

SEG-D, Rev 2.1

SEG Field Tape Standards
January 2006

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1.0 Introduction

For several years now there has been talk of the need for a new revision of the SEG-D standard for seismic field data. The last revision of the standard, Rev 2.0, was published in 1996, and in the intervening decade there have been significant developments in acquisition and computer technologies, and a new revision would bring the standard into line with current industry techniques and practices.

At the SEG convention in Denver in 2004, the SEG Technical Standards Committee decided to revive the SEG-D Format Subcommittee, with Jill Lewis of Troika International volunteering to chair the subcommittee and provide the necessary energy to drive it forward. Since then there has been considerable behind the scenes activity to ascertain what should be contained in the new revision, culminating in meetings of interested parties at the EAGE in Madrid and the SEG in Houston in 2005.

The following individuals have been active participants in this effort:

Jill Lewis	Troika International	Chairman
Bob Firth	Troika International	
Nils Aatland	Aatland IT Consulting	
Rune Hagelund	WesternGeco	
Bjorn Svenkerud	WesternGeco	
Jacques Hamon	Sercel	
Malcolm Lansley	Sercel	
Angus Stott	PGS	
Hamed A Al-Ghambi	Saudi Aramco	
James Richard	Saudi Aramco	
Shelton Hubbell	Saudi Aramco	

Numerous other people have also participated at various times.

To begin with there was considerable discussion as to whether a new revision of the SEG-D standard is what is actually required, or whether the time has come to develop a completely new format, SEG-E perhaps. After all the SEG-D standard is now thirty years old, and while it has gone through several revisions to maintain its utility as the industry has evolved, there comes a time when a format has been coerced as far as it can go, and ultimately it is appropriate to start again from scratch. However it was felt that developing a new format would be a major effort which could be undertaken in the longer term, but at least one more revision of the SEG-D standard should be produced to address the issues that are concerning people today. Hopefully this revision could be produced fairly quickly.

One of the main driving forces behind a revision to the SEG-D standard at this time is the advent of what might be considered very high capacity tape devices. Of particular significance in the seismic industry is the IBM 3592 with a capacity of 300 Gbytes, and higher capacities promised to follow quickly behind. Traditionally a tape cartridge would only contain data from a single seismic line, but with these high capacities this has become an unreasonable restriction, and a way had to be found to uniquely identify SEG-D records from different lines on the same cartridge.

Inevitably in an exercise such as this there has been a diversity of views on what should be included in the revision, boiling down to a conflict between completeness and compatibility. Obviously there is a desire to make the new revision as complete as possible, providing facilities for recording the variety of attribute values and the multiplicity of channels that a modern acquisition system makes available. However many attributes were simply not envisaged when the format was first defined, and finding a place for them would require significant structural changes to the format. For instance it is being proposed that the size of a Channel Set Descriptor, currently 32 bytes, should be increased to 64 or 96 bytes. Many felt that this would be a change too far, requiring extensive modifications to SEG-D reading software which in some cases might not be easy, or even possible, to make. In particular there are widely used software packages for QC that are not

being actively maintained any more. However some of the more extensive changes being proposed are definitely required to solve real problems, and they must be accommodated somehow in a format revision.

In order to address the conflicting concerns of the interested parties, it was decided that the revision should be implemented in two stages. This is the first of those stages, Rev 2.1, which is a relatively minor revision implementing some changes that everyone agrees are required, particularly the usage of very high capacity media, while maintaining substantial downward compatibility with Rev 2.0. Many of the issues being addressed by Rev 2.1 have been raised by users of the SPS processing support format, and a minor revision of the SPS standard is being produced in parallel. In the meantime work continues on a more extensive revision, Rev 3, which will require a substantial amount of work. Nevertheless, it is envisaged that SEG-D Rev 3 will follow less than a year behind Rev 2.1.

1.1 Controlling Organization

The SEG-D rev 2.1 is administered by the SEG Technical Standards Committee. Any questions, corrections or problems encountered in the format should be addressed to:

Society of Exploration Geophysicists
P.O. Box 702740
Tulsa, Ok 74170-2740

Attention: SEG Technical Standards Committee
Phone: (918) 497-5500
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2.0 Changes Introduced in Revision 2.1

The following list discusses each of the specific changes made in Revision 2.1 compared to Revision 2.0.

1. Revision number changed from 2.0 to 2.1, see
 - Chapter 4, field number 2
 - Chapter 8.2 (General Header # 2, byte 11 and 12).
2. Since Rev 2.1 is intended to handle ultra high density tapes, acceptable media is expanded to include:
 - STK 9940B, IBM 3592 (Jaguar-1) and IBM TS1120 (Jaguar-2).For further details, see Appendix F.
3. Field file number not changed (same as previous revision), range is 0-16.777.215
4. More than one production line per tape is allowed, as long as a unique combination of **field file number** and line **sequence number** are used per storage unit.
 - Sequence number is added, see General Header # 2, byte 21-22. Range is 1-65535 (Set to 0 if not valid).
5. Appendix C is updated (API Producer Organization Codes). Organization codes are now assigned by Energistics, which maintains the current list of codes (API in previous revision).
6. Appendix A is updated (Manufacturers of Seismic Field Recorders).
7. Producer organization code is no longer a required field (Chapter 4, field number).

2.1 Changes Introduced in Rev 2.0

The following list discusses each of the specific changes made in Revision 2.0 compared to Revision 1.0. Also mentioned are changes which were discussed as potential changes to be included in Rev 2.0, but were not included in Rev 2.0.

1. Since Rev 2.0 is intended to handle higher density tapes, acceptable media is expanded to include: 3490/3490E, 3590, D2, and D3.
2. It is not anticipated that the higher density drives will be used to record multiplexed data. Rev 2.0 does not support multiplexed data.
3. No specific changes will be made to SEG-D to handle “non-shot domain” data. Either a new committee should be formed, or the charter of this committee should be extended to develop a new format for this application. It does not appear practical to extend SEG-D to fit this application.
4. No special arrangements will be made to provide a standard method of recording SPS in the SEG-D header. The relevant portions of SPS can be put into existing header extensions in user defined positions.
5. The MP factor description will be modified to clarify the meaning for fixed bit data (see MP discussion in section 7).
6. The description of byte 12 in the General Header is being clarified to clearly state that the byte defines the number of additional blocks. Figure 4 in the SEG-D Rev 1 document will be changed from # BLKS IN GEN HDR to “# Additional blks in Gen Hdr”. Another correction will be made to correctly state, for byte 1 of the General Header, “File number of four digits (0-9999) set to FFFF (Hex) when the file number is greater than 9999.
7. The RECEIVER LINE NUMBER (bytes 1-3) and RECEIVER POINT NUMBER (Bytes 4-6) in the Trace Header Extension have been modified to include a fractional component. An all one’s pattern (FFFFFF Hex) in either of these fields, will serve as a flag to indicate that the complete five byte value will be located in newly defined locations in the Trace Header Extension. See Trace Header Extension table below.
8. The maximum number of Trace Header Extensions is now limited to 15.
9. Channels within the same Channel Set must now have the same number of Trace Header Extensions. Since all traces within a Channel Set will now contain the same number of Trace Header Extensions, the number of Trace Header Extensions will be indicated in the Channel Set Descriptor. The previously unused nibble of Byte 29 in the Channel Set Descriptor will now be defined to be a 4 bit binary parameter that defines the number of Trace Header Extensions for that Channel Set. Byte 29 of the Channel Set descriptor will now be:

0	1	2	3	4	5	6	7
EFH ₃	EFH ₂	EFH ₁	EFH ₀	THE ₃	THE ₂	THE ₁	THE ₀

As a result of this limitation the Trace Header Extension field in Byte 10 of the Trace Header will also be redefined as a 4 bit value limited to a maximum of 15 Trace Header Extensions.

10. The length of each trace within a Channel Set is now restricted to be the same value. This limitation and the restricting the number of Trace Header Extensions to the same number within a Channel Set will result in each trace within a Channel Set being recorded with the same number of bytes.
11. A tape label will be required on each tape. The details of this label format are described in section 4.

12. Data may be recorded in large logical blocks to maximize the transfer rates with high density tape systems. 3 types of device structures are supported:

A) Variable block length devices.

Every shot record must be aligned on a block boundary (i.e. each block will contain data from only one shot record). Multiple channel sets may be included in each block. When the data to be recorded in a block contains less than the maximum number of bytes in the block, there will be no padding characters to fill the block.

Storage Unit Structure in field 3 in Storage Unit Label must contain the text “RECORD”

B) Byte stream devices

There is no concept of a block, even though there is a hidden underlying physical block structure. Within each file, one or more shot records are written consecutively without any gap.

