THE ASEG-GDF2 STANDARD
FOR POINT LOCATED DATA

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Prepared
for the
Australian Society of Exploration Geophysicists

ASEG Standards Committee

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ASEG/SEG Standards

ABSTRACT

ASEG-GDF2 is an ASCII data exchange and archive standard for geophysical point and line data. The standard has evolved from the earlier ASEG-GDF standard (Dampney et al,1985) and SEG draft standard (Dampney et al,1978). It defines the way in which data such as aeromagnetic, airborne EM, gravity and other point located data sets should be exchanged and archived. The primary objective of the standard is to provide a self-documenting and consistent method for exchanging and archiving of located geophysical data between organisations with different hardware and software systems. The standard has been extended to support the recording of the SEG Geographic Coordinate System that applies to the sample locations within each data set.

The standard describes a self defining format that will allow located data to be automatically identified and loaded in a computer application. An ASEG-GDF2 data exchange has a minimum of four files. A decodable format description in the primary file separates the formatting details from the data. A second file contains a text description of the data and survey contents. The third file contains associated metadata with specification details for the map datum and projection for the geophysical data. The fourth file contains the geophysical data. The format description file defines information such as field names, units of measurement, format, comments and missing data substitution values (nulls). The data is contained in simple, multi-column ASCII files (tables). Geophysical data that complies with the standard can be read by applications that do not have support for ASEG-GDF2, but they lose the flexibility of automatic loading of data field names and definitions.

The data definitions are called DEFN records. A separate DEFN record is used for each data set type that is included in the data exchange set. A set of DEFN records could be used to describe final processed aeromagnetic and radiometric data, base station magnetometer data and spectral calibration information. When an ASEG-GDF2 application opens a data file, each record is identified by its name and the corresponding format information in the DEFN record is used for automatic decoding of the data.

ASEG-GDF2 data is written as a set of related ASCII files and is independent of exchange media and computer operating systems. Recommendations are made regarding the media used for exchange and methods for encapsulation of the files. The ASEG has also developed free computer software to assist with the reading and writing of ASEG-GDF2 compliant data.

Key Words: standard, point, located, ASCII, exchange

INTRODUCTION

The Australian Society of Exploration Geophysicists (ASEG) has developed the ASEG General Data Format Revision 2 (ASEG-GDF2) for exchanging and archiving of located point and line data. The standard is suitable for the exchange of gravity, aeromagnetic, electromagnetic and radiometric data. The standard assumes that there will be one or more channels of information recorded at each point. For a magnetic survey the channels could include line, flight, data, time, easting, northing, raw magnetic field, diurnally corrected magnetic field, IGRF corrected magnetic field etc. The original ASEG-GDF publication (Dampney et al, 1985) was based on a draft SEG standard (Dampney et al, 1978). An introduction to the ASEG-GDF2 standard was published in Preview (Pratt, 1994).

The original GDF standard was written when data was exchanged on 9 track magnetic tape. This medium has all but disappeared from our industry and it is no longer used for data exchange. CDs, Exabytes, DAT tapes and the Internet have replaced the 9 track tape. These media will soon be replaced by others such as digital video disks (DVD) and digital linear tape (DLT).

Much of the complexity of the original standard has been removed in this second release and simple examples are used to illustrate its application. The ASEG has funded the development of a simple menu driven program to help construct the format information necessary to comply with the standard. The full definition of the standard is provided in Appendix 1.

ASEG-GDF2 has been submitted to the SEG for consideration as a point data exchange format. The SEG Standards Committee has contributed recommendations for the inclusion of datum and projection information so that it complies with general SEG standards requirements. A set of data definition records (DEFN) is included in Appendix 3 to show how datum and projection information should be included in the data exchange.

INDUSTRY DRIVEN NEEDS FOR A STANDARD

When the GDF standard was first introduced a small number of highly specialised geophysicists processed and exchanged located data on 9 track magnetic tapes. Today, many geophysical interpreters routinely process data on desktop systems but lack the programming skills or tools to load poorly formatted data. Processing tasks that used to take days now take minutes. The largest proportion of time may now be spent loading geophysical data and ensuring that it is consistent with other data types such as grids and GIS vectors. Acceptance and widespread use of the ASEG-GDF2 standard will help reduce the data preparation time with automatic data loading. Data problems will also be reduced where they relate to incorrect interpretation of the information content such as channel names, units, datums and projections.

ASEG/SEG Standards

The industry recognises the following problems associated with the exchange of geophysical data:

Physical units for channels are undefined.
Data record structure is undefined or incorrect.
Paper documentation is lost.
Paper documentation does not match the data.
No digital documentation is included with the data.
Digital documentation does not match the data.
Operator misinterprets channel descriptions and loads the wrong data.
Receiving organisation cannot strip header information from the data.
Record structures are convoluted.

With the advent of the powerful desktop PC, many geophysicists now have access to sophisticated data processing systems. Efficient loading of exchange data is essential for reducing the high cost of building a project database. The Australian Industry has responded well to this requirement since the introduction of ASEG-GDF in 1985. Most government organisations are requesting that data be submitted in GDF format.

ASEG-GDF2 - AN OVERVIEW

Data that complies with the standard is exchanged or stored as a set of related ASCII files. A minimum file set must include:

- The located geophysical data (*File1*.DAT, *File2*.DAT, ..);
- Supporting descriptive documentation in GDF2 format (*survey*.DES);
- Format information in GDF2 format (*survey*.DFN).
- Associated metadata (*survey*.MET)

A located geophysical data file (*File**n***.DAT) contains a series of records where each record contains the spatial coordinates of a measurement point and a series of data values. Aeromagnetic data will include easting and northing projected coordinate pairs and possibly a latitude and longitude coordinate pair. The data values will normally include the flight number, line name, fiducial, time, date, altimeter, GPS height, raw magnetic intensity, diurnal magnetic intensity and IGRF corrected magnetic intensity. These data records could look similar to that shown in Figure 1.

The supporting descriptive information file contains a brief report on the located geophysical data set. This file will normally describe the geophysical system, client, contractor, survey locality and other information about the survey (Fig. 3). By convention, the format of the located geophysical data is also described in this file. The format is suitable for inclusion in the appendix of a survey report, however the free form nature of this report makes it unsuitable for automated decoding of the geophysical data.

Rigorous format information on the geophysical data contents is contained in the ASEG-GDF2, DEFN records. For each data channel (column), the DEFN record defines the name, description, units and format details for the channel. The syntax of the DEFN records provides an automated method for describing the contents of geophysical data records. This makes it possible to write programs that automate the loading of geophysical data into a data base or application program.

The set of ASCII files must be kept together when exchanged or stored on disk. If a CD is used as the exchange medium, then all files are contained within the one directory. If a cartridge tape (Exabyte, DAT etc.) is used, then all the files should be encapsulated in a single "tar" format file. If the files are transferred over the Internet, it is preferable to encapsulate them within a single file that uses an acceptable format such as ZIP or tar. Refer to the section on "exchange media and encapsulation".

Metadata such as projection and datum details, system specifications etc are recorded in the "*survey*.MET" file.

The standard can define complex formats and records of different DEFN types can be mixed within the one file. Unless such record mixing is an underlying requirement of the geophysical procedure, it is recommended that ASEG-GDF2 data exchanges should be kept as simple as possible. This reduces the burden for organisations that must write decoding software to comply with the standard.

AN EASY EXAMPLE

The important concepts of ASEG-GDF2 are best illustrated by providing a simple example of a file exchange between two organisations. In general, most located data are stored or converted to an ASCII multi-column file similar to that shown in Figure 1.

EXAMPLE OF NON-STANDARD INDUSTRY PRACTICE

```
20440   590010627620.80 3110.00 814721.007238150.00 70.0  54935.61  56635.93  55159.801  54987.96
20440   590010627621.00 3111.00 814730.317238141.00 70.0  54940.83  56635.93  55159.841  54992.29
20440   590010627621.20 3112.00 814739.567238131.50 70.0  54945.31  56635.93  55159.891  54996.15
20440   590010627621.40 3113.00 814748.887238122.00 70.0  54949.28  56635.93  55159.931  54999.69
20440   590010627621.60 3114.00 814758.197238113.00 70.0  54952.91  56635.93  55159.981  55002.93
20440   590010627621.80 3115.00 814767.507238103.50 70.0  54956.28  56635.93  55160.021  55005.81
20440   590010627622.00 3116.00 814776.817238094.00 70.0  54959.25  56635.93  55160.071  55008.42
20440   590010627622.20 3117.00 814786.127238085.00 69.8  54961.96  56635.93  55160.111  55010.78
```

Figure 1. Sample multi-column data file (MAG.DAT)

What do these numbers mean if there is no associated documentation? Much of the information is obvious, but the last four channels represent magnetic data. What is the difference between them? If the file is small, the sending organisation might insert channel names at the beginning of the file to make it easy to decipher (Figure 2).

```
Line FltDate Time          Fid Easting    Northing  Alt  Mag-raw  Mag-diurn      IGRF   Mag-corr

20440   590010627620.80 3110.00 814721.007238150.00 70.0  54935.61  56635.93  55159.801  54987.96
20440   590010627621.00 3111.00 814730.317238141.00 70.0  54940.83  56635.93  55159.841  54992.29
20440   590010627621.20 3112.00 814739.567238131.50 70.0  54945.31  56635.93  55159.891  54996.15
20440   590010627621.40 3113.00 814748.887238122.00 70.0  54949.28  56635.93  55159.931  54999.69
20440   590010627621.60 3114.00 814758.197238113.00 70.0  54952.91  56635.93  55159.981  55002.93
20440   590010627621.80 3115.00 814767.507238103.50 70.0  54956.28  56635.93  55160.021  55005.81
20440   590010627622.00 3116.00 814776.817238094.00 70.0  54959.25  56635.93  55160.071  55008.42
20440   590010627622.20 3117.00 814786.127238085.00 69.8  54961.96  56635.93  55160.111  55010.78
```

Figure 2. Channel or field names improve the understanding of the data.

