "ellipse" about the impedance tensor element in the complex plane. The >Z**R.VAR, >Z**I.VAR, and >Z**.COV (where ** is XX, XY, YX, or YY) keywords are provided for the real variance, imaginary variance, and covariance, respectively, for each tensor element. (Section 13.0).

However, the usual practice is to calculate a simplified "variance" as defined by Gamble, 1978, pp. 66-72. This is a real number (an estimate of the average of the variances of the real and imaginary parts) that is the radius of a circle about the tensor element in the complex plane. This circle approximates the error ellipse and for most purposes is an adequate estimate of the statistical uncertainty. The >Z**.VAR keyword is

provided (Section 13.0) for this parameter. This is typically the only error estimate provided for impedance tensor components.

5.5 Apparent Resistivities and Phases

Apparent resistivities are given as:

$$\rho_{ij} = \frac{|Z_{ij}|^2}{\omega\mu} \qquad i, j = x, y$$

(where m is the permeability of free space and w is the frequency in radians), and are in units of W-meters.

The impedance phases are given by:

$$\phi_{ij} = \tan^{-1}\left(\frac{\mathrm{Im}\{ Z_{ij} \}}{\mathrm{Re}\{ Z_{ij} \}} \right) \qquad i, j = x, y$$

and are in degrees measured counterclockwise from the positive real axis in the complex plane. A homogeneous earth requires E and H fields to be in phase. The in-phase condition becomes +45 degrees for Z_{xy} and -135 degrees for Z_{xy} for generally accepted sign conventions for E and H. Note that this differs from the convention followed for azimuthal angles as specified in Section 5.1.

Unless specified otherwise by the ROT option, the impedances are assumed to be computed for the measurements in the measurement directions as defined in the >DEFINEMEAS section.

To allow reprocessing using alternative rotations of apparent resistivities for tensor MT data, the apparent resistivity magnitudes and phases computed from all four tensor impedances should be included. Although they may be delivered in the measurement directions with no >RHOROT data block included, it is often more convenient to rotate all of the apparent resistivities to either true north or to the strike angle. In the first case the ROT option should specify ROT=NORTH. Alternatively, a >RHOROT data block may be included which indicates the rotation angle for each frequency relative to true north, and the ROT option should specify ROT=RHOROT.

In cases where no reprocessing is anticipated, a two-dimensional model is sometimes assumed and the apparent resistivities are rotated such that Rho_{xy} is parallel to the geological strike (or to another agreed upon angle) and Rho_{yx} is perpendicular. In this case, Rho_{xx} and Rho_{yy} are assumed to be negligible and are not included.

For EMAP data, the apparent resistivity magnitudes and phases derived from the impedances computed from the parallel H component (Rho_{xx} and Phs_{xx}), and from the perpendicular H component (Rho_{xy} and Phs_{xy}) should be delivered. The apparent resistivity magnitude and phase from the corresponding spatially filtered impedances: $FRho_{xy}$, $FPhs_{xy}$, $FRho_{xx}$, and $FPhs_{xx}$, should also be delivered.

5.6 Continuous 1-D Inversion

Continuous, one-dimensional inversions can be computed from apparent resistivity data sets. The Bostick inverse is the most common. A continuous inverse consists of two data sets. One record must contain a set of values representing depths which are strictly increasing. The units for the depths are meters unless

the UNITS option specifies UNITS=FT. The second record contains a set of resistivity values which correspond one-to-one with the depth values. It is always in units of W-meters.

Any continuous inversion data blocks in a data section are assumed to be derived from the preceding apparent resistivity data blocks. If this is not true, it should be clearly indicated in the >INFO section. Unless specified otherwise by the ROT option, the inversions are assumed to be computed for the measurements in the measurement directions as defined in the >DEFINEMEAS section.

For tensor MT data, continuous inversions may be delivered for up to four apparent resistivities, although inversions for only RHOXY and RHOYX are usually included. For EMAP data, continuous inversions for the apparent resistivities computed from both the unfiltered and spatially filtered perpendicular impedance (RES1DXY, DEP1DXY, FRES1DXY, and FDEP1DXY) should be delivered. Optionally, continuous inversions for the apparent resistivities computed from both the unfiltered and spatially filtered parallel impedance (RES1DXY, DEP1DXX, FRES1DXX, and FDEP1DXX) may also be delivered.

The TYPE option should clearly indicate the technique used for inversion. If additional explanation is indicated, it should be in the >INFO section. For Bostick inversion, the type should indicate whether the apparent resistivity amplitudes (TYPE=BOSTICK-AMP) or Hilbert transform of the phase (TYPE=BOSTICK-PHS) data was used for estimating the slopes used in the inversion.

5.7 Signal Amplitude and Coherencies

The signal amplitude and coherencies are used in evaluating data quality, and identifying the source(s) of noise in the data. For identifying the source(s) of noise in the data it is most useful to have these parameters in the direction of the acquisition sensors, and for evaluating data quality it is most useful to have these parameters in the direction of the apparent resistivities. The orientation of these parameters can be specified using the ROT option. This option may be ROT=NONE, meaning that the parameters correspond to the measurement directions, ROT=RHOROT, meaning that the parameters correspond to the rotation angles given in the >RHOROT block, or RHO=NORTH, meaning that the parameters have been rotated to true north. The default is ROT=NONE.

The signal amplitude or power spectral density for any measurement can be delivered using a SIGAMP data block. The signal level may be useful in diagnosing poor data. The default for SIGAMP data is amplitude spectra. However, the option AMPPWR=PWR can be used to provide auto-power spectra instead. The units are the same as those for >SPECTRA data blocks (see Section 5.3), except, of course, for the appropriate amplitude/power conversion. The EUNITS or HUNITS option (as appropriate) may be used to specify the units if other than the default.

The signal amplitude (or power spectral density) can either be calculated from the total field (including the noise amplitude) or estimated using a remote field to eliminate the noise amplitude (Gambel, 1978). The default for the signal amplitude is the total field; however, the option TYPE=SIGNAL or TYPE=NOISE can be used to deliver the estimated signal or estimated noise.

For any two measurements A and B (in the temporal frequency domain), the coherency between A and B is defined as:

$$COH = \frac{| < A\ B^* > |^2}{< A\ A^* > \quad < B\ B^* >}$$

A and B are commonly the orthogonal electric and magnetic fields.

One can use an estimate of the impedance tensor to compute predicted E's, PE_x and PE_y, from the measured H's as:

$$PE_x = Z_{xx}\ H_x + Z_{xy}\ H_y$$
$$PE_y = Z_{yx}\ H_x + Z_{yy}\ H_y$$

In a similar manner, one can use an estimate of the admittance tensor to compute predicted H's, PHx and PHx from measured E's:

$$PH_x = Y_{xx}\ E_x + Y_{xy}\ E_y$$
$$PH_y = Y_{yx}\ E_x + Y_{yx}\ E_y$$

The E-predicted coherency can be computed using the predicted E and the orthogonal measured H, or an H-predicted coherency can be computed using the predicted H and measured E.

5.8 Parameters Calculated for Surface Impedance Tensor and Tipper

The impedance principal direction or "strike" (see >ZSTRIKE in Section 18.0) can be defined in many ways. For example it can be defined as the angle which:

1) Maximizes $\left|Z'_{xy} + Z'_{yx}\right|^2$,
2) Maximizes $\left|Z'_{xy}\right|^2 + \left|Z'_{yx}\right|^2$,
3) Minimizes $\left|Z'_{xx}\right|^2 + \left|Z'_{yy}\right|^2$, or
4) Minimizes $\left|Z'_{xx} + Z'_{yy}\right|^2$;

where Z'_{xx}, Z'_{xy}, Z'_{yx}, and Z'_{yy} are the impedances rotated to the impedance strike angle. The principal direction, A, may be determined by incrementally rotating the impedance tensor, or alternatively it may be calculated analytically from the maximization of $\left|Z'_{xy} + Z'_{yx}\right|^2$ (Sims and Bostick, 1969) as:

$$A = \frac{1}{4} * \tan^{-1}\left(\frac{2R_1 * R_2 + I_1 * I_2}{R_1^2 + I_1^2 - R_2^2 - I_2^2}\right)$$

where $R1 = Re\left\{Z_{xx} - Z_{yy}\right\}$,
$I1 = Im\left\{Z_{xx} - Z_{xy}\right\}$,
$R2 = Re\left\{Z_{xy} + Z_{yx}\right\}$,
and $I2 = Im\left\{Z_{xy} + Z_{yx}\right\}$,

or from an eigenstate formulation (Eggers, 1982) (Section 5.10). For a perfect two-dimensional earth, the same angle will satisfy all of these relationships. In actual field data, typically a three-dimensional anisotropic environment, the different methods produce different principal directions. However, in most interpretable situations they are not significantly different. There is an inherent 90 degree ambiguity in the calculated principal directions which can only be resolved by interpreting the off-diagonal element (Z_{xy} or Z_{yx}) of the rotated impedance tensor best represents the E-parallel (TE) mode and which the E-perpendicular (TM) mode. In practice, this is sometimes attempted by the field data acquisition crew, but more often is an interpretation task done after the fact. In any case, the method used to calculate the

principal directions and resolve its ambiguities (if attempted) should always be documented or referenced in the >INFO text.

The impedance skew (See >ZSKEW in Section 18.0) is usually defined as

$$ZSKEW = \frac{\left|Z'_{xx} + Z'_{yy}\right|}{\left|Z'_{xy} - Z'_{yx}\right|}$$

where Z'_{xx} , Z'_{xy} , Z'_{yx} , and Z'_{yy} are the rotated impedance elements. Any departure from this definition should be documented in the >INFO text.

The impedance ellipticity (See >ZELLIP in Section 18.0) is usually defined as

$$ZELLIP = \frac{\left|(Z_{xx} - Z_{yy}) * \cos(2A) + (Z_{xy} + Z_{yx}) * \sin(2A)\right|}{\left|(Z_{xy} + Z_{yx}) * \cos(2A) + (Z_{xx} - Z_{yy}) * \sin(2A)\right|}$$

where A is the calculated impedance principal direction. Any departure from this definition should be documented in the >INFO text.

The complex tipper components, Tx and Ty, satisfy the tipper relation:

$$Hz = T_x \ H_x + T_y \ H_y$$

The tipper relation above may be solved for Tx and Ty using either local or remote reference fields, Rx and Ry, as in the impedance case. Thus, the computation of the tipper parameters, Tx and Ty (in a least-squares sense) can be described by specifying 5 measurements: Hx, Hy, Hz, Rx, and Ry, where Rx and Ry may be coincident with Hx and Hy (local reference) or may be other measurements (remote reference).

From Tx and Ty, the tipper magnitude and tipper phase can be defined as:

$$TIPMAG = \sqrt{|Tx|^2 + |Ty|^2}$$

$$TIPPHS = \frac{|Tx|^2 * Phs(Tx) + |Ty|^2 * Phs(Ty)}{|Tx|^2 + |Ty|^2}$$

In a manner similar to the impedance principal direction, the tipper principal direction (see >TSTRIKE in Section 18.0) can be defined as the angle which:

(1) Minimizes $|T'_x|^2$

(2) Maximizes $|T'_y|^2$ or

(3) Maximizes $|T'_y|^2 + |T'_x|^2$

where T 'x and T 'y are the tipper components rotated to the tipper strike angle. However, this method has the same 90 degree ambiguity as the impedance principal direction defined earlier. An alternative, preferred method for defining the tipper principal direction, B, is given by Jupp and Vozoff, 1976:

$$B = \frac{(TxR^2 + TyR^2) * \tan^{-1}\left(\frac{TyR}{TxR}\right) + (TxI^2 + TyI^2) * \tan^{-1}\left(\frac{TyI}{TxI}\right) + 90}{|Tx|^2 + |Ty|^2}$$

where TxR, TxI, TyR, and TyI represent the real and imaginary parts of Tx and Ty respectively, and B is measured clockwise from true north in the defined azimuthal coordinate system. This is the angle which maximizes the coherency between the vertical and horizontal magnetic field. It has an inherent ambiguity of plus or minus 180 degrees. However, one can choose the principal direction for which the phase of COH(H'z,H'x) (the coherency between the vertical magnetic field, Hz, and the horizontal field component, Hx, rotated to the chosen principal direction) falls between +90 degrees and -90 degrees from the real axis in the complex plane.

The tipper principal direction defined in this way is unambiguous for a perfect two-dimensional earth, that is, it always points toward the resistive side of the contact which induces the vertical magnetic field component. The preferred definition of keyword >TSTRIKE is then B plus 90 degrees. Again, the method for determining tipper strike should always be documented or referenced in the >INFO text.

5.9 Spatial Filter Parameters

The width of the spatial filters used for EMAP processing can be delivered for examination or for use in reprocessing. A filter parameter represents the length of a spatial filter which is applied to the impedances. This filter length may be expressed in terms of distance units (FILWIDTH) or in terms of equivalent dipole lengths (EQUIVLEN). For a non-straight EMAP line, a filter angle (FILANGLE) is also required.

5.10 Alternate Processing Techniques

Alternative methods for computation of apparent resistivities have been presented by Eggers (1982) and LaTorraca (1986). Data to be delivered if using these methods includes eigenvalues, principal axis directions for eigenvectors, eigenvectors (complex), appropriate ellipticities, skews, and the apparent resistivities corresponding to the eigenvalues.

Although no data blocks have been provided for this information, .EXP blocks can be used to deliver all of these parameters. The use of .EXP blocks should always be fully documented in the >INFO text.

6.0 SYNTACTIC DEFINITIONS AND CONVENTIONS

6.1 Context-Free Grammars and BNF Notation

For the syntactic specification of a data interchange file, we shall use a notation called a context-free grammar (or grammar, for short). This is also called a BNF (Backus-Naur Form) description. This notation has been borrowed from the designers of programming languages (Aho and Ullman, 1978). It has a number of advantages as a method of syntax specification:

(1) A grammar gives a precise, yet easy to understand, syntactic specification.

(2) An efficient parser can be constructed automatically from a properly designed grammar. Certain parser construction processes can reveal syntactic ambiguities and other difficult to parse constructs which might otherwise go undetected in the initial specification of the syntax.

(3) A grammar imparts a structure to a syntax that is useful for its translation into a usable form and for the detection of errors.

In general, our grammar is constructed from terminals, nonterminals, and productions. The basic elements which comprise our data interchange file are ASCII characters. These are our terminals. Nonterminals are special symbols such as <integer> which denote a set of particular terminals arranged in a particular way. Productions define the ways in which nonterminals may be built up from one another and from terminals.

The following symbols are meta-symbols belonging to the BNF formalism, and are not symbols (unless explicitly noted) in our syntax definition:

“A”	A character inside of double quotes represents that ASCII character.
/nnn	A slash followed by 3 decimal digits represents the ASCII character with the character code nnn. This is generally used for non-printing characters.
“ ”	Two double quotes denote the empty terminal symbol, i.e., no character.
<string>	A string enclosed in < > denotes a nonterminal.
::=	Two colons and an equal defines a production. Read it as “is defined as”.
|	A vertical bar means “or”.
“A”..“Z”	Two characters, specified by either of the two conventions above, separated by two periods is a shorthand notation for any one of the characters in the indicated range. (e.g. “A”..“Z” ::= “A” | “B” | ... “Y” | “Z”)
{ }	A pair of curley brackets denote the repetition of the enclosed symbols zero or more times.
{ }+	A pair of curly brackets followed by a plus denote repetition of the enclosed symbols one or more times.
( )	Parentheses may be used to indicate precedence. Normally, concatenation (ordering) has the highest precedence, followed next by |, then finally { } and { }+, all being evaluated left to right.

6.2 Syntactic Definitions

6.21 Character Set

The following productions divide all of the 256 possible values for an 8 bit ASCII character code into various character sets. The nonterminals defined here will be used in later productions.

```
<upc_letter>    ::= “A” .. “Z”
<lwc_letter>    ::= “a” .. “z”
<digit>         ::= “0” .. “9”
<special>       ::= “>”
<other>         ::= “!” | “ ' ” | “#” | “$” | “%” | “&” | “(” | “)” |
                    “*” | “+” | “,” | “-” | “.” | “/” | “:” | “;” | “<” |
                    “=” | “?” | “@” | “[” | “\” | “]” | “^” | “_” | “ ` ” |
                    “{” | “|” | “}” | “~”
<space>         ::= “ ”
```

```
<null>          ::= /000 | /010 |  /013
<illegal>       ::= /001 .. /009 | /011 .. /012 | /014 .. /031 |
                    /127 .. /255
```

Alternatively, we could have used the /nnn form to represent all of our sets:

```
<upc_letter>    ::=  /065 .. /090
<lwc_letter>    ::=  /097 .. /122
<digit>         ::=  /048 .. /057
<special>       ::=  /062
<other>         ::=  /033 .. /047 | /058 .. /061 | /063 .. /064 |
                      /091 .. /096 | /123 .. /126
<space>         ::=  /032
<null>          ::=  /000 | /010 | /013
<illegal>       ::=  /000 .. /009 | /011 .. /012 | /014 .. /031 |
                     /127 .. /255
```

Spaces (/032) are preserved as data are read. Spaces may serve as delimiters, be used to enhance readability, or can be used to pad logical records.

The syntax of an EDI file is based only upon a stream of characters, neither physical nor logical records have syntactic significance. The mechanism for separating both physical and logical records is implemented by the system's device drivers. No other explicit record terminators are to be added when writing an EDI file. With the exception of three characters described below, only printing characters may be in EDI files.

For magnetic tape (Section 4.1) or any other media (Section 4.2), the system device drivers define the mechanism for record separation. The mechanism used by the system for record separation should be transparent to an application program which simply calls the system's read and write record routines.

However, because different computer systems may be used for reading and writing interchange files, the device drivers could fail to remove all of the record separators. Carriage return (/013) and linefeed (/010) characters (sometimes used by systems as logical record separators) could in some cases appear as part of the data. In like manner, ASCII null (/000) characters (sometimes used for padding physical records) could in some cases appear as part of the data.

Therefore, the three ASCII characters: carriage return, linefeed, and null are tolerated within the data but are to be completely ignored. The presence of any other non-printing ASCII characters within an EDI file is considered to be an error.

6.22 Strings and Numbers

We can simply define nonterminals for strings, numbers, and other simple syntactic constructs as follows:

```
<letter>        ::=  <upc_letter> | <lwc_letter>
<legal_char>    ::=  <letter> | <digit> | <other>
<unsign_int>    ::=  { <digit> }+
<unsign_real>   ::=  <unsign_int> "." <unsign_int> | <unsign_int> "." | "." <unsign_int>
<sign>          ::=  "+" | "-"
<int>           ::=  ( <sign> | " " ) <unsign_int>
<real>          ::=  ( <sign> | " " ) <unsign_real>
<exp>           ::=  <real> "E" <int>
<string>        ::=  { <legal_char> }+ | ( " " " { <legal_char> | " " } " " " )
<number>        ::=  <int> | <real> | <exp>
<date>          ::=  <digit> <digit> "/" <digit> <digit> "/" <digit> <digit>
```

<lat_long> ::= <int> ":" <unsign_int> ":" (<unsign_int> | <unsign_real)

6.23 Data

Blocks of data values may be represented with one of two forms:

(1) An ASCII data set consists of the characters "//", followed by a count, followed by a set of data values. The count and all data values are represented by textual representations for <number>. (Section 6.22).

(2) A Binary data set is represented in an EDI file by one of three special sets of characters which mean "read binary data from the current position in the open binary data file". The three special character sets "/I/", "/R/", and "/D/" corresponding to the three forms of binary data: INTEGER (two's complement 16 bit integers), REAL (IEEE format 32 bit reals), and DOUBLE (IEEE format 64 bit reals).

An ASCII data set begins with two slash characters, "//". This is followed by a count, and then the actual data values. The count is an integer in the range 0 to 32767. A count of zero means that the data set is empty. The number of data values must be EXACTLY the same as the count. Any or all of the data values may be represented with a special value meaning "there is no value for this data point". This value is determined by the EMPTY option in the >HEAD block (Section 8.0). If the option is not specified, its static default value is 1.00E+32.

In BNF notation, an ASCII data set is represented as:

<ascii_data_set> ::= "//" <unsign_int> { <number> }

EDI files are always ASCII files, made up of readable, printable characters. However, a mechanism is provided for a parallel binary file containing data values in binary form. The BINDATA option in the >HEAD block (Section 8.0) allows the EDI file to reference another file which must contain only binary data.

If the BINDATA option is the null string (null is the static default), then the EDI file must contain only ASCII data. If the BINDATA option is not null, then it assumed that some or all data values will be read from a parallel binary file. When reading an EDI file which references binary data, the user will have to tell the reading program the name of the binary file to be used. Sufficient information must be provided in the tape header or through other means for the user to relate binary files to EDI files.

The appropriate binary file will be opened and rewound at the time the EDI file is opened. The first item in the binary file is a 16 character file tag (written with a FORTRAN 16A image or equivalent) which identifies the data set. This file tag must exactly agree with the string in the BINDATA option in the >HEAD block or a mismatch error occurs.

Data sets will always be read sequentially from that current file pointer position in the binary file. A data set consists of a count and a set of data values. The count is a 16 bit two's-complement integer (FORTRAN INTEGER*16 or equivalent). It gives the number of values in the data set, 0 to 32767. A count of zero represents an empty data set. The data values which follow are in one of the three supported binary formats. The number of values must be EXACTLY equal to the value of count. Any or all of the data values may be represented with a special value meaning "there is no value for this data point". This value is determined by the EMPTY option in the >HEAD block (Section 8.0). If the option is not specified, its static default value is 1.00E+32 (be careful to use a value which is exactly representable in the specified format).

Hint:	*The use of binary data is discouraged except in situations where the volume of data makes it impractical to use an ASCII representation. In practice, time series data (>TSERIES) blocks are the only place where this might occur (see Section 10.2).*

In BNF notation, binary data are represented (in the EDI file) as:

<bin_data_set> ::= "/I/" | "/R/" | "/D/"

A measurement ID set is a special case of a data set. It cannot be a binary data set. Its elements must be unsigned integers or unsigned reals. In BNF notation it may be represented as:

<meas_ID_set> ::= "//" <unsign_int> { <unsign_int> | <unsign_real> }

In summary, the BNF notation for a data set is represented as:

<data_set> ::= <ascii_data_set> | <bin_data_set> | <meas_ID_set>

ASCII should be considered the primary method for data representation in an EDI file. A provision for handling binary data has been included to accommodate very large data sets such as time series where the more compact representation of data is absolutely necessary.

6.24 Option Lists

Option lists may be a part of many of the data blocks defined below. An option list is simply a sequence of option names followed by a corresponding option argument. The option name is an abbreviated mnemonic keyword such as NCHAN for number of channels or BW for bandwidth. The option argument may be a string, a number, a date, or a lat/long. All of these were syntactically defined in Section 6.22. The option name and option argument are always separated by an equals sign. In BNF notation:

<option_name> ::= <letter> { <letter> | <digit> }
<option arg> ::= <string> | <number> | <date> | <real> | <lat_long>
<option> ::= <option name> "=" <option arg>
<option list> ::= { <option> }

A list of allowed options is given for each keyword in sections 8-20. Included in the list are any restrictions and defaults for each option. Default values for options are applied if an option is omitted from the option list. Options may be required, have static defaults, or have dynamic defaults. Dynamic defaults depend upon previously set values. The first block in a new section can define the dynamic defaults for some options. Then, any data block within the section can use the default value by not specifying that option or may specify a different value by specifying the option. There are nine defined dynamic defaults: HX, HY, HZ, EX, EY, RX, RY, NF, and NC.

6.25 Comments

Comments can be placed anywhere in an EDI file where a space could occur except within a data set. A comment begins with the two character sequence ">!" . It is terminated by another exclamation point "!". Between these may be any number of legal characters (Section 6.22) except, of course, for "!". In non-standard annotated BNF notation:

<comment> ::= ">!" {<legal char> } "!"
(Where <legal_char> does not include "!" or ">")

Characters within a comment have no syntactic meaning; they are used simply for enhancing the readability of an EDI file. Comments may not appear within data sets. They cannot be nested. The characters within comments are read from logical records just as the other characters.

7.0 HIGH LEVEL ORGANIZATION OF DATA INTERCHANGE FILES

7.1 Overview

An EDI file is organized very much like the source file for a computer program. Its basic element is a data block (analogous to a program statement). Sometimes, contiguous data blocks are grouped into larger units called data sections (analogous to subroutines). All data blocks begin with a keyword. A keyword is the character ">" followed by 1 to 16 letters. As in a programming language, the type of data block and its semantics depend on what the keyword is. Special keywords, beginning with a right arrow character and an equal character ">=", indicate data blocks which define the beginning of a data section (analogous to SUBROUTINE statements). Following the keyword may be an option list (section 6.24), and following this may be a data set (section 6.23). Whether the option list and/or data set is required depends on the type of the data block. In BNF notation:

```
<keyword>       ::=   ">"  <letter>  {  <letter>  |  <digit>  }
<data_block>    ::=   <keyword>  |
                ::=   <keyword>  <option_list>  |
                ::=   <keyword>  <data_set>  |
                ::=   <keyword>  <option_list>  <data_set>
```

It should be noted that the ">" character is also used to begin comments. Other than keywords and comments, the ">" character should not appear in an EDI file (i.e., not in the >INFO text or within comments). This restriction enables rapid scanning of EDI files.

An EDI file consists basically of the following elements:

(1) A >HEAD block
(2) An >INFO block
(3) Info Text
(4) A Define Measurements Section
(5) One or More Data Sections of the following types
    (a) Time Series Data
    (b) Spectra Data
    (c) MT Data
    (d) EMAP Data
    (e) Other Data
(6) An >END block

Each of these elements is discussed in the sections which follow.

7.2 >HEAD Block

All EDI files must begin with a >HEAD block (analogous to a PROGRAM statement). The >HEAD block uses an option list (Section 6.24) to define a number of conventions which apply to the entire file. It has no data set.

<head_block> ::= ">HEAD" <option_list>

7.3 >INFO Block

Immediately after the >HEAD block, is an >INFO block. It also has an option list but no data set. Following the >INFO block is free-form text. This is the repository for all important notes regarding the acquisition and processing of the data within the file. The info text continues until the next keyword is encountered. In BNF notation:

<info_block> ::= ">INFO" <option_list>
<info_text> ::= { <legal_char> }
(Note: legal character does not include ">")

7.4 >=DEFINEMEAS Section

Following the >INFO text, there must be a define measurements section which defines all of the measurements which will be referenced within the file. Each measurement is assigned a unique measurement ID by which it may later be referenced. It is analogous to the DIMENSION statements in a program. The section begins with a >=DEFINEMEAS block. The option list for this block defines the reference system to be used for sensor locations and other parameters. The block has no data set.

The rest of the define measurements section consists of a series of >EMEAS and >HMEAS data blocks, one for each electric or magnetic field measurement. A measurement references both a channel and a run to uniquely identify a particular set of data. The definition of a measurement includes a complete description of the sensor location(s) and configuration, sensor ID, filters, gain, acquisition channel, etc. (See Channel, Run, and Measurement ID under Terms and Definitions).

Each >EMEAS or >HMEAS block uses an option list to specify the location and orientation of the data sensor(s) as well as information pertaining to the run.