Storage Unit Structure in field 3 in Storage Unit Label must contain the text “RECORD”

C) Fixed block length devices

Every shot record must be aligned on a block boundary (i.e. each block will contain data from only one shot record). Multiple channel sets may be included in each block. Typically the last block in a shot record will contain less data than the block size, the remaining part of this block will be padded with characters without any information.

Storage Unit Structure in field 3 in Storage Unit Label must contain the text “FIXREC” and the block size is found in field 5 in Storage Unit Label.

Note: Structure A can be mapped to a file directly but one can not re-generate the same interblock gaps and File Marks from data stored on a file. Structure B and C can be mapped to a file directly and the structure can be re-generated apart from the original position of the File Marks.

13. An appendix will be added to indicate the maximum allowable block size for accepted types of media. It is expected that this table will need to be updated approximately once per year.
14. Byte 12 of the Trace Header will have an additional option, TR= 03 Trace has been edited. This parameter will indicate the acquisition system has modified one or more samples of this trace. During data acquisition, if a telemetry error occurs, a sample may be corrupted. Some radio acquisition systems fill in this missing data with a copy of the previous sample, or interpolate to fill in the missing sample. Trace edit can also occur when a noise edit process is applied by the acquisition system. The TR=03 flag should be set for those traces which have been modified by the acquisition system.
15. The SEG-D, Rev 2.0 format treats data going to tape as a byte stream. File Marks are not required to separate shot records, however File Marks may be included in between shot records where appropriate to ease error recovery and/or to provide logical partitioning of the data. If used, File Marks may only be recorded at shot record boundaries. For field tapes, File Marks should be written as frequently as possible, preferably for every shot. If data is staged on disk, many shots can be stored in each file. When SEG-D, Rev 2.0 data is recorded on tape, an EOD mark must be recorded after the last valid record and prior to the end of tape
16. The time standard referenced by byte 14 of the General Header has been changed from GMT to UTC.
17. Partitioning of a tape or other type media volume is now allowed. Each partition, or each tape if not partitioned, constitutes one storage unit. The storage unit label shall consist of the first 128 bytes of the first user-writable tape record in the first user-writable physical block and may, optionally, be followed by an File Mark. No File Mark shall be written before the storage unit label.

18. Added a field in the Trace Header extension to indicate the type of sensor used for that trace (Byte 21).

2.2 Changes Introduced in Rev 1

In 1994, several changes were introduced to SEG-D to increase flexibility. These changes are listed below.

1. To allow for additional defined fields in SEG-D headers, additional blocks are allowed for the General Header and Demux Trace Header.
2. Added provision for an optional set of General Trailer blocks. This type header allows provisions for recording auxiliary seismic system and real-time navigation related data in the trailer. The trailer is optional and typically follows all other recorded data.

The addition of the trailer will allow the accumulation of system faults, data QC information, real-time navigation position, and timing information on the same tape, and contiguous with, the shotpoint that it relates to. By recording this data after all of the other data, additional time is provided for collecting the data and transferring it to the recording system.

The Trailer blocks take the same general form as the Channel Set Descriptor. Byte 11 uses the "Channel Type Identification" set to 1100 to indicate a Trailer block. Bytes 1 and 2 indicate the number of the General Trailer block, with the first block numbered as 1.

All other information in the trailer is optional and may be formatted as desired by the manufacturer/user.

The number of General Trailer blocks is indicated in bytes 13 and 14 of General Header Block #2.

3. Provide provision to include the revision of SEG-D format. Added to Bytes 11 and 12 of General Header Block #2 contain the SEG-D Revision Number. The revision number is a 16 bit unsigned binary number. The Revision number is 1 for the proposed version.

In addition, in the General Header Block #1, nibble 1 of byte 12 contains the number of additional blocks in the general header. Nibble 1, byte 12 is an unsigned binary number. This number will be 1 or greater for SEG D Rev 1.

4. Added provision to include the source and receiver locations for each source and receiver location. Source locations are included in the General Header Blocks. Block #3 contains the position for Source Set #1. Additional General Header Blocks may be included to allow for additional Source Sets.

Source positions are defined by a Source Line Number (three bytes integer and two bytes fraction), a Source Point Number (three bytes integer and two bytes fraction), and a Source Point Index (one byte). This index allows several locations for the source in the grid, the original value is 1 and that value is incremented by 1 every time the source is moved, even when it is moved back to a previous location).

Receiver locations are included in Trace Header Extensions to be used with Demux Trace Headers. Receiver positions are defined by a Receiver Line Number (three integer bytes and two fraction bytes), a Receiver Point Number (three bytes integer and two bytes fraction), and a Receiver Point Index (one byte). This index allows for defining the receiver group in the grid, the original value is 1 and that value is incremented by 1 every time the receiver is moved, even when it is moved back to the previous location.

5. Provide for the use of File Numbers greater than 9999. Bytes 1, 2, and 3 in General Header Block #2 allow for a three byte, binary file number. When the file number is greater than 9999, bytes 1 and 2 in the General Header Block #1 must be set to FFFF.

6. Provide for Extended Channel Sets/Scan Types. General Header Block #2 allows for a two byte, binary number of Channel Sets/Scan Types in bytes 4 and 5. When using the Extended Channel Sets/Scan Types, byte 29 of General Header #1 must be set to FF.
7. Provide for additional Extended and External Header blocks. General Header Block #2 bytes 6 and 7 (for Extended Header blocks) and Bytes 8 and 9 (for External Header blocks) allow the use of a two byte, binary number to allow more than 99 blocks. When using these capabilities, General Header Block #1 byte 31 (for extended) and byte 32 (for external) must be set to FF.
8. Provide a mechanism for recording additional information about vibrator sources. Byte 15 of the General Header Block #N indicates the signal used to control vibrator phase. Byte 16 indicates the type of vibrator (P, Shear, Marine). Bytes 28 and 29 contain the phase angle between the pilot and the phase feedback signal.

The additional vibrator information may be recorded for multiple sets of sources by using additional General Header blocks.

9. Provide for larger number of samples per trace. Using bytes 8, 9, and 10 of the Trace Header Extension.
10. Provide provisions for using 1/2" square tape cartridges. (ANSI X3.180 1989).
11. Allow recording data in IEEE and other new formats.
Additional Valid Format Codes for bytes 3 & 4 of the General Header are:

0036	24 bit 2's compliment integer multiplexed
0038	32 bit 2's compliment integer multiplexed
0058	32 bit IEEE multiplexed
8036	24 bit 2's compliment integer demultiplexed
8038	32 bit 2's compliment integer demultiplexed
8058	32 bit IEEE demultiplexed

The IEEE format is fully documented in the IEEE standard, "ANSI/IEEE Std 754 - 1985", available from the IEEE.

The IEEE format is summarized as follows:

Bit	0	1	2	3	4	5	6	7
Byte 1	S	C ₇	C ₆	C ₅	C ₄	C ₃	C ₂	C ₁
Byte 2	C ₀	Q ₋₁	Q ₋₂	Q ₋₃	Q ₋₄	Q ₋₅	Q ₋₆	Q ₋₇
Byte 3	Q ₋₈	Q ₋₉	Q ₋₁₀	Q ₋₁₁	Q ₋₁₂	Q ₋₁₃	Q ₋₁₄	Q ₋₁₅
Byte 4	Q ₋₁₆	Q ₋₁₇	Q ₋₁₈	Q ₋₁₉	Q ₋₂₀	Q ₋₂₁	Q ₋₂₂	Q ₋₂₃ (see Note 1)

The value (v) of a floating-point number represented in this format is determined as follows:

if $e = 255$ & $f \neq 0$. .v = NaN	Not-a-Number (see Note 2)
if $e = 255$ & $f = 0$. .v = $(-1)^s * \infty$	Overflow
if $0 < e < 255$v = $(-1)^s * 2^{e-127} * (1.f)$	Normalized
if $e = 0$ & $f \neq 0$v = $(-1)^s * 2^{e-126} * (0.f)$	Denormalized
if $e = 0$ & $f = 0$v = $(-1)^s * 0$	\pm zero

where e = binary value of all C's (exponent)
 f = binary value of all Q's (fraction)

NOTES: 1. Bit 7 of byte 4 must be zero to guarantee uniqueness of the start of scan in the Multiplexed format (0058). It may be non zero in the demultiplexed format (8058).