If the file is large, the manual addition of a header is impractical with a text editor and in many cases the receiving organisation has to strip out the header before processing. The number of available characters to describe the field is also limited by the field width.

Format and descriptive information might be included in a separate file that is then used to help identify channels at the time they are imported into a geophysical database. An example of part of an accompanying description file is shown in Figure 3.

```
WILD BOAR - WESTERN AUSTRALIA   AIRBORNE GEOPHYSICAL SURVEY

Job number                       1396
Client                           IRON DUKE MINES N.L.
Survey date                      December 1989 to March 1990
Tape Creation date               7-4-90
Central meridian                 117 degrees

SURVEY SPECIFICATIONS

Aircraft                 - ROCKWELL SHRIKE COMMANDER 500S
Magnetometer             - SCINTREX V201 Split Beam Cesium Vapour
Resolution               - 0.04 nanoTesla
Cycle Rate               - 0.2 seconds
Sample Interval          - 13 metres (average)
Data Acquisition         - 8 Channel WATANABE MC 6700 Chart Recorder
Traverse Line Spacing    - 200 metres for areas 1
Traverse Line Direction  - 000-180 degrees for area 1
Tie Line Spacing         - 2000 metres for area 1
Tie Line Direction       - orthogonal to traverse lines
Survey Height            - 60 metres - mean terrain clearance
Navigation               - SYLEDIS UHF radio positioning system

Record length   96 bytes
Block size    9600 bytes

RECORD FORMAT

Format  Undefined  Variable

    i5      99999  line
    i3        999  flight
    i6     999999  date
  f8.2      99999  time
  f8.2      99999  fiducial
 f10.2     999999  easting - metres
 f10.2    9999999  northing - metres
  f5.1        999  radar altitude
 f10.2     999999  raw magnetic intensity
 f10.2      99999  diurnal
 f10.2      99999  igrf
 f11.2     999999  final magnetic intensity

NOTES

Final magnetic intensity corrections:
IGRF model 1985 removed - base value 55200 nanotesla
Diurnal correction applied - base value 56640 nanotesla
System parallax of 1.2 fiducials removed
```

Figure 3. Example of information that might be found in a description file.

The descriptive information shown in Figure 3 is sufficient to decode the data shown in Figure 1 and provides documentation of the physical significance of each of the channels. Data loading would be simplified if software could read the format statements directly from the descriptive information in Figure 3. This objective can be achieved with the addition of one extra file (DFN) containing the format information and some minor additions to the descriptive information file.

MAKING THE EXAMPLE ASEG-GDF2 COMPLIANT

ASEG-GDF2 provides the format information using a structured format definition file consisting of a series of DEFN records similar to that shown in the Figure 4. For the purpose of this example, the sample MAG.DFN file in Figure 4 has been simplified. It is recommended that full descriptions, physical unit definitions and null value assignments for each channel are normally included in the DEFN records. See Appendix 1 and 2 for more comprehensive examples.

```
DEFN   ST=RECD,RT=COMM;RT:A4;COMMENTS:A76          Format of comment records RT=COMM
DEFN 1 ST=RECD,RT=; FLTLINE:I5                     Format of located data records RT=
DEFN 2 ST=RECD,RT=; FLIGHT:I3                      allows one record type to have
DEFN 3 ST=RECD,RT=; DATE:I6                        no name.
DEFN 4 ST=RECD,RT=; TIME:F8.2                                      "
DEFN 5 ST=RECD,RT=; FIDUCIAL:F8.2                                  "
DEFN 6 ST=RECD,RT=; EASTING:F10.2                                  "
DEFN 7 ST=RECD,RT=; NORTHING:F10.2                                 "
DEFN 8 ST=RECD,RT=; ALTITUDE:F5.1                                  "
DEFN 9 ST=RECD,RT=; TMAGRAW:F10.2                                  "
DEFN 10 ST=RECD,RT=; TMAGDIUR:F10.2                                "
DEFN 11 ST=RECD,RT=; TMAGIGRF:F10.2                                "
DEFN 12 ST=RECD,RT=; TMAGCORR:F11.2                                "
DEFN 13 ST=RECD,RT=; END DEFN
```

Figure 4. Simple example of ASEG-GDF2 DEFN structure file (MAG.DFN). Measurement units, null values and field descriptions would normally be included. Comments in *italics* are not part of the DEFN record.

This example defines the format of the information in both the description file (Figure 3) and the data file (Figure 1). The first line of the MAG.DFN file defines the FORTRAN format of the "COMM" comment records. The second line of the MAG.DFN file contains the first of thirteen lines that define the format of the aeromagnetic data.

ASEG-GDF2 requires each record to be preceded by a record name such as "COMM", "DATA", "SPEC" etc. In Figure 4 the comment record name is identified in the MAG.DFN file by "RT=COMM". The description information is converted into an ASEG-GDF2 compatible format by prefixing each record with "COMM" as shown below in Figure 5. The "COMM" record identifier is stripped from the record by the ASEG-GDF2 enabled import program.

There is one exception to this rule where one record type is allowed to have no identifier (null record type). In the DEFN example in Figure 4, a null record type is identified by "RT=". This exception is useful when large airborne geophysical data sets only have one record type. Apart from reducing total file size, it is possible for organisations that do not have ASEG-GDF2 writing software to build a compliant data set with the addition of the DES and DFN files. The "DES" file can be prepared in a standard text editor and the DFN file written with software provided by the ASEG.

```
COMMWILD BOAR - WESTERN AUSTRALIA   AIRBORNE GEOPHYSICAL SURVEY
COMM
COMMJob number                       1396
COMMClient                           IRON DUKE MINES N.L.
      .
      .
      .
      .
COMMIGRF model 1985 removed - base value 55200 nanotesla
COMMDiurnal correction applied - base value 56640 nanotesla
COMMSystem parallax of 1.2 fiducials removed
COMM
```

Figure 5. Free form description from Fig. 3 prefixed by COMM record identifier (MAG.DES).

To conform to ASEG-GDF2 in this example, the files corresponding to the file fragments illustrated in Figures 1, 4 and 5 would be copied to the output medium as three discrete files:

MAG.DFN (ASEG-GDF2 DEFN information)

MAG.DES (Free form description prefixed by COMM identifier)

MAG.DAT (Geophysical data)

ASEG-GDF2 does not require the use of specific file names, however the above file extensions are recommended where 3 character file extensions are supported. The file name prefix can be of any suitable length, but will be truncated to the first 8 characters in DOS environments. The use of standard extensions simplifies the writing of software to guide users in the selection of appropriate files.

If multiple data files (DAT) such as radiometrics and diurnal magnetic data, then the DAT files could be named:

RAD.DAT
DIURNAL.DAT

The DAT extension clearly identifies the geophysical data.

SPECIFIC REQUIREMENTS FROM A GENERAL STANDARD

Flexibility is an important attribute of ASEG-GDF2, but it is also a potential problem. The standard is self-defining and can be used to for almost any form of spatial data. The fields are defined in the DEFN records by the organisation that prepares the data for exchange.

To comply with the SEG Geographic Coordinate System for location data, the field names EASTING, NORTHING, LATITUDE and LONGITUD are reserved for the primary coordinate system used to describe the location of data points. These are the only predefined field names required to be present in the DEFN records.

During the period since the original publication of the GDF standard, many geophysicists have requested the use of a recommended set of field names. This is not practical when covering so many different disciplines and statutory reporting requirements. Developments in geophysical technology will require constant updating of the field names. The field names used in the examples are not a mandatory part of the standard.

The Standards Committee will publish examples of different applications on the Society's web site. Organisations with specific reporting standards will be able to submit them to the Committee for posting on the web site. Changes can be made as a function of industry requirements. The Standards Committee can then ensure that the associated DEFN files comply with the ASEG-GDF2 standard.

The SEG has recommended that the names and units comply with any gravity or magnetic terms listed in the 3rd Edition of the "Encyclopedic Dictionary of Exploration Geophysics." by Robert E. Sheriff. This reference is to be used as a guide, rather than an absolute reference because the ASEG-GDF2 format limits field names to 8 characters. An ASEG-GDF2 comment can be used to assist with a more complete description of the field name. The SEG dictionary should be used as the definitive reference for standard geophysical terms. If the field name is not available in the dictionary, the comment field should provide adequate information and possible reference to other descriptive definitions.

EXAMPLE FIELD NAMES FOR GEOPHYSICAL DATA

Pilkington (1984) prepared a set of field name recommendations for the Department of Mines and Energy, South Australia (now PIRSA) for the recording of associated information such as survey details, map sheet, comments, flight lines, base station data and geophysical readings. These are listed in Appendix 2 as a guide to the use of the standard.

The examples illustrate how all data acquired in a survey can be defined in ASEG-GDF2 format. DEFN records include summary information for the survey, magnetic base station readings, base station barometer readings as well as the recorded magnetic and spectrometer data. This ability to define all information associated with a survey is an important way of preserving the documentation for the data as well as providing an automated decoding method.

These examples also highlight the changes that have taken place since the original standard was introduced. In 1984, barometers were being used to provide sensor elevation data and this has now been replaced by differential GPS measurements of sensor position. Importantly, ASEG-GDF2 is not tied to a particular set of readings, field names or geophysical methodology. It has the ability to define new instrumentation and reporting requirements to keep pace with geophysical developments.

MIXED RECORD TYPES (RT) IN A SINGLE FILE

ASEG-GDF2 allows all record type to be stored in a single file but this practice is not recommended. The mixing of record type creates a range of problems that are likely to detract from its widespread acceptance.

- A mistake in a metafile data record may invalidate the main data set and require rewriting the complete dataset.
- Most commercially available software packages expect the main data file to be restricted to a single record type. An ASEG-GDF2 format located data record with a "NULL" type record identification or a 4 character, RT record name should be compatible with most commercial packages.
- Associated data files such as base station records and metadata are often written by separate processes and thus is simpler to manage as separate files.

A single DEFN record set should be used to define all the record types contained within the file set.