<emeas_block> ::= ">EMEAS" <option_list>
<hmeas_hlock> ::= ">HMEAS" <option_list>
<def_meas_section> ::= ">=DEFINEMEAS" <option_list>
{ <emeas_block> | <hmeas_block> }

7.5 Data Sections

Following the define measurement section may be one or more data sections. Five types of data sections are presently defined: time series data, spectra data, MT data, EMAP data, and other data. Data sections may be in any order and there may be more than one of a given type.

Although data sections are completely independent of one another, it is strongly recommended that the same set of frequencies (and their order) be used for all data sections pertaining to the same data set. For

example, the frequencies for an >=MTSECT data section should be exactly the same as those for the corresponding >=SPECTRASECT data section.

7.51 Time Series Data Sections

If time series data are included in the EDI file, it is in one or more time series data sections. Each time series data section begins with a >=TSERIESSECT block. This block has an option list which defines the number of data measurements and other parameters. It also has a data set which contains an ordered list of the measurement ID's which define the set of measurements for which data are presented.

The rest of the section consists of one or more >TSERIES blocks. Each block has an option list which completely describes the organization of the time series data. This block has an option list which defines the number of data measurements and other parameters. It also has a data set which contains an ordered list of the measurement ID's which define the set of measurements for which data are presented. Following this is a data set which contains the actual time series data. In BNF notation:

<tseriessect_block> ::= ">=TSERIESSECT" <option_list> <mead_ID_set>
<tseries_block> ::= ">TSERIES" <option_list> <data_set>
<tseries_section> ::= <tseriessect_block> { <tseries_block> }

Because acquisition systems vary so much, it is very important that the acquisition hardware and system response be adequately documented or referenced in the >INFO section.

7.52 Spectra Data Sections

If power spectra data are included in the EDI file, it is in one or more spectra data sections. Each spectra data section begins with a >=SPECTRASECT block. This block has an option list which defines the number of data measurements and other parameters. It also has a data set which contains an ordered list of the measurement ID's which define the set of measurements for which data are presented.

The rest of the section consists of one or more >SPECTRA blocks, one for each frequency. Each spec data block has an option list which defines the frequency, bandwidth, and other parameters which characterize the possible auto and cross power spectra for the entire set of measurements.

In BNF notation:.

<spectrasect_block> ::= ">=SPECTRASECT" <option_list> <meas_ID_set>
<spectra_block> ::= ">SPECTRA" <option_list> ";" <data_set>
<spectra_section> ::= <spectrasect_block> { <spectra_block> }

7.53 MT Data Sections

It will often be most convenient to use a separate EDI file for each MT sounding. However, one or more MT soundings may be included in an EDI file, each in its own MT data section. Each of these MT data sections begin with an >=MTSECT data block. The option list for this block contains default measurement ID's for up to five MT components and two references. It has no data set.

If data for multiple rotations are to be presented, a separate >=MTSECT data section should be used for each rotation.

Following the >=MTSECT block must be a >FREQ data block. The data set with this block defines the frequency set for the sounding. Following the >FREQ block are data blocks for the sounding.

First are the impedance data blocks. If the impedances are not in the measurement directions, the first impedance block must be >ZROT. For MT, up to four Z components may be included: ZXX, ZXY, ZYX, and ZYY. For each component, there may be up to 6 data blocks. No provision has been made to include separate data sets for impedance polar diagrams because they can be calculated so easily from the four Z components.

Next are the apparent resistivity data blocks. If the impedances are not in the measurement directions, the first impedance block must be >RHOROT. For MT, up to four apparent resistivities may be included: RHOXX, RHOXY, RHOYX, and RHOYY. For each of these there are corresponding PHS and up to 6 other data blocks.

Next are the continuous 1-D inverse data blocks. There may be up to four inversions corresponding to the four apparent resistivities above. For each of these there may be RES1D and DEPTH1D data blocks.

Finally, are all of the other data blocks for the MT sounding. These include coherencies, predicted coherencies, signal amplitudes, signal-to-noise, up to 8 tipper parameters, strikes, skews, ellipticities, and ".EXP" data blocks.

All of these data blocks are discussed in detail in the sections below. In BNF form, an MT data section can be represented as:

<mtsect_block> ::= ">=MTSECT" <option_list>
<mt_data_block> ::= <keyword> <option_list> <data_set>
<mt_section> ::= <mtsect_block> { <mt_data_block> }

7.54 EMAP Data Sections

An EMAP data section contains an EMAP profile or a section of an EMAP profile. Each of these EMAP data sections begin with an >=EMAPSECT block. This block has an option list which contains the default measurement ID's for the magnetic and reference components. The data set for this block contains an ordered list of measurement ID's which define the EMAP array.

Following the >=EMAPSECT block must be a >FREQ data block which defines the frequency set for the profile. Following the >FREQ block are data blocks for the profile.

First are the impedance data blocks. Impedances for an EMAP profile must be in the measurement directions. Therefore, an EMAP section can not have a >ZROT data block. For an EMAP profile, there are up to two Z components: ZXX and ZXY. There may also be spatially filtered components: FZXX and FZXY. For each component, there may be up to 6 data blocks.

Next are the apparent resistivity data blocks. Because the apparent resistivities for an EMAP profile correspond to the measurement directions, the default for the ROT option, ROT=NONE should be used. For an EMAP profile, up to four apparent resistivities may be included: RHOXX, RHOXY FRHOXX, and FRHOXY . For each of these there are corresponding PHS and up to 6 other data blocks.

Next are the continuous 1-D inverse data blocks. There may be up to four inversions corresponding to the four apparent resistivities above. For each of these there may be RES1D and DEPTH1D data blocks.

Finally, are all of the other data blocks for the EMAP profile. These include coherencies, predicted coherencies, signal amplitudes, signal-to-noise, spatial filter information, and ".EXP" data blocks.

All of these data blocks are discussed in detail in the sections below. In BNF form, an MT data section can be represented as:

<emapsect_block> ::= ">=EMAPSECT" <option_list> <meas_ID_set>

<emap_data_block> ::= <keyword> <option_list> <data_set>
<emap_section> ::= <emapsect_block> { <emap_data_block> }

7.55 Other Data Sections

For defined techniques such as MT and EMAP, data blocks have been ordered and restricted to simplify processing and assure consistent and reasonable data. However, the standard also includes a provision for the unrestricted inclusion data blocks for non-standard applications.

All of these data blocks are discussed in detail in the sections below. In BNF form, an MT data section can be represented as:

<othersect_block> ::= ">=OTHERSECT" <option_list> <meas_ID_set>
<data_block> ::= <keyword> <option_list> <data_set>
<other_section> ::= <othersect_block> { <data_block> }

7.6 >END Block

Finally, the EDI file must conclude with an >END block. It has no option list and no parameters. In BNF notation, it is represented as:

<end_block> ::= ">END"

7.7 >BNF Representation of an EDI File

Using the non-terminals defined in Sections 7.1-7.6, we can represent the syntax of an EDI file as follows:

<edi_file> ::= <head_block>
<info_block>
<info_text>
<def_meas_section>
{ <tseries_section> | spectra_section> |
<mt_section> | <emap_section> | <other_section> }
<end_block>

8.0 HEAD, INFO, FREQUENCY, ZROT, RHOROT, & END BLOCKS

8.1 >HEAD

Description: The head block contains a series of options which (1) identify the data set, (2) describe when, where, and by whom it was acquired, and (3) describe when, how and by whom it was written.

Example:

```
>HEAD
   DATAID=DEMO88
   ACQBY="ACME MT"
   FILEBY="ACME MT"
   ACQDATE=04/30/88
   FILEDATE=06/06/88
   PROSPECT=DEMO88
   LOC="DEMO PROSPECT"
   LAT=+30:20:00
   LONG=-122:20:00
   ELEV=200
   STDVERS="SEG 1.0"
   PROGVERS=1.0
   PROGDATE=08/07/89
   MAXSECT=999
   EMPTY=1.0E+32
```

Restrictions: Exactly one >HEAD block is allowed per file. It must be the first block in the file.

Option Name	Description	Restrictions	Default
DATAID	Identifier for data set	String	Required
ACQBY	Name of contractor or other party	String	Required
FILEBY	Name of contractor or other party	String	Required
ACQDATE	Date of (start of) data acquisition	Date	Required
ENDDATE	Date of end of data acquisition	Date or " "	" "
FILEDATE	Date EDI file was written	Date	Required
COUNTRY	Name of country of acq	String or " "	" "
STATE	State(s) / Province(s) of acq	String or " "	" "
COUNTY	County(s) of acq.	String or " "	" "
PROSPECT	Name of associated prospect(s)	String or " "	" "
LOC	Description of location of Acq	String or " "	" "
LAT	Avg. (approx) latitude of Acq	Latitude or " "	" "
LONG	Avg. (approx) longitude of Acq	Longitude or " "	" "
ELEV	Avg (approx) elevation of Acq	Number or " "	" "
UNITS	Units for elevation	"M" or "FT"	"M"
STDVERS	Version of EDI Format for this file	String	Required
PROGVERS	Version ID for prog writing file	String	Required
PROGDATE	Last Revision of prog writing file	String	Required
MAXSECT	Maximum data sections in EDI file	Integer> =1	"16"
BINDATA	If not " ", tag for binary data file	String or " "	" "
EMPTY	Value which represents "no data"	Number	"1.0E32"

Data Set: None

Notes:

1. The LAT and LONG options are required for measured data, but not for model data.

2. The BINDATA option is " " if there is no parallel binary data file. If one or more of the data blocks in the file refer to binary data, this is a tag which must appear at the very beginning of the binary data file. This assures proper matching of EDI and binary files (Section 6.23).

3. The EMPTY option defines a special value which represents an empty data value. When this value is encountered in any data record in the file, it is interpreted as "there is no value for this data point". Because of the limits in converting between real numbers and their textual representations, care should be taken in selecting this value.

Hints:

1. *Remember that the maximum length for any option argument is 16 characters. If it is a string option and the argument contains blanks, you must enclose the argument in double quotes ""(total length of quoted string is 18 chars). Do not quote numbers, integers, dates, or latitude/longitudes.*

2. *Remember that the format for dates must be mm/dd/yy and the format for latitudes and longitudes is ddd:mm:ss.s. West longitudes are negative.*

3. *Set the DATAID to the name of the survey. Usually the ACQBY and FILEBY will be filled in with the name of the contractor. ACQDATE must be filled in with the date the survey began and FILEDATE must give the date the EDI file was written. All of these fields are required.*

4. *The options ENDDATE, COUNTRY, STATE, COUNTY, PROSPECT, LOC, LAT, LONG, AND ELEV are not required. It is recommended, however, that these be filled in for documentation purposes. If LAT, LONG, and ELEV are set, use the same location as the REFLAT, REFLONG, and REFELEV options in the >=DEFINEMEAS block (see Section 9.1).*

5. *If your distance units for this survey are feet, then you must specify this using the UNITS option. Otherwise, meters will be assumed.*

6. *The options STDVERS must be set to "1.0" (this version of the standard). The PROGVERS and PROGDATE options must be filled in with sufficient information that whoever was listed in the FILEBY option could identify (and hopefully find) the program used to write the EDI file.*

7. *If you have more than 16 data sections (generally a section is the spectra or plots for one site) in this file, then set MAXSECT to an appropriately big value.*

8. *You do not need to specify the BINDATA option unless there is binary data associated with this file. You do not need to specify the EMPTY option unless you are using a value other than 1.0E32 to represent missing data values. USE AN EXPLICIT EMPTY VALUE to represent missing or null data (1.0E32 is recommended). Do not use zero for this purpose.*

8.2 >INFO

Description: The >INFO block indicates the beginning of free-form text. This text section is to contain all important notes concerning data acquisition and processing. Any non-standard practices used must be documented here. The text may not include any legal characters except for the character ">".

Example:

```
>INFO  MAXINFO=2000
```

Run Information

Calibration Files

Project: DEMO PHASE 1
Client: BIGOIL PETROLEUM
Run: DEMO88-101/102

Operator: SMITH
Date: 30 Apr 1988
Time: 15:48:30

Program Version: ACQSYSTEM
Latest Revision: 01 Feb 1988
MT Ref Field: 4 = Rem H Ref
XPR Weighting: RHO VAR STN
XPR Recording Hi Passes: 2
XPR Recording Lo Stacks: 1500
Notch Filters: 60,180,300 Hz
Digitizer: D209

Digitizer: D#209-10Mar88-10
SP--Stn01: B#219-14Mar88-05
SP--Stn02: B#336-14Mar88-05
Sens-Ch01: C#238-11Mar88-01
Sens-Ch02: C#239-11Mar88-01
Sens-Ch03: L#333-12Mar88-01
Sens-Ch06: C#431-11Mar88-01
Sens-Ch07: C#309-11Mar88-01
Sens-Ch08: L#334-12Mar88-01

Operator Log for DEMO88-101/102

DEMO88-101/102

Start: 15:58:30 30 Apr 1988
End: 06:05:26 1 May 1988

Cultural Factors:

People near both sites during daylight hours. Electrical lines 1.2 km to the south.

Weather Conditions:

Dry and very hot. Light breeze at times. Some distant lightning late in evening.

Other Factors:

Low signal levels overnight.

Summary of Stacks & Quality

Freq Num	Unedited Stacks	Edited Stacks	Unedited Quality	Edited Quality
1	2141	1790	.703	.712
2	2141	1662	.746	.773
3	2144	1728	.684	.724
4	2144	1664	.645	.654
5	36797	17901	.612	.635
6	36797	17901	.596	.609
7	18380	9571	.424	.394
8	18380	8947	.338	.302
9	9171	5071	.202	.162
10	9171	4239	.121	.101
11	4467	2409	.049	.037
12	4593	2553	.027	.024
13	2248	1456	.019	.015
14	2188	276	.020	.017
15	1018	126	.016	.023
16	1084	982	.019	.019
17	529	255	.024	.035
18	555	495	.024	.024
19	486	204	.015	.020

```
      20          594          132          .017          .035
-------------------------------------------------------------------------------------------------
```

Restrictions: Exactly one >INFO block is allowed per file. It must be the second block in the file, immediately after the >HEAD block.

Option Name	Description	Restrictions	Default
MAXINFO	Maximum number of text lines in info text (may be less).	Integer >=1	"256"

Data Set: None

Notes: None

Hints:

1. *Be generous with the relevant material you include in the INFO text. Put yourself in the shoes of an interpreter using this data 10 years from now.*
2. *Design your acquisition and processing so that they automatically generate machine readable layout information, operator logs, and data stacking & processing logs. It is then easy to paste these together to create a very complete INFO text.*
3. *Be careful not to include the ">" character anywhere in the INFO text. This is the character used to terminate it. Any text which was typed in such as an operator log should always be scanned for the inclusion of this character.*
4. *You only need to set the MAXINFO option if you are including more than 256 lines of text. Although the standard allows lines (records) up to 128 characters in length, limit your lines to 80 characters so that they can be viewed comfortable on any terminal or PC.*

8.3 >FREQ

Description: Data block containing a set of frequencies in Hz. It defines the frequency set for succeeding data within that data section which are functions of frequency.

Example:

```
>FREQ   //20
  1.20000000E+019.00000000E+006.00000000E+004.50000000E+003.00000000E+00
  2.25000000E+001.50000000E+001.12500000E+00 7.50000000E-01 5.62500000E-01
   3.75000000E-01 2.81250000E-01 1.87500000E-01 1.40625000E-01 9.37500000E-02
   7.03125000E-02 4.68750000E-02 3.51562500E-02 2.34375000E-02 1.75781250E-02
```

Restrictions: Exactly one >FREQ block is required to immediately follow >=MTSECT or >=EMAPSECT blocks. One or more may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF

ORDER	Ordering of frequencies	"INC" or "DEC"	"DEC"
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Must contain NFREQ values in strictly increasing or decreasing order as specified by the ORDER option. The values must be within the legal range for reals and >0. Empty data values and empty data sets (Section 6.23) are not allowed.

Notes:

1. The dynamic default for NF was set by the NFREQ option in the section head block.
2. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *Generally the NFREQ option will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism. The number given in the NFREQ option must be the exactly same number that follows the two slashes "//" and the number of data values. Always begin the actual data values on a new line.*
2. *The frequencies must be monotonic in either increasing or decreasing order. Therefore, if the data was acquired in overlapping bands, the contractor must merge the bands such that the frequencies are in order. If the order is increasing then use the "ORDER=INC" option. Otherwise, decreasing order is assumed.*
3. *The >FREQ block appears only in MT sections (>=MTSECT) and other sections containing computed parameters. It must be the first block in the section. It is not used for spectra sections (>=SPECTRASECT) where each >SPECTRA block has its own frequency.*
4. *Note that the same number of values and order is assumed for all other records in the section (unless the dynamic default is overridden). If you have to sort the frequencies, you must sort all of the other data records in the section the same way.*
5. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

8.4 >ZROT

Description: Data block containing a set of rotation angles used for impedances.

Example:

```
>ZROT   // 20
    5.5246933E+01  3.1937851E+01  3.3514709E+01  2.0876354E+01  2.5652016E+01
    2.5561487E+01  2.8420677E+01  2.7789608E+01  2.7317364E+01  3.2120583E+01
    4.1798073E+01  2.8956604E+01  1.2983720E+01  4.0194614E+01  1.3554901E+01
    2.6992781E+01  1.1652201E+01  2.3906601E+01  2.8832569E+01 -2.7098677E+01
```

Restrictions: One >ZROT block may optionally appear in an >=MTSECT data section. If present, the >ZROT block must immediately follow the >FREQ block. It may not appear in an >=EMAPSECT data section. One or more may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the rotation angles for the impedances at the corresponding frequencies. The values must be within the legal range for angles (Section 5.1). The data set may not contain empty values (Section 6.23). It may not be an empty data set and may not contain binary data (Section 6.23).

Notes:

1. The dynamic default for NF was set by the NFREQ option in the first block of the section.

2. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *The number that follows the two slashes "//" and the number (and order) of data values should be the same as that specified by the NFREQS option in the first data block (>FREQ) in the section. If this is true, it is not necessary to re-specify the NFREQ option here. Always begin the actual data values on a new line.*

2. *The >ZROT block appears only in MT sections (>=MTSECT) and other sections containing computed parameters. It is only needed if you are going to include any impedance (Z) blocks in the section and the ROT option for those blocks is set to ROT=ZROT. It must precede any impedance blocks.*

3. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

8.5 >RHOROT

Description: Data block containing a set of rotation angles used for apparent resistivities.

Example:

```
>RHOROT   // 20
    5.5246933E+01  3.1937851E+01  3.3514709E+01  2.0876354E+01  2.5652016E+01
    2.5561487E+01  2.8420677E+01  2.7789608E+01  2.7317364E+01  3.2120583E+01
    4.1798073E+01  2.8956604E+01  1.2983720E+01  4.0194614E+01  1.3554901E+01
    2.6992781E+01  1.1652201E+01  2.3906601E+01  2.8832569E+01 -2.7098677E+01
```

Restrictions: One >RHOROT block may optionally appear in an >=MTSECT data section. If present, the >RHOROT block must immediately follow the >FREQ block and any impedance blocks. It may not appear in an >=EMAPSECT data section. One or more may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the rotation angles for the apparent resistivities at the corresponding frequencies. The values must be within the legal range for angles (Section 5.1). The data set may not contain empty values (Section 6.23). It may not be an empty data set and may not contain binary data (Section 6.23).

Notes:

1. The dynamic default for NF was set by the NFREQ option in the first block of the section.

2. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *The number that follows the two slashes "//" and the number (and order) of data values should be the same as that specified by the NFREQS option in the first data block (>FREQ) in the section. If this is true, it is not necessary to re-specify the NFREQ option here. Always begin the actual data values on a new line.*

2. *The >RHOROT block appears only in MT sections (>=MTSECT) and other sections containing computed parameters. It is only needed if you are going to include any rho, phase, or res1d blocks in the section and the ROT option for those blocks is set to ROT=RHOROT. It must precede any of these blocks.*

3. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

8.6 >END

Description: Denotes the end of an EDI File.

Example:

```
>END
```

Restrictions: Exactly one >END block is allowed per file. It must be the last block in the file.

Options: None

Data Set: None

8.7 >! Comment !

Description: Begins a comment.

Example:

```
>! This is a comment which can be inserted (almost) anywhere in an EDI file !
```

Restrictions: Comments may appear anywhere in an EDI file where a space may appear except within data sets. Any legal characters may appear within a comment except for "!" and ">".

Notes: >! is only a pseudo keyword which causes all following characters to be syntactically ignored until another exclamation character ! is encountered.

Hints:

1. *The one place where comments can not appear is inside a data set. After an EDI reading program finds "//" followed by a number, it expects to be able to read that many values beginning with the next record. For efficiency a Fortran unformatted read is often used here and it does not understand comments.*
2. *Comments should begin and end on the same line. Although not required, it is better to put comments on their own separate line if possible.*
3. *Be sure that the characters "!" and ">" do not appear within the comment.*
4. *Note that blank lines can appear anywhere in an EDI file except for within a data set (see hint 1 above). They can be used to greatly enhance the readability of an EDI file.*

9.0 MEASUREMENT DEFINITION BLOCKS

9.1 >=DEFINEMEAS

Description: Begins a Measurement Definition data section. Defines locations of sensors and parameters pertaining to runs for each measurement.

Example Measurement Definition Section:

```
>=DEFINEMEAS
      MAXRUN = 999
      MAXMEAS = 1000
      REFTYPE = "UTM 6"
      REFLAT = 30:15:22.2
      REFLONG = -98:16:20.0
>!  Measurements for Site 11.  Located at reference.  100M lines layed out at 45 deg  !
>HMEAS     ID=111.001     CHTYPE=HX     X=0.0          Y=0.0          AZM=45
>HMEAS     ID=112.001     CHTYPE=HY     X=0.0          Y=0.0          AZM=135
>HMEAS     ID=113.001     CHTYPE=HZ     X=0.0          Y=0.0          AZM=0
>EMEAS     ID=114.001     CHTYPE=EX     X=-70.7        Y=-70.7        X2=70.7        Y2=70.7
>EMEAS     ID=115.001     CHTYPE=EY     X=70.7         Y=-70.7        X2=-70.7       Y2=70.7
>!  Measurements for Site 12.  Located at 1 km north and 1 km east of reference.  100M lines layed out at 30
deg  !
>HMEAS     ID=121.001     CHTYPE=HX     X=1000.0       Y=1000.0       AZM=30
>HMEAS     ID=122.001     CHTYPE=HY     X=1000.0       Y=1000.0       AZM=120
>HMEAS     ID=123.001     CHTYPE=HZ     X=1000.0       Y=1000.0       AZM=0
>EMEAS     ID=124.001     CHTYPE=EX     X=913.4        Y=950.0        X2=1086.6      Y2=1050.0
>EMEAS     ID=125.001     CHTYPE=EY     X=1050.0       Y=913.4        X2=950         Y2=1086.6
```

Restrictions: Exactly one instance of a >DEFINEMEAS data block can appear in an EDI file. It must immediately follow the >HEAD block, >INFO block, and info text.

Option Name	Description	Restrictions	Default
MAXCHAN	Maximum number of channels	Integer >=1	“16”
MAXRUN	Maximum number of runs	Integer >=1	“0”
MAXMEAS	Maximum number of measurements	Integer >=1	“64”
UNITS	Units for sensor offsets from reference	“M” or “FT”	“M”
REFTYPE	Type of offset from reference	String	“CART”
REFLOC	Description of location of reference	String or “ ”	“ ”
REFLAT	Latitude of reference	Latitude or “ ”	“ ”
REFLONG	Longitude of reference	Longitude or “ ”	“ ”
REFELEV	Elevation of reference	Number or “ ”	“ ”

Data Set: None

Notes:

1. MAXCHAN is the maximum channel number used in the EDI file. MAXRUN is the maximum run number used in the EDI file. Measurement IDs incorporate both channel number and run number. The integer part is the channel number. There may be a fractional part which gives the run number. The run number for the first run is always 0. Thus, there is no fractional part in the measurement ID's for the first (and often only) run in the file. The number of digits in the fractional part is 2, 3, or 4, depending on the value of the MAXRUN option in the >=DEFINEMEAS data block. If the value is 0 (default), then all measurement IDs are simply the channel number. If the MAXRUN <100, then all measurement IDs are chan num+(run num/100). If MAXRUN is >=100 and <1000 then all measurement IDs are chan num+(run num/1000). Finally, if MAXRUN is >=1000, then measurement IDs are chan num+(run num/10,000).

2. The REFLAT, REFLONG, and REFELEV options are required for measured data, but not for model data.

3. All sensor locations within the section are defined relative to an arbitrary reference location. The reference type describes the Cartesian projection in which X, Y, and Z offsets relative to the reference define a sensor location. The offsets are in meters unless the UNITS=FT option is specified. Positive X, Y, and Z offsets correspond to true north, east, and up from the reference, respectively. Because such a coordinate system begins to deviate after 7-10 minutes of longitude, other reference types may be added to the standard in the future to handle more sophisticated specification of sensor locations.

Hints:

1. *The measurement definition section is always required whether an EDI file contains computed parameters such as an MT section (>=MTSECT) or spectra (>=SPECTRASECT) or both.*

2. *The location of every E and H sensor used to acquire the data in the EDI file is defined in terms of offsets from a single reference location. Positive X is north and positive Y is east.*

3. *The REFLAT and REFLONG options specify the reference location. If the data for a survey is spread across multiple EDI files, it is recommended, but not required that all use the same reference location. The reference location should generally be near the center of the survey. The REFELEV and REFLOC may optionally be provided. If REFELEV is not specified, it is assumed to be zero.*

4. *Each measurement in a survey must have a measurement id which is unique across the entire survey, even if it spans multiple EDI files. The following convention is suggested for generating unique measurement id's.*

$$measid = 10 * site\ number + channel + \frac{run\ number}{1000}$$

where channel =
1 for Hx
2 for Hy
3 for Hz
4 for Ex
5 for Ey
6 for short remote Rx (not part of another site)
7 for short remote Ry (not part of another site)

5. *A run number which is unique across the survey, even if it spans multiple EDI files, is assigned to each acquisition run. Sometimes this is referred to as a "setup". An acquisition crew might make 1 or 2 runs per day, each consisting of one or more sites acquired simultaneously. One simple way to assign run numbers is sequentially, beginning with run 1 at the beginning of the survey.*

6. *The MAXCHAN option needs to be specified only if more than 16 channels are acquired simultaneously. The MAXRUN option should always be set to 999 (this is necessary in order to use the suggested measurement id naming in hint 3 above). The MAXMEAS option should be set to any large value greater than 10 times the maximum site number. The UNITS option should be set to UNITS=FT if feet are to be used to specify the measurement locations within the section. Otherwise, meters are assumed.*

7. *The REFTYPE option is used to describe the coordinate system in which the offsets were computed. The recommended procedure is to use the appropriate Universal Transverse Mercator (UTM) projection. Determine the UTM zone in which the reference location resides and compute its UTM coordinates using the projection for that zone. Use this same UTM projection for computing the UTM coordinates of each site or sensor. Subtract the reference coordinates to get the locations in terms of offsets from the reference.*

9.2 >EMEAS

Description: Defines the electrode locations and run parameters for an electric field measurement.