2. A Not-a-Number (NaN) is interpreted as an invalid number. All other numbers are valid and interpreted as described above.
12. Allow for the use of blocked records. Allow blocked demultiplexed data (integral number of traces in a block). Headers will not be blocked. All records in a block will be the same size. Not all blocks will be the same size. Byte 20 in the general header (B1 = 1) will indicate blocked data. Blocks will be limited to 128 kilobytes. All traces in a block are in the same Channel Set.
13. Added the effective stack order (unsigned binary), in byte 30 in the Channel Set descriptor. Set to 0 if the trace data was intentionally set to real 0. Set to 1 if no stack. Set to the effective stack order if the data is the result of stacked data (with or without processing).
14. Improved definition of undefined fields. All undefined fields will be specified as: "This field is undefined by this format".
15. Added provisions for a Trace Edit byte (byte 10 of Demux Trace Header) to indicate traces zeroed for roll-on or roll-off and to indicate deliberately zeroed traces.
 - TR=0 No edit of this trace,
 - TR=1 Trace part of dead channels for roll-on or roll-off spread; trace intentionally zeroed.
 - TR=2 Trace intentionally zeroed.
16. Increased precision of MP factor, using byte 7 of the Channel Set descriptor.
17. Since modern seismic vessels record more than one streamer at a time, a standard convention is required to identify which streamer recorded each channel of data. The Channel Set Descriptors are updated to handle this task. The definition of a channel set is expanded to include the following rules. A channel set is a group of channels that:
 - a) Use identical recording parameters. This includes the same record length and sample interval.
 - b) Use identical processing parameters, including the same filter selection and array forming parameters. A field has been added to Channel Set Descriptor byte 32 to describe any array forming applied to data in that channel set.
 - c) Originates from the same streamer cable for marine data. The streamer cable number for each channel set has been added to Channel Set Descriptor byte 31.
 - d) Consists of channels with the same group spacing. For example, if one steamer has short group spacing close to the boat and longer groups spacing at long offsets, the data from that steamer would be recorded as two channel sets.

In addition, the first channel in each channel set will start with Trace number one.

18. Correct the MP factor calculation (refer to Appendix E7 in the SEG-D recording format description).

MP CALCULATION

The calculation of **MP** for a data recording method is given by one of the following equations:

- (1) $MP = FS - PA - C_{max}$; for binary exponents,
- (2) $MP = FS - PA - 2 \times C_{max}$; for quaternary exponents,
- (3) $MP = FS - PA - 4 \times C_{max}$; for hexadecimal exponents (except the 4 byte excess 64 method),
- (4) $MP = FS - PA - 4 (C_{max} - 64)$; for excess 64 hexadecimal exponents and for 4 byte IEEE exponents,

where

2^{FS} = Converter full scale (millivolts),

2^{PA} = Minimum system gain,

and

C_{max} = maximum value of the data exponent,

$C_{\text{max}} = 15$ for binary exponents,

7 for quaternary exponents,

3 for hexadecimal exponents except excess 64; and

64 for excess 64 exponents and for 4 byte IEEE exponents.

19. Added the option for using record lengths in millisecond increments (rather than the previous 0.5 second increments). The Extended Record Length is the record length, in unsigned binary milliseconds, and is recorded in bytes 15-17 in General Header Block #2. If this option is used, Record Length (R), in the General Header Block #1, bytes 26, 27 must be set to FFF.

3.0 Format Overview

The SEG-D, Rev 2.x formats treats data going to tape as a byte stream. Figure 1 illustrates a typical record structure.

A tape, or other media to be used for SEG-D, Rev 2.x recording may be partitioned. Each partition, or each tape if not partitioned, constitutes one storage unit. The storage unit label shall consist of the first 128 bytes of the first user-writable tape record in the first user-writable physical block and may, optionally, be followed by a File Mark. No File Mark shall be written before the storage unit label.

Each SEG-D Rev 2.x tape must begin with a tape label, as detailed in section 4. Following the tape label, each seismic record is recorded in demultiplexed format. SEG-D, Rev 2.x does not support multiplexed data records.

When blocked data is being recorded, all of the headers may be included in the same block with the initial channel set. Each channel set may be split across block boundaries. Block boundaries may not occur within a trace.

Data may be recorded in large blocks to maximize the transfer rates with high density tape systems. 3 types of device structures are supported:

A) Variable block length devices.

Every shot record must be aligned on a block boundary (i.e. each block will contain data from only one shot record). Multiple channel sets may be included in each block. When the data to be recorded in a block contains less than the maximum number of bytes in the block, there will be no padding characters to fill the block.

Storage Unit Structure in field 3 in Storage Unit Label must contain the text “RECORD”

B) Byte stream devices

There is no concept of a block, even though there is a hidden underlying physical block structure. Within each file, one or more shot records are written consecutively without any gap.

Storage Unit Structure in field 3 in Storage Unit Label must contain the text “RECORD”

C) Fixed block length devices

Every shot record must be aligned on a block boundary (i.e. each block will contain data from only one shot record). Multiple channel sets may be included in each block. Typically the last block in a shot record will contain less data than the block size, the remaining part of this block will be padded with characters without any information.

Storage Unit Structure in field 3 in Storage Unit Label must contain the text “FIXREC” and the block size is found in field 5 in Storage Unit Label.

Note: Structure A can be mapped to a file directly but one can not re-generate the same interblock gaps (if present) and File Marks from data stored on a file. Structure B and C can be mapped to a file directly and the structure can be re-generated apart from the original position of the File Marks.

The SEG-D, Rev 2.x format treats data going to tape as a byte stream. File Marks are not required to separate shot records, however File Marks may be included in between shot records where appropriate to ease error recovery and/or to provide logical partitioning of the data. If used, File Marks may only be recorded at shot record boundaries. For field tapes, File Marks should be written as frequently as possible, preferably for every shot. If data is staged on disk, many shots can be stored in each file. When SEG-D, Rev 2.x data is recorded on tape, an EOD mark must be recorded after that last valid record and prior to the end of tape.

If the tape media supports multiple partitions, SEG-D data may be written to any of the partitions of the tape, each beginning with a Storage Unit Label. Data from one partition can not “run-over” into a subsequent partition, each partition must be capable of being decoded in isolation.

On one tape, it is allowed to mix partitions containing SEG-D data with partitions containing non SEG-D formatted information.

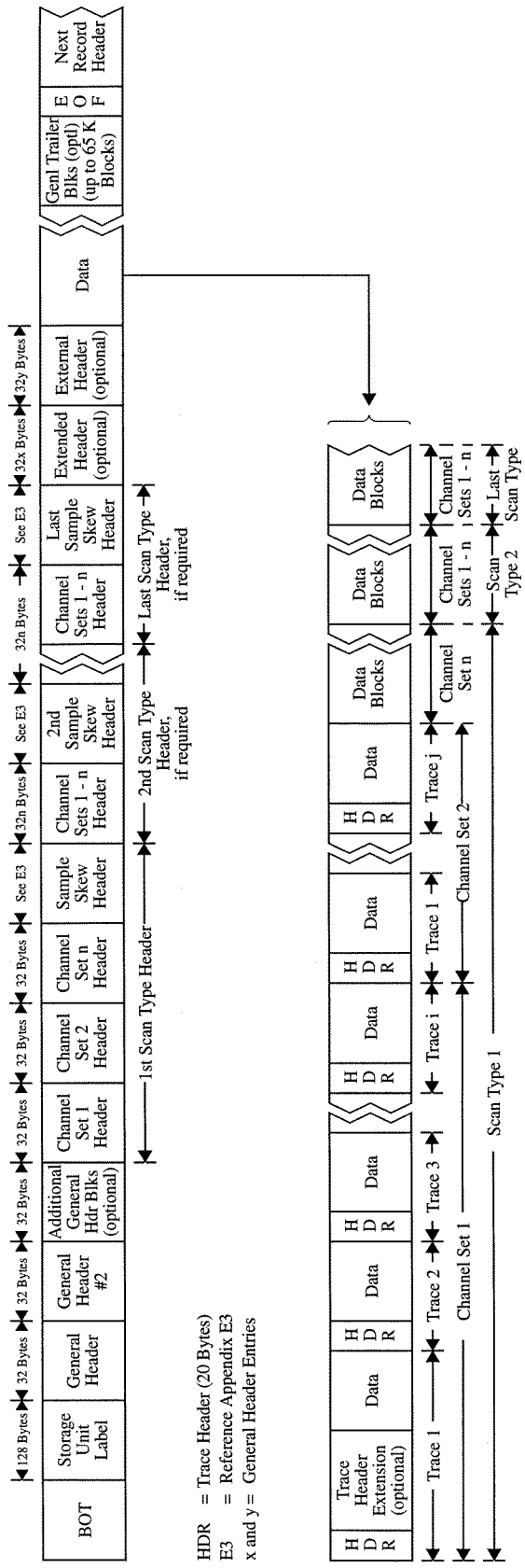
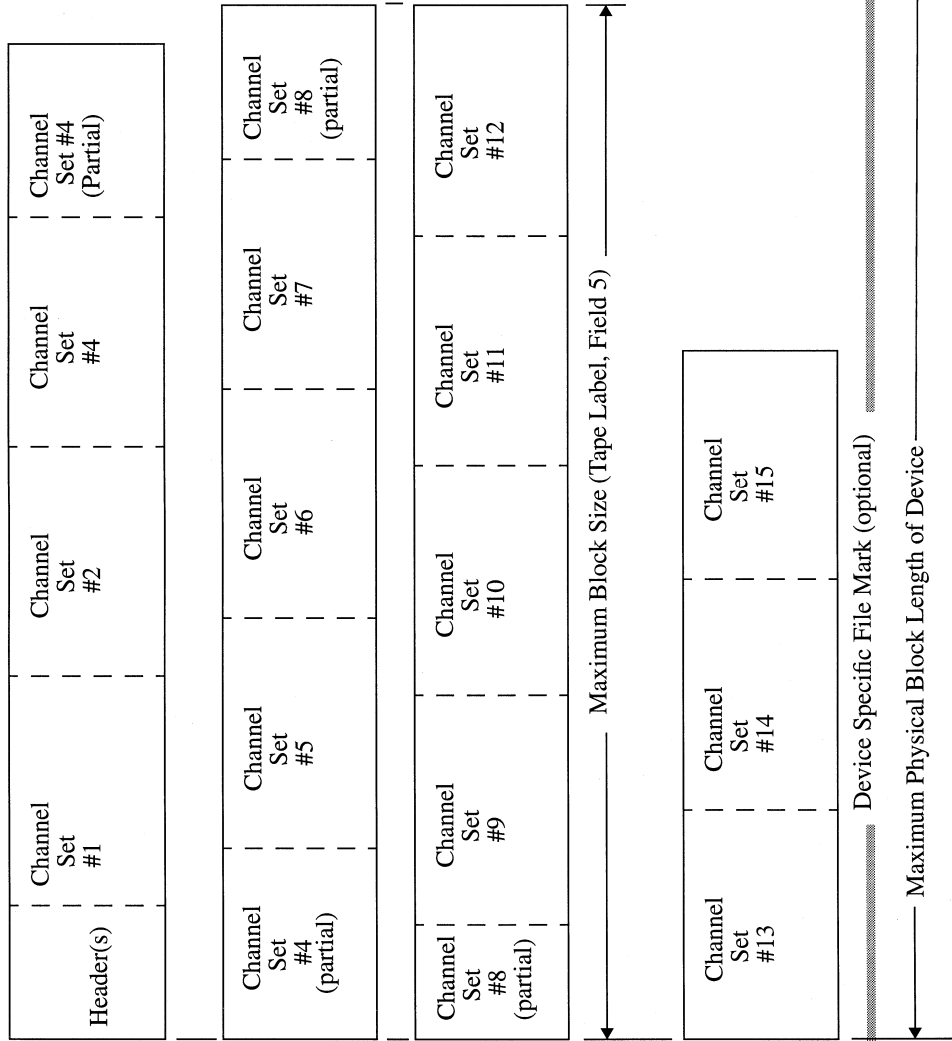