METADATA - AN ADVANCED USE OF ASEG-GDF2

Metadata is an important component of all geophysical surveys. Metadata includes such information as instrumentation details, precision, client names, survey specification and descriptive information that relate to the collection and processing of the survey data. Metadata is formally specified so that the contents of the data records are capable of being loaded into a data base.

Historically this information was recorded in a printed report that accompanied the original data. The digital data was loaded onto a computer system and the report filed in the library.

When the digital data was copied and transferred to another organisation, the report was often missing. Without appropriate documentation, the data can be significantly devalued.

Within ASEG-GDF2 metadata can be defined just as easily as the main geophysical data channel names. The DEFN record can be used by government departments to provide data in a specific format with predefined record types (RT) and field names.

Defining metadata records in ASEG-GDF2 is an advanced use of the standard. The use of the standard in this way is only of value if both reading and writing software exists to utilise the information contained in the metadata records. The management of metadata is an issue being faced by many regulatory bodies and the use of automated methods for capturing such data will reduce labour costs and data entry mistakes.

A METADATA EXAMPLE

Metadata with different record DEFN types should be contained in the one file. This provides an opportunity to load metadata directly into a data base.

A fragment of the descriptive file shown earlier is listed here to show how it can be used to supply metadata to a program designed to process the metadata.

```
WILD BOAR - WESTERN AUSTRALIA   AIRBORNE GEOPHYSICAL SURVEY

Job number                       1396
Client                           IRON DUKE MINES N.L.
Survey date                      December 1989 to March 1990
Tape Creation date               7-4-90
Central meridian                 117 degrees

SURVEY SPECIFICATIONS

Aircraft                 - ROCKWELL SHRIKE COMMANDER 500S
Magnetometer             - SCINTREX V201 Split Beam Cesium Vapour
Resolution               - 0.04 nanoTesla
```

The DFN file bellow illustrates how associated metadata records can be specified.

```
DEFN   ST=RECD,RT=COMM; RT: A4; COMMENT: A76: Descriptive information
DEFN   ST=RECD,RT=COMP; RT: A4; CONAME: A40: NAME=Company Name, Lease owner
DEFN   ST=RECD,RT=SDAT; RT: A4; SURVDATE: A10: NAME=Survey date, DD/MM/YYYY
DEFN   ST=RECD,RT=ZONE; RT: A4; ZONE: I3: NAME=UTM ZONE, UTM zone number
DEFN   ST=RECD,RT=AIRC; RT: A4; AIRCRAFT: A40: survey aircraft
DEFN   ST=RECD,RT=MINS; RT: A4; MAGINSTR: A40: Magnetometer instrument
DEFN 1 ST=RECD,RT=MRES; RT: A4; MAGRES: F10.3: UNIT=nT, Magnetometer resolution
DEFN 2 ST=RECD,RT=MRES; END DEFN
```

The example below illustrates the way in which the metadata values can be included in a descriptive DES file. Descriptive information that is not required for loading into a database is allocated to the "COMM" record type. This method provides a mechanism for regulatory bodies to request data with appropriate metadata tags.

```
COMMWILD BOAR - WESTERN AUSTRALIA   AIRBORNE GEOPHYSICAL SURVEY
COMM
COMMJob number                       1396
COMPIRON DUKE MINES N.L.
SDAT31/03/1990
COMMTape Creation date               7-4-90
ZONE 50
COMM
COMMSURVEY SPECIFICATIONS
COMM
AIRCROCKWELL SHRIKE COMMANDER 500S
MINSSCINTREX V201 Split Beam Cesium Vapour
MRES 0.04
```

Metadata files should use the name convention *filename*.MET.

PROJECTION AND DATUM METADATA

The inclusion of projection and datum metadata is required by the SEG Standards Committee.

Specification of the projection and datum details of located data is an important issue for the exploration industry. Data are often exchanged without any information regarding the map projection and datum details that relate to the location information.

The SEG Standards Committee requires that projection details are included in the SEG-GXF3 grid exchange format. The preparation of a draft document by MacLeod (2001) has been used as the basis for defining the same specification for ASEG-GDF2.

Appendix 3 shows the DEFN record specification for projection and datum information that complies with the SEG-GXF3 specifications.

EXCHANGE MEDIA AND ENCAPSULATION

ASEG-GDF2 is independent of the medium that is used for the purpose of exchange. All the files described in the DEFN records are included together on the medium and restored to a single disk directory.

GDF2 can be used for any size data set, but it is anticipated that its major use will be for the exchange of airborne geophysical data such as gravity, magnetic, radiometric, electromagnetic and airborne gravity gradiometer surveys.

Large data sets may be exchanged on high capacity magnetic tape media such as Exabyte, DAT or DLT tapes. Smaller data sets may be exchanged on CD, ZIP disks, floppy disks or the Internet.

Because there are three or more files associated with an ASEG-GDF2 exchange, it is appropriate to consider how the files are transmitted. If you are using the Internet, it is inconvenient to transmit numerous files and it is appropriate to encapsulate the files with a compressed ZIP file or tar file, if it is being transferred to a Unix environment. If you are using magnetic tape, it is important to encapsulate the files within a single tar file that can be read on both PC and Unix systems.

For PC users the tar format may not be familiar but it is widely used on Unix machines and PC programs are available to read and write tar files to tape and disk. The tar format provides a method of encapsulating files and directories into a single file. Some geophysical surveys now exceed the capabilities of a single 5 Gbyte Exabyte tape. DLT tapes have much larger capacity and the tar format is capable of storing up to 68 Gbytes in a single file.

The table below lists the media and preferred method of encapsulation.

Media	**Encapsulation method**	**Comments**
Internet	ZIP, tar	
Floppy disk	Directory, ZIP	
CD	Directory, ZIP	ISO standard
DAT	Tar	
Exabyte	Tar	
DLT	Tar	

The recommendations for media and encapsulation method will change with time. For those organisation that use ASEG-GDF2 as an archive format, the longevity of the media and encapsulation software must be considered. Although the shelf life of magnetic media may exceed 25 years, the practical life has shortened to 4 to 8 years. Exabyte and DAT have replaced 9 track media during the life of this standard. High capacity DLT tapes are starting to replace Exabyte and DAT tapes in many organisations. These changes are market driven and hardware to read old media can be impractical to maintain beyond a normal 4 to 8 year life span.

SOFTWARE TO HELP CREATE DEFN RECORDS

The sample screen in Figure 6 is produced from a DOS program developed by the ASEG to assist with the creation of correctly formatted DEFN records.

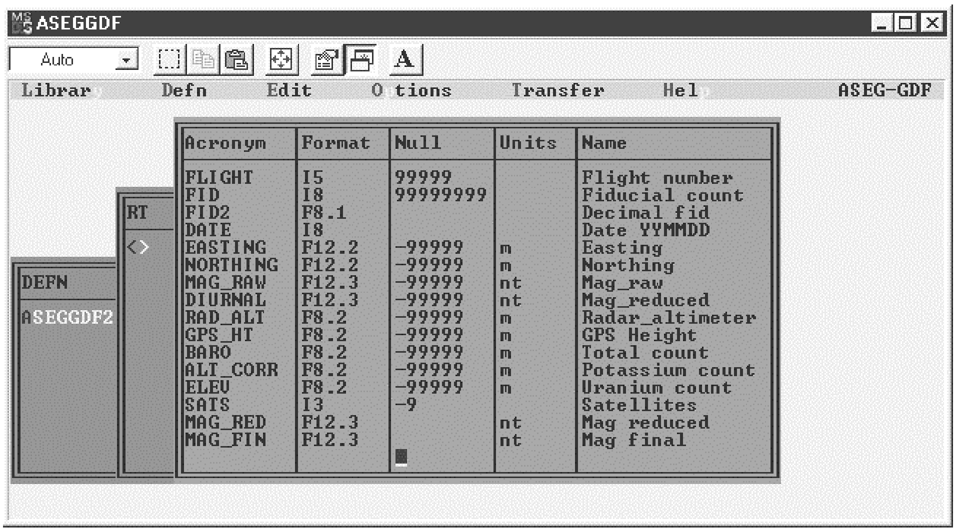

Figure 6. sample screen for entry of the field definitions using DOS based software.

DEFN records can be created in a standard text editor, however this process is prone to error. The ASEG has funded the development of software for creating and validating ASEG-GDF2 format files. This software was written in C by Graham Pilkington and the code is available from the ASEG (www.aseg.org.au).

The ASEG-GDF2 software provides a method of building standard libraries of DEFN records that can be used and modified on subsequent projects. It also provides a method for validating a data file to ensure that it is consistent with the DEFN records.

The C code can be used by software developers as a guide to writing syntax validation software for reading DEFN records. The source code was written so that it could be translated to run on Unix if required.

CONCLUSIONS

ASEG-GDF2 is a simplified implementation of the original ASEG-GDF format that is easier to use and provides a documentation discipline that ensures essential information about the data is preserved with the data. The provision of ASEG-GDF2 software and source code will help organisations with the preparation of DEFN records and development of import/export modules for existing software packages.

Many of the objectives of the ASEG-GDF standard have been achieved since its introduction in 1985 with the major benefits arising from the inclusion of digital documentation and simple table formats for the writing of the geophysical data records. Many Australian government agencies request that exploration data is submitted in ASEG-GDF2 format. The format is supported as an export and import option in some popular geophysical software packages.

The inclusion of projection and datum information with the located data is also an important objective. The omission of this information is believed to be one of the main causes of lost time on projects, where mismatches with other data sets are only discovered at the mature phase of a project. ASEG-GDF2 provides a mechanism for achieving these objectives.

The concepts embodied in the original proposed SEG standard have survived major changes in computer technology. The extensible nature of ASEG-GDF2 will allow it to grow with the changing needs of the exploration geophysics industry.

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APPENDIX 1 - THE ASEG-GDF2 SYNTAX

THE DATA DEFINITION FILE (DFN)

The definition file has a specific syntax that enables the writing of code for unambiguous recovery of the geophysical data fields and their associated formats. The syntax is based on a Fortran format style of definition that conforms to the original SEG specification (Dampney et al 1978). Although most programs that will be written to decode this type of data will be written in the C language, conversion internally to a C type format specification is not difficult.