Example:

```
>! E Measurements for Site 11. Located at reference. 100M lines layed out at 45 deg !
>EMEAS    ID=114.001    CHTYPE=EX    X=-70.7    Y=-70.7    X2=70.7    Y2=70.7
>EMEAS    ID=115.001    CHTYPE=EY    X=70.7     Y=-70.7    X2=-70.7   Y2=70.7
>! E Measurements for Site 12. Located at 1 km north and 1 km east of reference. 100M lines layed out at 30
deg !
>EMEAS    ID=124.001    CHTYPE=EX    X=913.4    Y=950.0    X2=1086.6  Y2=1050.0
>EMEAS    ID=125.001    CHTYPE=EY    X=1050.0   Y=913.4    X2=950     Y2=1086.6
```

Restrictions: Zero or more >EMEAS blocks can appear within the Define measurements section. One block must be included for each electrical field measurement which is used in the EDI file. Note that multiple runs using the same channel are considered to be separate measurements, each requiring an >EMEAS block.

Option Name	Description	Restrictions	Default
ID	Measurement ID	Number >=1	Required
CHTYPE	Type of E measurement	"EX" or "EY"	Required
X	X offset from ref for first electrode	Number	Required
Y	Y offset from ref for first electrode	Number	Required
Z	Z offset from ref for first electrode	Number or " "	" "
X2	X offset from ref for 2nd electrode	Number	Required
Y2	Y offset from ref for 2nd electrode	Number	Required
Z2	Z offset from ref for 2nd electrode	Number or " "	" "

ACQCHAN	Description of acq chan for run	String or " "	" "
FILTER	Description of filter(s) for run	String or " "	" "
GAIN	Gain used for run	Number >0 or " "	" "
MEASDATE	Date of run	Date or " "	" "

Data Set: None

Notes:

1. The type is designated as EX or EY as appropriate.

2. Measurement IDs incorporate both channel number and run number. The integer part is the channel number. There may be a fractional part which gives the run number. The run number for the first run is always 0. Thus, there is no fractional part in the measurement ID's for the first (and often only) run in the file. The number of digits in the fractional part is 2, 3, or 4, depending on the value of the MAXRUN option in the >=DEFINEMEAS data block. If the value is 0 (default), then all measurement IDs are simply the channel number. If the MAXRUN <100, then all measurement IDs are chan num+(run num/100). If MAXRUN is >=100 and <1000 then all measurement IDs are chan num+(run num/1000). Finally, if MAXRUN is >=1000, then measurement IDs are chan num+(run num/10,000).

3. For MT soundings EX usually designates the dipoles most nearly oriented in the north-south direction and EY designates the corresponding orthogonal dipoles. For measurements of type EX, the first electrode is the southern-most of the pair. For measurements of type EY, the first electrode is the western-most of the pair. For EMAP lines, dipoles along the line are generally designated as EX, and any perpendicular dipoles are designated EY. Along the line, the first electrode should be defined consistently such that the first electrode of each dipole is coincident with the second electrode of the previous one.

4. All electrode locations are relative to the reference location defined in the >=DEFINEMEAS block. Currently the only reference type allowed is Cartesian in which X, Y, and Z offsets relative to the reference define an electrode location. The offsets are in meters unless the UNITS=FT option is specified in the >=DEFINEMEAS block. Positive X, Y, and Z offsets correspond to true north, east, and up from the reference, respectively. Because such a coordinate system begins to deviate after 7-10 minutes of longitude, other reference types may be added to the standard in the future to handle more sophisticated specification of sensor locations.

Hints:

1. *Be sure to carefully read all of the hints for >=DEFINEMEAS above.*

2. *The ID option must specify a measurement id which is unique across the survey even if it spans multiple EDIFILES. The following is suggested for generating unique E measurement id's.*

$$measid = 10 * site\ number + channel + \frac{run\ number}{1000}$$

where channel = 4 for Ex
5 for Ey

3. *The CHTYPE option must be set to either EX or EY.*

4. *The coordinate of the first electrode for the E measurement is (X,Y). The coordinate for the second electrode is (X2,Y2). These options must be filled in with the offsets of the electrodes relative to the reference for the entire survey. If you are doing simple MT where electrode geometry is not critical (as it is in EMAP), it is usually sufficient to generate these from the site offset, the line length, and the line azimuth. First, determine the site offset as explained in hint 7 for >=DEFINEMEAS above. Then compute the sensor offsets based on the site offset. For example, assuming an X electrode configuration centered at the site offset:*

   $X = X_{site}$ *- E-length * cos (E-angle)*
   $Y = Y_{site}$ *- E-length * sin (E-angle)*
   $X2 = X_{site}$ *+ E-length * cos (E-angle)*
   $X2 = Y_{site}$ *+ E-length * sin (E-angle)*

5. *The Z and Z2 options do not need to be specified unless topography is being taken into account.*

6. *The options ACQCHAN, FILTER, GAIN, and MEASDATE may be filled in for documentation purposes, but are optional.*

9.3 >HMEAS

Description: Defines the sensor location and orientation, and run parameters for a magnetic field measurement.

Example:

```
>! H Measurements for Site 11. Located at reference. Layed out at 45 deg !
>HMEAS   ID=111.001   CHTYPE=HX   X=0.0      Y=0.0      AZM=45
>HMEAS   ID=112.001   CHTYPE=HY   X=0.0      Y=0.0      AZM=135
>HMEAS   ID=113.001   CHTYPE=HZ   X=0.0      Y=0.0      AZM=0
>! H Measurements for Site 12. Located at 1 km north and 1 km east of reference. Layed out at 30 deg !
>HMEAS   ID=121.001   CHTYPE=HX   X=1000.0   Y=1000.0   AZM=30
>HMEAS   ID=122.001   CHTYPE=HY   X=1000.0   Y=1000.0   AZM=120
>HMEAS   ID=123.001   CHTYPE=HZ   X=1000.0   Y=1000.0   AZM=0
```

Restrictions: Zero or more >HMEAS blocks can appear within the Define measurements section. One block must be included for each magnetic field measurement which is used in the EDI file. Note that multiple runs using the same channel are considered to be separate measurements, each requiring an >HMEAS block.

Option Name	Description	Restrictions	Default
ID	Measurement ID	Number >=1	Required
CHTYPE	Type of H measurement	“HX”,“HY”, or “HZ”	Required
X	X offset from ref for sensor	Number	Required
Y	Y offset from ref for sensor	Number	Required
Z	Z offset from ref for sensor	Number	Required
AZM	Azimuth angle for sensor	Number	Required
DIP	Dip angle for sensor	Number	“0”

ACQCHAN	Description of acq channel for run	String or " "	" "
FILTER	Description of filter(s) for run	String or " "	" "
SENSOR	Description of sensor for run	String or " "	" "
GAIN	Gain used for run	Number >0 or " "	" "
MEASDATE	Date of run	Date or " "	" "

Data Set: None

Notes:

1. If the measurement is a vertical magnetic field measurement, its type should be HZ. Otherwise, it should be HX or HY as appropriate.

2. For MT soundings, HX usually designates the measurements most nearly oriented in the north-south direction, and HY designates the corresponding orthogonal measurements. For EMAP surveys, magnetic field measurements parallel to the line are generally designated as HX, and measurements perpendicular to the line are designated HY.

3. Measurement IDs incorporate both channel number and run number. The integer part is the channel number. There may be a fractional part which gives the run number. The run number for the first run is always 0. Thus, there is no fractional part in the measurement ID's for the first (and often only) run in the file. The number of digits in the fractional part is 2, 3, or 4, depending on the value of the MAXRUN option in the >=DEFINEMEAS data block. If the value is 0 (default), then all measurement IDs are simply the channel number. If the MAXRUN <100, then all measurement IDs are chan num+(run num/100). If MAXRUN is >=100 and <1000 then all measurement IDs are chan num+(run num/1000). Finally, if MAXRUN is >=1000, then measurement IDs are chan num+(run num/10,000).

4. All sensor locations are relative to the reference location defined in the >=DEFINEMEAS block. Currently the only reference type allowed is Cartesian in which X, Y, and Z offsets relative to the reference define an electrode location. The offsets are in meters unless the UNITS=FT option is specified in the >=DEFINEMEAS block. Positive X, Y, and Z offsets correspond to true north, east, and up from the reference, respectively. Because such a coordinate system begins to deviate after 7-10 minutes of longitude, other reference types may be added to the standard in the future to handle more sophisticated specification of sensor locations.

5. Azimuth angles are measured on a level plane, plus or minus 180 degrees relative to true north with positive angles being clockwise. Dip angles are plus or minus 90 degrees relative to that level plane. Loop type sensors should be treated like the equivalent coil; that is, a coil which is normal to, and in the center of the plane defined by the loop sensor.

Hints:

1. *Be sure to carefully read all of the hints for >=DEFINEMEAS above.*

2. *The ID option must specify a measurement id which is unique across the survey even if it spans multiple EDIFILES. The following is suggested for generating unique H measurement id's.*

   $$measid = 10 * site\ number + channel + \frac{run\ number}{1000}$$

   where channel =
   1 for Hx
   2 for Hy
   3 for Hz
   6 for short remote Rx (not part of another site)
   7 for short remote Ry (not part of another site)

3. *The CHTYPE option must be set to either HX, HY, or HZ. There is no channel type RX or RY. Even if it is a reference, it must be an E or an H.*

4. *The coordinate of the H measurement is (X,Y). These options must be filled in with the offsets of the H sensors relative to the reference for the entire survey. For most MT surveys, it is sufficient to assume that all H measurements are made at exactly the site location. Determine the site offset as explained in hint 6 for >=DEFINEMEAS above and use this for the measurement offsets.*

5. *The Z option does not need to be specified unless topography is being taken into account.*

6. *The AZM option must specify its azimuth measured clockwise from true north. For Hz, the AZM option must be specified even though it has no meaning unless the DIP option is also specified. This was done for syntactic consistency among all the H measurements. Fill in zero in this case.*

7. *The options ACQCHAN, FILTER, GAIN, MEASDATE, and SENSOR may be filled in for documentation purposes, but are optional.*

10.0 TIME SERIES BLOCKS

10.1 >=TSERIESSECT

Description: Begins a time series data section. Defines the set of measurements for which time series data are presented.

Example:

```
>=TSERIESSECT
    SECTID=DEMO-1112
    NCHAN=10
    //10
      111.001     112.001     113.001     114.001     115.001     121.001
      122.001     123.001     124.001     125.001
```

Restrictions: One or more instances of a >=TSERIESSECT can appear in an EDI file. Each one begins a new time series data section. It may immediately follow the >HEAD block, >INFO block, and info text, or it may appear after any other data section is complete.

Option Name	Description	Restrictions	Default
SECTID	Identifying name for this section	String or " "	" "
NCHAN	Number channels for time series data	Integer >=1	Required
MAXBLKS	Max number of data blocks in section	Integer >=1	"16"
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NCHAN data values. Each value is a measurement ID for a measurement defined in the >=DEFINEMEAS section. The ordering of the channels in the data set is the order used for the time series data. The data set may not contain empty values (Section 6.23). It may not be an empty data set and may not contain binary data (Section 6.23).

Notes:

1. All data blocks within the section will contain time series data for the set of measurements defined in this block.
2. The dynamic default for NC is set by the NCHAN option.
3. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.
4. Because time series data are highly system dependent, a thorough explanation of the data acquisition procedure and system response should be included in the >INFO block.

Hints:

1. *Although this standard provides a framework to the representation of time series data, it is not precisely defined due to the many system dependencies associated with time series data. Agreement between contractor and client is necessary to assure that the data is usable.*
2. *The >INFO section should contain a full and accurate description of the system dependencies in the data. Specifically, this should address any calibration or system response which is present in the data.*
3. *There should be sufficient information included in the file to remove any system response and produce normalized spectra in standard units.*

10.2 >TSERIES

Description: Single or multi-channel time series data.

Example:

```
>TSERIES   SECTID=b1-s12   NPTS=8   SR=288   // 80
        5744          -7834             45           4542            151          -3344
       23232          13243           1431          12567          -7879           7677
       -6568           7887            -67            178           -878           8008
        9854            -45          32078           4387          -7801           -567
         787          12057          -5870             23           9837           5437
       -5678            243           4580          -4874             46          25637
        3908           7699            -269          -8743           4370           -853
         659          -8759          -7807            329          -6539              4
       -5389           3790          12544         -20878            -67          -7546
         667             98          19875           6549          -7649          19984
         -78         -30199          -6787           -563           6430         -22900
       18220           7870             18           5439          -5292           7690
       -7809           4327          -6654            -78           6564           2316
         898          -9869
```

Restrictions: Zero or more >TSERIES data blocks can appear within a time series data section. A time series data section must begin with a >=TSERIESSECT data block which defines the set of measurements for which time series data are given.

Option Name	Description	Restrictions	Default
SECTID	Identifying name for this section	String or " "	" "
NCHAN	Number of channels	Integer >=1	Dyn NC
NPTS	Number of points/channel	Integer >=1	Required
SR	Sample Rate (Hz)	Number >0	Required
MPX	Multiplex type	"TIME" or "CHAN"	"CHAN"
BAND	Name of frequency band	String or " "	" "
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Exactly (NCHAN x NPTS) data values are to be included in the data set. The values must be within the legal range for reals. The special value for no data (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If the mpx option is MPX=TIME, then the data values multiplexed in time. That is, they are ordered such that the first NCHAN values correspond to the first sample for each of the channels (in the order they appear in the >=TSERIESSECT data set). The next NCHAN values correspond to the second sample, and so on. If the mpx option is MPX=CHAN, then the data values are channel multiplexed. That is, the first NPTS values correspond to the time series data for the first channel, the next NPTS values correspond to the second channel, and so on.

2. The sample rate at which the data was acquired is in Hz. A name for the frequency band may be included using the band option. A complete discussion of the units, calibration, filters, etc. for the acquisition of time series data must be included in the >INFO text.

3. The dynamic default for NC was set by the NCHAN option in the section head block.

4. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *Although this standard provides a framework to the representation of time series data, it is not precisely defined due to the many system dependencies associated with time series data. Agreement between contractor and client is necessary to assure that the data is usable.*

2. *This is generally the only place where the use of a binary data file (see Section 6.23) may be appropriate. Even for time series data, the use of binary data is discouraged.*

3. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

11.0 SPECTRA BLOCKS

11.1 >=SPECTRASECT

Description: Begins a spectra data section. Defines the set of measurements for which spectra data are presented.

Example:

```
>=SPECTRASECT
    SECTID=DEMO-1112
    NCHAN=7
    NFREQ=25
    //7
      111.001      112.001      113.001      114.001      115.001      121.001
      122.001
```

Restrictions: One or more instances of a >=SPECTRASECT can appear in an EDI file. Each one begins a new spectra data section. It may immediately follow the >HEAD block, >INFO block, and info text, or it may appear after any other data section is complete.

Option Name	Description	Restrictions	Default
SECTID	Identifying name for this section	String or " "	" "
NCHAN	Number channels for spectra data	Integer >=1	Required
NFREQ	Number frequencies for spectra data	Integer >=1	Required
MAXBLKS	Max number of data blocks in section	Integer >=1	"16"
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NCHAN data values. Each value is a measurement ID for a measurement defined in the >=DEFINEMEAS section. The ordering of the channels in the data set is the order used for the spectra data. The data set may not contain empty values (Section 6.23). It may not be an empty data set and may not contain binary data (Section 6.23).

Notes:

1. All data blocks within the section will contain a complete set of all auto and cross power spectra for the set of measurements defined in this block.
2. The dynamic default for NC is set by the NCHAN option.
3. The dynamic default for NF is set by the NFREQ option.
4. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *Stacked spectra provide a compact representation of the data which still allows a great deal of flexibility in re-processing. This is a recommended representation for archiving data. It represents a compromise between re-processing flexibility and data compactness.*
2. *Spectra segments allow all the reprocessing flexibility of stacked spectra plus the ability to re-stack the spectra discarding or weighting the various segments.*
3. *The spectra model for EDI is based on a non-sparse matrix representation. Any unavailable spectra terms must be filled in using the "empty" data value (see Section 8.0). The order of the measurement id's in the data set for this block defines the order of the measurements which represent the rows and columns of the spectra matrix.*
4. *Every measurement id in the data set for a >=SPECTRASECT block must be defined in the measurement definition section of that EDI file.*
5. *Although data for multiple sites may be acquired as large spectra matrices (10x10, 15x15, 16x16, or larger), it is recommended that the contractor break this up into a separate spectra section for each site. Each spectra section (for one site) will generally be a 5x5, 7x7, or 9x9 spectra depending on how many remote reference options are practical for the site. By convention, when a spectra section corresponds to a single site, the recommended order for the measurements is HX, HY, HZ, EX, EY, RX1, RY1, RX2, RY2, ...*
6. *The SECTID option for a section corresponding to the spectra for a single site specifies the name to be associated with that site. The recommended form is SSSSSSSS-NNN, where SSSSSSSS is the survey name and NNN is the site number.*
7. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

11.2 >SPECTRA

Description: Auto and cross power spectra data.

Example:

```
>SPECTRA  SECTID=DEMO-11  FREQ=144  BW=36  AVGF=12  AVGT=128  //25
   4.52746406E-07-1.71115211E-08-4.42694681E-09-7.01830118E-07-7.73957981E-06
   4.36456673E-07 4.56306566E-08-1.71640231E-08 3.09438576E-07 6.37708419E-09
   5.58939155E-06 1.00488244E-07-7.48501421E-08 2.94604973E-07 9.91281368E-09
  -4.22392699E-09 4.54804372E-09 1.92081714E-07 2.60549939E-07-5.23433918E-09
   5.64745140E-09-3.90451675E-07-5.53199288E-06-3.02203738E-08 2.29023019E-04
```

Restrictions: Zero or more >SPECTRA data blocks can appear within a spectra data section. A spectra data section must begin with a >=SPECTRASECT data block which defines the set of measurements for which power spectra are given.

Option Name	Description	Restrictions	Default
NCHAN	Number of channels	Integer >=1	Dyn NC
FREQ	Frequency (Hz)	Number >0	Required
ROTSPEC	Rotation angle of spectra	Angle or " "	" "
BW	Bandwidth (Hz)	Number >0	Required
AVGT	Number of independent avgs in time	Number >0	"1"
AVGF	Number of independent avgs in freq	Number >0	"1"
BAND	Name of frequency band	String or " "	" "
SEGNUM	Number identifying a partial spectra	Integer >=0	"0"
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Exactly (NCHAN x NCHAN) data values are to be included in the data set. The data set represents an estimate of the auto and cross power spectra for a set of NCHAN measurements over a particular frequency range. The values must be within the legal range for reals. The special value for empty data (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty. The values are packed as described in note below.

Notes: 1. Crosspower matrices are Hermitian and can be packed as shown in the following example. The complex auto and cross power spectra for 4 channels A, B, C, and D:

	A	B	C	D
A	<AA*>	<AB*>	<AC*>	<AD*>
B	<BA*>	<BB*>	<BC*>	<BD*>
C	<CA*>	<CB*>	<CC*>	<CD*>
D	<DA*>	<DB*>	<DC*>	<DD*>

can be stored as follows:

	A	B	C	D
A	<AA*>	Imag<AB*>	Imag<AC*>	Imag<AD*>
B	Real<AB*>	<BB*>	Imag<BC*>	Imag<BD*>
C	Real<AC*>	Real<BC*>	<CC*>	Imag<CD*>
D	Real<AD*>	Real<BD*>	Real<CD*>	<DD*>

with the real part in the lower left triangle and the imaginary part in the upper right triangle. Note that the auto spectra are real. The only ambiguity is the sign of the imaginary values. This is defined such that the sign associated with the imaginary values is in the upper right triangle of the original matrix is preserved in the compressed matrix. The data set is this compressed matrix, read by row, e.g. <AA*>, Imag<AB*>, Imag<AC*>, ... Real<CD*>, <DD*>.

2. The ordered set of measurements for which spectra are being given is defined by the >=SPECTRASECT block. The ordered list of measurements corresponds to the ordered list "A,B,C,D" in the example above.

3. The value of the FREQ option gives the center frequency of the spectra estimates in Hz. The BW option specifies the bandwidth in Hz between the (half-power) cut-off frequencies.

4. The value of the AVGT option is the number of independent estimates in time which were averaged to make these spectra estimates. Cascade decimation averages constant percentage bandwidth spectra estimates which are independent in time. Weighted averaging can lead to a number of independent samples which is not an integer. The AVGF option is the number of independent estimates in frequency which were averaged to make these spectra estimates. Spectra estimates generated from an FFT are averaged in frequency to produce constant percentage bandwidth spectra. Note that if a number of FFT runs are averaged, both AVGT and AVGF can be greater than 1.

5. If the ROTSPEC option is omitted, the spectra are assumed to be in the measurement directions. If the option is included, it must be an angle representing the (average) rotation angle of the type Ex and Hx channels from true north and the type Ey and Hy channels from east. If sensor layouts are orthogonal, rotation transformations can be applied to all of the horizontal sensor pairs to rotate the spectra. However, if the sensors are not all layed out orthogonally, the meaning of ROTSPEC should be explained in the >INFO text.

6. If the SEGNUM option is omitted, or is zero, then the spectra are assumed to be final averages. The SEGNUM option allows delivery of partial spectra estimates, which can then be averaged as desired to effect a form of data editing. Note that delivery of spectra segments greatly increases the quantity of data.

7. The dynamic default for NC was set by the NCHAN option in the section head block.

8. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *Efforts to standardize sign and conjugation standards for spectra have been hampered by different conventions for sensor polarity, amplifier response, and even Fourier transform definition. Generally, computation of standard MT parameters should produce a phase for the xy component in the first quadrant and a phase for the yx component in the third quadrant.*

2. *There are at least four combinations of spectra sign and conjugation which produce correct rho values and phase quadrants. These different combinations lead to (among other things) different variances (error bars). Only one of these combinations is actually correct. Believable predicted coherencies have proved to be a reasonably good indicator of the correct combination of sign and conjugation.*

3. *Although the spectra blocks within a spectra section may be in any order, it is recommended that they be in monotonically descending order of frequency.*

4. *The preferred rotation for spectra is that all components be rotated such that the x components correspond to true north. A less desirable alternative is to rotate the spectra for the reference measurements to be aligned with the azimuth for the site and to specify the azimuth of the site. The least desirable alternative is to deliver spectra in measurement directions.*

5. *For FTT based processing , AVGF is the number of harmonics averaged and AVGT is the (weighted) number of FFT records stacked. For cascade decimation based processing, AVGF is 1 and AVFT is the (weighted) number of DFT records averaged.*

12.0 MT, EMAP, AND OTHER SECTION HEAD BLOCKS

12.1 >=MTSECT

Description: Begins an MT data section. Defines the default measurements for an MT sounding.

Example:

```
>=MTSECT
    SECTID=DEMO-11
    NFREQ=40
    HX=111.003
    HY=112.003
    HZ=113.003
    EX=113.003
    RX=121.003
    RY=122.003
```

Restrictions: One or more instances of an >=MTSECT can appear in an EDI file. Each one begins a new MT data section. It may immediately follow the >HEAD block, >INFO block, and info text, or it may appear after any other data section is complete.

Option Name	Description	Restrictions	Default
SECTID	Identifying name for this section	String or " "	" "
NFREQ	Number of frequencies	Integer >=1	Required
MAXBLKS	Maximum number of blocks in section	Integer >=1	"64"
HX	Meas ID for Hx measurement	Def Meas ID or " "	" "
HY	Meas ID for Hy measurement	Def Meas ID or " "	" "

HZ	Meas ID for Hz measurement	Def Meas ID or " " " "
EX	Meas ID for Ex measurement	Def Meas ID or " " " "
EY	Meas ID for Ey measurement	Def Meas ID or " " " "
RX	Meas ID for Rx ref measurement	Def Meas ID or " " " "
RY	Meas ID for Ry ref measurement	Def Meas ID or " " " "

Data Set: None

Notes:

1. The dynamic defaults for HX, HY, HZ, EX, EY, RX, and RY may be set by the >=MTSECT block. If any are not specified, the corresponding dynamic default is set to " ". All of the data blocks within the section may use these dynamic defaults if the corresponding options are not specified. After application of any appropriate dynamic defaults, an option argument will be a defined measurement ID or it may be " ", indicating no measurement.

2. Although no restrictions are enforced, all appropriate measurements should be defined for a given data block. For scalar MT, only one E and one H are required (e.g. Ey and Hx). For tensor MT, two E's and two H's are required. If tipper parameters are being computed, Hz must also be defined. If least-squares estimation of the impedances is used, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

3. Under normal circumstances, the measurements for HX, HY, HZ, EX, EY, RX, and RY should be the same for all data blocks within an >=MTSECT data section.

4. The dynamic default for NF is set to the value of the NFREQ option.

Hints:

1. *Computed MT parameters provide a representation of the data which requires no additional processing. This is a recommended representation for archiving data because it can be readily used by anyone without requiring MT processing capability.*

2. *The SECTID option for a section corresponding to the computed parameters for a site specifies the name to be associated with that site. The recommended form is SSSSSSSS-NNN, where SSSSSSSS is the survey name and NNN is the site number.*

3. *If there are blocks for more than 64 computed parameters included for this site, then the MAXBLKS option should be set to an appropriate value.*

4. *The HX, HY, HZ, EX, EY, RX, RY, and NREQ options should be specified for the >=MTSECT block. These then become the dynamic defaults for all blocks within that section. If specified here, they do not need to be re-specified for other blocks in the section.*

12.2 >=EMAPSECT

Description: Begins an EMAP data section. Defines the measurements which make up an EMAP line.

Example:

```
>=EMAPSECT
    SECTID=linea
    NFREQ=40
    NDIPOLE=8
    HX=11.005
    HY=12.005
    RX=21.005
    RY=22.005
    //8
      314.005      324.005      334.005      344.005      354.005      364.005
      374.005      384.005
```

Restrictions: One or more instances of an >=EMAPSECT can appear in an EDI file. Each one begins a new EMAP data section. It may immediately follow the >HEAD block, >INFO block, and info text, or it may appear after any other data section is complete.

Option Name	Description	Restrictions	Default
SECTID	Identifying name for this section	String or " "	" "
NFREQ	Number of frequencies	Integer >=1	Required
MAXBLKS	Maximum number of blocks in section	Integer >=1	"64"
NDIPOLE	Number of dipoles in the EMAP line	Integer >=1	Required
TYPE	Descr of spatial filter type used	String or " "	" "
HX	Meas ID for Hx measurement	Def Meas ID or " "	" "
HY	Meas ID for Hy measurement	Def Meas ID or " "	" "
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	" "
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	" "
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NDIPOLE data values. Each value is a measurement ID for a measurement defined in the >=DEFINEMEAS section. The ordering of the measurements in the data defines the measurements which make up the EMAP line. The type of all of the measurement ID's (as defined by the CHTYPE option in the corresponding >EMEAS block) should be EX, although this restriction is not enforced. The data set may not contain empty values; nor may it be an empty data set and or contain binary data (Section 6.23).