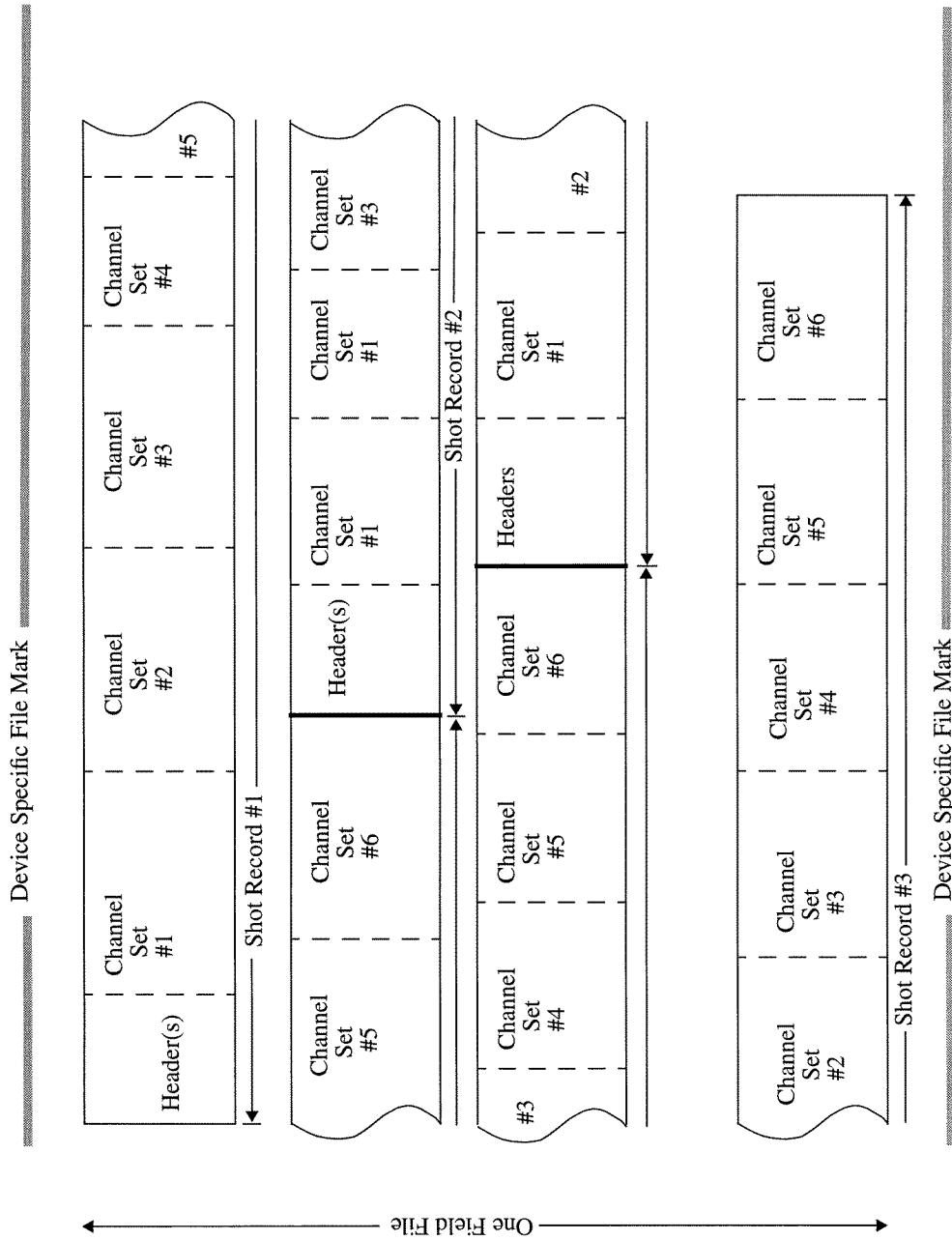
Figure 1. Record Format

Device Specific File Mark (optional)



Tape Label Requirements
Field 3 - Record
Field 5 - Largest Block Size

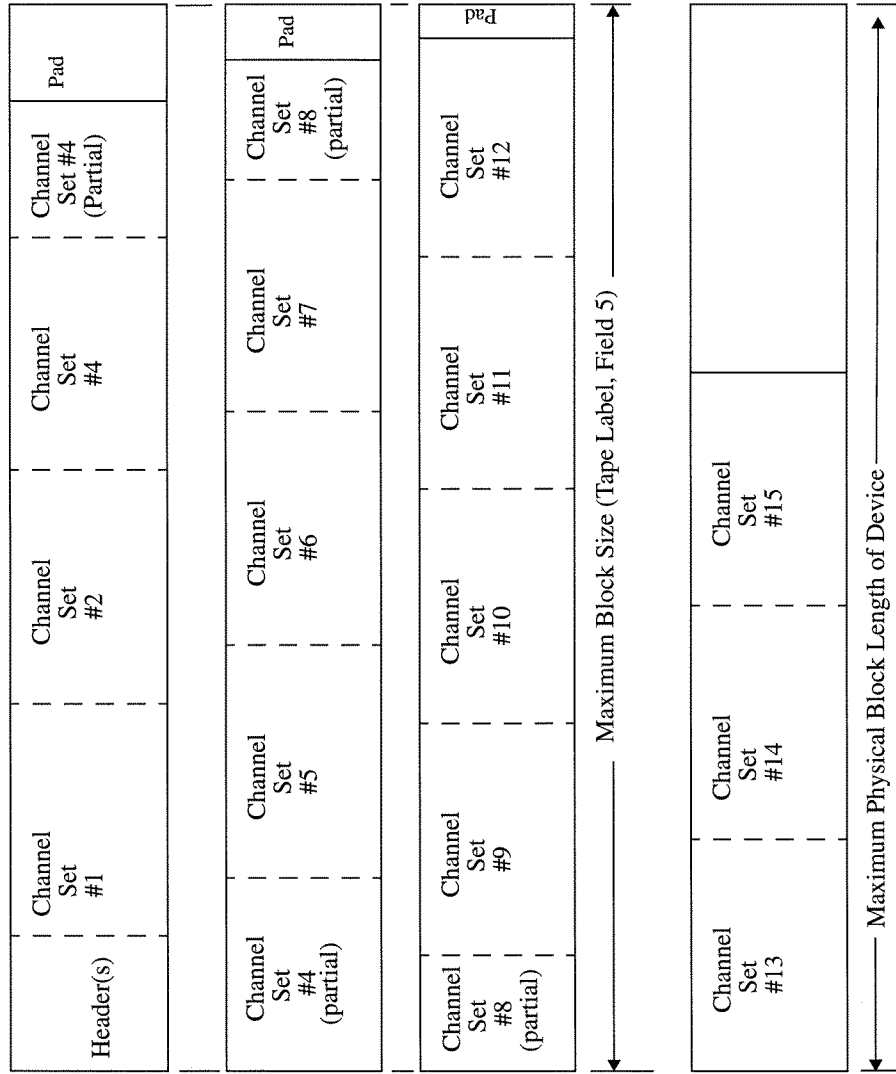
Figure 2. Variable Block Length Format Example