The data file may contain records that are all of the same type or mixtures of record types. It is recommended for general use, that only one record type is used in each data file. The standard allows for mixtures of record types, but most commercial processing systems will only accept files with a single type of record.

This may change in the future, when for example, it may be desirable to mix high frequency magnetic data records recorded at 10 times per second with gamma ray spectrometer records at 1 record per second.

Figure 7 below shows a sample DFN file for aeromagnetic data. The first line defines the format of the file containing the descriptive information about the survey (RT=COMM) and the remaining lines define the format of the main data file (RT=). This example also takes advantage of the "NULL" record name allowed by the standard. This example is sufficient for the majority of data exchanges that are currently used with processed airborne geophysical data. It is not sufficient for field data archiving or 256 channel gamma ray spectral data.

```
DEFN   ST=RECD,RT=COMM;RT:A4;COMMENTS:A76:   NAME=Description
DEFN 1 ST=RECD,RT=; LINE: I6:   NAME=Flight Line
DEFN 2 ST=RECD,RT=; FLIGHT: I5:   NAME=Flight number
DEFN 3 ST=RECD,RT=; FID: I8:   NAME=Fiducial count
DEFN 4 ST=RECD,RT=; FID2: F8.1:   NAME=Decimal fid
DEFN 5 ST=RECD,RT=; TIME: I5:  UNIT=sec, NAME=Time in seconds
DEFN 6 ST=RECD,RT=; DATE: I8:   NAME=Date YYMMDD
DEFN 7 ST=RECD,RT=; EASTING: F12.2:  UNIT=m, NAME=Easting, GDA94 / MGA zone 54
DEFN 8 ST=RECD,RT=; NORTHING: F12.2:  UNIT=m, NAME=Northing, GDA94 / MGA zone 54
DEFN 9 ST=RECD,RT=; MAG_RAW: F12.3:  UNIT=nt, NAME=Mag_raw
DEFN 10 ST=RECD,RT=; DIURNAL: F12.3:  UNIT=nt, NAME=Mag_reduced
DEFN 11 ST=RECD,RT=; RAD_ALT: F8.2:  UNIT=m, NAME=Radar_altimeter
DEFN 12 ST=RECD,RT=; GPS_HT: F8.2:  UNIT=m, NAME=GPS Height
DEFN 13 ST=RECD,RT=; BARO: F8.2:  UNIT=m, NAME=Total count
DEFN 14 ST=RECD,RT=; ALT_CORR: F8.2:  UNIT=m, NAME=Potassium count
DEFN 15 ST=RECD,RT=; ELEV: F8.2:  UNIT=m, NAME=Uranium count
DEFN 16 ST=RECD,RT=; SATS: I3:   NAME=Satellites
DEFN 17 ST=RECD,RT=; MAG_RED: F12.3:  UNIT=nt, NAME=Mag reduced
DEFN 18 ST=RECD,RT=; MAG_FIN: F12.3:  UNIT=nt, NAME=Mag final
DEFN 19 ST=RECD,RT=; END DEFN
```

Figure 7. Sample DEFN file that defines the contents of an aeromagnetic survey with one descriptive file (RT=COMM) and the main data file (RT=).

This example illustrates the essential elements of the DEFN record. There are only two record types, the COMM record type and the default (no record identifier) type. Only one line is required for the COMM record type while 19 lines are required in this example for the geophysical data record. One line is used to define each field and the record continuation count is incremented on each line.

The formal definition of the DEFN structure is given by:

DEFN [continuation] ST=RECD,RT=[name]{;<field definition>},

Where:

[ ] implies optional.

{ } implies repetition.

< > implies the contents are mandatory.

DEFN is mandatory as the first four characters.

Continuation is the DEFN sequence number. If the record type is completely defined on a single line then no continuation value is required as in the "COMM" example. Note that multiple field definitions can appear on a single line such as the one shown below by separating them with ";".

```
DEFN 1 ST=RECD,RT=;LINE:I6;FLIGHT:I5;FID:I8;TIME:I5;DATE:I8;EASTING:F12.2;NORTHING:F12.2
DEFN 2 ST=RECD,RT=;ALTITUDE:F5.1;TMAGRAW:F10.2;TMAGDIUR:F10.2;TMAGIGRF:F10.2
..
..
..
DEFN 19 ST=RECD,RT=;END DEFN
```

The clarity of the information is improved when one field definition is included on each line.

It is compulsory for the last data definition element in a multiple record definition to be declared as "**END DEFN**", spelt as shown in upper case with only one SPACE between "END" and "DEFN".

ST=RECD defines the structure as type RECD for record. There is no other structure type defined within the standard. This identifier allows for future expansion of the standard.

RT= [name] defines the name of this record type. "**name**" must appear at the beginning of each record in the data that corresponds to this record type. An example of this is shown below where two record types are defined.

```
DEFN   ST=RECD,RT=COMM;RT:A4;COMMENTS:A76: Description
DEFN 1 ST=RECD,RT=DATA; RT: A4
DEFN 2 ST=RECD,RT=DATA; FLTLINE: I6:   Flight line number
DEFN 3 ST=RECD,RT=DATA; FIDUCIAL: I6:   Sequential fiducial number
DEFN 4 ST=RECD,RT=DATA; RECOVERD: A1:   * recovered space not recovered
DEFN 5 ST=RECD,RT=DATA; EASTING: F9.1:  UNIT=m, Easting in metres
DEFN 6 ST=RECD,RT=DATA; NORTHING: F10.1:  UNIT=m, Northing in metres
DEFN 7 ST=RECD,RT=DATA; TOTALMAG: F10.3:  UNIT=nT, NULL=-9999, Total magnetic intensity
DEFN 8 ST=RECD,RT=DATA; TOTSCINT: I8:  UNIT=cps, NULL=-9999, Total count
DEFN 9 ST=RECD,RT=DATA; K-CINT: I6:  UNIT=cps, NULL=-9999, Potassium count in cps
DEFN 10 ST=RECD,RT=DATA; TH-SCINT: I6:  UNIT=cps, NULL=-9999, Thorium count in cps
DEFN 11 ST=RECD,RT=DATA; U-CINT: I6:  UNIT=cps, NULL=-9999, Uranium count in cps
DEFN 12 ST=RECD,RT=DATA; ALTITUDE: F8.1:  UNIT=m, NULL=-9999, Radar altimeter in metres
DEFN 13 ST=RECD,RT=DATA; END DEFN
```

The "COMM" record type defines the format of comment records (Figure 5), while the "DATA" record type is used to define the format of the main airborne geophysical data records.

Note in this case that "COMMENT" is a field definition. In the example above the format for the "COMM" identifier is "**RT:A4**". Larger record type names can be used but four should be sufficient for most applications.

[**name**] is defined as optional but this can be true for only one record type. This flexibility was added to make it easy for companies to comply with the standard when a large file of airborne geophysical data had been written as a multi-column file with no record identifier.

```
DEFN 1 ST=RECD,RT=; LINE: I6: NAME=Flight Line
```

The example above contains the first DEFN record in a DFN file that describes data from an airborne geophysical survey where "**RT=**" indicates that a record type identifier is not required. When reading a file of this type, it is important that the input data file does not have records that commence with names that could be equivalent to another record type. Note that the RT field format (RT:A4) is omitted in this case.

<field definition> is the format definition of an individual data field. In the case of the comment description this is "**;COMMENTS:A76: NAME=Description**". The structure of the field definition includes provision for the full name of the field, the data format, physical units and a description:

<field name>[*<start>]:<format> [:<other_field_attribute>,{<other_field_attributes>}]

field_name is the name of the data field up to a maximum of 8 characters including blanks.

start is used for an index into an array. This is rarely used but can be used to fill an array starting from the "start" element.

```
DEFN 13 ST=RECD,RT=; BARO*11: 256I3:  UNIT=cps, NAME=Spectrum, 256 ch gamma spectrum
```

In the example above, the reading program will read 256 spectral channels into array "baro" starting at the 11th array element of an integer array that is of dimension 266 or larger. The "*" precedes the index number to indicate the offset into the array "BARO". Another DEFN record may be used to fill the first 10 elements of the array. This method allows an input record to be organised in a different order to the input file. If "start" does not exist, then "start" defaults to the value "*1". Note that this address is based on Fortran, where unlike the C language, element 1 is the first element in the array.

format is the Fortran format of the data for this field and takes one of the following forms:

nAw	character field
nDw.d	double precision real in exponent form
nEw.d	real in exponent form
nFw.d	real in floating point form
nIw	integer type
nLw	logical type
nX	skip over these spaces on reading, or fill with SPACES on writing.

Where:

n represents the number of repeats for array definitions
w represents the number of characters used, and
d represents the number of decimal places.

Multiple or bracketed formats are not allowed for example "2X,I6" or "(F7.1)". SPACES are not significant. The format must not contain the colon "**:**" separator.

<other_field_attributes> provide additional optional information on the attributes of a field. Four attributes are recognised in the standard, with each attribute separated by a "**,**"

[UNIT[S] = <units name>]

[NAME = <expanded field name>]

[NULL = <null value>] must be same type as the field

[<comment>] cannot contain UNITS, NAME or NULL if these field attributes do not exist. Leading or trailing spaces are ignored.

Below is an example of the other field attributes for reduced magnetic data.

```
UNIT=nt, NAME=Mag_reduced, NULL=-99999,Levelled magnetic data
```

These other attributes satisfy the requirements of most magnetic processing systems in terms of the metadata required for a full definition of each field. All four field types are optional and the reading software must be able to cope with absent information.