Notes:

1. The dynamic defaults for HX, HY, RX, and RY may be set by the >=EMAPSECT block. If any are not specified, the corresponding dynamic default is set to " ". All of the data blocks within the section may use these dynamic defaults if the corresponding options are not specified. After application of any appropriate dynamic defaults, an option argument will be a defined measurement ID or it may be " ", indicating no measurement.

2. Although no restrictions are enforced, all appropriate measurements should be defined for a given data block. For synthetic EMAP only Hx is required for parallel parameters and only Hy is required for perpendicular parameters. However, for field data, where the line layout is not perfectly straight, both Hx and Hy are generally required. If least-squares estimation of the impedances is used, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

3. Under normal circumstances, the measurements for HX, HY, EX, RX, and RY should be the same for all data blocks corresponding to a given span within the >=EMAPSECT data section.

4. The TYPE option gives the filter type for spatial filter used; for example, “HANNING”. If explanation is required, it should be included in the >INFO section.

5. The dynamic default for NF is set to the value of the NFREQ option.

6. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *Computed EMAP parameters provide a representation of the data which requires no additional processing. This is a recommended representation for archiving data because it can be readily used by anyone without requiring MT processing capability.*

2. *The SECTID option for a section corresponding to the computed parameters for a site specifies the name to be associated with that dipole. The recommended form is SSSSSSSS-NNN, where SSSSSSSS is the survey name and NNN is the dipole number.*

3. *If there are blocks for more than 64 computed parameters included for this dipole, then the MAXBLKS option should be set to an appropriate value.*

4. *The Hx, Hy, Rx, Ry, and Nfreq options should be specified for the >=EMAPSECT block. These then become the dynamic defaults for all blocks within that section. If specified here, they do not need to be re-specified for other blocks in the section.*

5. *The data section for this block is an ordered list of the measurement id’s which make up the line of dipoles.*

6. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

12.3 >=OTHERSECT

Description: Begins an OTHER data section. Defines default measurements and a set of ordered measurements.

Example:

```
>=OTHERSECT
    SECTID=DEMO-100
    NFREQ=40
    N=6
    HX=11.007
    HY=12.007
    EX=14.007
    EY=15.007
    //6
      314.007      324.007      334.007      344.007      354.007      364.007
```

Restrictions: One or more instances of an >=OTHERSECT can appear in an EDI file. Each one begins a new MT data section. It may immediately follow the >HEAD block, >INFO block, and info text, or it may appear after any other data section is complete.

Option Name	Description	Restrictions	Default
SECTID	Identifying name for this section	String or " "	" "
NFREQ	Number of frequencies	Integer >=1	Required
MAXBLKS	Maximum number of blocks in section	Integer >=1	"64"
N	Number of meas ID's in the ordered set	Integer >=0	"0"
HX	Meas ID for Hx measurement	Def Meas ID or " "	" "
HY	Meas ID for Hy measurement	Def Meas ID or " "	" "
HZ	Meas ID for Hz measurement	Def Meas ID or " "	" "
EX	Meas ID for Ex measurement	Def Meas ID or " "	" "
EY	Meas ID for Ey measurement	Def Meas ID or " "	" "
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	" "
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	" "
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly N data values, although N may be zero. Each value is a measurement ID for a measurement defined in the >=DEFINEMEAS section. The ordering of the measurements in the data defines the measurements which make up any ordered set of measurements such as an EMAP line. The type of all of the measurement ID's (as defined by the CHTYPE option in the corresponding >EMEAS or >HMEAS block) may be anything. The data set may not contain empty values; nor may it be an empty data set or contain binary data (Section 6.23).

Notes:

1. The dynamic defaults for HX, HY, HZ, EX, EY, RX, and RY may be set by the >=OTHERSECT block. If any are not specified, the corresponding dynamic default is set to " ". All of the data blocks within the section may use these dynamic defaults if the corresponding options are not specified. After application of any appropriate dynamic defaults, an option argument will be a defined measurement ID or it may be " ", indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined for a given data block.

2. The dynamic default for NF is set to the value of the NFREQ option.

3. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

13.0 IMPEDANCE DATA BLOCKS

13.1 >ZXXR, >ZXXI, ZXXR.VAR, >ZXXI.VAR, >ZXX.VAR, >ZXX.COV

Description:

>ZXXR	Real component of impedance Z_{XX} (E_X / H_X)
>ZXXI	Imaginary component of impedance Z_{XX} (E_X / H_X)
>ZXXR.VAR	Variance of real component of impedance Z_{XX}
>ZXXI.VAR	Variance of imaginary component of impedance Z_{XX}
>ZXX.VAR	Variance of impedance Z_{XX}
>ZXX.COV	Covariance of impedance Z_{XX}

Example:

```
>ZXXR   ROT=ZROT   // 20
   6.01820767E-01 7.74375319E-01 5.08936584E-01 4.09464180E-01 3.14963371E-01
   2.60999680E-01 2.38515064E-01 2.67349362E-01 2.46229470E-01 1.61181539E-01
   1.14646673E-01 9.87800136E-02-5.15134633E-01-1.03739366E-01 2.51554072E-01
   1.23188727E-01-7.75714070E-02 2.89261997E-01 1.84981659E-01-1.65735200E-01
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT or >=EMAPSECT data section. Any impedance blocks in these sections must immediately follow the >FREQ block and the optional >ZROT block, if included. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	Type of estimation used	String or " "	"LEASTSQ"
ROT	Type of rotation applied	"NONE", "NORTH", or "ZROT"	"NONE"
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
EX	Meas ID for Ex measurement	Def Meas ID or " "	Dyn EX
EY	Meas ID for Ey measurement	Def Meas ID or " "	Dyn EY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If the ROT option is “ZROT” then the impedances are assumed to have been rotated to the angles indicated in the >ZROT data block. If it is “NORTH”, they are assumed to have been rotated to true north. If it is “NONE”, they are assumed to be in the measurement directions. Only tensor impedances (see note below) may be rotated.

2. The dynamic defaults for HX, HY, EX, EY, RX, and RY were set by the >=MTSECT, >=EMAPSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to “ ”. All of these options (after application of dynamic defaults) may be “ ”, indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each scalar impedance only one E and one H are required (e.g. Ex and Hx for ZXX). For tensor impedances, two E’s and two H’s are required. If least-squares estimation was used, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

3. The dynamic default for NF was set by the NFREQ option in the section head block.

4. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *For MT data, it is recommended that impedances be delivered rotated to maximize one of the criteria described in Section 5.8. In this case, this rotation angle must be specified in a >ZROT block which must appear previously. For EMAP data, it is recommended that impedances be delivered in measurement directions.*

2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

3. *An EDI file should provide either the total variance (ZXX.VAR) or the real, imaginary and covariance (ZXXR.VAR, ZXXI.VAR, and ZXX.COV), but not both.*

4. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

13.2 >ZXYR, >ZXYI, ZXYR.VAR, >ZXYI.VAR, >ZXY.VAR, >ZXY.COV

Description:

>ZXYR	Real component of impedance Z_{xy} (E_x / H_y)
>ZXYI	Imaginary component of impedance Z_{xy} (E_x / H_y)
>ZXYR.VAR	Variance of real component of impedance Z_{xy}
>ZXYI.VAR	Variance of imaginary component of impedance Z_{xy}
>ZXY.VAR	Variance of impedance Z_{xy}
>ZXY.COV	Covariance of impedance Z_{xy}

Example:

```
>ZXYR   ROT=ZROT   // 20
  1.82304420E+011.58144493E+011.27437716E+011.13909054E+019.03257847E+00
  7.78446531E+005.97235203E+004.77245998E+003.46459270E+003.04857588E+00
  2.71974206E+002.15195584E+001.05662036E+001.92158365E+002.20907617E+00
  1.70448887E+001.45904374E+001.43950450E+00 8.96938622E-01 9.33596849E-01
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT or >=EMAPSECT data section. Any impedance blocks in these sections must immediately follow the >FREQ block and the optional >ZROT block, if included. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	Type of estimation used	String or " "	"LEASTSQ"
ROT	Type of rotation applied	"NONE", "NORTH", or "ZROT"	"NONE"
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
EX	Meas ID for Ex measurement	Def Meas ID or " "	Dyn EX
EY	Meas ID for Ey measurement	Def Meas ID or " "	Dyn EY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If the ROT option is "ZROT" then the impedances are assumed to have been rotated to the angles indicated in the >ZROT data block. If it is "NORTH", they are assumed to have been rotated to true north. If it is "NONE", they are assumed to be in the measurement directions. Only tensor impedances (see note 2 below) may be rotated.

2. The dynamic defaults for HX, HY, EX, EY, RX, and RY were set by the >=MTSECT, >=EMAPSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to " ". All of these options (after application of dynamic defaults) may be " ", indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each scalar impedance only one E and one H are required (e.g. Ex and Hy for ZXY). For tensor impedances, two E's and two H's are required. If least-squares estimation was used, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

3. The dynamic default for NF was set by the NFREQ option in the first block of the section.

4. The CHKSUM, if specified, option may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *For MT data, it is recommended that impedances be delivered rotated to maximize one of the criteria described in Section 5.8. In this case, this rotation angle must be specified in a >ZROT block which must appear previously. For EMAP data, it is recommended that impedances be delivered in measurement directions.*
2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*
3. *An EDI file should provide either the total variance (ZXY.VAR) or the real, imaginary and covariance (ZXYR.VAR, ZXYI.VAR, and ZXY.COV), but not both.*
4. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

13.3 >ZYXR, >ZYXI, ZYXR.VAR, >ZYXI.VAR, >ZYX.VAR, >ZYX.COV

Description:

>ZYXR	Real component of impedance Z_{yx} (E_y / H_x)
>ZYXI	Imaginary component of impedance Z_{yx} (E_y / H_x)
>ZYXR.VAR	Variance of real component of impedance Z_{yx}
>ZYXI.VAR	Variance of imaginary component of impedance Z_{yx}
>ZYX.VAR	Variance of impedance Z_{yx}
>ZYX.COV	Covariance of impedance Z_{yx}

Example:

```
>ZYXR   ROT=ZROT   // 20
   -1.83230228E+01 -1.51980267E+01 -1.23099728E+01 -1.02583351E+01 -8.56172848E+00
   -6.79286957E+00 -4.86690569E+00 -3.88225937E+00 -2.75575304E+00 -2.31945348E+00
   -1.89399958E+00 -1.41652894E+00 -1.46898735E+00 -1.60360003E+00 -1.37504911E+00
    -3.73708814E-01  -6.21191323E-01 -5.30263722E-01  -3.15491974E-01 -5.12749434E-01
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT data section. They may not appear in an >=EMAPSECT data section. Any impedance blocks must immediately follow the >FREQ block and the optional >ZROT block, if included. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	Type of estimation used	String or " "	"LEASTSQ"
ROT	Type of rotation applied	"NONE", "NORTH", or "ZROT"	"NONE"
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
EX	Meas ID for Ex measurement	Def Meas ID or " "	Dyn EX
EY	Meas ID for Ey measurement	Def Meas ID or " "	Dyn EY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If the ROT option is "ZROT" then the impedances are assumed to have been rotated to the angles indicated in the >ZROT data block. If it is "NORTH", they are assumed to have been rotated to true north. If it is "NONE", they are assumed to be in the measurement directions. Only tensor impedances (see note 2 below) may be rotated.

2. The dynamic defaults for HX, HY, EX, EY, RX, and RY were set by the >=MTSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to " ". All of these options (after application of dynamic defaults) may be " ", indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each scalar impedance only one E and one H are required (e.g. Ey and Hx for ZYX). For tensor impedances, two E's and two H's are required. If least-squares estimation was used, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

3. The dynamic default for NF was set by the NFREQ option in the first block of the section.

4. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *For MT data, it is recommended that impedances be delivered rotated to maximize one of the criteria described in Section 5.8. In this case, this rotation angle must be specified in a >ZROT block which must appear previously. For EMAP data, it is recommended that impedances be delivered in measurement directions.*

2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

3. *An EDI file should provide either the total variance (ZYX.VAR) or the real, imaginary and covariance (ZYXR.VAR, ZYXI.VAR, and ZYX.COV), but not both.*

4. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

13.4 >ZYYR, >ZYYI, ZYYR.VAR, >ZYYI.VAR, >ZYY.VAR, >ZYY.COV

Description:

>ZYYR	Real component of impedance Z_{yy} (E_y / H_y)
>ZYYI	Imaginary component of impedance Z_{yy} (E_y / H_y)
>ZYYR.VAR	Variance of real component of impedance Z_{yy}
>ZYYI.VAR	Variance of imaginary component of impedance Z_{yy}
>ZYY.VAR	Variance of impedance Z_{yy}
>ZYY.COV	Covariance of impedance Z_{yy}

Example:

```
>ZYYR   ROT=ZROT   // 20
  -4.14399713E-01 3.37689847E-01-1.36755705E-01-7.88401291E-02 2.10223034E-01
   2.23552525E-01 2.38290370E-01 2.43170977E-01 2.11295232E-01 1.55212507E-01
   1.09562479E-01 9.46080014E-02 9.78896096E-02 4.17534620E-01 3.39732528E-01
   2.83228546E-01-3.45761515E-02 5.55908121E-02-2.84877960E-02 1.25025302E-01
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT data section. They may not appear in an >=EMAPSECT data section. Any impedance blocks must immediately follow the >FREQ block and the optional >ZROT block, if included. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	Type of estimation used	String or " "	"LEASTSQ"
ROT	Type of rotation applied	"NONE", "NORTH", or "ZROT"	"NONE"
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
EX	Meas ID for Ex measurement	Def Meas ID or " "	Dyn EX
EY	Meas ID for Ey measurement	Def Meas ID or " "	Dyn EY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If the ROT option is "ZROT" then the impedances are assumed to have been rotated to the angles indicated in the >ZROT data block. If it is "NORTH", they are assumed to have been rotated to true north. If it is "NONE", they are assumed to be in the measurement directions. Only tensor impedances (see note 2 below) may be rotated.

2. The dynamic defaults for HX, HY, EX, EY, RX, and RY were set by the >=MTSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to " ". All of these options (after application of dynamic defaults) may be " ", indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each scalar impedance only one E and one H are required (e.g. Ey and Hy for ZYY). For tensor impedances, two E's and two H's are required. If least-squares estimation was used, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

3. The dynamic default for NF was set by the NFREQ option in the first block of the section.

4. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *For MT data, it is recommended that impedances be delivered rotated to maximize one of the criteria described in Section 5.8. In this case, this rotation angle must be specified in a >ZROT block which must appear previously. For EMAP data, it is recommended that impedances be delivered in measurement directions.*

2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

3. *An EDI file should provide either the total variance (ZYY.VAR) or the real, imaginary and covariance (ZYYR.VAR, ZYYI.VAR, and ZYY.COV), but not both.*

4. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

13.5 >FZXXR, >FZXXI, >FZXYR, >FZXYI

Description:

>FZXXR	Real component of spatially filtered impedance Z_{xx} (E_x / H_x)
>FZXXI	Imaginary component of spatially filtered impedance Z_{xx} (E_x / H_x)
>FZXYR	Real component of spatially filtered impedance Z_{xy} (E_x / H_y)
>FZXYI	Imaginary component of spatially filtered impedance Z_{xy} (E_x / H_y)

Example:

```
>FZYXR   ROT=ZROT   // 20
   -1.83230228E+01 -1.51980267E+01 -1.23099728E+01 -1.02583351E+01 -8.56172848E+00
   -6.79286957E+00 -4.86690569E+00 -3.88225937E+00 -2.75575304E+00 -2.31945348E+00
   -1.89399958E+00 -1.41652894E+00 -1.46898735E+00 -1.60360003E+00 -1.37504911E+00
    -3.73708814E-01  -6.21191323E-01 -5.30263722E-01  -3.15491974E-01 -5.12749434E-01
```

Restrictions: One instance of any or all of these data blocks can appear in an >=EMAPSECT data section. They may not appear in an >=MTSECT data section. Any impedance blocks must immediately follow the >FREQ block. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	Type of estimation used	String or " "	"LEASTSQ"
ROT	Type of rotation applied	"NONE", "NORTH", or "ZROT"	"NONE"
EX	Meas ID for Ex measurement	Defined Meas ID	Required
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. The dynamic defaults for HX, HY, RX, and RY were set by the >=EMAPSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to " ". All of these options (after application of dynamic defaults) may be " ", indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each scalar impedance one E and one H are required (e.g. Ex and Hx for ZXX, Ex and Hy for ZXY). If least-squares estimation was used, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

2. The dynamic default for NF was set by the NFREQ option in the first block of the section.

3. For EMAP filtered impedances, the ROT option should be "NONE", indicating that the impedances correspond to the measurement directions.

4. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *For EMAP data, it is recommended that impedances be delivered in measurement directions.*

2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options will be provided by the >=EMAPSECT block through the dynamic default mechanism.*

3. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

14.0 APPARENT RESISTIVITY AND PHASE DATA BLOCKS

14.1 >RHOXX, >PHSXX, >RHOXX.VAR, >PHSXX.VAR >RHOXX.ERR, >PHSXX.ERR, >RHOXX.FIT, >PHSXX.FIT

Description:

>RHOXX	Magnitude of apparent resistivity (W-m) computed from Z_{XX}
>PHSXX	Phase angle of apparent resistivity (deg) computed from Z_{XX}
>RHOXX.VAR	Variance of Rho_{XX} computed from variances of real and imag parts of Z_{XX}
>PHSXX.VAR	Variance of Phs_{XX} computed from variances of real and imag parts of Z_{XX}
>RHOXX.ERR	Log_{10} error bar (in decades) assoc. with Rho_{XX}
>PHSXX.ERR	Error bar (in degrees) assoc. with Phs_{XX}
>RHOXX.FIT	Data values defining smoothed curve which fits the Rho_{XX} data
>PHSXX.FIT	Data values defining smoothed curve which fits the Phx_{XX} data

Example:

```
>RHOXX   ROT=RHOROT   // 20
  1.08579102E+011.09430246E+011.05040903E+011.13740978E+011.04564753E+01
  1.09703875E+011.08448954E+011.03996630E+019.13816547E+008.84461498E+00
  8.36482430E+008.65559006E+009.26512432E+006.76110649E+001.29676619E+01
  1.17602291E+011.24114132E+012.58277512E+011.86857986E+011.18354082E+01
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT or >=EMAPSECT data section. Any apparent resistivity blocks in these sections must follow the >FREQ block, any impedance blocks, and the optional >RHOROT block, if included. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	Confidence % for .ERR data or fitting method for .FIT data	String or " "	" "
ROT	Type of rotation applied	"NONE", "NORTH", or "RHOROT"	"NONE"
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
EX	Meas ID for Ex measurement	Def Meas ID or " "	Dyn EX
EY	Meas ID for Ey measurement	Def Meas ID or " "	Dyn EY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If the ROT option is “RHOROT” then the apparent resistivities are assumed to have been rotated to the angles indicated in the >RHOROT data block. If it is “NORTH”, they are assumed to have been rotated to true north. If it is “NONE”, they are assumed to be in the measurement directions. Only apparent resistivities computed from tensor impedances (see note 2 below) may be rotated.

2. The dynamic defaults for HX, HY, EX, EY, RX, RY were set by the >=MTSECT, >=EMAPSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to “ ”. All of these options (after application of dynamic defaults) may be “ ”, indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each apparent resistivity computed from a scalar impedance only one E and one H are required (e.g. Ex and Hx for RHOXX). For rotatable apparent resistivities two E’s and two H’s are required. If least-squares estimation was used for the impedances, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

3. The dynamic default for NF was set by the NFREQ option in the first block of the section.

4. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *For MT data, it is recommended that rho’s be delivered rotated to maximize one of the criteria described in Section 5.8. In this case, this rotation angle must be specified in a >RHOROT block which must appear previously. For EMAP data, it is recommended that rho’s be delivered in measurement directions.*

2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

3. *The >RHOXX.ERR block gives the size (in decades) of the error bars representing +/- one standard deviation of $\log_{10}$(rho). This error bar is symmetrical in $\log_{10}$(rho) space.*

4. *The >RHOXX.FIT block may be optionally included to specify a smooth or interpreted curve to be associated with the raw data.*

5. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

14.2 >RHOXY, >PHSXY, >RHOXY.VAR, >PHSXY.VAR >RHOXY.ERR, >PHSXY.ERR, >RHOXY.FIT, >PHSXY.FIT

Description:

>RHOXY	Magnitude of apparent resistivity (W-m) computed from Z_{xy}
>PHSXY	Phase angle of apparent resistivity (deg) computed from Z_{xy}
>RHOXY.VAR	Variance of Rho_{xy} computed from variances of real and imag parts of Z_{xy}
>PHSXY.VAR	Variance of Phs_{xy} computed from variances of real and imag parts of Z_{xy}
>RHOXY.ERR	Log_{10} error bar (in decades) assoc. with Rho_{xy}
>PHSXY.ERR	Error bar (in degrees) assoc. with Phs_{xy}
>RHOXY.FIT	Data values defining smoothed curve which fits the Rho_{xy} data
>PHSXY.FIT	Data values defining smoothed curve which fits the Phs_{xy} data

Example:

```
>RHOXY   ROT=RHOROT   // 20
  1.08579102E+011.09430246E+011.05040903E+011.13740978E+011.04564753E+01
  1.09703875E+011.08448954E+011.03996630E+019.13816547E+008.84461498E+00
  8.36482430E+008.65559006E+009.26512432E+006.76110649E+001.29676619E+01
  1.17602291E+011.24114132E+012.58277512E+011.86857986E+011.18354082E+01
>PHSXY   ROT=RHOROT   // 20
  4.44184723E+014.45486832E+014.41194191E+014.45983124E+014.38439178E+01
  4.55155830E+014.85306206E+015.13925629E+015.37120476E+015.23208351E+01
  4.66266098E+015.19162025E+016.89909592E+012.81978683E+012.63625183E+01
  3.30418930E+013.11888943E+014.74999847E+015.26897507E+012.37417355E+01
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT or >=EMAPSECT data section. Any apparent resistivity blocks in these sections must follow the >FREQ block, any impedance blocks, and the optional >RHOROT block, if included. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	Confidence % for .ERR data or fitting method for .FIT data.	String or " "	" "
ROT	Type of rotation applied	"NONE", "NORTH", or "RHOROT"	"NONE"
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
EX	Meas ID for Ex measurement	Def Meas ID or " "	Dyn EX
EY	Meas ID for Ey measurement	Def Meas ID or " "	Dyn EY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If the ROT option is “RHOROT” then the apparent resistivities are assumed to have been rotated to the angles indicated in the >RHOROT data block. If it is “NORTH”, they are assumed to have been rotated to true north. If it is “NONE”, they are assumed to be in the measurement directions. Only apparent resistivities computed from tensor impedances (see note below) may be rotated.

2. The dynamic defaults for HX, HY, EX, EY, RX, and RY were set by the >=MTSECT, >=EMAPSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to “ ”. All of these options (after application of dynamic defaults) may be “ ”, indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each apparent resistivity computed from a scalar impedance only one E and one H are required (e.g. Ex and Hy for RHOXY). For rotatable apparent resistivities two E’s and two H’s are required. If least-squares estimation was used for the impedances, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

3. The dynamic default for NF was set by the NFREQ option in the first block of the section.

4. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *For MT data, it is recommended that rho’s be delivered rotated to maximize one of the criteria described in Section 5.8. In this case, this rotation angle must be specified in a >RHOROT block which must appear previously. For EMAP data, it is recommended that rho’s be delivered in measurement directions.*

2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

3. *The >RHOXY.ERR block gives the size (in decades) of the error bars representing +/- one standard deviation of $\log_{10}$(rho). This error bar is symmetrical in $\log_{10}$(rho) space.*

4. *The >RHOXY.FIT block may be optionally included to specify a smooth or interpreted curve to be associated with the raw data.*

5. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

14.3 >RHOYX, >PHSYX, >RHOYX.VAR, >PHSYX.VAR >RHOYX.ERR, >PHSYX.ERR, >RHOYX.FIT, >PHSYX.FIT

Description:

>RHOYX	Magnitude of apparent resistivity (W-m) computed from Z_{yx}
>PHSYX	Phase angle of apparent resistivity (deg) computed from Z_{yx}
>RHOYX.VAR	Variance of Rho_{yx} computed from variances of real and imag parts of Z_{yx}
>PHSYX.VAR	Variance of Phs_{yx} computed from variances of real and imag parts of Z_{yx}
>RHOXY.ERR	Log_{10} error bar (in decades) assoc. with Rho_{yx}
>PHSXY.ERR	Error bar (in degrees) assoc. with Phs_{yx}
>RHOXY.FIT	Data values defining smoothed curve which fits the Rho_{yx} data
>PHSXY.FIT	Data values defining smoothed curve which fits the Phs_{yx} data

Example:

```
>RHOYX   ROT=RHOROT   // 20
  1.17042065E+011.11513662E+011.18186188E+011.15031490E+011.08769321E+01
  1.04818220E+019.34318638E+008.43346500E+007.19581127E+006.51003361E+00
  6.20709038E+005.71676922E+004.03001356E+007.23312092E+001.38045464E+01
  7.60633039E+007.40507936E+005.60898781E+005.02285671E+001.28740139E+01
>PHSYX   ROT=RHOROT   // 20
 -1.33743698E+02-1.32722519E+02-1.30825089E+02-1.29616257E+02-1.32089432E+02
 -1.28722198E+02-1.25549049E+02-1.24309563E+02-1.22039192E+02-1.22824020E+02
 -1.23723236E+02-1.19973267E+02-1.39091095E+02-1.35322647E+02-1.22721138E+02
 -1.03210579E+02-1.18133347E+02-1.22277962E+02-1.14281380E+02-1.18818275E+02
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT data section. They may not appear in an >=EMAPSECT data section. Any apparent resistivity blocks in the sections must follow the >FREQ block, any impedance blocks, and the optional >RHOROT block, if included. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	Confidence % for .ERR data or fitting method for .FIT data.	String or " "	" "
ROT	Type of rotation applied	"NONE", "NORTH", or "RHOROT"	"NONE"
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
EX	Meas ID for Ex measurement	Def Meas ID or " "	Dyn EX
EY	Meas ID for Ey measurement	Def Meas ID or " "	Dyn EY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If the ROT option is “RHOROT” then the apparent resistivities are assumed to have been rotated to the angles indicated in the >RHOROT data block. If it is “NORTH”, they are assumed to have been rotated to true north. If it is “NONE”, they are assumed to be in the measurement directions. Only apparent resistivities computed from tensor impedances (see note 2 below) may be rotated.

2. The dynamic defaults for HX, HY, EX, EY, RX, and RY were set by the >=MTSECT, >=EMAPSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to “ ”. All of these options (after application of dynamic defaults) may be “ ”, indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each apparent resistivity computed from a scalar impedance only one E and one H are required (e.g. Ey and Hx for RHOYX). For rotatable apparent resistivities two E’s and two H’s are required. If least-squares estimation was used for the impedances, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

3. The dynamic default for NF was set by the NFREQ option in the first block of the section.

4. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *For MT data, it is recommended that rho’s be delivered rotated to maximize one of the criteria described in Section 5.8. In this case, this rotation angle must be specified in a >RHOROT block which must appear previously. For EMAP data, it is recommended that rho’s be delivered in measurement directions.*

2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

3. *The >RHOYX.ERR block gives the size (in decades) of the error bars representing +/- one standard deviation of $\log_{10}$(rho). This error bar is symmetrical in $\log_{10}$(rho) space.*

4. *The >RHOYX.FIT block may be optionally included to specify a smooth or interpreted curve to be associated with the raw data.*

5. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors.*

14.4 >RHOYY, >PHSYY, >RHOYY.VAR, >PHSYY.VAR >RHOYY.ERR, >PHSYY.ERR, >RHOYY.FIT, >PHSYY.FIT

Description:

>RHOYY	Magnitude of apparent resistivity (W-m) computed from Z_{yy}
>PHSYY	Phase angle of apparent resistivity (deg) computed from Z_{yy}
>RHOYY.VAR	Variance of Rho_{yy} computed from variances of real and imag parts of Z_{yy}
>PHSYY.VAR	Variance of Phs_{yy} computed from variances of real and imag parts of yy
>RHOYY.ERR	Log_{10} error bar (in decades) assoc. with Rho_{yy}
>PHSYY.ERR	Error bar (in degrees) assoc. with Phs_{yy}
>RHOYY.FIT	Data values defining smoothed curve which fits the Rho_{yy} data
>PHSYY.FIT	Data values defining smoothed curve which fits the Phs_{yy} data

Example:

```
>RHOYY   ROT=RHOROT   // 20
  1.17042065E+011.11513662E+011.18186188E+011.15031490E+011.08769321E+01
  1.04818220E+019.34318638E+008.43346500E+007.19581127E+006.51003361E+00
  6.20709038E+005.71676922E+004.03001356E+007.23312092E+001.38045464E+01
  7.60633039E+007.40507936E+005.60898781E+005.02285671E+001.28740139E+01
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT data section. They may not appear in an >=EMAPSECT data section. Any apparent resistivity blocks in the sections must follow the >FREQ block, any impedance blocks, and the optional >RHOROT block, if included. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	Confidence % for.ERR data or fitting method for .FIT data.	String or " "	" "
ROT	Type of rotation applied	"NONE", "NORTH", or "RHOROT"	"NONE"
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
EX	Meas ID for Ex measurement	Def Meas ID or " "	Dyn EX
EY	Meas ID for Ey measurement	Def Meas ID or " "	Dyn EY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If the ROT option is “RHOROT” then the apparent resistivities are assumed to have been rotated to the angles indicated in the >RHOROT data block. If it is “NORTH”, they are assumed to have been rotated to true north. If it is “NONE”, they are assumed to be in the measurement directions. Only apparent resistivities computed from tensor impedances (see note 2 below) may be rotated.