Tape Label Requirements
 Field 3 - Record
 Field 5 - Largest Block Size
 set to zero (undeclared)
 Field 10 - Max shots/file = 3

Figure 3. Byte Stream Device Example

Device Specific File Mark (optional)



Tape Label Requirements
 Field 3 - FixRec
 Field 5 - Block Length of Drive

Device Specific File Mark (optional)

Figure 4. Fixed Block Length Example

4.0 SEG-D, Rev 2.1 Tape Label

The first 128 bytes of data on a Rev 2.1 (and Rev 2.0) tape must consist of ASCII characters and will constitute a storage unit label. This label is very similar to the RP-66 storage unit label. The label format is summarized in the table below.

If the tape media supports multiple partitions, SEG-D data may be written to any of the partitions of the tape, each beginning with a Storage Unit Label. Data from one partition can not “run-over” into a subsequent partition, each partition must be capable of being decoded in isolation.

On one tape, it is allowed to mix partitions containing SEG-D data with partitions containing non SEG-D formatted information.

Table 1: Label

Field	Description	Byte s	Start end byte
1	Storage unit sequence number	4	1 - 4
2	SEG-D Revision	5	5 - 9
3	Storage unit structure (fixed or variable)	6	10 - 15
4	Binding edition	4	16 - 19
5	Maximum block size	1 0	20 - 29
6	API Producer organization code	1 0	30 - 39
7	Creation date	1 1	40 - 50
8	Serial number	1 2	51 - 62
9	Reserved	6	63 - 68
10	Storage set identifier	6 0	
	External Label Name	1 2	69 - 80
	Recording Entity Name	2 4	81 - 104
	User defined	1 4	105 - 118
	Max shot records per field record	1 0	119 - 128

- Field 1 The **Storage Unit Sequence Number** is an integer in the range 1 to 9999 that indicates the order in which the current storage unit occurs in the storage set. The first storage unit of a storage set has sequence number 1, the second 2, and so on. This number is represented using the characters 0 to 9, right justified with leading blanks if needed to fill out the field (No leading zeros). The rightmost character is in byte 4 of the label. *This field is optional.* If not used, it must be blank (filled with blank characters). This implies that this is the only storage unit within the storage set. Separate Storage Sets should be used for different data types.
- Field 2 The **SEG-D Revision** field indicates which revision of SEG-D was used to record the data on this tape. SD2.1 indicates that the data was recorded using SEG-D, Revision 2.1 (SD2.0 in previous revision)- *This field is required.*
- Field 3 **Storage Unit Structure** is a name indicating the record structure of the storage unit. This name is left justified with trailing blanks if needed to fill out the field. The leftmost character is in byte 10 of the label. For SEG-D, Rev 2.1 and 2.0 tapes, this field must contain “RECORD” or “FIXREC”. *This field is required.*
- “RECORD” -- Records may be of variable length, ranging up to the Blocksize length specified in the maximum Block size field of the storage unit label (if not zero). If the maximum Block size specified is zero, then records may be of any length.
- “FIXREC” -- All records in the storage unit have the same length, namely that specified in the maximum Block size field of the storage unit label. Although all storage units in the same storage set must have a FIXREC structure, the maximum record length may be different in different storage units. When the FIXREC option is used, then the maximum record length field shall not be 0 (zero).
- Field 4 **Binding edition** is the character B in byte 16 of the label followed by a positive integer in the range 1 to 999 (no leading zeros), left justified with trailing blanks if needed to fill out the field. The integer value corresponds to the edition of the Part 3 of the API, RP66 standard used to describe the physical binding of the logical format to the storage unit. *This field is required.*
- Field 5 **Maximum Block Size** is an integer in the range of 0 to 4,294,967,295 ($2^{32}-1$), indicating the maximum block length for the storage unit, or 0 (zero) if undeclared. This number is represented using the characters 0 to 9, right justified, with leading blanks if necessary to fill out the field (no leading zeros). The rightmost character is byte 29 of the label. A valid value or 0 (zero) must be recorded.
- Field 6 **Producer organization code** is an integer in the range of 0 to 4,294,967,295 ($2^{32}-1$) indicating the organization code of the storage unit producer. This number is represented using the characters 0 to 9, right justified, with leading blanks if necessary to fill out the field (NO leading zeros). The rightmost character is byte 39 of the label. *This field may be empty, i.e. may contain all blanks, in which case no storage unit producer is specified (e.g. same as RP-66 V2).*

Organization codes are assigned by Energistics (API, American Petroleum Institute in previous revision), which maintains the current list of codes. To request a new organization code, contact:

Energistics
24 Greenway Plaza
Suite 1000-B
Houston, TX 77046 USA
+1 713 784-1880 telephone
+1 713 784-9219 fax
www.energistics.org

- Field 7 **Creation date** is the earliest date that any current information was recorded on the storage unit. The date is represented in the form dd-MMM-yyyy, where yyyy is the year (e.g. 1996), MMM is one of (JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC), and dd is the day of the month in the range 1 to 31. Days 1 to 9 may have one leading blank. The separator is a hyphen (code 45₁₀). *This field is required.*
- Field 8 **Serial number** is an ID used to distinguish the storage unit from other storage units in an archive of an enterprise. The specification and management of serial numbers is delegated to organizations using this standard. If an external label is used the name/number must be a subset of the serial number or the External Label Name in Field 10, and must occupy the rightmost characters in the serial number (or External Label Name). *This field is required.*
- Field 9 This field is reserved and should be recorded as all blanks (code 32₁₀).
- Field 10 The **Storage set identifier** is a descriptive name for the storage set. Every storage unit in the same storage set shall have the same value for the **user defined portion** of the storage set identifier in its storage unit label. Included in the **Storage Set Identifier** is the **External Label Name**. The characters in this field are right justified with leading blank characters as required. If the tape does not have a physical label, then this field must be blank. A physical label is optional, but if it exists, then this field is required only if the external label is different from the lower 6 characters of the Serial Number in field 8. The next field in the Storage set identifier is the **Recording Entity Name**. This must contain the crew number or name, or some other unique identifier which will differentiate the recording entity which recorded this data from any other recording entity within the organization (as included in field 6). The 24 bytes may be any alphanumeric characters. If multiple recording systems are used on a vessel or crew, then data recorded on each system must be clearly distinguished. For example, an ABC Geophysical crew (party 13), on the M/V Gopher, recording data on two Zip 6000 recording systems might have a Recording Entity Name on tapes recording on the first recording system of:

ABC, Gopher, P13, Zip#1

On the second system, the Recording Entity Name might be:

ABC, Gopher, P13, Zip#2

The Recording Entity Name field is required.

USER DEFINED

The next 14 bytes in this field may contain any other user input information. The only restriction is that the data must be in ASCII.

Max Number of shot records per field record. Field Records are data between File Marks (10 bytes).

It is not acceptable to use an ANSI label (or any other label or data) prior to the Storage Unit Label.

An external, physical label is not required.

5.0 Header blocks

The headers are blocks of data prior to the seismic data, which contain auxiliary information about the seismic data, the acquisition parameters, acquisition geometry, plus user defined information. The header block includes at least two General Headers, one or more Scan Type headers, and optional Extended and External headers. Trace Headers are included in conjunction with each seismic data trace. Sections 7 and 8 include detailed information about the content of each type header.

In addition to header blocks which are recorded prior to the seismic data traces, an optional General Trailer is allowed following the seismic data. This allows recording other auxiliary information which is not available at the beginning of the record. Sections 7 & 8 include detailed description of the allowed fields of the General Trailer.

5.1 General Headers (*General Header #1 and #2 are required*)

General Header #1 is 32 bytes long and contains information similar to SEG A, B, C, and the original SEG-D headers. Abbreviations are as close as possible to those used in previous formats.