APPENDIX 2 - FIELD NAME SUGGESTIONS FOR AIRBORNE GEOPHYSICAL SURVEYS

ASEG-GDF2 does not define the data contents that must be recorded in a set of data files. It describes the method for recording the data. For this reason, the standard does not describe the precise format and names of all fields that should be used when submitting an airborne survey to a government organisation or simply exchanging data between two organisations. Such a requirement is beyond the scope of the standard. An exception is the use of the field names EASTING, NORTHING, LATITUDE and LONGITUD that are assigned to the primary Geographic Coordinate System used to describe the location of data points.

The tables and descriptions shown below were derived from a publication from the Department of Mines and Energy south Australia (Pilkington, 1984). They represent typical examples of data and metadata information that could be recorded in geophysical surveys. The examples are kept simple to illustrate the ASEG-GDF2 DFN files. Each table is accompanied by its equivalent DEFN set.

Survey Header - Specifications (RT=HEAD)

Acronym	Format	Description
SURVNAME	A50	name of the survey
LICENCE	A50	Licence identification, eg. "EL 123 S.A."
SURVSIZE	I10	size of survey in square km
FLTDIST	I8	total line kilometres flown
CMPYFLEW	A50	company that flew the survey
CMPYPROC	A50	company that processed the survey
COMPYFOR	A50	company that the survey was flown for
FLTPATH	A50	flight path recovery method, eg DGPS, photographic
FLTDNSTY	I6	flight line separation in metres
TIEDNSTY	I6	tie line separation in metres
ALTITUDE	I6	average height above sea level in metres
GRDCLEAR	I6	average ground clearance in metres
LNBEARNG	I4	flight line bearing relative to grid north
TIBEARNG	I4	tie line bearing relative to grid north
SAMPINT	F6.2	sample interval in metres

```
DEFN 1 ST=RECD,RT=HEAD; RT: A4
DEFN 2 ST=RECD,RT=HEAD; SURVNAME: A50:   Name of the airborne survey
DEFN 3 ST=RECD,RT=HEAD; LICENCE: A50:   Licence name eg. EL 123 SA"
DEFN 4 ST=RECD,RT=HEAD; SURVSIZE: I10:  UNIT=km^2, Size of the survey in square km
DEFN 5 ST=RECD,RT=HEAD; FLTDIST: I8:  UNIT=km, Total line km flown
DEFN 6 ST=RECD,RT=HEAD; CMPYFLEW: A50:   Company that flew the survey
DEFN 7 ST=RECD,RT=HEAD; CMPYPROC: A50:   Company that processed the survey
DEFN 8 ST=RECD,RT=HEAD; CMPYFOR: A50:   Company that the survey was flown for
DEFN 9 ST=RECD,RT=HEAD; FLTPATH: A50:   Flight path recovery method eg. DGPS
DEFN 10 ST=RECD,RT=HEAD; FLTDNSTY: I6:  UNIT=m, Flight line separation in metres
DEFN 11 ST=RECD,RT=HEAD; TIEDNSTY: I6:  UNIT=m, Tie line separation in metres
DEFN 12 ST=RECD,RT=HEAD; ALTITUDE: I6:  UNIT=m, Average height above sea level in metres
DEFN 13 ST=RECD,RT=HEAD; GRDCLEAR: I6:  UNIT=m, Average ground clearance in metres
DEFN 14 ST=RECD,RT=HEAD; LNBEARNG: I4:  UNIT=deg, Flight line bearing in deg from true north
DEFN 15 ST=RECD,RT=HEAD; TIBEARNG: I4:  UNIT=deg, Tie line bearing in degrees from true north
DEFN 16 ST=RECD,RT=HEAD; SAMPINT: F6.2:  UNIT=m, Sample interval in metres
DEFN 17 ST=RECD,RT=HEAD; END DEFN
```

Map Sheet - Specification (RT=MAPS)

Acronym	Format	Description
MAPS50K	I5	50K map sheet number
MAPS100K	I5	100K map sheet number

```
DEFN 1 ST=RECD,RT=MAPS; RT: A4
DEFN 2 ST=RECD,RT=MAPS; MAPS50K: I5:   50K map sheet numbers
DEFN 3 ST=RECD,RT=MAPS; MAPS100K: I5:   100K map series
DEFN 4 ST=RECD,RT=MAPS; END DEFN
```

Comments - General Descriptive Information (RT=COMM)

Acronym	Format	Description
COMMENTS	A68	General text description for survey

```
DEFN 1 ST=RECD,RT=COMM; RT: A4
DEFN 2 ST=RECD,RT=COMM; COMMENTS: A68:   Descriptive information about the survey
DEFN 3 ST=RECD,RT=COMM; END DEFN
```

Flight Line Information (RT=FLTL)

Acronym	Format	Description
FLIGHT	A8	The flight designation
FLTLINE	I6	The flight line number
DIRECTN	A2	Direction of flight E, NE etc
STRTDATE	I6	Starting date GMT as YYDDD
STRTTIME	F9.5	Start time GMT HH.MMSS (decimal ss)
STOPDATE	I6	Stop date GMT as YYDDD
STOPTIME	F9.5	Stop time GMT HH.MMSS (decimal ss)
ALTITUDE	I6	Height of sensor above sea level in metres
GRDCLEAR	I6	Height of sensor above ground in metres
LNBEARNG	I4	Line bearing relative to true north
LNBEARING	I4	flight line bearing relative to grid north

```
DEFN 1 ST=RECD,RT=FLTL; RT: A4
DEFN 2 ST=RECD,RT=FLTL; FLIGHT: A4:   The flight designation
DEFN 3 ST=RECD,RT=FLTL; FLTLINE: A8:   Flight line number
DEFN 4 ST=RECD,RT=FLTL; DIRECTN: A2:   Line direction E, N, S, W, NE, SW etc
DEFN 5 ST=RECD,RT=FLTL; STRTDATE: I6:   Start date GMT as YYDDD
DEFN 6 ST=RECD,RT=FLTL; STRTTIME: F9.5:   GMT as HH.MMSS (decimal SS)
DEFN 7 ST=RECD,RT=FLTL; STOPDATE: I6:   Stop date GMT as YYDDD
DEFN 8 ST=RECD,RT=FLTL; STOPTIME: F9.5:   GMT as HH.MMSS (decimal SS)
DEFN 9 ST=RECD,RT=FLTL; ALTITUDE: I6:  UNIT=m, Average height above sea level
DEFN 10 ST=RECD,RT=FLTL; GRDCLEAR: I6:  UNIT=m, Average ground clearance
DEFN 11 ST=RECD,RT=FLTL; LNBEARNG: I4:  UNIT=deg, Flight line bearing relative to grid north
DEFN 12 ST=RECD,RT=FLTL; END DEFN
```

This DEFN set is designed to provide a summary of all flight lines in a survey. A similar DEFN set can be produced for tie lines by substituting the record type TIEL for FLTL and "TIELINE" for "FLTLINE".

Magnetometer Base Station Information (RT=BASE)

Acronym	Format	Description
BASENET	A8	Network in which the base station belongs
BASESTN	A20	Name of the base station
ALTITUDE	I6	Height of the base station above sea level
LATITUDE	F9.5	South latitude in decimal degrees (RESERVED)
LONGITUD	F10.5	East longitude in decimal degrees (RESERVED)
ZONE	I2	Zone Number
EASTING	F9.1	Easting in metres (RESERVED)
NORTHING	F10.1	Northing in metres (RESERVED)
STRTDATE	I6	Starting date GMT as YYDDD
STRTIME	F9.5	Start time GMT HH.MMSS (decimal SS)
STOPDATE	I6	Stop date GMT as YYDDD
STOPTIME	F9.5	Stop time GMT HH.MMSS (decimal SS)

The location data must be in the same projection and datum as the primary survey data.

```
DEFN 1 ST=RECD,RT=BASE; RT: A4
DEFN 2 ST=RECD,RT=BASE; BASENET: A8:   Network in which the base station belongs
DEFN 3 ST=RECD,RT=BASE; BASESTN: A20:   Name of the base station
DEFN 4 ST=RECD,RT=BASE; ALTITUDE: I6:  UNIT=m, Height of the base station above sea level
DEFN 5 ST=RECD,RT=BASE; LATITUDE: F9.5:  UNIT=deg, NAME=South latitude, South latitude in
decimal degrees
DEFN 6 ST=RECD,RT=BASE; LONGITU: F10.5:  UNIT=deg, NAME=East longitude, East longitude in
decimal degrees
DEFN 7 ST=RECD,RT=BASE; ZONE: I2:   UTM zone number
DEFN 8 ST=RECD,RT=BASE; EASTING: F9.1:  UNIT=m, Easting in metres
DEFN 9 ST=RECD,RT=BASE; NORTHING: F10.1:  UNIT=m, Northing in metres
DEFN 10 ST=RECD,RT=BASE; STRTDATE: I6:   Start date GMT as YYDDD
DEFN 11 ST=RECD,RT=BASE; STRTIME: F9.5:   Start time GMT as HH.MMSS (decimal SS)
DEFN 12 ST=RECD,RT=BASE; STOPDATE: I6:   Stop date GMT as YYDDD
DEFN 13 ST=RECD,RT=BASE; STOPTIME: F9.5:   Stop time GMT as HH.MMSS (decimal SS)
DEFN 14 ST=RECD,RT=BASE; END DEFN
```

Barometer Base Station Data (RT=BDAT)

Acronym	Format	Description
RT	A4	"BDAT"
BASESTN	A20	Name of the barometer base station
STRTDATE	I6	Starting date GMT as YYDDD
STRTIME	F9.5	Start time GMT HH.MMSS (decimal SS)
INTERVAL	F5.2	Time interval
BASEBARO	9F8.3	Base station barometer readings at INTERVAL

```
DEFN 1 ST=RECD,RT=BDAT; RT: A4
DEFN 2 ST=RECD,RT=BDAT; BASESTN: A20:   Name of the barometer base station
DEFN 3 ST=RECD,RT=BDAT; STRTDATE: I6:   Start date GMT as YYDDD
DEFN 4 ST=RECD,RT=BDAT; STRTTIME: F9.5:   Start time GMT as HH.MMSS (decimal SS)
DEFN 5 ST=RECD,RT=BDAT; INTERVAL: F5.2:  UNIT=sec, Time interval between reading
DEFN 6 ST=RECD,RT=BDAT; BASEBARO: F8.3:   Base station barometer readings at INTERVAL
DEFN 7 ST=RECD,RT=BDAT; END DEFN
```