2. The dynamic defaults for HX, HY, EX, EY, RX, and RY were set by the >=MTSECT, >=EMAPSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to “ ”. All of these options (after application of dynamic defaults) may be “ ”, indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each apparent resistivity computed from a scalar impedance only one E and one H are required (e.g. Ey and Hy for RHOYY). For rotatable apparent resistivities two E’s and two H’s are required. If least-squares estimation was used for the impedances, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

3. The dynamic default for NF was set by the NFREQ option in the first block of the section.

4. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *For MT data, it is recommended that rho’s be delivered rotated to maximize one of the criteria described in Section 5.8. In this case, this rotation angle must be specified in a >RHOROT block which must appear previously. For EMAP data, it is recommended that rho’s be delivered in measurement directions.*

2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

3. *The >RHOYY.ERR block gives the size (in decades) of the error bars representing +/- one standard deviation of $\log_{10}$(rho). This error bar is symmetrical in $\log_{10}$(rho) space.*

4. *The >RHOYY.FIT block may be optionally included to specify a smooth or interpreted curve to be associated with the raw data.*

5. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors*

14.5 >FRHOXX, >FPHSXX, >FRHOXX.FIT, >FPHSXX.FIT, >FRHOXY, >FPHSXY, >FRHOXY.FIT, >FPHSXY.FIT

Description:

>FRHOXX	Apparent resistivity (W-m) comp. from spatially filtered Z_{XX}
>FPHSXX	Phase (deg) computed from spatially filtered Z_{XX}
>FRHOXX.FIT	Data defining smoothed curve which fits the filtered Rho_{XX}
>FPHSXX.FIT	Data defining smoothed curve which fits the filtered Phs_{XX}
>FRHOXY	Apparent resistivity (W-m) comp. from filtered Z_{XY}
>FPHSXY	Phase (deg) computed from filtered Z_{XY}
>FRHOXY.FIT	Data defining smoothed curve which fits the filtered Rho_{XY} data
>FPHSXY.FIT	Data defining smoothed curve which fits the filtered Phs_{XY}

Example:

```
>FRHOXY   ROT=RHOROT   // 20
  1.08579102E+011.09430246E+011.05040903E+011.13740978E+011.04564753E+01
  1.09703875E+011.08448954E+011.03996630E+019.13816547E+008.84461498E+00
  8.36482430E+008.65559006E+009.26512432E+006.76110649E+001.29676619E+01
  1.17602291E+011.24114132E+012.58277512E+011.86857986E+011.18354082E+01
>FPHSXY   ROT=RHOROT   // 20
  4.44184723E+014.45486832E+014.41194191E+014.45983124E+014.38439178E+01
  4.55155830E+014.85306206E+015.13925629E+015.37120476E+015.23208351E+01
  4.66266098E+015.19162025E+016.89909592E+012.81978683E+012.63625183E+01
  3.30418930E+013.11888943E+014.74999847E+015.26897507E+012.37417355E+01
```

Restrictions: One instance of any or all of these data blocks can appear in an >=EMAP data section. They may not appear in an >=MTSECT data section. Any apparent resistivity blocks in the sections must follow the >FREQ block, and any impedance blocks. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	Fitting method for .FIT data	String or " "	" "
ROT	Type of rotation applied	"NONE", "NORTH", or "RHOROT"	"NONE"
EX	Meas ID for Ex measurement	Defined Meas ID	Required
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. The dynamic defaults for HX, HY, RX, and RY were set by the >=EMAPSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to " ". All of these options (after application of dynamic defaults) may be " ", indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each apparent resistivity one E and one H are required (e.g. Ex and Hx for RHOXX, Ex and Hy for RHOXY). If least-squares estimation was used, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

2. The dynamic default for NF was set by the NFREQ option in the first block of the section.

3. For apparent resistivities derived from EMAP filtered impedances, the ROT option should be "NONE", indicating that the apparent resistivities correspond to the measurement directions.

4, The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *For EMAP data, it is recommended that rho's be delivered in measurement directions.*

2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options will be provided by the >=EMAPSECT block through the dynamic default mechanism.*

3. *The .FIT blocks may be optionally included to specify a smooth or interpreted curve to be associated with the raw data.*

4. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors*

15.0 CONTINUOUS 1-D INVERSION DATA BLOCKS

15.1 >RES1DXX, >DEP1DXX. RES1DXY, >DEP1DXY

Description:

>RES1DXX	True resistivity (W-m) computed from Rho_{XX} using 1-D continuous inverse
>DEP1DXX	Depth (units) computed from Rho_{XX} using 1-D continuous inverse
>RES1DXY	True resistivity (W-m) computed from Rho_{XY} using 1-D continuous inverse
>DEP1DXY	Depth (units) computed from Rho_{XY} using 1-D continuous inverse

Example:

```
>RES1DXY   ROT=RHOROT   // 20
  1.17015715E+011.32999439E+011.30004625E+011.19078741E+011.02527933E+01
  9.63494396E+007.98624992E+006.89576387E+006.04798603E+006.33519840E+00
  6.31925201E+006.30551910E+008.21470928E+001.22897148E+011.78367996E+01
  3.04577389E+014.93220749E+016.53172836E+017.49221878E+017.50644455E+01
>DEP1DXY   ROT=RHOROT   // 20
  3.37705719E+023.98757294E+024.91241516E+025.76613159E+026.95680969E+02
  7.99844788E+029.56142578E+021.07347095E+031.26384119E+031.40669055E+03
  1.68963354E+031.89222839E+032.29579883E+032.69996313E+033.48682007E+03
  4.27994043E+035.86284277E+037.42579736E+031.02798584E+041.28665928E+04
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT or >=EMAPSECT data section. Any continuous 1-D data blocks in these sections must follow the >FREQ block, any impedance blocks, and any apparent resistivity blocks. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of freqs used for inversion	Integer >=1	Dyn NF
TYPE	Type of inversion	String or " "	" "
ROT	Type of rotation applied to Rho data	"NONE", "NORTH", or "RHOROT"	"NONE"
UNITS	Units for depth	"M" or "FT"	"M"
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
EX	Meas ID for Ex measurement	Def Meas ID or " "	Dyn EX
EY	Meas ID for Ey measurement	Def Meas ID or " "	Dyn EY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values. There is a one-to-one correspondence between a depth block and its corresponding resistivity block. The values must be within the legal range for reals. Depth values are relative to the surface and increase with depth. Thus, they must be all greater than zero and strictly increasing. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If the ROT option is "RHOROT" then the inversion is assumed to have been computed from apparent resistivities which were rotated to the angles indicated in the >RHOROT data block. If it is "NORTH", they are assumed to have been rotated to true north. If it is "NONE", the apparent resistivities are assumed to be in the measurement directions. Inversion of MT data in the measurement directions or rotated to true north is usually of little interest, so ROT=RHOROT should almost always specified for inversion data blocks in an >=MTSECT data section. Only apparent resistivities computed from tensor impedances (see note 2 below) may be rotated.

2. For inversions derived from EMAP impedances, the ROT option should be "NONE", indicating that the impedances correspond to the measurement directions.

3. The dynamic defaults for HX, HY, EX, EY, RX, and RY were set by the >=MTSECT, >=EMAPSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to " ". All of these options (after application of dynamic defaults) may be " ", indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each continuous inversion derived from a scalar impedance only one E and one H are required (e.g. Ex and Hx for RESXX and DEP1DXX, or Ex and Hy for RESXY and DEP1DXY). For inversions computed from rotated apparent resistivities two E's and two H's are required. If least-squares estimation was used for the impedances, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

4. The dynamic default for NF was set by the NFREQ option in the first block of the section.

5. The type of inversion used may be BOSTICK or another technique. If applicable, the option should also indicate how the slope was derived (e.g from amplitude differences or Hilbert transform of phase).

6. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *1-D continuous inversions are derived from a rho data set. For MT data, it is recommended that rho's be rotated to maximize one of the criteria described in Section 5.8. In this case, this rotation angle must be specified in a >RHOROT block which must appear previously. For EMAP data, it is recommended that rho's be in measurement directions.*

2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options for the rho data from which the 1-D inverse was derived will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

3. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors*

15.2 >RES1DYX, >DEP1DYX, RES1DYY, >DEP1DYY

Description:

>RES1DYX	True resistivity (W-m) computed from Rho_{yx} using 1-D continuous inverse
>DEP1DYX	Depth (units) computed from Rho_{yx} using 1-D continuous inverse
>RES1DYY	True resistivity (W-m) computed from Rho_{yy} using 1-D continuous inverse
>DEP1DYY	Depth (units) computed from Rho_{yy} using 1-D continuous inverse

Example:

```
>RES1DYX   ROT=RHOROT   // 20
  9.14013386E+001.07764425E+011.23268681E+019.24939346E+008.64568615E+00
  6.52991819E+004.99243736E+003.91825318E+003.63707042E+004.04100895E+00
  5.38858700E+007.09615088E+008.23903465E+009.36382961E+001.00957212E+01
  1.01091537E+019.00431824E+007.09470081E+006.01520729E+005.34585762E+00
>DEP1DYX   ROT=RHOROT   // 20
  3.43829926E+023.84529755E+024.88384460E+025.52063416E+026.72104675E+02
  7.52524536E+028.82921448E+029.59777039E+021.10508777E+031.21033301E+03
  1.44122864E+031.67296021E+032.08549585E+032.46865527E+033.11859448E+03
  3.69985205E+034.63237549E+035.34728369E+036.42516455E+037.25676367E+03
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT data section. They may not appear in an >=EMAPSECT data section. Any continuous 1-D data blocks in these sections must follow the >FREQ block, any impedance blocks, and any apparent resistivity blocks. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of freqs used for inversion	Integer >=1	Dyn NF
TYPE	Type of inversion	String or " "	" "
ROT	Type of rotation applied to Rho data	"NONE", "NORTH", or "RHOROT"	"NONE"
UNITS	Units for depth	"M" or "FT"	"M"
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
EX	Meas ID for Ex measurement	Def Meas ID or " "	Dyn EX
EY	Meas ID for Ey measurement	Def Meas ID or " "	Dyn EY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values. There is a one-to-one correspondence between a depth block and its corresponding resistivity block. The values must be within the legal range for reals. Depth values are relative to the surface and increase with depth. Thus, they must be all greater than zero and strictly increasing. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If the ROT option is "RHOROT" then the inversion is assumed to have been computed from apparent resistivities which were rotated to the angles indicated in the >RHOROT data block. If it is "NORTH", they are assumed to have been rotated to true north. If it is "NONE", the apparent resistivities are assumed to be in the measurement directions. Inversion of MT data in the measurement directions or rotated to true north is usually of little interest, so ROT=RHOROT should almost always specified for inversion data blocks in an >=MTSECT data section. Only apparent resistivities computed from tensor impedances (see note 2 below) may be rotated.

2. For inversions derived from EMAP impedances, the ROT option should be "NONE", indicating that the impedances correspond to the measurement directions.

3. The dynamic defaults for HX, HY, EX, EY, RX, and RY were set by the >=MTSECT, >=EMAPSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to " ". All of these options (after application of dynamic defaults) may be " ", indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each continuous inversion derived from a scalar impedance only one E and one H are required (e.g. Ey and Hx for RESYX and DEP1DYX, or Ey and Hy for RESYY and DEP1DYY). For inversions computed from rotated apparent resistivities two E's and two H's are required. If least-squares estimation was used for the impedances, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

4. The dynamic default for NF was set by the NFREQ option in the first block of the section.

5. The type of inversion used may be BOSTICK or another technique. If applicable, the option should also indicate how the slope was derived (e.g from amplitude differences or Hilbert transform of phase).

6. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *1-D continuous inversions are derived from a rho data set. For MT data, it is recommended that rho's be rotated to maximize one of the criteria described in Section 5.8. In this case, this rotation angle must be specified in a >RHOROT block which must appear previously. For EMAP data, it is recommended that rho's be in measurement directions.*

2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options for the rho data from which the 1-D inverse was derived will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

3. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors*

15.3 >FRES1DXX, >FDEP1DXX, FRES1DXY, >FDEP1DXY

Description:

>FRES1DXX	True resistivity (W-m) computed using a 1-D cont. inverse from apparent resistivity data derived from spatially filtered Z_{XX} data
>FDEP1DXX	Depth (units) corresponding one-to-one with the FRES1DXX resistivities
>FRES1DXY	True resistivity (W-m) computed using a 1-D cont. inverse from apparent resistivity data derived from spatially filtered Z_{XY} data
>FDEP1DXY	Depth (units) corresponding one-to-one with the FRES1DXY resistivities

Example:

```
>FRES1DXY   ROT=RHOROT   // 20
  1.17015715E+011.32999439E+011.30004625E+011.19078741E+011.02527933E+01
  9.63494396E+007.98624992E+006.89576387E+006.04798603E+006.33519840E+00
  6.31925201E+006.30551910E+008.21470928E+001.22897148E+011.78367996E+01
  3.04577389E+014.93220749E+016.53172836E+017.49221878E+017.50644455E+01
>FDEP1DXY   ROT=RHOROT   // 20
  3.37705719E+023.98757294E+024.91241516E+025.76613159E+026.95680969E+02
  7.99844788E+029.56142578E+021.07347095E+031.26384119E+031.40669055E+03
  1.68963354E+031.89222839E+032.29579883E+032.69996313E+033.48682007E+03
  4.27994043E+035.86284277E+037.42579736E+031.02798584E+041.28665928E+04
```

Restrictions: One instance of any or all of these data blocks can appear in an >=EMAPSECT. They may not appear in an >=MTSECT data section. Any continuous 1-D data blocks in the sections must follow the >FREQ block, any impedance blocks, and any apparent resistivity blocks. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of freqs used for inversion	Integer >=1	Dyn NF
TYPE	Type of inversion	String or " "	" "
ROT	Type of rotation applied to Rho data	"NONE", "NORTH", or "RHOROT"	"NONE"
UNITS	Units for depth	"M" or "FT"	"M"
HX	Meas ID for Hx measurement	Def Meas ID or ""	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
EX	Meas ID for Ex measurement	Def Meas ID or " "	Dyn EX
EY	Meas ID for Ey measurement	Def Meas ID or " "	Dyn EY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values. There is a one-to-one correspondence between a depth block and its corresponding resistivity block. The values must be within the legal range for reals. Depth values are relative to the surface and increase with depth. Thus, they must be all greater than zero and strictly increasing. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. The dynamic defaults for HX, HY, EX, EY, RX, and RY were set by the >=MTSECT, >=EMAPSECT, or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to " ". All of these options (after application of dynamic defaults) may be " ", indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For each continuous inversion derived from a scalar impedance one E and one H are required (e.g. Ex and Hx for FRESXX and FDEPXX, or Ex and Hy for FRESXY and FDEP1DXY). If least-squares estimation was used for the impedances, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

2. For inversions derived from EMAP filtered impedances, the ROT option should be “NONE”, indicating that the impedances correspond to the measurement directions.

3. The dynamic default for NF was set by the NFREQ option in the first block of the section.

4. The type of inversion used may be BOSTICK or another technique. If applicable, the option should also indicate how the slope was derived (e.g from amplitude differences or Hilbert transform of phase).

5. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hints:

1. *1-D continuous inversions are derived from a rho data set. For MT data, it is recommended that rho’s be rotated to maximize one of the criteria described in Section 5.8. In this case, this rotation angle must be specified in a >RHOROT block which must appear previously. For EMAP data, it is recommended that rho’s be in measurement directions.*

2. *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options for the rho data from which the 1-D inverse was derived will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

3. *The CHKSUM option, as defined, has proven to be unreliable because of rounding errors*

16.0 COHERENCY AND SIGNAL DATA BLOCKS

16.1 >COH

Description: Ordinary coherency between any two measurements as a function of freq.

Example:

```
>COH   MEAS1=1011.101   MEAS2=1015.101   ROT=NORTH   // 20
   9.60033655E-01 9.72313225E-01 9.66603339E-01 9.59068954E-01 9.55812097E-01
   9.49533224E-01 9.30146277E-01 9.02701676E-01 7.87032247E-01 7.49909878E-01
   5.95737398E-01 4.28677410E-01 3.08223873E-01 5.21349132E-01 6.18800640E-01
   6.26757741E-01 7.85922527E-01 5.30418575E-01 6.13066256E-01 6.97230458E-01
```

Restrictions: One or more instances of this data block can appear in an >=MTSECT data section, or an >=EMAPSECT data section. Any coherency data blocks in these sections must follow the >FREQ block, any impedance blocks, any apparent resistivity blocks, and any 1-D inversion blocks. One or more may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of freqs used inversion	Integer >=1	Dyn NF
MEAS1	Meas ID for the 1st meas.	Def Meas ID	Required
MEAS2	Meas ID for the 2nd meas.	Def Meas ID	Required
ROT	Rotation of measurements	“NONE”, “NORTH”, or “RHOROT”	“NONE”
CHKSUM	Checksum total for data values	Number or “ ”	“ ”

Data Set: Data set must contain exactly NFREQ data values. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If coherencies are being used in identifying the source(s) of noise in the data, it is most useful to have these parameters in the direction of the measurements (ROT=NONE). For evaluating data quality it is most useful to have these parameters in the direction of the apparent resistivities (ROT=RHOROT or ROT=NORTH).

2. The dynamic default for NF was set by the NFREQ option in the first block of the section.

3. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hint: *Generally the NFREQ option will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

16.2 >EPREDCOH

Description: Multiple coherency relationship between an E measurement, and a predicted E measurement derived from two H measurements and a tensor impedance Z.

Example:

```
>EPREDCOH   MEAS1=1011.001   MEAS2=1012.001   EPRED=1014.001   ROT=NORTH   // 20
   9.34974968E-01 8.53829205E-01 9.41578388E-01 9.22673702E-01 9.20535862E-01
   9.21728909E-01 9.01208401E-01 8.90061975E-01 7.63703167E-01 7.29590595E-01
   5.30870974E-01 3.44830692E-01 2.02085733E-01 2.30681986E-01 4.38924909E-01
   6.36722207E-01 7.63903916E-01 5.41088402E-01 4.80003685E-01 5.86532772E-01
```

Restrictions: One or more instances of this data block can appear in an >=MTSECT data section, or an >=EMAPSECT data section. Any coherency data blocks in these sections must follow the >FREQ block, any impedance blocks, any apparent resistivity blocks, and any 1-D inversion blocks. One or more may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of freqs for inversion	Integer >=1	Dyn NF
MEAS1	Meas ID for the 1st H meas.	Def Meas ID	Required
MEAS2	Meas ID for the 2nd H meas.	Def Meas ID	Required
EPRED	Meas ID for predicted E meas.	Def Meas ID	Required
ROT	Orientation of measurements	“NONE”, “NORTH”, or “RHOROT”	“NONE”
CHKSUM	Checksum total for data values	Number or “ ”	“ ”

Data Set: Data set must contain exactly NFREQ data values. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If coherencies are being used in identifying the source(s) of noise in the data, it is most useful to have these parameters in the direction of the measurements (ROT=NONE). For evaluating data quality it is most useful to have these parameters in the direction of the apparent resistivities (ROT=RHOROT or ROT=NORTH).

2. The dynamic default for NF was set by the NFREQ option in the first block of the section.

3. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hint: *Generally the NFREQ option will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

16.3 >HPREDCOH

Description: Multiple coherency relationship between an H measurement, and a predicted H measurement derived from two E measurements and a tensor admittance Y.

Example:

```
>HPREDCOH   MEAS1=1014.001   MEAS2=1015.001   HPRED=1011.001   ROT=NORTH   // 20
   9.60707903E-01 9.75124002E-01 9.66981709E-01 9.60868239E-01 9.57774282E-01
   9.52683330E-01 9.39414024E-01 9.17613506E-01 8.33122373E-01 7.89471686E-01
   6.43265784E-01 4.61068988E-01 3.09651703E-01 5.41831315E-01 6.20322108E-01
   6.84999466E-01 7.98119485E-01 5.46519339E-01 6.25260115E-01 7.96124279E-01
```

Restrictions: One or more instances of this data block can appear in an >=MTSECT data section, or an >=EMAPSECT data section. Any coherency data blocks in these sections must follow the >FREQ block, any impedance blocks, any apparent resistivity blocks, and any 1-D inversion blocks. One or more may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of freqs for inversion	Integer >=1	Dyn NF
MEAS1	Meas ID for the 1st E meas.	Def Meas ID	Required
MEAS2	Meas ID for the 2nd E meas.	Def Meas ID	Required
HPRED	Meas ID for predicted H meas.	Def Meas ID	Required
ROT	Orientation of measurements	“NONE”, “NORTH”, or “RHOROT”	“NONE”
CHKSUM	Checksum total for data values	Number or “ ”	“ ”

Data Set: Data set must contain exactly NFREQ data values. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. If coherencies are being used in identifying the source(s) of noise in the data, it is most useful to have these parameters in the direction of the measurements (ROT=NONE). For evaluating data quality it is most useful to have these parameters in the direction of the apparent resistivities (ROT=RHOROT or ROT=NORTH).

2. The dynamic default for NF was set by the NFREQ option in the first block of the section.

3. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hint: *Generally the NFREQ option will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

16.4 >SIGAMP

Description: Signal amplitude (or power) spectra for a measurement as a function of frequency.

Example:

```
>SIGAMP   MEAS=1012.001   ROT=NORTH   // 20
   1.92698289E-03 1.83258369E-03 1.74875022E-03 1.55375735E-03 1.58419774E-03
   1.70137570E-03 1.95880537E-03 2.05492927E-03 2.16831383E-03 2.20897049E-03
   2.01171148E-03 2.24006665E-03 2.48103053E-03 2.50982610E-03 3.42130358E-03
   1.38269709E-02 1.86840594E-02 1.62400678E-02 2.61241812E-02 2.74835080E-02
```

Restrictions: One or more instances of this data block can appear in an >=MTSECT data section, or an >=EMAPSECT data section. Any signal data blocks in these sections must follow the >FREQ block, any impedance blocks, any apparent resistivity blocks, and any 1-D inversion blocks. One or more may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of freqs for inversion	Integer >=1	Dyn NF
MEAS	Meas ID for the measurement.	Def Meas ID	Required
AMPPWR	Whether spectra is amp or power	“AMP” or “PWR”	“AMP”
EUNITS	Units for E spectra (amplitude).	“MV/KM” or “V/M”	“MV/KM”
HUNITS	Units for H spectra (amplitude)	“NT”	“NT”
ROT	Orientation of measurements	“NONE”, “NORTH”, or “RHOROT”	“NONE”
TYPE	Total field, est. signal, or est. noise	“FIELD”, “SIGNAL”, or “NOISE”	“FIELD”
CHKSUM	Checksum total for data values	Number or “ ”	“ ”

Data Set: Data set must contain exactly NFREQ data values. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. Either the EUNITS option or the HUNITS option, as appropriate for the measurement, may be specified for documentation purposes, or if E spectra are not in default units. If the AMPPWR option is PWR, then the units are the squares of the amplitude units.

2. If signal amplitude (or power spectral density) is being used in identifying the source(s) of noise in the data, it is most useful to have these parameters in the direction of the measurements (ROT=NONE). For evaluating data quality it is most useful to have these parameters in the direction of the apparent resistivities (ROT=RHOROT or ROT=NORTH).

3. The signal amplitude (or power spectral density) can either be calculated from the total field (TYPE=FIELD), from the estimated signal only (TYPE=SIGNAL), or from the estimated noise only (TYPE=NOISE). The estimated signal and noise can be computed using a remote reference (Gamble, 1978).

4. The dynamic default for NF was set by the NFREQ option in the first block of the section.

5. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hint: *Generally the NFREQ option will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

16.5 >SIGNOISE

Description: Signal-to-noise ratio for a measurement as a function of frequency.

Example:

```
>SIGNOISE   MEAS=1011.001   ROT=NORTH   // 20
   9.63047802E-01 9.83598828E-01 9.88982439E-01 9.92118776E-01 9.87905025E-01
   9.89448309E-01 9.90553796E-01 9.87476230E-01 9.82665181E-01 9.80461240E-01
   9.35843825E-01 9.11659241E-011.00718665E+00 8.27387989E-01 8.91560793E-01
   9.85390067E-01 9.93908286E-01 9.94895220E-01 8.03094149E-01 9.87491071E-01
```

Restrictions: One or more instances of this data block can appear in an >=MTSECT data section, or an >=EMAPSECT data section. Any signal data blocks in these sections must follow the >FREQ block, any impedance blocks, any apparent resistivity blocks, and any 1-D inversion blocks. One or more may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of freqs for inversion	Integer >=1	Dyn NF
MEAS	Meas ID for the measurement.	Def Meas ID	Required
ROT	Orientation of measurements	“NONE”, “NORTH”, or “RHOROT”	“NONE”
CHKSUM	Checksum total for data values	Number or “ ”	“ ”

Data Set: Data set must contain exactly NFREQ data values. All data values must be >=0 and <=1. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. The estimated signal and noise can be computed using a remote reference (Gamble, 1978). From these, signal/(signal+noise) can be computed.