SEG-D, Rev 2.1 and 2.0 requires the use of General Header #1 and General Header #2 (as was also required in SEG-D, Rev 1). General Header #2 provides locations to record the source location, and other parameters, for each record. Source positions are defined by a source line number (three bytes integer and two bytes fraction), a source point number (three bytes integer and two bytes fraction), and a source point index (one byte). This index allows several locations for the source in the grid, the original value is 1 and that value is incremented by 1 every time the source is moved, even when it is moved back to a previous location. More General header block extensions may be added to record parameters for additional sources.

General Header blocks #3 (optional) and higher provide locations to record information about vibrator sources. Byte 15 of the general header block #N (N>2) indicates the signal used to control vibrator phase. Byte 16 indicates the type of vibrator. Bytes 28 and 29 contain the phase angle between the pilot and the phase feedback signal.

Bytes 1,2,3 in general header block #2 allow for a three byte, binary file number. When the file number is greater than 9999, bytes 1 and 2 in the general header block #1 must be set to FFFF.

General header block #2 also allows for a two byte, binary number of channel sets/scan types in bytes 4 and 5. When using the extended channel sets/scan types, byte 29 of the general header #1 must be set to FF.

Additional blocks may be added as needed by the manufacturer or user.

5.2 Scan Type Headers (*required*)

The Scan Type header is used to describe the information of the recorded channels (filters, sample intervals, sample skew, etc.). The Scan Type header is composed of one or more channel set descriptors followed by skew information. The channel set descriptors must appear in the same order as their respective channel sets will appear within a base scan interval. A channel set, which is part of a scan type, is defined as a group of channels all recorded with identical recording parameters. One or more channel sets can be recorded concurrently within one scan type. In addition, there can be multiple scan types to permit dynamic scan type changes during the record (e.g., 12 channels at 1/2 ms switched at about 1 second to 48 channels at 2 ms). Where there are dynamic changes, scan type header 1 describes the first part of the record, scan type header 2 the second part, etc. Within the scan type header, each channel set descriptor is composed of a 32 byte field, and up to 99 channel set descriptors may be present. In addition, up to 99 scan type headers may be utilized in a record.

Following the channel set descriptors of a scan type are a number of 32 byte fields (SK, specified in byte 30 of the general header #1) that specify sample skew. Sample skew (SS) is recorded in a single byte for each sample of each subscan of each channel set, in the same order as the samples are recorded in the scan. Each byte represents a fractional

part of the base scan interval (Byte 23 of general header #1). The resolution is 1/256 of this interval. For instance, if the base scan interval is 2 msec, the least significant bit in the sample skew byte is 1/256 of 2 msec or 7.8125 microseconds.

A channel set is a group of channels that:

- a) Use identical recording parameters. This includes the same record length and sample interval.
- b) Use identical processing parameters, including the same filter selection and array forming parameters.
- c) Originates from the same streamer cable for marine data. The streamer cable number for each channel set is included in the channel set descriptor byte 31.
- d) Consists of channels with the same group spacing. For example, if one streamer has short group spacing close to the boat and longer group spacing at long offsets, the data from the streamer would be recorded as two channel sets. The first channel in each channel set will start with trace number one.

The following is a list of ground rules for the scan type header:

- 1. The order in which channel sets are described in the header will be the same as the order in which the data are recorded for each channel set.
- 2. In a scan type header containing multiple channel set descriptors with different sample intervals, each channel set descriptor will appear only once in each scan type header. Within the data block, however, shorter sampling interval data are recorded more frequently.
- 3. In the case of multiple scan type records, such as the dynamically switched sampling interval case, each scan type will contain the same number of channel sets. Any unused channel sets needed in a scan type must be so indicated by setting bytes 9 and 10 (channels per channel set) to zero in the channel set descriptor.
- 4. In multiple scan type records, the number of bytes per base scan interval must remain a constant for all scan types recorded.
- 5. Channel set order within a scan type should be: auxiliary channels, long sampling interval channels, short sampling interval channels. All channel sets of the same sampling interval should be contiguous.
- 6. Channels within the same Channel Set must now have the same number of Trace Header Extensions. Since all traces within a Channel Set will contain the same number of Trace Header Extensions, the number of Trace Header Extensions will be indicated in the Channel Set Descriptor. The previously unused nibble of Byte 29 in the Channel Set Descriptor will now be defined to be a 4 bit binary parameter that defines the number of Trace Header Extensions for that Channel Set. Byte 29 of the Channel Set descriptor will now be:

0	1	2	3	4	5	6	7
E	E	E	E	T	T	T	T
F	F	F	F	H	H	H	H
H	H	H	H	E	E	E	E
3	2	1	0	3	2	1	0

As a result of this limitation the Trace Header Extension field in Byte 11 of the Trace Header is also redefined as a 4 bit value limited to a maximum of 15 Trace Header Extensions.

- 7. The length of each trace within a Channel Set is restricted to be the same value. This limitation and the restricting the number of Trace Header Extensions to the same number within a Channel Set will result in each trace within a Channel Set being recorded with the same number of bytes.

5.3 Trace Header (required)

The trace header length is 20 bytes and is an identifier that precedes each channel's data. The trace header and the trace data are recorded as one block of data. A trace is restricted to one channel of data from one channel set of one scan type. Some of the information in the trace header is taken directly from the general header and the scan type header.

Bytes 7, 8, and 9 comprise the timing word that would accompany the first sample if these data were written in multiplex format. To obtain the exact sample time, the actual sample skew time (Byte 11 multiplied by the base scan interval) must be added to the time recorded in Bytes 7, 8, and 9.

The timing word is in milliseconds and has the following bit weight assignments:

Timing word								
Bit	0	1	2	3	4	5	6	7
Byte 5	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8
Byte 6	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Byte 7	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}
Byte 8	0	0	0	0	0	0	0	0

The timing word LSB (2^{-8}) is equal to 1/256 msec, and the MSB (2^{15}) is equal to 32,768 msec. The timing word for each scan is equal to the elapsed time from zero time to the start of that scan. Timing words of from 0 to 65,535.9961 msec are codable. For longer recordings the timing word may overflow to zero and then continue.

The first scan of data has typically started with timing word zero. However, this is not a requirement. In a sampling system, it is not always practical to resynchronize the system even though most seismic data acquisition systems have to date. Possible reasons for not wanting to resynchronize could be digital filtering, communication restrictions, etc.

Whether the system is resynchronized or not, the timing word will contain the time from the energy source event to the start of scan of interest. For example, assume the sampling interval is 2 msec, the system does not resynchronize, and the energy source event occurs $1 + 9/256$ msec before the next normal start of scan. The timing word values would be:

First timing word	$0 + 1 + 9/256$ msec
Second	$2 + 1 + 9/256$ msec
Third	$4 + 1 + 9/256$ msec
Fourth	$6 + 1 + 9/256$ msec
...	...
One-thousandth timing word	$1998 + 1 + 9/256$ msec

Byte 11 contains sample skew of the first sample of this trace. This is identical to the first byte of sample skew for this channel in the scan type header.

Bytes 13, 14, 15 are included as an integrity check on time break. They comprise the timing word of the scan in which TWI changed to a one. Thus, it represents the time from the time break to the end of the time break window. Random variations in this time indicate a problem in the fire control system. The presence of a value less than the base scan interval indicates that time break was not detected and recording commenced at the end of the time break window.

A trace header extension block may be added to include the receiver location for that trace. Receiver locations are defined by a receiver line number (three integer bytes and two fraction bytes), a receiver point number (three bytes integer and two bytes fraction) and a receiver point index (one byte). This index allows for defining the receiver group

in the grid, the original value is 1 and that value is incremented by 1 every time the receiver is moved, even when it is moved back to the previous location. The Sensor type (vertical geophone, hydrophone, etc.) may be indicated in Byte 21.

Additional trace header blocks may be added as needed by the manufacturer or user. The maximum number of Trace Header Extensions is limited to 15.

A larger number of samples per trace may be recorded using bytes 8, 9, and 10 of the trace header extension.

5.4 Extended Header (optional)

The extended header provides additional areas to be used by equipment manufacturers to interface directly with their equipment. Since the nature of this data will depend heavily on the equipment and processes being applied, it will be the responsibility of the equipment manufacturer to establish a format and document this area. Byte 31 of the general header #1 contains the number of 32 byte fields in the extended header. If more than 99 extended header blocks are used, then General Header Block #1, Byte 31 is set to FF and Bytes 6 and 7 in the General Header Block #2 indicate the number of Extended Header Blocks.

5.5 External Header (optional)

The external header provides a means of recording special user desired information in the header block. This data format will be defined and documented by the end user. The means of putting this information into the header has usually been provided by the equipment manufacturer. Byte 32 of the General Header Block #1 contains the number of 32 byte fields in the external header. If more than 99 External header blocks are used, then General Header Block #1, Byte 32 is set to FF and Bytes 8 and 9 of General Header Block #2 indicates the number of External Header Blocks.