Reduced Airborne Survey Measurements (RT=DATA)

Acronym	Format	Description
RT	A4	"DATA"
FLTLINE	I6	Flight line number
FIDUCIAL	I6	Sequential fiducial number
EASTING	F9.1	Easting in metres (RESERVED)
NORTHING	F10.1	Northing in metres (RESERVED)
TOTALMAG	F10.3	Total magnetic intensity in metres
TOTSCINT	I8	Total count
K-CINT	I6	Potassium count in cps
TH-SCINT	I6	Thorium count in cps
U-SCINT	I6	Uranium count in cps
ALTITUDE	F8.1	Radar altimeter in metres

```
DEFN 1 ST=RECD,RT=DATA; RT: A4
DEFN 2 ST=RECD,RT=DATA; FLTLINE: I6:   Flight line number
DEFN 3 ST=RECD,RT=DATA; FIDUCIAL: I6:   Sequential fiducial number
DEFN 4 ST=RECD,RT=DATA; EASTING: F9.1:  UNIT=m, Easting in metres
DEFN 5 ST=RECD,RT=DATA; NORTHING: F10.1:  UNIT=m, Northing in metres
DEFN 6 ST=RECD,RT=DATA; TOTALMAG: F10.3:  UNIT=nanotesla, NULL=-9999, Total magnetic
intensity
DEFN 7 ST=RECD,RT=DATA; TOTSCINT: I8:  UNIT=cps, NULL=-9999, Total count
DEFN 8 ST=RECD,RT=DATA; K-CINT: I6:  UNIT=cps, NULL=-9999, Potassium count in cps
DEFN 9 ST=RECD,RT=DATA; TH-SCINT: I6:  UNIT=cps, NULL=-9999, Thorium count in cps
DEFN 10 ST=RECD,RT=DATA; U-CINT: I6:  UNIT=cps, NULL=-9999, Uranium count in cps
DEFN 11 ST=RECD,RT=DATA; ALTITUDE: F8.1:  UNIT=m, NULL=-9999, Radar altimeter in metres
DEFN 12 ST=RECD,RT=DATA; END DEFN
```

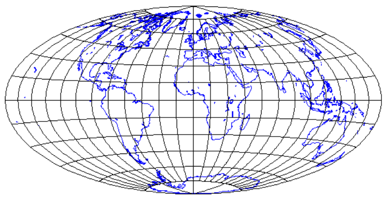
COMBINING THE DEFN RECORDS

The individual data records defined by each DEFN set can be combined into a single DEFN set that can then be used to process any records that are encountered from a given group of data files associated with a survey. The example below shows the concatenated version of the DEFN records. This file name would be "survey.DFN".

```
DEFN 1 ST=RECD,RT=HEAD; RT: A4
DEFN 2 ST=RECD,RT=HEAD; SURVNAME: A50:   Name of the airborne survey
DEFN 3 ST=RECD,RT=HEAD; LICENCE: A50:   Licence name eg. EL 123 SA"
DEFN 4 ST=RECD,RT=HEAD; SURVSIZE: I10:  UNIT=km^2, Size of the survey in square km
DEFN 5 ST=RECD,RT=HEAD; FLTDIST: I8:  UNIT=km, Total line km flown
DEFN 6 ST=RECD,RT=HEAD; CMPYFLEW: A50:   Company that flew the survey
DEFN 7 ST=RECD,RT=HEAD; CMPYPROC: A50:   Company that processed the survey
DEFN 8 ST=RECD,RT=HEAD; CMPYFOR: A50:   Company that the survey was flown for
DEFN 9 ST=RECD,RT=HEAD; FLTPATH: A50:   Flight path recovery method eg. DGPS
DEFN 10 ST=RECD,RT=HEAD; FLTDNSTY: I6:  UNIT=m, Flight line separation in metres
DEFN 11 ST=RECD,RT=HEAD; TIEDNSTY: I6:  UNIT=m, Tie line separation in metres
DEFN 12 ST=RECD,RT=HEAD; ALTITUDE: I6:  UNIT=m, Average height above sea level in metres
DEFN 13 ST=RECD,RT=HEAD; GRDCLEAR: I6:  UNIT=m, Average ground clearance in metres
DEFN 14 ST=RECD,RT=HEAD; LNBEARNG: I4:  UNIT=deg, Flight line bearing in deg from true north
DEFN 15 ST=RECD,RT=HEAD; TIBEARNG: I4:  UNIT=deg, Tie line bearing in degrees from true north
DEFN 16 ST=RECD,RT=HEAD; SAMPINT: F6.2:  UNIT=m, Sample interval in metres
DEFN 17 ST=RECD,RT=HEAD; END DEFN
DEFN 1 ST=RECD,RT=MAPS; RT: A4
DEFN 2 ST=RECD,RT=MAPS; MAPS50K: I5:   50K map sheet numbers
DEFN 3 ST=RECD,RT=MAPS; MAPS100K: I5:   100K map series
DEFN 4 ST=RECD,RT=MAPS; END DEFN
DEFN 1 ST=RECD,RT=COMM; RT: A4
DEFN 2 ST=RECD,RT=COMM; COMMENTS: A68:   Descriptive information about the survey
DEFN 3 ST=RECD,RT=COMM; END DEFN
DEFN 1 ST=RECD,RT=FLTL; RT: A4
DEFN 2 ST=RECD,RT=FLTL; FLIGHT: A4:   The flight designation
DEFN 3 ST=RECD,RT=FLTL; FLTLINE: A8:   Flight line number
```

```
DEFN 4 ST=RECD,RT=FLTL; DIRECTN: A2: Line direction E, N, S, W, NE, SW etc
DEFN 5 ST=RECD,RT=FLTL; STRTDATE: I6:   Start date GMT as YYDDD
DEFN 6 ST=RECD,RT=FLTL; STRTTIME: F9.5:   GMT as HH.MMSS (decimal SS)
DEFN 7 ST=RECD,RT=FLTL; STOPDATE: I6:   Stop date GMT as YYDDD
DEFN 8 ST=RECD,RT=FLTL; STOPTIME: F9.5:   GMT as HH.MMSS (decimal SS)
DEFN 9 ST=RECD,RT=FLTL; ALTITUDE: I6:  UNIT=m, Average height above sea level
DEFN 10 ST=RECD,RT=FLTL; GRDCLEAR: I6:  UNIT=m, Average ground clearance
DEFN 11 ST=RECD,RT=FLTL; LNBEARNG: I4:  UNIT=deg, Flight line bearing relative to grid north
DEFN 12 ST=RECD,RT=FLTL; END DEFN
DEFN 1 ST=RECD,RT=BASE; RT: A4
DEFN 2 ST=RECD,RT=BASE; BASENET: A8:   Network in which the base station belongs
DEFN 3 ST=RECD,RT=BASE; BASESTN: A20:   Name of the base station
DEFN 4 ST=RECD,RT=BASE; ALTITUDE: I6:  UNIT=m, Height of the base station above sea level
DEFN 5 ST=RECD,RT=BASE; LATITUDE: F9.5:  UNIT=deg, NAME=South latitude, South latitude in
decimal degrees
DEFN 6 ST=RECD,RT=BASE; LONGITUD: F10.5:  UNIT=deg, NAME=East longitude, East longitude in
decimal degrees
DEFN 7 ST=RECD,RT=BASE; ZONE: I2:   UTM zone number
DEFN 8 ST=RECD,RT=BASE; EASTING: F9.1:  UNIT=m, Easting in metres
DEFN 9 ST=RECD,RT=BASE; NORTHING: F10.1:  UNIT=m, Northing in metres
DEFN 10 ST=RECD,RT=BASE; STRTDATE: I6:   Start date GMT as YYDDD
DEFN 11 ST=RECD,RT=BASE; STRTIME: F9.5:   Start time GMT as HH.MMSS (decimal SS)
DEFN 12 ST=RECD,RT=BASE; STOPDATE: I6:   Stop date GMT as YYDDD
DEFN 13 ST=RECD,RT=BASE; STOPTIME: F9.5:   Stop time GMT as HH.MMSS (decimal SS)
DEFN 14 ST=RECD,RT=BASE; END DEFN
DEFN 1 ST=RECD,RT=BDAT; RT: A4
DEFN 2 ST=RECD,RT=BDAT; BASESTN: A20:   Name of the barometer base station
DEFN 3 ST=RECD,RT=BDAT; STRTDATE: I6:   Start date GMT as YYDDD
DEFN 4 ST=RECD,RT=BDAT; STRTTIME: F9.5:   Start time GMT as HH.MMSS (decimal SS)
DEFN 5 ST=RECD,RT=BDAT; INTERVAL: F5.2:  UNIT=sec, Time interval between reading
DEFN 6 ST=RECD,RT=BDAT; BASEBARO: F8.3:   Base station barometer readings at INTERVAL
DEFN 7 ST=RECD,RT=BDAT; END DEFN
DEFN 1 ST=RECD,RT=DATA; RT: A4
DEFN 2 ST=RECD,RT=DATA; FLTLINE: I6:   Flight line number
DEFN 3 ST=RECD,RT=DATA; FIDUCIAL: I6:   Sequential fiducial number
DEFN 4 ST=RECD,RT=DATA; EASTING: F9.1:  UNIT=m, Easting in metres
DEFN 5 ST=RECD,RT=DATA; NORTHING: F10.1:  UNIT=m, Northing in metres
DEFN 6 ST=RECD,RT=DATA; TOTALMAG: F10.3:  UNIT=nanotesla, NULL=-9999, Total magnetic
intensity
DEFN 7 ST=RECD,RT=DATA; TOTSCINT: I8:  UNIT=cps, NULL=-9999, Total count
DEFN 8 ST=RECD,RT=DATA; K-CINT: I6:  UNIT=cps, NULL=-9999, Potassium count in cps
DEFN 9 ST=RECD,RT=DATA; TH-SCINT: I6:  UNIT=cps, NULL=-9999, Thorium count in cps
DEFN 10 ST=RECD,RT=DATA; U-CINT: I6:  UNIT=cps, NULL=-9999, Uranium count in cps
DEFN 11 ST=RECD,RT=DATA; ALTITUDE: F8.1:  UNIT=m, NULL=-9999, Radar altimeter in metres
DEFN 12 ST=RECD,RT=DATA; END DEFN
```

APPENDIX 3 SEG RECOMMENDATIONS ON DATUMS AND MAP PROJECTIONS



This appendix is based on the draft proposal before the SEG for the documentation of datum and projection information in the SEG-GXF3 standard for grid data exchange. This is an extension of the ASEG-GXF standard (Collins, 1991).