2. If signal amplitude (or power spectral density) is being used in identifying the source(s) of noise in the data, it is most useful to have these parameters in the direction of the measurements (ROT=NONE). For evaluating data quality it is most useful to have these parameters in the direction of the apparent resistivities (ROT=RHOROT or ROT=NORTH).

3. The dynamic default for NF was set by the NFREQ option in the first block of the section.

4. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hint:	*Generally the NFREQ option will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

17.0 TIPPER DATA BLOCKS

17.1 >TIPMAG, >TIPPHS, >TIPMAG.ERR, >TIPPHS.ERR, >TIPMAG.FIT, >TIPPHS.FIT

Description:

>TIPMAG	Magnitude of total tipper
>TIPPHS	Phase angle of total tipper
>TIPMAG.VAR	Variance of Tipper magnitude
>TIPPHS.VAR	Variance of Tipper phase
>TIPMAG.ERR	Error bar assoc. with TIPMAG
>TIPPHS.ERR	Error bar (in degrees) assoc. with TIPPHS
>TIPMAGFIT	Data values defining smoothed curve which fits the TIPMAG data
>TIPPHS.FIT	Data values defining smoothed curve which fits the TIPPHS data

Example:

```
>TIPMAG   // 20
   3.44053991E-02 2.77741961E-02 1.57841984E-02 1.58313140E-02 1.29138678E-02
   2.00289786E-02 2.53893416E-02 3.00401263E-02 1.78977810E-02 6.76133260E-02
   8.58623311E-02 6.44834638E-01 3.79827708E-01 2.41298199E-011.22498584E+00
   1.08001776E-01 7.38304779E-02 1.37485325E-01 2.12266326E-01 2.85834283E-01
>TIPPHS   // 20
  4.28428040E+013.32755089E+014.26912880E+011.10915861E+011.09842672E+01
  1.32586594E+011.12150545E+014.03483810E+019.63721161E+018.86814423E+01
  1.10555733E+021.10969086E+02-5.10283546E+01-6.45015945E+01-3.42821960E+01
 -1.12413170E+027.66205835E+001.56070114E+024.22109604E+019.70897522E+01
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT data section. They may not appear in an >=EMAPSECT data section. Any tipper blocks in the section must follow the >FREQ block, any impedance blocks, any apparent resistivity blocks, and any 1-D inversion blocks. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	Confidence % for .ERR data or fitting method for .FIT data.	String or " "	" "

HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
HZ	Meas ID for Hz measurement	Def Meas ID or " "	Dyn EX
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. The dynamic defaults for HX, HY, HZ, RX, and RY were set by the >=MTSECT or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to " ". All of these options (after application of dynamic defaults) may be " ", indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For the total tipper, HX, HY, and HZ are required. If least-squares estimation was used for the tipper, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

2. The dynamic default for NF was set by the NFREQ option in the first block of the section.

3. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hint: *Generally the HX, HY, HZ, RX, RY, and NFREQ options will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

18.0 STRIKE, SKEW, AND ELLIPTICITY DATA BLOCKS

18.1 >ZSTRIKE, >ZSKEW, >.ZELLIP

Description:

>ZSTRIKE	Impedance strike angle computed from the impedance tensor Z
>ZSKEW	Impedance skew computed from the impedance tensor Z
>ZELLIP	Impedance ellipticity computed from the impedance tensor Z

Example:

```
>ZSTRIKE   // 20
   5.52469330E+013.19378510E+013.35147095E+012.08763542E+012.56520157E+01
   2.55614872E+012.84206772E+012.77896080E+012.73173637E+013.21205826E+01
   4.17980728E+012.89566040E+011.29837198E+014.01946144E+011.35549011E+01
   2.69927807E+011.16522007E+012.39066010E+012.88325691E+01-2.70986767E+01
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT data section. They may not appear in an >=EMAPSECT data section. Any strike, skew, or ellipticity blocks in the section must follow the >FREQ block, any impedance blocks, any apparent resistivity blocks, and any 1-D inversion blocks. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	For ZSTRIKE, criteria for determining strike angle	String or " "	" "
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
EX	Meas ID for Ex measurement	Def Meas ID or " "	Dyn EX
EY	Meas ID for Ey measurement	Def Meas ID or " "	Dyn EY
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. The dynamic defaults for HX, HY, EX, EY, RX, and RY were set by the >=MTSECT or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to " ". All of these options (after application of dynamic defaults) may be " ", indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For tensor impedances, two E's and two H's are required. If least-squares estimation was used, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

2. The dynamic default for NF was set by the NFREQ option in the section head block.

3. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hint: *Generally the HX, HY, EX, EY, RX, RY, and NFREQ options will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

18.2 >TSTRIKE, >TSKEW, >TELLIP

Description:

>TSTRIKE	Tipper strike angle computed from the tipper tensor T
>TSKEW	Tipper skew computed from the tipper tensor T
>TELLIP	Tipper ellipticity computed from the tipper tensor T

Example:

```
>TSTRIKE   // 20
  -1.36445892E+02 -1.40237686E+02 -1.67916595E+02  1.56392731E+02  1.45596680E+02
   1.54393463E+02 -1.61574371E+02 -1.75743118E+02  1.58962204E+02 -1.52523285E+02
   1.65875214E+02  1.57556396E+02 -1.11872910E+02  1.92892666E+01  7.56694870E+01
   5.56710930E+01  6.83958511E+01  4.75166893E+01  9.93813171E+01  1.33683578E+02
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT data section. They may not appear in an >=EMAPSECT data section. Any strike, skew, or ellipticity blocks in the section must follow the >FREQ block, any impedance blocks, any apparent resistivity blocks, and any 1-D inversion blocks. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
TYPE	For TSTRIKE, criteria for determining strike angle	String or " "	" "
HX	Meas ID for Hx measurement	Def Meas ID or " "	Dyn HX
HY	Meas ID for Hy measurement	Def Meas ID or " "	Dyn HY
HZ	Meas ID for Hz measurement	Def Meas ID or " "	Dyn HX
RX	Meas ID for Rx ref measurement	Def Meas ID or " "	Dyn RX
RY	Meas ID for Ry ref measurement	Def Meas ID or " "	Dyn RY
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. The dynamic defaults for HX, HY, HZ, RX, and RY were set by the >=MTSECT or >=OTHERSECT block. If any were not specified, the corresponding dynamic default was set to " ". All of these options (after application of dynamic defaults) may be " ", indicating no measurement. Although no restrictions are enforced, all appropriate measurements should be defined. For a tipper, Hx, Hy, and Hz are required. If least-squares estimation was used, the reference measurements Rx and Ry must be indicated. This is true whether they are coincident with other measurements (local reference) or distinct (remote reference).

2. The dynamic default for NF was set by the NFREQ option in the section head block.

3. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hint: *Generally the HX, HY, HZ, RX, RY, and NFREQ options will be provided by the >=MTSECT or >=EMAPSECT block through the dynamic default mechanism.*

19.0 SPATIAL FILTER BLOCKS

19.1 >FILWIDTH, FILANGLE, EQUIVLEN

Description:

>FILWID	Length of spatial filter in meters (or feet if UNITS=FT)
>FILANGLE	Angle of spatial filter in degrees (relative to true north)
>EQUIVLEN	Length of spatial filter in equivalent dipole lengths

Example:

```
>FILWIDTH   //25
-2.347654E+01  2.941484E+02  4.387478E+02  7.347589E+02  8.547757E+02  9.374453E+02
-1.545830E+03  2.957935E+03  2.996078E+03  4.247589E+03  5.576574E+03  7.347774E+03
-8.398290E+03  9.984084E+03  1.963377E+04  2.347776E+04  2.576756E+04  3.547445E+04
-3.654398E+04  3.947066E+04  4.347478E+04  5.046567E+04  5.787054E+04  6.347487E+04
-6.455098E+04
```

Restrictions: One instance of any or all of these data blocks can appear in an >=EMAP data section. They may not appear in an >=MTSECT data section. Any spatial filter width blocks in the section must follow the >FREQ block, any impedance blocks, any apparent resistivity blocks, and any 1-D inversion blocks. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
NFREQ	Number of frequencies	Integer >=1	Dyn NF
UNITS	Units for filter/dipole lengths	“M” or “FT”	“M”
DIPLEN	Dipole lengths for EQUIVLEN	Number >0 or “ ”	“ ”
CHKSUM	Checksum total for data values	Number or “ ”	“ ”

Data Set: Data set must contain exactly NFREQ data values corresponding to the frequencies defined by the >FREQ block. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. The dynamic default for NF was set by the NFREQ option in the section head block.
2. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

Hint: *Generally the NFREQ option will be provided by the >=EMAPSECT block through the dynamic default mechanism.*

20.0 NON-STANDARD DATA BLOCKS

Description: >____.EXP Data of a type not specified by this standard

Example:

```
>RHOLAT1.EXP  ROT=RHOROT  // 20
  1.08579102E+011.09430246E+011.05040903E+011.13740978E+011.04564753E+01
  1.09703875E+011.08448954E+011.03996630E+019.13816547E+008.84461498E+00
  8.36482430E+008.65559006E+009.26512432E+006.76110649E+001.29676619E+01
  1.17602291E+011.24114132E+012.58277512E+011.86857986E+011.18354082E+01
```

Restrictions: One instance of any or all of these data blocks can appear in an >=MTSECT data section or an >=EMAPSECT data section. Any .EXP blocks in the sections must follow the >FREQ block, any impedance blocks, any apparent resistivity blocks, and any 1-D inversion blocks. One or more of any or all may appear anywhere in >=OTHERSECT sections.

Option Name	Description	Restrictions	Default
String [1-16]	Any desired option	String or " "	" "
CHKSUM	Checksum total for data values	Number or " "	" "

Data Set: Data set may contain any number of values. The values must be within the legal range for reals. The special value for empty (Section 6.23) should be used to denote missing data values and the count should be set to zero (Section 6.23) if the data set is empty.

Notes:

1. The use of .EXP data blocks require the consent of all parties. The definition of the data, the options, and the defaults for .EXP blocks should be in the >INFO text.

2. The CHKSUM option, if specified, may be used to detect errors in data writing, reading, or transmission. The value of the checksum is the exact sum of all of the data values in the block. For purposes of summing, the values represented by the output format are to be used. Empty values (Section 6.23) are summed as zeroes. Blocks with binary data sets may use the CHKSUM option. Because of the limits in formatting real numbers, care should be exercised in writing and testing checksums.

21.0 FUTURE EXTENSIONS

The >OTHERSECT data section and the .EXP data blocks are intended to provide flexibility to handle cases not covered by this standard for limited applications or in an interim role. As new techniques and data types come into use, the standard should be revised to reflect these.

APPENDIX 1 - TERMS AND DEFINITIONS

ASCII Data Set

An ASCII data set consists of the character sequence "//", followed by a count, followed by zero or more data values. The count and the data values are represented by data values. See section 6.23, Data Set, and Data Value.

Backus-Naur Form (BNF)

Backus-Naur form, or BNF, is a formal notation for precise syntax specification used in this standard. See section 6.1 for a description of the notation. It is described in detail by Aho and Ullman (1978). See section 6.1.

Binary Data Set

A binary data set is a special kind of data set for use with very large data sets where data compression is required. Binary data values are placed in a parallel binary file and are referenced by the EDI interchange file. When one of three special character sequences: "/I/", "/R/", or "/D/" (for Integer, Real, and Double-precision Real data respectively) is encountered, data is read from the binary data file. See section 6.23.

Channel

A channel refers to a particular sensor setup. For electric field channels, it is represented by a pair of X,Y, and Z offsets from the reference location, one for each electrode. For magnetic field channels it is represented by an X, Y, Z offset of the sensor from the reference location, and azimuth and dip angles of the sensor. See Measurement ID.

Comment

Comments may be freely embedded within an EDI file any place where a space can be except within a data set. A comment begins with the two characters >! and continues until another ! character is encountered. See section 6.25.

Data Block (or block)

Data blocks are the basic building blocks from which EDI files are constructed. Each consists of a keyword followed by an option list and a data set. The keyword is required, but the option list and the data set may or may not be present, depending on the keyword. A mechanism has been included for including non-standard data blocks. See section 7.1 and EXP. Data Block.

Data Set

A data set is a series of values. There are two kinds of data sets: ASCII data sets and binary data sets. A data set is indicated by "//" (ASCII), "/I/" (Binary integer), "/R/" (Binary real), or "/D/" (Binary double). If it is an ASCII data set it is followed by a count and zero or more data values. If it is a binary data set, the count and data values are read from a parallel binary file. See section 6.23, ASCII Data Set, and Binary Data Set.

Data Section

A data section is a group of contiguous blocks which are related. All data sections begin with a block whose keyword begins with >=. All EDI files must contain a >=DEFMEAS data section which defines the measurements used by the file. They may then contain one or more of the following optional data sections:

>=TSERIESSECT, >=SPECTRASECT, >=MTSECT, >EMAPSECT, or >=OTHERSECT. Any of these optional sections can be processed independently of the others. See section 7.5.

Data Value

A data value is a single number in an ASCII data set. It is a set of ASCII characters which represent a valid number. It may be an integer, real, or floating point format. An empty data value is represented by a special value defined by the EMPTY option in the >HEAD block. See section 6.22, ASCII Data Set, and Empty Data Value.

Date

The correct syntactic form for a date is MM/DD/YY, where MM is the month 01 to 12, DD is the day 01 to 31, and YY is the last two digits of the year, 00 to 99. See section 6.22.

Dynamic Option Default

Some options have default values which depend upon previously set values. The first block in a new section can define the dynamic defaults for some options. Then, any data block within the section can use the default value by not specifying that option or may specify a different value by specifying the option. There are nine defined dynamic defaults: HX, HY, HZ, EX, EY, RX, RY, NF, and NC. When writing an option list, if the option value = default value, the option does not have to be written. When reading, the default value should be filled in if the option is not specified. See also section 6.24., and Option.

Electrical Data Interchange (or EDI) File

An ASCII data file whose format corresponds to the syntactic and semantic specifications set forth in this standard.

EMAP

An acronym for Electro-Magnetic Array Profiling, a recently developed geophysical exploration technique (Bostick, 1986), which uses magnetic field measurements and an array of contiguous electric field measurements to estimate the subsurface resistivity structure. See section 7.54.

EMAP Data Section

An EMAP data section is a group of data blocks in an EDI file which corresponds to an EMAP line, or a section of an EMAP line. It must begin with an >=EMAPSECT data block which lists the measurements used for the EMAP processing. Following are data blocks for frequencies, impedances (Z's), apparent resistivities (Rho's), one-dimensional continuous inversions, coherencies, signal parameters, and other data blocks. See section 7.54.

Empty Data Set

A data set (either ASCII or binary) is a count followed by a series of data values. When a data set is completely empty, the count should be set to zero, and no data presented. The use of a special representation is in lieu of filling the data set with some arbitrary data value such as zero or 9E99 to represent no data. See section 6.23 and Data Set.

Empty Data Value

When one or more, but not all (see Empty Data Set), of the values in a data set unknown, a special "empty value" is used to represent those values. The use of this special representation is in lieu of filling the data value with some arbitrary number such as zero or 9E99. The empty value is defined by the EMPTY option in the >HEAD block. The static default for the EMPTY option is 1.0E32. See section 6.23 and Data Value.

End Block

This data block has no option list and no data set. There is always exactly one in each EDI file and it is always the last block in the file.

EXP Data Block

A special mechanism has been included within this standard for handling data blocks within an EDI file other than those currently defined by the standard. This may be used to handle new types of data until they can be officially added to the standard, or may be used for conveying special data types. Encountering a data block with any keyword not included in the standard is normally considered to be an error. However, if the keyword ends with the extension ".EXP" the data block is considered to be EXPerimental or an EXcePtion. In this case it must be a syntactically correct data block, but no restrictions are enforced on its option list or data set. Any use of EXP data blocks should be by agreement of effected parties and should be documented in the >INFO section. See section 20.0

Head Block

The head block is always the first block in an EDI file. There is exactly one head block per file. It has an option list but no data set. Options describe when, where, and by whom the data was collected as well as when, where, and by whom the EDI file was written.

Integer

Integers are considered to be two's compliment 16 bit quantities. The range of integers is -32768 to 32767. See section 6.22, section 6.23, Binary Data Set.

Interchange Media

This standard addresses the interchange media on which an EDI file resides as a separate issue from the format of an EDI file. The only standardized media are 9 track 1/2" magnetic tape and IBM 3480 compatible tape cartridges, but any media acceptable to all concerned parties may be used for the interchange of EDI files. Only 1600 BPI 9 track tape is acceptable for archival purposes. See sections 4.1 and 4.2.

Keyword

All data block begin with a keyword. Keywords begin with the character ">". The current standard defines 119 keywords. Additionally, the .EXP extension allows non-standard keywords to be used within an EDI file. New keywords may be added to the standard in the future as required. See section 7.1, Data Block, EXP Data Block.

Info Block

The info block is the second block in an EDI file, immediately following the head block. There is exactly one info block per file. The info block has an option list with one option and no data set. Following the info block is text which continues until another keyword is encountered. This is a repository for important field comments, descriptions of data acquisition and processing, data quality tables, and any other relevant information.

Measurement

A measurement combines a channel and a run to uniquely identify a particular set of data. The definition of a measurement includes a complete description of the sensor location(s) and configuration, sensor ID, filters, gain, acquisition channel, etc. All measurements must be defined in the Define Measurement section. It may then be uniquely referred to by its measurement ID. See Channel, Run, Measurement ID.

Measurement ID (or ID)

A number which uniquely identifies one of the measurements defined in the Define Measurements section. Measurement IDs incorporate both channel number and run number. The integer part is the channel number. There may be a fractional part which gives the run number. The run number for the first run is always 0. Thus, there is no fractional part in the measurement ID's for the first (and often only) run in the file. The number of digits in the fractional part is 2, 3, or 4, depending on the value of the MAXRUN option in the >=DEFINEMEAS data block. If the value is 0 (default), then all measurement IDs are simply the channel number. If the MAXRUN <100, then all measurement IDs are chan num+(run num/100). If MAXRUN is >=100 and <1000 then all measurement IDs are chan num+(run num/1000). Finally, if MAXRUN is >=1000, then measurement IDs are chan num+(run num/10,000).

Magnetotellurics (or MT)

Magnetotellurics, or MT, is a geophysical exploration technique which uses relationship between the earth's electric and magnetic fields as measured at the surface to estimate the subsurface resistivity structure.

MT Data Section

An MT data section is a set of contiguous data blocks associated with an MT sounding. It always begins with a >=MTSECT data block which defines the measurements associated with the sounding. Following this may be data blocks for frequencies, impedances (Z's), apparent resistivities (Rho's), one-dimensional continuous inversions, coherencies, signal parameters, and other data blocks. See section 7.53.

Option

An option is an option name, followed by the character "=", followed by an option argument. It is the component from which option lists are built. The type of the option is indicated by its option name. See section 6.24, Option Argument, Option List, Option Name, Dynamic Option Default, and Static Option Default.

Option Argument

An option argument is a string of 1 to 16 characters. Depending upon the option name, there may be syntactic or semantic restrictions on the option argument. Possible restrictions include valid measurement ID, valid date, valid latitude, valid longitude, integer >=0, integer >=1, number >0, number >=0, etc. These are given in the option tables in sections 8-20. See section 6.24, Option, Option List, Option Name, Dynamic Option Default, and Static Option Default.

Option List

An option list is a set of 0 or more options. They may appear only in data blocks. For a given data block type, there is a list of allowable options. Some are required, and some have default values and may be omitted. These are given in the option tables in sections 8-20. See section 6.24, option, Option Argument, Option Name, Dynamic Option Default, and Static Option Default.

Option Name

An option name consists of 1 to 16 characters. Option names define the type of an option just as keywords define the type of a data block. They are defined by the standard in the same way as keywords. For a given data block type there is an allowable set of options as given in sections 8-20. See section 6.24,Option, Option Argument, Option List, Dynamic Option Default, and Static Option Default.

Other Data Section

Both MT and EMAP data sections are made up of basically the same of data blocks. They both impose restrictions as to which data blocks may be included and on the ordering of the blocks. The OTHER section allows unrestricted inclusion of all of these data blocks. See section 7.55.

Real Number

Because the range and precision of real numbers is machine dependent, all real data values must be representable using a "least common denominator" definition. All real data values are to be within the range -1.0E-32 to -1.0E-32, the value 0.0, or within the range 1.0E-32 to 1.0+32. There may be from 1 to 16 significant figures.

Reference Location

All of the sensor locations in the define measurements section are given in terms of X, Y, and Z offsets from a reference location. The latitude, longitude, and elevation of the reference location are required in the option list for the define measurements data block. See section 9.1 and Define Measurements Section.

Run

A "run" refers to the acquisition of one data set from a given set of channels. Each run represented in an EDI file has a unique run number. The first run has a run number of 0. The run number is included within a measurement ID. See Measurement ID.

Spectra Data Section

A Spectra data section consists of a series of contiguous data blocks which represent the cross and auto power spectra estimates for a given set of measurements. Each spectra data section begins with a >=SPECTRASECT data block which defines the set of measurements for which spectra are given. A series of >SPEC data blocks, one per frequency, contain the actual spectra estimates. See section 7.52.

Static Option Option

Some options have default values which are used when the option is not specified. A data block can use the default value by omitting that option from its option list, or may specify a different value by including the option. When writing an option list, if the option value=default value, the option does not have to be written. When reading, the default value should be filled in if the option is not specified. See section 6.24, Option, Option Argument, Option List, Option Name, and Dynamic Option Default.

Tseries Data Section

A time series data section is a series of contiguous data blocks which contain time series data for a given set of measurements. Each tseries data section begins with a >=TSERIESSECT data block which defines the set of measurements for which time series data are presented. A series of one or more >TSERIES data blocks contain the actual time series data.

APPENDIX 2 - SYNTAX SUMMARY FOR EDI FILES

Refer to Section 6.1 for the notation used in the BNF (Backus-Naur Form) representation presented here.

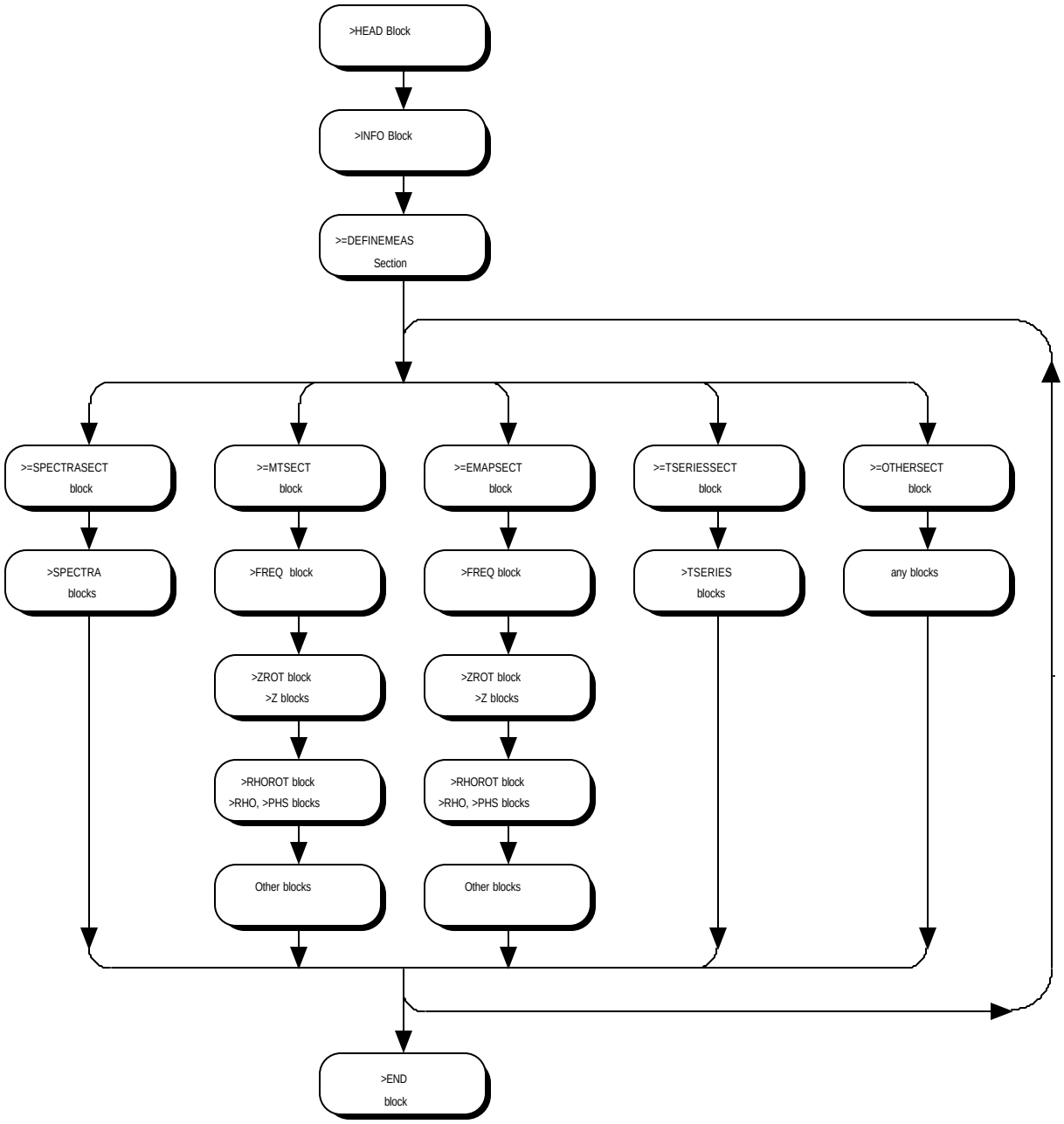
<u>Character Classes:</u>

<upc_letter> ::= "A" .. "Z"

```
<lwc_letter>        ::=   “a” .. “z”
<digit>             ::=   “0” .. “9”
<special>           ::=   “>”
<other>             ::=   “!” | “ ' ” | “#” | “$” | “%” | “&” | “(” | “)” |
                          “*” | “+” | “,” | “-” | “.” | “/” | “:” | “;” | “<” |
                          “=” | “?” | “@” | “[” | “\” | “]” | “^” | “_” | “ ' ” |
                          “{” | “|” | “}” | “~”
<space>             ::=   “ ”
<null>              ::=   /000 | /010 | /013
<illegal>           ::=   /001 .. /009 | /011 .. /012 | /014 .. /031 |
                          /127 .. /255