5.6 Data Trailer (optional)

Following the seismic data, a General Trailer may be recorded. This type header allows provisions for recording auxiliary system and navigation related data. The addition of the trailer will allow the accumulation of system faults, data QC information, real-time navigation position, and timing information on the same record and contiguous with, the shotpoint that it relates to. By recording this data after all of the other data, additional time is provided for collecting the data and transferring it to the recording system. The trailer blocks take the same general form as the Channel Set Descriptor. Byte 11 uses the "Channel Type Identification" set to 1100 to indicate a trailer block. Bytes 1 and 2 indicate the number of the general trailer block, with the first block numbered as 1. All other information in the trailer is optional and may be formatted as desired by the manufacturer or user. The number of general trailer blocks is indicated in bytes 13 and 14 of the General Header Block #2.

6.0 Data Body

Data is recorded as a byte stream in demultiplexed format. Preceding each trace of data is a trace header, and optionally trace header extensions. Each trace is a sequential set of points from one channel in one channel set.

6.1 Data Recording Method

To accommodate diverse recording needs, the data recording utilizes sample sizes of 8, 16, 20, and 32 bits.

The data word is a number representation of the sign and magnitude of the instantaneous voltage presented to the system. It is not an indication of how the hardware gain system functions. The output of stepped gain systems may be represented as a binary mantissa and a binary exponent of base 2, 4, or 16 (binary, quaternary, or hexadecimal system).

Following are descriptions of each of the data recording methods permitted. The same number system is to be used on all samples in a record, including auxiliary and all other types of channels. All recording methods are valid for multiplexed and demultiplexed records. The 2 1/2 byte binary demultiplexed method uses the LSB whereas the comparable multiplexed method does not (in order to preserve the uniqueness of the start of scan code).

1 byte quaternary exponent data recording method

The following illustrates the 8 bit word and the corresponding bit weights:

Bit	0	1	2	3	4	5	6	7
Byte 1	S	C ₂	C ₁	C ₀	Q ₋₁	Q ₋₂	Q ₋₃	Q ₋₄

S=sign bit. ---(One = negative number).

C=quaternary exponent.---This is a three bit positive binary exponent of 4 written as 4^{CCC} where CCC can assume values from 0-7.

Q₁₋₄-fraction.---This is a 4 bit one's complement binary fraction. The radix point is to the left of the most significant bit (Q₋₁) with the MSB being defined as 2^{-1} . The fraction can have values from $-1+2^{-4}$ to $1-2^{-4}$. In order to guarantee the uniqueness of the start of scan, negative zero is invalid and must be converted to positive zero.

Input signal = S.QQQQ x 4^{CCC} x 2^{MP} millivolts where 2^{MP} is the value required to descale the data sample to the recording system input level. MP is defined in Byte 8 of each channel set descriptor in the scan type header.

2 byte quaternary exponent data recording method

The following illustrates the 16-bit word and the corresponding bit weights:

Bit	0	1	2	3	4	5	6	7
Byte 1	S	C ₂	C ₁	C ₀	Q ₋₁	Q ₋₂	Q ₋₃	Q ₋₄
Byte 2	Q ₋₅	Q ₋₆	Q ₋₇	Q ₋₈	Q ₋₉	Q ₋₁₀	Q ₋₁₁	Q ₋₁₂

S=sign bit.---(One = negative number).

C=quaternary exponent.---This is a three bit positive binary exponent of 4 written as 4^{CCC} where CCC can assume values from 0-7.

Q₁₋₁₂ --fraction.---This is a 12 bit one's complement binary fraction. The radix point is to the left of the most significant bit (Q₋₁) with the MSB being defined as 2^{-1} . The fraction can have values from $-1 + 2^{-12}$ to $1 - 2^{-12}$. In order to guarantee the uniqueness of the start of scan, negative zero is invalid and must be converted to positive zero.

Input signal = S.QQQQ,QQQQ,QQQQ x 4^{ccc} x 2^{MP} millivolts where 2^{MP} is the value required to descale the data sample to the recording system input level. MP is defined in Byte 8 of each channel set descriptor in the scan type header.

2½ byte binary exponent data recording method---demultiplexed

The following illustrates the 20 bit word and the corresponding bit weights:

Bit	0	1	2	3	4	5	6	7	
Byte 1	C ₃	C ₂	C ₁	C ₀	C ₃	C ₂	C ₁	C ₀	Exponent for
Byte 2	C ₃	C ₂	C ₁	C ₀	C ₃	C ₂	C ₁	C ₀	samples 1 thru 4 ^b
Byte 3	S	Q ₋₁	Q ₋₂	Q ₋₃	Q ₋₄	Q ₋₅	Q ₋₆	Q ₋₇	Sample 1
Byte 4	Q ₋₈	Q ₋₉	Q ₋₁₀	Q ₋₁₁	Q ₋₁₂	Q ₋₁₃	Q ₋₁₄	Q ₋₁₅	
Byte 5	S	Q ₋₁	Q ₋₂	Q ₋₃	Q ₋₄	Q ₋₅	Q ₋₆	Q ₋₇	Sample 2
Byte 6	Q ₋₈	Q ₋₉	Q ₋₁₀	Q ₋₁₁	Q ₋₁₂	Q ₋₁₃	Q ₋₁₄	Q ₋₁₅	
Byte 7	S	Q ₋₁	Q ₋₂	Q ₋₃	Q ₋₄	Q ₋₅	Q ₋₆	Q ₋₇	Sample 3
Byte 8	Q ₋₈	Q ₋₉	Q ₋₁₀	Q ₋₁₁	Q ₋₁₂	Q ₋₁₃	Q ₋₁₄	Q ₋₁₅	
Byte 9	S	Q ₋₁	Q ₋₂	Q ₋₃	Q ₋₄	Q ₋₅	Q ₋₆	Q ₋₇	Sample 4
Byte 10	Q ₋₈	Q ₋₉	Q ₋₁₀	Q ₋₁₁	Q ₋₁₂	Q ₋₁₃	Q ₋₁₄	Q ₋₁₅	

^b In the demultiplexed format, Bytes 1 and 2 contain the exponents for the following four samples of the channel. The sample numbers are relative and are only to denote position in the four sample subset.

S=sign bit---(One = negative number).

*C=binary exponent---*This is a 4 bit positive binary exponent of 2 written as 2^{cccc} where CCCC can assume values of 0-15. The four exponents are in sample order for the four samples starting with the first sample in bits 0-3 of Byte 1.

*Q₁₋₁₅fraction---*This is a 15 bit one’s complement binary fraction. The radix point is to the left of the most significant bit (Q₋₁) with the MSB being defined as 2^{-1} . The sign and fraction can assume values from $1 - 2^{-15}$ to $-1 + 2^{-15}$. Negative zero is invalid and must be converted to positive zero.

Input signal=S.Q,QQQ,QQQQ,QQQQ,QQQ 2^{cccc} x 2^{MP} millivolts where 2^{MP} is the value required to descale the data word to the recording system input level. MP is defined in Byte 8 of each of the corresponding channel set descriptors in the scan type header.

Note that in utilizing this data recording method, the number of samples per channel must be exactly divisible by 4 in order to preserve the data grouping of this method.

1 byte hexadecimal exponent data - recording method

The following illustrates the 8-bit word and the corresponding bit weights:

Bit	0	1	2	3	4	5	6	7
Byte 1	S	C ₋₁	C ₋₀	Q ₋₁	Q ₋₂	Q ₋₃	Q ₋₄	Q ₋₅

S=sign bit---(One = negative number).

C=hexadecimal exponent.---This is a two positive binary exponent of 16 written as 16^{CC} where CC can assume values from 0-3.

Q₁₋₅-fraction.---This is a 5 bit positive binary fraction. The radix point is to the left of the most significant bit (Q₋₁) with the MSB being defined as 2^{-1} . The sign and fraction can have any value from $-1 + 2^{-5}$ to $1 - 2^{-5}$. In order to guarantee the uniqueness of the start of scan, an all one's representation (sign=negative, exponent=3, and fraction= $1-2^{-5}$) is invalid. Thus the full range of values allowed is $-(1 - 2^{-4}) \times 16^3$ to $+(1 - 2^{-5}) \times 16^3$.

Input signal=S.QQQQ,Q $\times 16^{CC} \times 2^{MP}$ millivolts where 2^{MP} is the value required to descale the data sample to the recording system input level. MP is defined in Byte 8 of each channel set descriptor in the scan type header.