The information content conforms to the POSC/EPSG projection data model and exploits the EPSG projection tables and the POSC naming conventions, which are based on the EPSG tables. All parameter names used to define projection information must use POSC/EPSG standard names where they are known or supported.

POSC - Petrotechnical Open Software Corporation.

EPSG - European Petroleum Survey Group.

See the References on POSC and EPSG for Internet world wide web reference information.

Although ASEG-GDF2 requires the use of POSC/EPSG names, all projection parameters must also be explicitly specified as part of the projection definitions. Where a particular parameter or name is not defined by POSC or EPSG, any appropriate name can be used and such names must begin with the "*" character. This is an important feature because it allows GDF2 to support x,y coordinates that use projections that are not defined in POSC/EPSG. It is not uncommon for exploration data to use obscure and even ad-hoc projections, and support for such projections has been a requirement in the recommendation of the SEG Standards Committee.

The full definition of EPSG/POSC parameter values is beyond the scope of this document, and developers of GDF2 readers and writers are referred to the EPSG and POSC references. EPSG Guidance Note 7 is a useful reference guide for expansion of the succinct definitions found in this document.

This specification is based on the projection system model described by POSC and EPSG, which distinguishes between a *Geographic Coordinate System* and a *Projected Coordinate System*.

GEOGRAPHIC COORDINATE SYSTEM

This is a coordinate system that uses longitude and latitude coordinates. It requires the identification of a geodetic datum, which includes the datum name, an ellipsoid definition and prime meridian. Common Geographic Coordinate Systems of the world are listed in the code range 4000 to 4999 in the "Coordinate system" table of the EPSG Geodesy Parameters (version 5.1). Refer to the EPSG and POSC information sources noted in the References for further information. POSC and EPSG Geographic Coordinate System names are generally composed by adopting the geodetic datum abbreviation or name if no abbreviation exists. For example, the datum "GDA94" (Geocentric Datum of Australia, 1994) uses the "GRS 1980" ellipsoid, the central meridian is at Greenwich (0.0).

PROJECTED COORDINATE SYSTEM

This is a *Geographic Coordinate System* together with a map projection system that is used to transform longitude, latitude coordinates of the *Geographic Coordinate System* to projected map coordinates (x,y). POSC and EPSG Projected Coordinate System names are composed by concatenating the Geographic Coordinate System (datum) name and the map projection name separated by " / " (space forward slash space) characters, with a maximum string length of 40 characters

For example, the projected coordinate system "GDA94 / MGA zone 54S" defines both the Datum, "GDA94", and the projection system, "MGA zone 54S", which is a Transverse Mercator projection for the Map Grid of Australia with standard defined parameters. Common Projected Coordinate Systems of the world are listed in the code range 2000 to 3999 and 20000 to 32766 in the "Coordinate system" table of the EPSG Geodesy Parameters (version 5.1).

POSC and EPSG names are case sensitive. If the POSC or EPSG name of any parameter is not known, a user defined name can be used. User defined names must start with a "*" character (eg "*SAMMP").

DATUM AND PROJECTION SPECIFICATION

Specification of the datum and projection parameters are reproduced from the draft definition for SEG-GXF (Revision 3) where three components are used to describe the coordinate system of the data within the GDF data set.

"coordinate system"
"datum", major_axis, eccentricity, prime_meridian
"projection method", parameters,...

"coordinate system" The unique key name of the projected coordinate system. This is the "COORD_SYS_EPSG_NAME" field value in the "Coordinate System" table of EPSG. An example for Transverse Mercator zone 54 is "GDA94 / MGA zone 54"

"datum" The name of the abbreviated geodetic datum, which will be the "COORD_SYS_EPSG_NAME" field value in the "Coordinate System" table of EPSG for EPSG codes in the range 4000 to 4999. Note that for Geographic Coordinate Systems (latitude, longitude), the "*coordinate system*" and "*datum*" names will be the same (e.g. GDA94).

There are times where only the ellipsoid is known (not the datum). This is an ambiguous coordinate system, and a GDF writer should attempt to determine a correct datum if possible. However, such coordinate systems can be described in EPSG and GDF by using a system from the code range 4001 to 4030 in the EPSG "Coordinate System" table. For example, a coordinate system based on the Clarke 1880 ellipsoid would be named "Unknown datum for Clarke 1880 ellipsoid".

major axis The ellipsoid semi-major axis in metres. This should be the value in the SEMI_MAJOR_AXIS field of the "ellipsoid" table in EPSG, converted to metres (6378137 for GRS 1980).

Eccentricity or inverse flattening The ellipsoid eccentricity. Eccentricity, ellipticity (also called inverse flattening) and flattening are related as follows:

flattening = 1 / inverse flattening
= (semi-major axis – semi-minor axis) /semi-major axis
eccentricity =√(2*flattening - flattening*flattening)

Values greater than 1.0 are assumed to be inverse-flattening (INV_FLATTENING from the "ellipsoid" table in EPSG). Values less than or equal to 1.0 are assumed to be eccentricity. Inverse flattening values (1/f) are published in the EPSG tables and the value for the GRS 1980 ellipsoid is 298.257222101 and are preferred for general usage.

Eccentricity is used in GDF2 in order to allow spherical ellipsoids to be defined (eccentricity = 0). Ellipsoid names and parameters can be found in EPSG table ELLIPSOID.

prime_meridian The location of the prime meridian in degrees relative to Greenwich (negative in the Western hemisphere). This is the value in the GREENWICH_LONGITUDE field of the "Prime meridian" table in EPSG, converted to decimal degrees (0 degrees for GDA94).

"projection method" The name of the projection method, which must be one of the CTRF_METHOD_EPSG_NAME field entries in the code range 9801 to 9899 from the "Transformation Method" table of EPSG (e.g. Transverse Mercator for MGA Zone 54). This component is not required for a Geographic Coordinate System (latitude, longitude).

User defined names cannot be used for the projection method because the parameter list cannot be undefined.

parameters A list of values that define all the parameters required by the projection mathematics. The list of required parameters depends on the projection type, and the requirements are specified in Table 1. The number and order of parameters conforms to the parameter requirements of EPSG. Note that angular parameters must be specified in degrees, and distance units must be specified in standard metres, regardless of the natural unit of the projection system. Be careful to use the correct conversion factor to convert from natural units to metres, particularly for False Easting and False Northing in non-metric systems. Refer to the conversion factors in the "Unit of Measure" table of EPSG, or Table 2.

As an example, there are 5 parameters for "MGA Zone 54":

Latitude of natural origin = 0.0

Longitude of natural original = 141.0

Scale factor at natural origin = 0.9996

False easting = 500000.0

False northing = 10000000.0

User Defined Projections

The EPSG standard is incomplete, in that a significant number of projections, datum(s) and ellipsoids in use have not been included in the standards. Because of this, GDF2 is designed to permit extension (using the EPSG projection data model). GDF2 also requires that all critical projection parameters be explicitly defined in numeric form.

GDF2 reading programs that use their own parameters based on the EPSG names, or similar aliases, may ignore the GDF2 parameters. GDF2 readers that do not have pre-defined projection parameters should use the provided parameter definitions. GDF2 writers should ensure that the provided parameters are correct for the defined EPSG projection name at the time the GDF2 file set is created.

Note that user defined projections may in fact map to a known projection in a GDF2 reader's environment. It is the responsibility of the GDF2 reader to determine this mapping if it is important to the reader.

Further, GDF writers may employ user defined projections even if a particular projection is defined in POSC or EPSG, although the use of POSC or EPSG names is strongly encouraged. This allows GDF2 files to be created for projections that do not exist in the POSC or EPSG standards at the time the GDF2 file set is created, although the projections may be added to the standards at some time in the future.

ASEG-GDF2 IMPLEMENTATION

The map projection DEFN record (RT=PROJ) defines the datum, projection system and parameters of the coordinates used to define the locations recorded in the data files (DAT).

Default: If the "RT=PROJ" DEFN record is not defined, the map projection is unknown and assumed to be in the working projection of the user of the data, hence no projection is required.

```
DEFN 1 ST=RECD,RT=PROJ; RT: A4
DEFN 2 ST=RECD,RT=PROJ; COORDSYS: A40:   NAME=projection name, POSC projection name
DEFN 3 ST=RECD,RT=PROJ; DATUM: A40:   NAME=datum name, EPSG compliant ellipsoid name
DEFN 4 ST=RECD,RT=PROJ; MAJ_AXIS: D12.1:  UNIT=m, NAME=major_axis, Major axis in units
relevant to the ellipsoid definition
DEFN 5 ST=RECD,RT=PROJ; INVFLATT: D14.9:   NAME=inverse flattening, 1/f inverse of flattening
DEFN 6 ST=RECD,RT=PROJ; PRIMEMER: F10.1:  UNIT=deg, NAME=prime_meridian, Location of prime
meridian relative to Greenwich
DEFN 7 ST=RECD,RT=PROJ; PROJMETH: A30:   NAME=projection_method, eg. Transverse Mercator,
Lambert etc
DEFN 8 ST=RECD,RT=PROJ; PARAM1: D14.0:   NAME=Proj_par1, 1st projecton paramater See Table 1
DEFN 9 ST=RECD,RT=PROJ; PARAM2: D14.0:   NAME=Proj_par2, 2nd  projection parameter
DEFN 10 ST=RECD,RT=PROJ; PARAM3: D14.0:   NAME=Proj_par3, 3rd projection parameter
DEFN 11 ST=RECD,RT=PROJ; PARAM4: D14.0:   NAME=Proj_par4, 4th projection parameter
DEFN 12 ST=RECD,RT=PROJ; PARAM5: D14.0:   NAME=Proj_par5, 5th projection parameter
DEFN 13 ST=RECD,RT=PROJ; PARAM6: D14.0:   NAME=Proj_par6, 6th projection parameter
DEFN 14 ST=RECD,RT=PROJ; PARAM7: D14.0:   NAME=Proj_par7, 7th projection parameter
DEFN 15 ST=RECD,RT=PROJ; END DEFN
```

Example RT=PROJ DEFN record for datum and projection data.