<letter>            ::=   <upc_letter> | <lwc_letter>
<legal_char>        ::=   <letter> | <digit> | <other>
<unsign_int>        ::=   { <digit> }+
<unsign_real>       ::=   <unsign_int> “.” <unsign_int> | <unsign_int> “.” |
                          “.” <unsign_int>
<sign>              ::=   “+” | “-”
<int>               ::=   ( <sign> | “ ” ) <unsign_int>
<real>              ::=   ( <sign> | “ ” ) <unsign_real>
<exp>               ::=   <real> “E” <int>
<string>            ::=   { <legal_char> }+ | ( “ ' ” { <legal_char> | “ ” } “ ' ” )
<number>            ::=   <int> | <real> | <exp>
<date>              ::=   <digit> <digit> “/” <digit> <digit> “/” <digit> <digit>
<lat_long>          ::=   <int> “:” <unsign_int> “:” ( <unsign_int> | <unsign_real )

<ascii_data_set>    ::=   “//” unsign_int { <number> }
<bin_data_set>      ::=   “/I/” | “/R/” | “/D/”

<meas_ID>           ::=   <unsign_int> | <unsign_real>
<meas_ID_set>       ::=   “//” <unsign_int> { <meas_ID> }

<data_set>          ::=   <ascii_data_set> | <bin_data_set> | <meas_ID_set>

<comment>           ::=   “>!” {<legal char> } “!”
                          (Where <legal_char> does not include “!” or “>”)

<keyword>           ::=   “>” <letter> { <letter> | <digit> }

<option_name>       ::=   <letter> { <letter> | <digit> }
<option arg>        ::=   <string> | <number> | <date> | <real> | <lat_long>
<option>            ::=   <option name> “=” <option arg>
<option list>       ::=   { <option> }

<data_block>        ::=   <keyword> |
                          <keyword> <option_list> |
                          <keyword> <data_set> |
                          <keyword> <option_list> <data_set>

<head_block>        ::=   “>HEAD” <option_list>

<info_block>        ::=   “>INFO” <option_list>
<info_text>         ::=   { <legal_char> }
                          ( Where legal character does not include “>” )

<emeas_block>       ::=   “>EMEAS” <option_list>
```

```
<hmeas_hlock>        ::=   ">HMEAS"  <option_list>
<def_meas_section>   ::=   ">=DEFINEMEAS"  <option_list>
                           {  <emeas_block>  |  <hmeas_block>  }

<tseriessect_block>  ::=   ">=TSERIESSECT" <option_list>  <mead_ID_set>
<tseries_block>      ::=   ">TSERIES"  <option_list>  <data_set>
<tseries_section>    ::=   <tseriessect_block>  {  <tseries_block>  }

<spectrasect_block>  ::=   ">=SPECTRASECT"  <option_list>  <meas_ID_set>
<spectra_block>      ::=   ">SPECTRA"  <option_list>  ";"  <data_set>
<spectra_section>    ::=   <spectrasect_block>  {  <spectra_block>  }

<mtsect_block>       ::=   ">=MTSECT"  <option_list>
<mt_data_block>      ::=   <keyword>  <option_list>  <data_set>
<mt_section>         ::=   <mtsect_block>  {  <mt_data_block>  }

<emapsect_block>     ::=   ">=EMAPSECT"  <option_list>  <meas_ID_set>
<emap_data_block>    ::=   <keyword>  <option_list>  <data_set>
<emap_section>       ::=   <emapsect_block>  {  <emap_data_block>  }
<othersect_block>    ::=   ">=OTHERSECT"  <option_list>  <meas_ID_set>

<data_block>         ::=   <keyword>  <option_list>  <data_set>
<other_section>      ::=   <othersect_block>  {  <data_block>  }
<end_block>          ::=   ">END"

<edi_file>           ::=   <head_block>
                           <info_block>
                           <info_text>
                           <def_meas_section>
                           {    <tseries_section>  |  spectra_section>  |
                                <mt_section>  |  <emap_section>  |  <other_section>   }
                           <end_block>
```

Appendix 3 - Ordering of Data Blocks



Appendix 4 - Example EDI File - MT Computed Parameters

```
>HEAD
   DATAID=DEMO88
   ACQBY="ACME MT"
   FILEBY="ACME MT"
   ACQDATE=04/30/88
   FILEDATE=06/06/88
   PROSPECT=DEMO88
   LOC="DEMO PROSPECT"
   LAT=+30:20:00
   LONG=-122:20:00
   ELEV=200
   STDVERS="SEG 1.0"
   PROGVERS=1.0
   PROGDATE=08/07/89
   MAXSECT=999
   EMPTY=1.0E+32

>INFO  MAXINFO=2000
-------------------------------------------------------------------------------------------------------
                              Run Information
                                                    Calibration Files
Project:  DEMO PHASE 1                    Digitizer:     D#209-10Mar88-10
Client:  BIGOIL PETROLEUM                 SP--Stn01:  B#219-14Mar88-05
Run: DEMO88-101/102                       SP--Stn02:  B#336-14Mar88-05
                                          Sens-Ch01:  C#238-11Mar88-01
Operator: SMITH                           Sens-Ch02:  C#239-11Mar88-01
Date: 30 Apr 1988                         Sens-Ch03:  L#333-12Mar88-01
Time: 15:48:30                            Sens-Ch06:  C#431-11Mar88-01
                                          Sens-Ch07:  C#309-11Mar88-01
Program Version: ACQSYSTEM                Sens-Ch08:  L#334-12Mar88-01
Latest Revision: 01 Feb 1988
MT Ref Field: 4 = Rem H Ref
XPR Weighting: RHO VAR STN
XPR Recording Hi Passes: 2
XPR Recording Lo Stacks: 1500
Notch Filters: 60,180,300 Hz
Digitizer: D209
-------------------------------------------------------------------------------------------------------
                    Operator Log for DEMO88-101/102
DEMO88-101/102
   Start:                    15:58:30  30 Apr 1988
   End:                      06:05:26   1 May 1988
Cultural Factors:
   People near both sites during daylight hours.  Electrical lines 1.2 km to the south.
Weather Conditions:
   Dry and very hot.  Light breeze at times.  Some distant lightning late in evening.
Other Factors:
   Low signal levels overnight.
```

Summary of Stacks & Quality

Freq Num	Unedited Stacks	Edited Stacks	Unedited Quality	Edited Quality
1	2141	1790	.703	.712
2	2141	1662	.746	.773
3	2144	1728	.684	.724
4	2144	1664	.645	.654
5	36797	17901	.612	.635
6	36797	17901	.596	.609
7	18380	9571	.424	.394
8	18380	8947	.338	.302
9	9171	5071	.202	.162
10	9171	4239	.121	.101
11	4467	2409	.049	.037
12	4593	2553	.027	.024
13	2248	1456	.019	.015
14	2188	276	.020	.017
15	1018	126	.016	.023
16	1084	982	.019	.019
17	529	255	.024	.035
18	555	495	.024	.024
19	486	204	.015	.020
20	594	132	.017	.035

```
>=DEFINEMEAS
  MAXCHAN=16
  MAXRUN=999
  MAXMEAS=9999
  UNITS=M
  REFTYPE=CART
  REFLOC=DEMO88-107
  REFLAT=+30:20:00
  REFLONG=-122:20:00
  REFELEV=200

>HMEAS  ID=1011.001  CHTYPE=HX  X=75136  Y=34949  Z=153
        AZM=-55  ACQCHAN=CH1  SENSOR=COIL238
>HMEAS  ID=1012.001  CHTYPE=HY  X=75136  Y=34949  Z=153
        AZM=+35  ACQCHAN=CH2  SENSOR=COIL239
>HMEAS  ID=1013.001  CHTYPE=HZ  X=75136  Y=34949  Z=153
        AZM=0  ACQCHAN=CH3  SENSOR=LOOP333
>EMEAS  ID=1014.001  CHTYPE=EX  X=75087  Y=35019  Z=153
        X2=75185  Y2=34879  Z2=153  ACQCHAN=CH4
>EMEAS  ID=1015.001  CHTYPE=EY  X=75057  Y=34894  Z=153
        X2=75214  Y2=35004  Z2=153  ACQCHAN=CH5

>HMEAS  ID=1021.001  CHTYPE=HX  X=46446  Y=19773  Z=198
        AZM=+25  ACQCHAN=CH6  SENSOR=COIL431
>HMEAS  ID=1022.001  CHTYPE=HY  X=46446  Y=19773  Z=198
        AZM=+115  ACQCHAN=CH7  SENSOR=COIL309
>HMEAS  ID=1023.001  CHTYPE=HZ  X=46446  Y=19773  Z=198
```

```
          AZM=0   ACQCHAN=CH8   SENSOR=LOOP334
>EMEAS   ID=1024.001   CHTYPE=EX   X=46377   Y=19741   Z=198
          X2=46514   Y2=19806   Z2=198   ACQCHAN=CH9
>EMEAS   ID=1025.001   CHTYPE=EY   X=46477   Y=19706   Z=198
          X2=46414   Y2=19841   Z2=198   ACQCHAN=CH10

>=MTSECT
  SECTID=DEMO88-101
  NFREQ=20
  HX=1011.001
  HY=1012.001
  HZ=1013.001
  EX=1014.001
  EY=1015.001
  HX=1021.001
  HY=1022.001

>FREQ   //20
  1.20000000E+019.00000000E+006.00000000E+004.50000000E+003.00000000E+00
  2.25000000E+001.50000000E+001.12500000E+00 7.50000000E-01 5.62500000E-01
   3.75000000E-01 2.81250000E-01 1.87500000E-01 1.40625000E-01 9.37500000E-02
   7.03125000E-02 4.68750000E-02 3.51562500E-02 2.34375000E-02 1.75781250E-02
>ZROT   // 20
    5.5246933E+01  3.1937851E+01  3.3514709E+01  2.0876354E+01  2.5652016E+01
    2.5561487E+01  2.8420677E+01  2.7789608E+01  2.7317364E+01  3.2120583E+01
    4.1798073E+01  2.8956604E+01  1.2983720E+01  4.0194614E+01  1.3554901E+01
    2.6992781E+01  1.1652201E+01  2.3906601E+01  2.8832569E+01 -2.7098677E+01
>ZXXR   ROT=ZROT   // 20
   6.01820767E-01 7.74375319E-01 5.08936584E-01 4.09464180E-01 3.14963371E-01
   2.60999680E-01 2.38515064E-01 2.67349362E-01 2.46229470E-01 1.61181539E-01
   1.14646673E-01 9.87800136E-02-5.15134633E-01-1.03739366E-01 2.51554072E-01
   1.23188727E-01-7.75714070E-02 2.89261997E-01 1.84981659E-01-1.65735200E-01
>ZXXI   ROT=ZROT   // 20
   3.82436991E-01 4.86611396E-01 2.32982397E-01 5.61997592E-01 1.48000553E-01
   2.08314955E-01 2.36181095E-01 1.96589693E-01 2.02463135E-01 1.20266847E-01
   8.94169956E-02 8.67609009E-02 2.81338722E-01-3.01315159E-01-1.72400922E-02
  -5.77442169E-01-1.04875311E-01-1.00008130E-01-2.17091888E-02 1.26323907E-03
>ZXX.VAR   ROT=ZROT   // 20
   7.98894018E-02 1.06651708E-01 2.63338871E-02 2.51712389E-02 1.99000398E-03
   1.61146396E-03 4.03572014E-03 4.76737041E-03 2.86063049E-02 4.47226837E-02
   3.56072813E-011.28422713E+004.62220716E+001.52441940E+015.08411503E+00
  1.11116517E+00 1.81610763E-01 2.96290845E-011.58825421E+00 2.12594986E-01
>ZXYR   ROT=ZROT   // 20
  1.82304420E+011.58144493E+011.27437716E+011.13909054E+019.03257847E+00
  7.78446531E+005.97235203E+004.77245998E+003.46459270E+003.04857588E+00
  2.71974206E+002.15195584E+001.05662036E+001.92158365E+002.20907617E+00
  1.70448887E+001.45904374E+001.43950450E+00 8.96938622E-01 9.33596849E-01
>ZXYI   ROT=ZROT   // 20
  1.78640862E+011.55672512E+011.23579521E+011.12322969E+018.67523193E+00
  7.92584085E+006.75779009E+005.97676611E+004.71855068E+003.94736171E+00
  2.87872338E+002.74608994E+002.75129199E+001.03025210E+001.09479427E+00
  1.10868073E+00 8.83241832E-011.57094276E+001.17696345E+00 4.10631716E-01
>ZXY.VAR   ROT=ZROT   // 20
```

```
   6.40567616E-02 1.29550219E-01 3.87462005E-02 5.38796373E-02 4.28105146E-03
   3.36414739E-03 7.68441008E-03 8.70212074E-03 4.84056659E-02 7.71162733E-02
   6.17848814E-011.35105288E+001.67389164E+011.09108038E+017.61349249E+00
   3.20321053E-01 3.02374005E-01 8.58611465E-011.58494043E+001.69539928E+00
>ZYXR   ROT=ZROT   // 20
  -1.83230228E+01-1.51980267E+01-1.23099728E+01-1.02583351E+01-8.56172848E+00
  -6.79286957E+00-4.86690569E+00-3.88225937E+00-2.75575304E+00-2.31945348E+00
  -1.89399958E+00-1.41652894E+00-1.46898735E+00-1.60360003E+00-1.37504911E+00
   -3.73708814E-01-6.21191323E-01-5.30263722E-01-3.15491974E-01-5.12749434E-01
>ZYXI   ROT=ZROT   // 20
  -1.91446934E+01-1.64569569E+01-1.42486191E+01-1.23930387E+01-9.47896576E+00
  -8.47215557E+00-6.81080961E+00-5.68913937E+00-4.40342093E+00-3.59577608E+00
  -2.83743882E+00-2.45614576E+00-1.27287626E+00-1.58564019E+00-2.14012170E+00
  -1.59199321E+00-1.16176021E+00-8.39508951E-01-6.99343145E-01-9.31983411E-01
>ZYX.VAR   ROT=ZROT   // 20
   5.77105992E-02 2.50179116E-02 1.91052631E-02 1.76006202E-02 1.31301337E-03
   1.05120661E-03 1.92553515E-03 2.54385453E-03 1.18605141E-02 2.31200252E-02
   2.17628509E-01 5.37685812E-012.76287913E+007.25540113E+004.10799170E+00
   6.95324838E-01 2.09015653E-01 2.21660748E-01 9.64904845E-01 1.40117034E-01
>ZYYR   ROT=ZROT   // 20
  -4.14399713E-01 3.37689847E-01-1.36755705E-01-7.88401291E-02 2.10223034E-01
   2.23552525E-01 2.38290370E-01 2.43170977E-01 2.11295232E-01 1.55212507E-01
   1.09562479E-01 9.46080014E-02 9.78896096E-02 4.17534620E-01 3.39732528E-01
   2.83228546E-01-3.45761515E-02 5.55908121E-02-2.84877960E-02 1.25025302E-01
>ZYYI   ROT=ZROT   // 20
   4.55903441E-01 1.84058860E-01 8.48331824E-02 8.55446607E-02 8.66406634E-02
   1.40346035E-01 2.31496125E-01 2.71421462E-01 2.81042844E-01 1.32645488E-01
   1.91107258E-01 9.73429605E-02 4.52326506E-01-2.86337221E-03 5.31141311E-02
  -1.36779368E-01 2.44650878E-02 1.90467075E-01 2.38164783E-01 2.35971957E-01
>ZYY.VAR   ROT=ZROT   // 20
   4.62733991E-02 3.03893499E-02 2.81104092E-02 3.76745462E-02 2.82465667E-03
   2.19453499E-03 3.66640906E-03 4.64342535E-03 2.00695638E-02 3.98663506E-02
   3.77623677E-01 5.65664768E-011.00055227E+015.19294500E+006.15174198E+00
   2.00444698E-01 3.48001957E-01 6.42343402E-01 9.62891638E-011.11740327E+00
>RHOROT   // 20
    5.5246933E+01  3.1937851E+01  3.3514709E+01  2.0876354E+01  2.5652016E+01
    2.5561487E+01  2.8420677E+01  2.7789608E+01  2.7317364E+01  3.2120583E+01
    4.1798073E+01  2.8956604E+01  1.2983720E+01  4.0194614E+01  1.3554901E+01
    2.6992781E+01  1.1652201E+01  2.3906601E+01  2.8832569E+01 -2.7098677E+01
>RHOXY   ROT=RHOROT   // 20
  1.08579102E+011.09430246E+011.05040903E+011.13740978E+011.04564753E+01
  1.09703875E+011.08448954E+011.03996630E+019.13816547E+008.84461498E+00
  8.36482430E+008.65559006E+009.26512432E+006.76110649E+001.29676619E+01
  1.17602291E+011.24114132E+012.58277512E+011.86857986E+011.18354082E+01
>RHOXY.ERR   ROT=RHOROT   // 20
   3.70884918E-05 9.92338682E-05 4.63789693E-05 7.94139632E-05 1.02954555E-05
   1.02818722E-05 3.56365454E-05 5.61119014E-05 5.32816397E-04 1.16935465E-03
   1.48592135E-02 4.18682545E-02 7.26903081E-01 8.65721345E-01 4.72446501E-01
   2.92239450E-02 3.92088071E-02 7.13360757E-02 2.73018241E-01 6.14777386E-01
>RHOXY.FIT   ROT=RHOROT   // 20
  1.08055725E+011.12992468E+011.14322338E+011.18133020E+011.14638700E+01
  1.13653736E+011.08274536E+011.02358246E+019.45879936E+008.78839207E+00
  8.45290565E+007.95113993E+007.80294704E+008.09408760E+008.99953556E+00
```

```
  1.01694565E+011.27217693E+011.53065901E+011.95557880E+012.29767914E+01
>PHSXY   ROT=RHOROT   // 20
  4.44184723E+014.45486832E+014.41194191E+014.45983124E+014.38439178E+01
  4.55155830E+014.85306206E+015.13925629E+015.37120476E+015.23208351E+01
  4.66266098E+015.19162025E+016.89909592E+012.81978683E+012.63625183E+01
  3.30418930E+013.11888943E+014.74999847E+015.26897507E+012.37417355E+01
>PHSXY.ERR   ROT=RHOROT   // 20
   1.61392301E-01 4.31820720E-01 2.01820210E-01 3.45573485E-01 4.48011458E-02
   4.47420478E-02 1.55074075E-01 2.44173512E-012.31857514E+005.08850002E+00
  6.46605453E+011.82191620E+023.16315063E+033.76722632E+032.05587280E+03
  1.27169350E+021.70618927E+023.10422241E+021.18805164E+032.67523218E+03
>RHOYX   ROT=RHOROT   // 20
  1.17042065E+011.11513662E+011.18186188E+011.15031490E+011.08769321E+01
  1.04818220E+019.34318638E+008.43346500E+007.19581127E+006.51003361E+00
  6.20709038E+005.71676922E+004.03001356E+007.23312092E+001.38045464E+01
  7.60633039E+007.40507936E+005.60898781E+005.02285671E+001.28740139E+01
>RHOYX.ERR   ROT=RHOROT   // 20
   3.09980242E-05 1.88053818E-05 2.03252894E-05 2.56507701E-05 3.03559023E-06
   3.36256312E-06 1.03649409E-05 2.02271804E-05 1.65792226E-04 4.76303976E-04
   7.05339387E-03 2.52282470E-02 2.75839061E-01 5.38114667E-01 2.39462674E-01
   9.80802774E-02 4.54265215E-02 8.48014802E-02 6.18335366E-01 4.67095934E-02
>RHOYX.FIT   ROT=RHOROT   // 20
  1.12010403E+011.05073242E+011.12996416E+011.08287973E+011.07000265E+01
  1.00603609E+019.23262310E+008.18244267E+007.23176861E+006.50611925E+00
  6.15016508E+006.21517706E+006.43886948E+006.76664209E+007.19911051E+00
  7.59960413E+007.94215775E+007.93704319E+007.63958073E+007.30883598E+00
>PHSYX   ROT=RHOROT   // 20
 -1.33743698E+02-1.32722519E+02-1.30825089E+02-1.29616257E+02-1.32089432E+02
 -1.28722198E+02-1.25549049E+02-1.24309563E+02-1.22039192E+02-1.22824020E+02
 -1.23723236E+02-1.19973267E+02-1.39091095E+02-1.35322647E+02-1.22721138E+02
 -1.03210579E+02-1.18133347E+02-1.22277962E+02-1.14281380E+02-1.18818275E+02
>PHSYX.ERR   ROT=RHOROT   // 20
   1.34889320E-01 8.18324462E-02 8.84463862E-02 1.11620553E-01 1.32095050E-02
   1.46323387E-02 4.51035164E-02 8.80194977E-02 7.21452355E-012.07265925E+00
  3.06931648E+011.09781853E+021.20032605E+032.34163013E+031.04203259E+03
  4.26800568E+021.97675674E+023.69017426E+022.69071460E+032.03258911E+02
>RES1DXY   ROT=RHOROT   // 20
  1.17015715E+011.32999439E+011.30004625E+011.19078741E+011.02527933E+01
  9.63494396E+007.98624992E+006.89576387E+006.04798603E+006.33519840E+00
  6.31925201E+006.30551910E+008.21470928E+001.22897148E+011.78367996E+01
  3.04577389E+014.93220749E+016.53172836E+017.49221878E+017.50644455E+01
>DEP1DXY   ROT=RHOROT   // 20
  3.37705719E+023.98757294E+024.91241516E+025.76613159E+026.95680969E+02
  7.99844788E+029.56142578E+021.07347095E+031.26384119E+031.40669055E+03
  1.68963354E+031.89222839E+032.29579883E+032.69996313E+033.48682007E+03
  4.27994043E+035.86284277E+037.42579736E+031.02798584E+041.28665928E+04
>RES1DYX   ROT=RHOROT   // 20
  9.14013386E+001.07764425E+011.23268681E+019.24939346E+008.64568615E+00
  6.52991819E+004.99243736E+003.91825318E+003.63707042E+004.04100895E+00
  5.38858700E+007.09615088E+008.23903465E+009.36382961E+001.00957212E+01
  1.01091537E+019.00431824E+007.09470081E+006.01520729E+005.34585762E+00
>DEP1DYX   ROT=RHOROT   // 20
  3.43829926E+023.84529755E+024.88384460E+025.52063416E+026.72104675E+02
```

```
   7.52524536E+028.82921448E+029.59777039E+021.10508777E+031.21033301E+03
   1.44122864E+031.67296021E+032.08549585E+032.46865527E+033.11859448E+03
   3.69985205E+034.63237549E+035.34728369E+036.42516455E+037.25676367E+03
>TIPMAG   // 20
    3.44053991E-02 2.77741961E-02 1.57841984E-02 1.58313140E-02 1.29138678E-02
    2.00289786E-02 2.53893416E-02 3.00401263E-02 1.78977810E-02 6.76133260E-02
    8.58623311E-02 6.44834638E-01 3.79827708E-01 2.41298199E-011.22498584E+00
    1.08001776E-01 7.38304779E-02 1.37485325E-01 2.12266326E-01 2.85834283E-01
>TIPMAG.ERR   // 20
    3.76806406E-06 3.72908039E-06 7.67111578E-06 8.83754910E-06 2.14069451E-06
    5.37461983E-06 2.81062730E-05 4.50495500E-05 3.06746981E-04 7.20269163E-04
    3.20429541E-03 2.38383822E-02 2.51837492E-01-1.58010080E-011.57495940E+00
    3.27604637E-02 7.30495201E-03 5.62215447E-02 6.69617236E-01 3.49914134E-01
>TIPPHS   // 20
   4.28428040E+013.32755089E+014.26912880E+011.10915861E+011.09842672E+01
   1.32586594E+011.12150545E+014.03483810E+019.63721161E+018.86814423E+01
   1.10555733E+021.10969086E+02-5.10283546E+01-6.45015945E+01-3.42821960E+01
  -1.12413170E+027.66205835E+001.56070114E+024.22109604E+019.70897522E+01
>TIPPHS.ERR   // 20
   3.85896563E+041.09772977E+052.02113876E+117.55311600E+062.60394594E+05
   8.57076406E+041.10416414E+056.11341250E+056.74735063E+118.28734125E+12
   2.92439980E+075.20001953E+032.43352250E+061.86224250E+057.55223125E+05
   1.85859500E+053.62959560E+073.38587375E+051.84026656E+081.44706176E+08
>ZSTRIKE   // 20
   5.52469330E+013.19378510E+013.35147095E+012.08763542E+012.56520157E+01
   2.55614872E+012.84206772E+012.77896080E+012.73173637E+013.21205826E+01
   4.17980728E+012.89566040E+011.29837198E+014.01946144E+011.35549011E+01
   2.69927807E+011.16522007E+012.39066010E+012.88325691E+01-2.70986767E+01
>ZSKEW   // 20
    1.65143926E-02 2.91311257E-02 1.33917565E-02 2.26892661E-02 2.27529295E-02
    2.72076949E-02 3.84579562E-02 4.76793759E-02 6.02902286E-02 4.37508821E-02
    4.88869660E-02 4.23249938E-02 1.77647114E-01 9.95563343E-02 1.22692734E-01
    2.41146311E-01 4.73060347E-02 1.14529058E-01 1.19565003E-01 1.21970117E-01
>ZELLIP   // 20
    7.93546796E-01 4.90819782E-01 3.41515541E-01 4.20682937E-01 1.30317226E-01
    6.85449764E-02 4.23808442E-03 8.40616897E-02 1.10856846E-01 1.69774536E-02
    1.23150088E-01 1.43890111E-02 4.14649457E-01 9.38576043E-01 8.43548477E-02
    3.31131220E-01 1.54371321E-01 3.19470048E-01 4.46943790E-01 5.57705045E-01
>TSTRIKE   // 20
  -1.36445892E+02-1.40237686E+02-1.67916595E+021.56392731E+021.45596680E+02
   1.54393463E+02-1.61574371E+02-1.75743118E+021.58962204E+02-1.52523285E+02
   1.65875214E+021.57556396E+02-1.11872910E+021.92892666E+017.56694870E+01
   5.56710930E+016.83958511E+014.75166893E+019.93813171E+011.33683578E+02
>TSKEW   // 20
    6.60710394E-01 8.02580893E-01 8.97978842E-01 9.03054416E-01 1.48976877E-01
    5.43319106E-01 3.26863348E-01 3.21052670E-01 4.11468536E-01 1.96716279E-01
    2.49405324E-01 5.73344529E-01 7.17403591E-01 6.57725573E-01 3.67916971E-02
    4.69498634E-01 2.21401542E-01 5.67200959E-01 4.14039373E-01 1.71631679E-01
>TELLIP   // 20
    4.25390005E-01 5.52190423E-01 8.63478661E-011.42479515E+001.72830153E+00
   1.10143661E+00 2.33034804E-01 4.63358998E-01 7.55712271E-01 1.20694175E-01
    6.25514030E-01 3.63811970E-011.79563320E+001.32683754E+00 5.86281084E-02
    6.24344170E-011.50295961E+00 4.11345899E-012.34622264E+00 2.86743581E-01
```

```
>COH   MEAS1=1011.101   MEAS2=1015.101   ROT=NORTH   // 20
   9.60033655E-01 9.72313225E-01 9.66603339E-01 9.59068954E-01 9.55812097E-01
   9.49533224E-01 9.30146277E-01 9.02701676E-01 7.87032247E-01 7.49909878E-01
   5.95737398E-01 4.28677410E-01 3.08223873E-01 5.21349132E-01 6.18800640E-01
   6.26757741E-01 7.85922527E-01 5.30418575E-01 6.13066256E-01 6.97230458E-01
>COH   MEAS1=1012.001   MEAS2=1014.001   ROT=NORTH   // 20
   9.34163392E-01 8.52472782E-01 9.37795401E-01 9.18854237E-01 9.19740617E-01
   9.21074510E-01 9.00534511E-01 8.89899254E-01 7.63477683E-01 7.28999436E-01
   5.25815785E-01 3.41834426E-01 1.85897052E-01 2.22749203E-01 4.37779665E-01
   6.26983762E-01 7.51004815E-01 5.24409890E-01 4.29688305E-01 5.70623815E-01
>COH   MEAS1=1011.001   MEAS2=1021.001   ROT=NORTH   // 20
   9.52571213E-01 9.74776983E-01 9.85351741E-01 9.88592207E-01 9.77083147E-01
   9.73743618E-01 9.72110212E-01 9.65922892E-01 9.54477787E-01 9.56499338E-01
   9.32995677E-01 9.08977509E-01 7.29260564E-01 8.65428805E-01 9.38159347E-01
   9.78484452E-01 9.87175405E-01 9.77970064E-01 8.80532801E-01 9.86519217E-01
>COH   MEAS1=1012.001   MEAS2=1022.001   ROT=NORTH   // 20
   9.36236620E-01 9.32445347E-01 9.40883279E-01 9.38185990E-01 9.55669701E-01
   9.59555328E-01 9.67278779E-01 9.68066931E-01 9.57643390E-01 9.59276617E-01
   8.92484188E-01 8.05794835E-01 5.49351037E-01 6.57734215E-01 8.69271278E-01
   9.69699204E-01 9.66140807E-01 9.53138351E-01 6.96024358E-01 8.77230406E-01
>EPREDCOH   MEAS1=1011.001   MEAS2=1012.001   EPRED=1014.001   ROT=NORTH   // 20
   9.34974968E-01 8.53829205E-01 9.41578388E-01 9.22673702E-01 9.20535862E-01
   9.21728909E-01 9.01208401E-01 8.90061975E-01 7.63703167E-01 7.29590595E-01
   5.30870974E-01 3.44830692E-01 2.02085733E-01 2.30681986E-01 4.38924909E-01
   6.36722207E-01 7.63903916E-01 5.41088402E-01 4.80003685E-01 5.86532772E-01
>EPREDCOH   MEAS1=1011.001   MEAS2=1012.001   EPRED=1015.001   ROT=NORTH   // 20
   9.60110545E-01 9.72558677E-01 9.66967463E-01 9.59174991E-01 9.56193924E-01
   9.50405538E-01 9.32586193E-01 9.06269968E-01 7.91613519E-01 7.54334390E-01
   5.97793758E-01 4.29177850E-01 3.08763087E-01 5.26233673E-01 6.28152251E-01
   6.62957251E-01 7.88255990E-01 5.54529369E-01 6.55136228E-01 7.00988650E-01
>HPREDCOH   MEAS1=1014.001   MEAS2=1015.001   HPRED=1011.001   ROT=NORTH   // 20
   9.60707903E-01 9.75124002E-01 9.66981709E-01 9.60868239E-01 9.57774282E-01
   9.52683330E-01 9.39414024E-01 9.17613506E-01 8.33122373E-01 7.89471686E-01
   6.43265784E-01 4.61068988E-01 3.09651703E-01 5.41831315E-01 6.20322108E-01
   6.84999466E-01 7.98119485E-01 5.46519339E-01 6.25260115E-01 7.96124279E-01
>HPREDCOH   MEAS1=1014.001   MEAS2=1015.001   HPRED=1012.001   ROT=NORTH   // 20
   9.34293807E-01 8.52630198E-01 9.39650178E-01 9.19990778E-01 9.23980176E-01
   9.26275134E-01 9.07121599E-01 8.95050645E-01 7.86238313E-01 7.52485216E-01
   5.53074300E-01 3.56081933E-01 1.93226978E-01 2.24225789E-01 4.61574793E-01
   6.67919099E-01 7.79454470E-01 5.33355713E-01 4.62981880E-01 7.27073312E-01
>HPREDCOH   MEAS1=1014.001   MEAS2=1015.001   HPRED=1013.001   ROT=NORTH   // 20
   3.04620683E-01 3.40898395E-01 1.47691086E-01 1.11252792E-01 6.77866265E-02
   6.38133064E-02 5.25812209E-02 6.98444173E-02 2.93103531E-02 7.93277323E-02
   5.58075383E-02 7.70503059E-02 5.39193749E-02 1.70277134E-01 2.86293745E-01
   2.10911140E-01 2.37972125E-01 9.81115550E-02 2.13403732E-01 2.44211435E-01
>SIGAMP   MEAS=1012.001   ROT=NORTH   // 20
   1.92698289E-03 1.83258369E-03 1.74875022E-03 1.55375735E-03 1.58419774E-03
   1.70137570E-03 1.95880537E-03 2.05492927E-03 2.16831383E-03 2.20897049E-03
   2.01171148E-03 2.24006665E-03 2.48103053E-03 2.50982610E-03 3.42130358E-03
   1.38269709E-02 1.86840594E-02 1.62400678E-02 2.61241812E-02 2.74835080E-02
>SIGAMP   MEAS=1013.001   ROT=NORTH   // 20
   2.33616185E-04 1.81822717E-04 2.37442495E-04 3.06473958E-04 3.71091854E-04
   5.22963936E-04 7.39932060E-04 7.78438116E-04 1.17328926E-03 1.44156173E-03
```

```
   1.61974924E-03 3.63558461E-03 5.33693843E-03 2.48669181E-03 1.00184130E-02
   6.86588371E-03 5.38131734E-03 1.74625944E-02 2.58656014E-02 3.04986350E-02
>SIGAMP   MEAS=1014.001   ROT=NORTH   // 20
   4.36866703E-03 5.19625749E-03 5.58836805E-03 5.97413862E-03 7.10765971E-03
   8.88536591E-03 1.26497410E-02 1.51213901E-02 2.12934054E-02 2.51495820E-02
   3.40503007E-02 5.88361174E-02 1.29315078E-01 1.02078117E-01 1.74526483E-01
   6.41632080E-01 8.84024560E-01 1.49140084E+00 2.36018038E+00 2.94081855E+00
>SIGAMP   MEAS=1015.001   ROT=NORTH   // 20
   4.97221947E-03 6.83178427E-03 8.26467015E-03 9.38632991E-03 9.28186812E-03
   1.07143363E-02 1.30347218E-02 1.46186659E-02 1.96029376E-02 2.38830149E-02
   3.57585996E-02 5.44844717E-02 1.21075049E-01 1.13870837E-01 1.84790015E-01
   5.80984712E-01 1.00179267E+00 1.36892831E+00 2.60550761E+00 4.20169735E+00
>SIGNOISE   MEAS=1011.001   ROT=NORTH   // 20
   9.63047802E-01 9.83598828E-01 9.88982439E-01 9.92118776E-01 9.87905025E-01
   9.89448309E-01 9.90553796E-01 9.87476230E-01 9.82665181E-01 9.80461240E-01
   9.35843825E-01 9.11659241E-01 1.00718665E+00 8.27387989E-01 8.91560793E-01
   9.85390067E-01 9.93908286E-01 9.94895220E-01 8.03094149E-01 9.87491071E-01
>SIGNOISE   MEAS=1012.001   ROT=NORTH   // 20
   9.59435701E-01 9.72226143E-01 9.76750910E-01 9.78079557E-01 9.81410325E-01
   9.85336065E-01 9.89126742E-01 9.87257838E-01 9.82562184E-01 9.78361428E-01
   8.89762521E-01 7.47886121E-01 6.48023427E-01 6.65342569E-01 8.80277395E-01
  1.00527894E+00 9.96248245E-01 9.70065236E-01 6.37964547E-01 8.69016051E-01
>SIGNOISE   MEAS=1013.001   ROT=NORTH   // 20
   9.84602943E-02 1.22894377E-01 2.45676246E-02 1.27272820E-02 4.90349438E-03
   4.50486410E-03 3.51630896E-03 5.78601332E-03 1.21771730E-03 7.62545737E-03
   1.11880945E-02 1.12089798E-01 3.73295508E-02 5.35447933E-02 1.87326252E-01
   7.32887536E-02 1.22538142E-01 1.41856372E-02 9.34924409E-02 6.15826659E-02
>SIGNOISE   MEAS=1014.001   ROT=NORTH   // 20
   9.11498487E-01 7.50137866E-01 9.07169998E-01 8.70288253E-01 8.63541484E-01
   8.62540126E-01 8.21192205E-01 8.02415073E-01 5.93471944E-01 5.43979526E-01
   3.14394534E-01 1.56734392E-01 5.68988174E-02 7.50180036E-02 2.18422621E-01
   4.03477728E-01 5.86048126E-01 3.05400968E-01 3.00980657E-01 3.78490716E-01
>SIGNOISE   MEAS=1015.001   ROT=NORTH   // 20
   9.57085550E-01 9.61609900E-01 9.45443749E-01 9.27327991E-01 9.25261259E-01
   9.12626028E-01 8.78106356E-01 8.32244158E-01 6.38401508E-01 5.80712140E-01
   3.85056317E-01 2.04922929E-01 9.21509862E-02 3.31813782E-01 4.38941211E-01
   4.48960394E-01 6.24023497E-01 3.13695878E-01 4.94904757E-01 5.04092336E-01

>=MTSECT
  SECTID=DEMO88-102
  NFREQ=20
  HX=1021.001
  HY=1022.001
  HZ=1023.001
  EX=1024.001
  EY=1025.001
  HX=1011.001
  HY=1012.001

>FREQ // 20
  1.20000000E+01 9.00000000E+00 6.00000000E+00 4.50000000E+00 3.00000000E+00
  2.25000000E+00 1.50000000E+00 1.12500000E+00 7.50000000E-01 5.62500000E-01
   3.75000000E-01 2.81250000E-01 1.87500000E-01 1.40625000E-01 9.37500000E-02
```

```
   7.03125000E-02 4.68750000E-02 3.51562500E-02 2.34375000E-02 1.75781250E-02
>ZROT // 20
    8.3579887E+01  8.4735565E+01  7.4092972E+01  6.6944489E+01  6.0900978E+01
    6.2374283E+01  7.2291351E+01  6.9820030E+01  7.1496559E+01  6.5928574E+01
    6.6308395E+01  7.2535866E+01  4.9795105E+01  5.3677925E+01  6.0597351E+01
    5.6869598E+01  8.6884895E+01  5.1381821E+01  6.2601913E+01  1.4939331E+01
...

>SIGNOISE   MEAS=1025.001   ROT=NORTH // 20
   9.59302008E-01 9.91037130E-01 9.27106082E-01 8.75554681E-01 8.70534122E-01
   8.70661080E-01 8.32570136E-01 7.99581409E-01 7.26698220E-01 6.31065965E-01
   5.76559186E-01 4.67171192E-01 4.17830288E-01 4.39184040E-01 6.74522400E-01
   8.40759218E-01 8.68123293E-01 9.56008136E-01 9.34558809E-01 7.97634721E-01

>END
```

Appendix 5 - Example EDI File - Stacked Spectra

```
>HEAD
   DATAID=DEMO88
   ACQBY="ACME MT"
   FILEBY="ACME MT"
   ACQDATE=04/30/88
   FILEDATE=06/06/88
   PROSPECT=DEMO88
   LOC="DEMO PROSPECT"
   LAT=+30:20:00
   LONG=-122:20:00
   ELEV=200
   STDVERS="SEG 1.0"
   PROGVERS=1.0
   PROGDATE=08/07/89
   MAXSECT=999
   EMPTY=1.0E+32

>INFO  MAXINFO=2000
-------------------------------------------------------------------------------------------------------
                                Run Information
                                                        Calibration Files
Project:: DEMO PHASE 1                  Digitizer:  D#209-10Mar88-10
Client:: BIGOIL PETROLEUM               SP--Stn01:  B#219-14Mar88-05
Run: DEMO88-101/102                     SP--Stn02:  B#336-14Mar88-05
                                        Sens-Ch01:  C#238-11Mar88-01
Operator: SMITH                         Sens-Ch02:  C#239-11Mar88-01
Date: 30 Apr 1988                       Sens-Ch03:  L#333-12Mar88-01
Time: 15:48:30                          Sens-Ch06:  C#431-11Mar88-01
                                        Sens-Ch07:  C#309-11Mar88-01
Program Version: ACQSYSTEM              Sens-Ch08:  L#334-12Mar88-01
Latest Revision: 01 Feb 1988
MT Ref Field: 4 = Rem H Ref
XPR Weighting: RHO VAR STN
XPR Recording Hi Passes: 2
XPR Recording Lo Stacks: 1500
Notch Filters: 60,180,300 Hz
Digitizer: D209
-------------------------------------------------------------------------------------------------------
                    Operator Log for DEMO88-101/102
DEMO88-101/102
   Start:                   15:58:30  30 Apr 1988
   End:                     06:05:26   1 May 1988
Cultural Factors:
   People near both sites during daylight hours.  Electrical lines 1.2 km to the south.
Weather Conditions:
   Dry and very hot.  Light breeze at times.  Some distant lightning late in evening.
Other Factors:
   Low signal levels overnight.
```

Summary of Stacks & Quality

Freq Num	Unedited Stacks	Edited Stacks	Unedited Quality	Edited Quality
1	2141	1790	.703	.712
2	2141	1662	.746	.773
3	2144	1728	.684	.724
4	2144	1664	.645	.654
5	36797	17901	.612	.635
6	36797	17901	.596	.609
7	18380	9571	.424	.394
8	18380	8947	.338	.302
9	9171	5071	.202	.162
10	9171	4239	.121	.101
11	4467	2409	.049	.037
12	4593	2553	.027	.024
13	2248	1456	.019	.015
14	2188	276	.020	.017
15	1018	126	.016	.023
16	1084	982	.019	.019
17	529	255	.024	.035
18	555	495	.024	.024
19	486	204	.015	.020
20	594	132	.017	.035

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  MAXCHAN=16
  MAXRUN=999
  MAXMEAS=9999
  UNITS=M
  REFTYPE=CART
  REFLOC=DEMO88-107
  REFLAT=+30:20:00
  REFLONG=-122:20:00
  REFELEV=200

>HMEAS  ID=1011.001  CHTYPE=HX  X=75136  Y=34949  Z=153
        AZM=-55  ACQCHAN=CH1  SENSOR=COIL238
>HMEAS  ID=1012.001  CHTYPE=HY  X=75136  Y=34949  Z=153
        AZM=+35  ACQCHAN=CH2  SENSOR=COIL239
>HMEAS  ID=1013.001  CHTYPE=HZ  X=75136  Y=34949  Z=153
        AZM=0  ACQCHAN=CH3  SENSOR=LOOP333
>EMEAS  ID=1014.001  CHTYPE=EX  X=75087  Y=35019  Z=153
        X2=75185  Y2=34879  Z2=153  ACQCHAN=CH4
>EMEAS  ID=1015.001  CHTYPE=EY  X=75057  Y=34894  Z=153
        X2=75214  Y2=35004  Z2=153  ACQCHAN=CH5

>HMEAS  ID=1021.001  CHTYPE=HX  X=46446  Y=19773  Z=198
        AZM=+25  ACQCHAN=CH6  SENSOR=COIL431
>HMEAS  ID=1022.001  CHTYPE=HY  X=46446  Y=19773  Z=198
        AZM=+115  ACQCHAN=CH7  SENSOR=COIL309
>HMEAS  ID=1023.001  CHTYPE=HZ  X=46446  Y=19773  Z=198
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          AZM=0   ACQCHAN=CH8   SENSOR=LOOP334
>EMEAS   ID=1024.001   CHTYPE=EX   X=46377   Y=19741   Z=198
          X2=46514   Y2=19806   Z2=198   ACQCHAN=CH9
>EMEAS   ID=1025.001   CHTYPE=EY   X=46477   Y=19706   Z=198
          X2=46414   Y2=19841   Z2=198   ACQCHAN=CH10

>=SPECTRASECT
  SECTID=DEMO88-101
  NCHAN=7
  NFREQ=20
  MAXBLKS=20
// 7
  1011.001
  1012.001
  1013.001
  1014.001
  1015.001
  1021.001
  1022.001

>SPECTRA   FREQ=1.200E+01   ROTSPEC=0   BW=3.000E+00   AVGT=1790   // 49
   4.52746406E-07-1.71115211E-08-4.42694681E-09-7.01830118E-07-7.73957981E-06
   4.36456673E-07 4.56306566E-08-1.71640231E-08 3.09438576E-07 6.37708419E-09
   5.58939155E-06 1.00488244E-07-7.48501421E-08 2.94604973E-07 9.91281368E-09
  -4.22392699E-09 4.54804372E-09 1.92081714E-07 2.60549939E-07-5.23433918E-09
   5.64745140E-09-3.90451675E-07-5.53199288E-06-3.02203738E-08 2.29023019E-04
   1.34846514E-05-1.73114984E-06 5.54458347E-06 7.99348345E-06-6.29705312E-07
   9.80942403E-08-1.50524220E-05 2.96675542E-04-7.65985715E-06-1.02632714E-06
   6.35002273E-09 1.61508531E-08-1.04411191E-08-6.46046090E-07-8.08830464E-06
   4.63793072E-07-1.66884728E-08-1.53994471E-08-6.14327131E-11 2.58307442E-09
   5.55394899E-06-6.18846400E-07-1.38529446E-08 3.19988573E-07
>SPECTRA   FREQ=9.000E+00   ROTSPEC=0   BW=3.000E+00   AVGT=1662   // 49
   8.40333598E-07-5.90497002E-08-1.28643396E-09-1.31842410E-06-1.25737060E-05
   8.33283877E-07 7.29381853E-08-4.26344116E-08 3.73151465E-07 4.45310144E-09
   5.74739670E-06 4.80741733E-07-1.26752397E-07 3.49300194E-07 1.62417102E-08
  -5.26743404E-09 3.67327790E-09 1.58929055E-07 2.88102342E-07-1.92381333E-09
   4.79557372E-09-3.85147274E-07-5.73280886E-06 9.53154444E-09 2.43009825E-04
   3.84140585E-05-2.39897349E-06 5.54325516E-06 1.32520308E-05-1.59949400E-06
   2.37432232E-07-2.61155456E-05 4.20059543E-04-1.27191088E-05-1.31608965E-06
   8.18305368E-10 4.41115802E-08-1.72784773E-08-6.55260465E-07-1.33560316E-05
   8.69609153E-07-1.08919418E-09-2.90511597E-08 2.48378407E-09 2.83953505E-09
   5.65893379E-06-7.75255387E-07-2.92501596E-08 3.76086462E-07
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>SPECTRA   FREQ=2.344E-02   ROTSPEC=0   BW=5.859E-03   AVGT=204   // 49
   8.18304494E-02-8.07959586E-03 3.65992822E-03-2.54557412E-02-2.72234846E-02
   6.64452538E-02-2.81977956E-03-7.00906664E-03 2.91188397E-02 1.59506081E-03
   1.56243229E-02 4.81680315E-03-1.88034959E-02 1.26437377E-02-1.22750457E-02
   3.17026186E-03 2.85452548E-02-2.35031545E-03-1.37817459E-02 3.14768730E-03
   1.65594229E-03 1.66836232E-02-2.13960931E-02-2.43494939E-03 1.30557463E-01
   6.02884181E-02-2.88852323E-02 9.78550967E-03 6.44395128E-02-2.19918098E-02
  -2.43755570E-03-1.25995213E-02 1.59109443E-01-3.01255900E-02-1.34579442E-03
   1.22129649E-03 5.99974720E-03 1.30403582E-02-2.38354411E-02-6.71192259E-02
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   6.96095154E-02-5.76109672E-03-6.10302202E-03 3.15448997E-04-7.73830281E-04
   1.34903351E-02 9.67766996E-03-5.28967381E-03 1.13396132E-02
>SPECTRA   FREQ=1.758E-02   ROTSPEC=0   BW=5.859E-03   AVGT=132   // 49
   1.65410206E-01-5.43532297E-02 9.76771815E-04-4.04219851E-02-7.53466859E-02
   1.68768689E-01-2.39050537E-02-3.25651094E-03 4.29706387E-02-1.67361286E-03
   3.14700343E-02 2.24619899E-02-5.83261587E-02 3.09599359E-02-1.98813751E-02
   3.09545454E-03 5.29161543E-02-1.94948050E-04-2.02756803E-02 7.49053492E-04
  -7.51384243E-04 5.65722473E-02-3.37149948E-02 1.16344616E-02 1.52022883E-01
   1.64999310E-02-4.66586947E-02 2.67254915E-02 1.38840556E-01-5.34817949E-02
  -1.40599255E-02-1.55608142E-02 3.10328782E-01-7.54711553E-02 4.81464015E-03
   1.05011999E-03 2.61434400E-03 2.03655716E-02-6.04705960E-02-1.47006005E-01
   1.76940471E-01-3.09695527E-02-3.87044437E-03 1.53176766E-03 1.74548605E-03
   2.40929872E-02 3.14649791E-02-3.48824752E-03 2.90577989E-02

>=SPECTRASECT
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  NCHAN=7
  NFREQ=20
  MAXBLKS=20
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  1022.001
  1023.001
  1024.001
  1025.001
  1011.001
  1012.001

>SPECTRA   FREQ=1.200E+01   ROTSPEC=0   BW=3.000E+00   AVGT=1184   // 49
   3.05212495E-07 1.04812010E-07-2.20425758E-08 8.01546832E-07-5.47468926E-06
   2.14765237E-07 1.20481317E-07-1.66441598E-08 2.35518485E-07 4.37948788E-09
   3.07083474E-06-2.27427404E-06 7.79069822E-08 1.39105722E-07-5.04609199E-09
  -3.59742680E-09 1.01496358E-08 1.45960684E-07 2.79222320E-07-3.20396261E-08
   1.29708662E-08-1.99990768E-06-4.37265817E-06-6.76999221E-08 1.31948225E-04
  -6.15994795E-05 5.99869338E-07 1.84059104E-06 7.02476427E-06 2.10822577E-06
  -6.15544877E-07-1.76183039E-05 2.77015788E-04-3.93358778E-06-2.57430656E-06
   2.00715378E-09 1.61708922E-08 6.76517242E-09 1.51532049E-06-5.06342394E-06
   3.07608815E-07 1.41989716E-07-1.19570398E-08 1.75704817E-09 5.21636734E-09
   2.63216816E-06-2.57187230E-06-1.84482101E-08 3.03167013E-07
>SPECTRA   FREQ=9.000E+00   ROTSPEC=0   BW=3.000E+00   AVGT=1280   // 49
   5.83694771E-07 1.19115997E-08-5.03532007E-08-8.99317683E-07-9.30306123E-06
   3.40557108E-07 8.15192607E-08-3.51616585E-08 3.08802157E-07 1.83401241E-08
   3.55408474E-06-6.54821122E-07 2.44925236E-08 1.59405459E-07-4.37912284E-09
  -1.72462022E-09 2.33106565E-08 2.72744160E-07 7.36812751E-07-8.59286615E-08
   3.13910355E-08-9.73203171E-08-4.78724542E-06-3.29195018E-07 1.25175517E-04
   1.24207563E-05-1.30586074E-07 1.83555278E-06 1.10605124E-05-2.52861582E-07
  -1.06282300E-06-1.44466840E-05 3.73689050E-04-5.66932158E-06-1.71625766E-06
  -5.22773913E-09 1.28344491E-08 9.25007715E-09 2.23112210E-07-6.63824494E-06
   5.76368848E-07 7.23958564E-08-2.02500949E-08 6.35152209E-10 7.37988115E-09
   2.49488812E-06-1.30704143E-06-3.78024900E-08 3.50467730E-07
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   4.26137373E-02 1.08925416E-03 4.18361695E-03-1.34028005E-03-3.78410034E-02
   4.50193277E-03 1.19546363E-02 9.11036041E-03 3.26712616E-02-6.28732145E-03
   2.45259926E-02 1.42231658E-02 9.48322378E-03-4.78451839E-03 2.58427230E-03
  -2.77578505E-031.16925251E+00-2.98989378E-03 1.84927694E-03-1.79092248E-03
   1.03148725E-02 7.25154532E-03-2.08268352E-02 7.70557113E-03 5.41835874E-02
   2.27221902E-02 1.31742675E-02-5.93658118E-03 3.79529931E-02 5.73992589E-03
   1.64149751E-04 6.09319890E-03 7.69919679E-02-3.25624272E-03-7.42649019E-04
  -7.25948368E-04-1.22135887E-02 3.15609504E-05-8.81139771E-04-5.50596276E-03
   3.95438746E-02 5.05024148E-03 1.31162954E-02-1.93338306E-03-5.67775685E-04
  -7.85254873E-03-2.33185980E-02 9.12131555E-03 3.83270457E-02
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   1.24460027E-01-5.69881964E-03 2.20929366E-03-5.31829055E-03-7.91237801E-02
  -9.76440609E-02 7.14167207E-03 9.81131685E-04 6.73595816E-02-8.42391886E-03
   5.76994605E-02 2.03629993E-02 2.21857540E-02-3.96373421E-02 1.91050454E-03
  -5.00096101E-03 3.22333612E-02-1.15342308E-02-1.88208278E-02 3.88966547E-03
   1.84472185E-02 9.82407946E-03-4.19762805E-02 1.75216794E-02 1.16784625E-01
   4.95606214E-02 1.32148815E-02-4.31268625E-02 1.02903694E-01-1.24882711E-02
   6.30441587E-03 1.11013921E-02 1.63885698E-01 5.53951412E-02-2.34826133E-02
  -5.73917583E-04-1.03599974E-03 3.15305288E-03 1.27512133E-02 8.20175111E-02
   1.25867650E-01 8.14224314E-03-8.67272611E-04-7.68693571E-04-2.08270992E-03
  -3.18901837E-02-1.38553334E-02 1.62106729E-03 7.57595301E-02

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REFERENCES

Aho, A.V., and Ullman, J.D., 1978, *Principles of Compiler Design*: Addison Wesley.

Bostick, F.X., 1986, *Electromagnetic Array Profiling (EMAP)*: Expanded Abstracts of the Technical Program of the 56th Annual International Meeting: Society of Exploration Geophysicists, p. 60.

Eggers, D.E., 1982, *An Eigenstate Formulation of the Magnetotelluric Impedance Tensor*: Geophysics, v. 47, p1204.

Gamble, T.D., 1978, *Remote Reference Magnetotellurics with Squids*: Ph.D. thesis, University of California, Berkeley, LBL-8062.

Jupp, D.L.B., and Vozoff, K., On: *The Magnetotelluric Method in the Exploration of Sedimentary Basins*: Geophysics, v. 41, p.325.

LaTorraca, T.R., Madden, T.R., and Korringa J, *An Analysis of the Magnetotelluric Impedance for Three-dimensional Conductivity Structures*: Geophysics, v 51, p 1819.

Ting, S.C., and Hohmann, G.W., 1981, *Integral Equation Modeling of Three-dimensional Magnetotelluric Response*: Geophysics, v. 46, p 182.

Vozoff, K., 1972, *The Magnetotelluric Method in the Exploration of Sedimentary Basins*: Geophysics, v. 37, p.98.