The following section illustrates sample projection data records with equivalent examples from SEG-GXF3 enclosed in an outline box. Note that the "+" symbols replace spaces to indicate the fixed width formatting requirement of ASEG-GDF2. Each group of lines below represents a single ASCII record terminated by a CR/LF or LF.

```
PROJGDA94 / MGA zone 54+++++++++++++++++++++
GDA94++++++++++++++++++++++++++++++++++++546378137+298.257222101+++++++0.0
Transverse Mercator++++++++++++++++++++++0.0+++++++++141.0++++++++0.9996
++++++500000.0++++10000000.0
```

```
#MAP_PROJECTION
“GDA94 / MGA zone 54”
“GDA94”,546378137,298.257222101,0.0
“Transverse Mercator”,0.0,141.0,0.9996,500000.0,10000000.0
```

```
PROJNAD27 / Ohio North++++++++++++++++++++++
NAD27++++++++++++++++++++++++++++++++++++++6378206.4+0.082551712+++++++0.0
Lambert Conic Conformal (2SP)+41.4333333333+++++++++41.70++39.666666667
+++++++++-82.5+++++609601.22+++++++++++0.0
```

```
#MAP_PROJECTION
“NAD27 / Ohio North”
“NAD27”,6378206.4,0.0822271854,0
“Lambert Conic Conformal (2SP)”,41.4333333333,41.7,39.6666666667,
-82.5,609601.22,0.0
```

```
PROJNAD83+++++++++++++++++++++++++++++++++++
NAD83++++++++++++++++++++++++++++++++++++++6378137.0+298.2572221+++++++0.0
```

```
#MAP_PROJECTION
“NAD83”
“NAD83”,6378137,0.081956469,0
```

```
PROJ*SAMMP sphere / *SAMMP grid projection++
*SAMMP sphere++++++++++++++++++6378249.145+++++++++0.0+++++++++0
Mercator+++++++++++++++++++++++++++++++++0.0+++++++++++0.0+++++++++++1.0+++++++++++0.0+++++++
++++0.0
```

```
#MAP_PROJECTION
“*SAMMP sphere/ *SAMMP grid projection”
“*SAMMP sphere”,6378249.145,0.0
“Mercator”,0.0,0.0,1.0,0.0,0.0
```

Naming Convention for Primary Coordinates in Data Files

This section describes the primary coordinate system that defines the location information in the GDF2 data files (DAT). It is possible for more than one set of coordinates to be present in a file. For example the file could contain coordinates on both the AGD66 and GDA94 datums. If only latitude and longitude coordinates are available, then the projection does not require definition in the RT=PROJ DEFN record.

The following names must be used to describe the coordinate fields of the primary coordinate system:

LATITUDE Latitude of the geographic coordinate system.

LONGITUD	Longitude of the geographic coordinate system.
EASTING	Easting of the projected coordinate system.
NORTHING	Northing of the projected coordinate system.

If a secondary set of coordinates are included in the data set, different names must be used to define the data fields. The datum and projection parameters should be included in the descriptive fields (COMM).

Note that the location data does not require both projected and geographic coordinates. If a Projected Coordinate System definition exists, then this implies that easting and northing coordinates will be present in the data.

TABLE 1 PROJECTION TRANSFORMATION METHODS

This table identifies all defined projection transformation methods. The parameters are listed in the order required in the "PROJ" DEFN record.

Except for methods marked with an asterisk (*), this table was compiled using EPSG Geodetic Parameter Set version 5.1 and POSC (2.2) as data sources. The order of parameters is based on the order of parameters defined in the "PROJ" DEFN record. Should EPSG add new methods in the future, GDF2 support for those methods is implied, and order of required parameters will be as defined by EPSG.

EPSG “Transverse Mercator (South Orientated)” is the same as POSC “Transverse Mercator (South Oriented)”, which corrects the spelling of “Oriented”.

Parameter Notes:

1) All distance references must be specified in metres.
2) All geographic references (latitudes and longitudes) are specified in degrees.
3) Longitudes in the Western hemisphere are negative.
4) Latitudes in the Southern hemisphere are negative.
5) Longitudes are relative to the prime meridian of the datum.
6) False Eastings and Northings are always specified in metres, regardless of the natural unit of the projection.

Projection method	Required parameters
Geographic	No parameters. This indicates that coordinates are longitudes and latitudes.
Hotine Oblique Mercator	Latitude of projection centre Longitude of projection centre Azimuth of initial line Angle from Rectified to Skew Grid Scale factor on initial line False Easting False Northing
Laborde Oblique Mercator	Latitude of projection centre Longitude of projection centre Azimuth of initial line Scale factor on initial line False Easting False Northing

Projection method	**Required parameters**
Lambert Conic Conformal (1SP)	Latitude of natural origin Longitude of natural origin Scale factor at natural origin False Easting False Northing
Lambert Conic Conformal (2SP)	Latitude of false origin Longitude of false origin Latitude of first standard parallel Latitude of second standard parallel Easting at false origin Northing at false origin
Lambert Conformal (2SP Belgium)	Latitude of false origin Longitude of false origin Latitude of first standard parallel Latitude of second standard parallel Easting at false origin Northing at false origin
Mercator (1SP)	Latitude of natural origin Longitude of natural origin Scale factor at natural origin False Easting False Northing
Mercator (2SP)	Latitude of first standard parallel Longitude of natural origin False Easting False Northing
New Zealand Map Grid	Latitude of natural origin Longitude of natural origin False Easting False Northing
Oblique Stereographic	Latitude of natural origin Longitude of natural origin Scale factor at natural origin False Easting False Northing

Projection method	Required parameters
Transverse Mercator	Latitude of natural origin Longitude of natural origin Scale factor at natural origin False Easting False Northing
Transverse Mercator (South Oriented) Transverse Mercator (South Orientated)	Latitude of natural origin Longitude of natural origin Scale factor at natural origin False Easting False Northing
*Albers Equal Conic	Latitude of first standard parallel Latitude of second standard parallel Latitude of false origin Longitude of false origin Easting at false origin Northing at false origin
*Equidistant Conic	Latitude of first standard parallel Latitude of second standard parallel Latitude of false origin Longitude of false origin Easting at false origin Northing at false origin
Amercian Polyconic	Latitude of false origin Longitude of false origin Easting at false origin Northing at false origin

TABLE 2 LENGTH UNITS

The following table is compiled from the UNIT_OF_LENGTH table in the EPSG tables. The unit names are the abbreviations defined in POSC. This table is for convenient reference only, and the EPSG table is considered the primary reference.

Unit	Description	Factor to metres
m	metre	1
GLM	German legal metre	1.000013597
mGer	German legal metre (POSC)	1.000013597
km	kilometre	1000
ft	foot	0.3048
ftBnA	British foot (Benoit 1895 A)	0.304799733
ftBnB	British foot (Benoit 1895 B)	0.304799735
ftBr(65)	British foot (1865)	0.304800833
ftCla	Clarke's foot	0.304797265
ftGoldCoast	Gold Coast foot	0.30479971
ftInd	Indian foot	0.30479951
ftInd(37)	Indian foot (1937)	0.30479841
ftInd(62)	Indian foot (1962)	0.3047996
ftInd(75)	Indian foot (1975)	0.3047995
ftSe	British foot (Sears 1922)	0.304799472
ftUS	US survey foot	0.30480061
chBnA	British chain (Benoit 1895 A)	20.1167824
chBnB	British chain (Benoit 1895 B)	20.11678249
chCla	Clarke's chain	20.11661949
chSe	British chain (Sears 1922)	20.11676512
chUS	US survey chain	20.11684023
lkBnA	British link (Benoit 1895 A)	0.201167824
lkBnB	British link (Benoit 1895 B)	0.201167825
lkCla	Clarke's link	0.201166195
lkSe	British link (Sears 1922)	0.201167651
lkUS	US survey link	0.201168402
mi	Statute mile	1609.344
miUS	US survey mile	1609.347219
nautmi	nautical mile (POSC)	1852
NM	nautical mile	1852

Unit	Description	Factor to metres
ydBnA	British yard (Benoit 1895 A)	0.9143992
ydBnB	British yard (Benoit 1895 B)	0.914399204
ydCla	Clarke's yard	0.914391795
ydInd	Indian yard	0.914398531
ydInd(37)	Indian yard (1937)	0.91439523
ydInd(62)	Indian yard (1962)	0.9143988
ydInd(75)	Indian yard (1975)	0.9143985
ydSe	British yard (Sears 1922)	0.914398415
Bin12.5m	Bin width 12.5 metres	12.5
Bin165ftUS	Bin width 165 US survey feet	50.29210058
Bin25m	Bin width 25 metres	25
Bin3.125m	Bin width 3.125 metres	3.125
Bin330ftUS	Bin width 330 US survey feet	100.5842012
Bin37.5m	Bin width 37.5 metres	37.5
Bin6.25m	Bin width 6.25 metres	6.25
Bin82.5ftUS	Bin width 82.5 US survey feet	25.14605029
deg	degree	n/a
dega	degree (POSC)	n/a