2 byte hexadecimal exponent data - recording method

The following illustrates the 16-bit word and the corresponding bit weights:

Bit	0	1	2	3	4	5	6	7
Byte 1	S	C ₁	C ₀	Q ₋₁	Q ₋₂	Q ₋₃	Q ₋₄	Q ₋₅
Byte 2	Q ₋₆	Q ₋₇	Q ₋₈	Q ₋₉	Q ₋₁₀	Q ₋₁₁	Q ₋₁₂	Q ₋₁₃

S=sign bit.---(One = negative number).

C=hexadecimal exponent.---This is a two bit positive binary exponent of 16^{CC} where CC can assume values from 0-3.

Q₁₋₁₃-fraction.---This is a 13 bit positive binary fraction. The radix point is to the left of the most significant bit (Q₋₁) with the MSB being defined as 2^{-1} . The sign and fraction can have any value from $-1 + 2^{-13}$. In order to guarantee the uniqueness of the start of scan, an all one's representation (sign = negative, exponent = 3, and fraction = $1 - 2^{-13}$) is invalid. Thus the full range of values allowed is $-(1 - 2^{-12}) \times 16^3$ to $+(1 - 2^{-13}) \times 16^3$.

Input signal = S.QQQQ,QQQQ,QQQQ,Q $\times 16^{CC} \times 2^{MP}$ millivolts where 2^{MP} is the value required to descale the data sample to the recording system input level. MP is defined in Byte 8 of each channel set descriptor in the scan type header.

4 byte hexadecimal exponent data - recording method

The following illustrates the 32-bit word and the corresponding bit weights:

Bit	0	1	2	3	4	5	6	7
Byte 1	S	C ₆	C ₅	C ₄	C ₃	C ₂	C ₁	C ₀
Byte 2	Q ₋₁	Q ₋₂	Q ₋₃	Q ₋₄	Q ₋₅	Q ₋₆	Q ₋₇	Q ₋₈
Byte 3	Q ₋₉	Q ₋₁₀	Q ₋₁₁	Q ₋₁₂	Q ₋₁₃	Q ₋₁₄	Q ₋₁₅	Q ₋₁₆
Byte 4	Q ₋₁₇	Q ₋₁₈	Q ₋₁₉	Q ₋₂₀	Q ₋₂₁	Q ₋₂₂	Q ₋₂₃	0

S=sign bit.---(One = negative number).

C=excess 64 hexadecimal exponent.---This is a binary exponent of 16. It has been biased by 64 such that it represents $16^{(CCCCC-64)}$ where CCCCCC can assume values from 0 to 127.

Q₁₋₂₃-magnitude fraction.---This is a 23 bit positive binary fraction (i.e., the number system is sign and magnitude). The radix point is to the left of the most significant bit (Q₋₁) with the MSB being defined as 2^{-1} . The sign and fraction can assume values from $(1 - 2^{-23})$ to $-1 + 2^{-23}$. It must always be written as a hexadecimal left justified number. If this fraction is zero, the sign and exponent must also be zero (i.e., the entire word is zero. Note that bit 7 of Byte 4 must be zero in order to guarantee the uniqueness of the start of scan.

Input signal = S.QQQQ,QQQQ,QQQQ,QQQQ,QQQQ,QQQ x 16^(ccccccc-64) x 2^{MP} millivolts where 2^{MP} is the value required to descale the data sample to the recording system input level. MP is defined in Byte 8 of each channel set descriptor in the scan type header. This data recording method has more than sufficient range to handle the dynamic range of a typical seismic system. Thus, MP may not be needed to account for any scaling and may be recorded as zero.

4 byte IEEE Floating Point Data - Recording Method

The IEEE format is fully documented in the IEEE standard, "ANSI/IEEE Std 754 - 1985", available from the IEEE.

The IEEE format is summarized as follows:

Bit	0	1	2	3	4	5	6	7
Byte 1	S	C ₇	C ₆	C ₅	C ₄	C ₃	C ₂	C ₁
Byte 2	C ₀	Q ₋₁	Q ₋₂	Q ₋₃	Q ₋₄	Q ₋₅	Q ₋₆	Q ₋₇
Byte 3	Q ₋₈	Q ₋₉	Q ₋₁₀	Q ₋₁₁	Q ₋₁₂	Q ₋₁₃	Q ₋₁₄	Q ₋₁₅
Byte 4	Q ₋₁₆	Q ₋₁₇	Q ₋₁₈	Q ₋₁₉	Q ₋₂₀	Q ₋₂₁	Q ₋₂₂	Q ₋₂₃ (see Note 1)

The value (v) of a floating-point number represented in this format is determined as follows:

if e = 255 & f = 0. .v = NaN	Not-a-Number (see Note 2)
if e = 255 & f ≠ 0. .v = (-1) ^s * ∞	Overflow
if 0 < e < 255. . . .v = (-1) ^s * 2 ^{e-127} * (1.f)	Normalized
if e = 0 & f ≠ 0. . . .v = (-1) ^s * 2 ^{e-126} * (0.f)	Denormalized
if e = 0 & f = 0. . . .v = (-1) ^s * 0	± zero

where e = binary value of all C's (exponent)
 f = binary value of all Q's (fraction)

- NOTES: 1. Bit 7 of byte 4 must be zero to guarantee uniqueness of the start of scan in the Multiplexed format (0058). It may be non zero in the demultiplexed format (8058).
2. A Not-a-Number (NaN) is interpreted as an invalid number. All other numbers are valid and interpreted as described above.

Integer formats:

24 bit format:

Table 2: 24 bit integer format

Bit	0	1	2	3	4	5	6	7
Byte 1	S	I	I	I	I	I	I	I
		2	2	2	1	1	1	1
		2	1	0	9	8	7	6
Byte 2	I	I	I	I	I	I	I	I
	1	1	1	1	1	1	9	8

	5	4	3	2	1	0		
Byte 3	I	I	I	I	I	I	I	I
	7	6	5	4	3	2	1	0

Input signal = S III, III, III, III, III, III x 2^{MP} millivolts.

32 bit format:

Table 3: 32 bit integer format

Bit	0	1	2	3	4	5	6	7
Byte 1	S	I	I	I	I	I	I	I
		3	2	2	2	2	2	2
		0	9	8	7	6	5	4
Byte 2	I	I	I	I	I	I	I	I
	2	2	2	2	1	1	1	1
	2	2	1	0	9	8	7	6
Byte 3	I	I	I	I	I	I	I	I
	1	1	1	1	1	1	9	8
	5	4	3	2	1	0		
Byte 4	I	I	I	I	I	I	I	I
	7	6	5	4	3	2	1	0

6.2 MP Factor calculation

The MP parameter is provided to allow the dimensionless numbers recorded on tape to be “descaled” back to the instantaneous sample values in millivolts at the system inputs. MP is encoded in Byte 8 of each channel set descriptor in the scan type header. It is a sign and magnitude binary exponent. It can have any value between -31.75 and +31.75 in increments of .25. Beginning with SEG-D, Rev 1, the MP parameter is expanded to a two byte value between -31.9990234375 and + 31.9990234375 in increments of .0009765625.

In general, recording systems scale the input signal level in order to match the useful range of input levels to the gain-ranging amplifier. MP must account for all scaling (unless, as in the 4 byte hexadecimal case, the data recording method has sufficient range).

The calculation of MP for a data recording method is given by one of the following equations:

For floating point data:

- | | |
|--------------------------------|--|
| 1. MP = FS - PA - Cmax | For binary exponents. |
| 2. MP = FS - PA - 2 * Cmax | For quaternary exponents. |
| 3. MP = FS - PA - 4 * Cmax | For hexadecimal exponents (except for the four byte excess 64 method). |
| 4. MP = FS - PA - 4* (Cmax-64) | For excess 64 hexadecimal exponents and for four byte IEEE exponents. |

Where:

${}_2\text{FS}$ = Converter full scale (millivolts),

2^{PA} = Minimum system gain,

C_{max} = maximum value of the data exponent;

C_{max} =

15 for binary exponents

7 quaternary exponents,

3 for hexadecimal exponents, except excess 64,

64 for excess 64 exponents and for 4 byte IEEE exponents, and the output

of the analog-to-digital converter is written as the fractional portion of the data value.

For integer data:

1. $MP = FS - PA - IS$;

Where:

2^{FS} = Converter full scale (millivolts),

2^{PA} = Minimum system gain,

2^{IS-1} = Integer number system positive full scale, and

the output of the analog-to-digital converter is written as an integer.

Input signal = $S \cdot 2^{IS-1} \cdot 2^{PA}$ millivolts.

The term “minimum system gain” includes preamplifier gain and the minimum floating point amplifier gain. For example, one system may use a preamplifier gain of 256 and a minimum floating point amplifier gain of one. The minimum system gain is $256 \times 1 = 2^8$, so $PA = 8$. Another system may use a preamplifier gain of 320 and a minimum floating point amplifier gain of 0.8. In this case, the minimum system gain is $320 \times 0.8 = 256$ or 2^8 . Again $PA = 8$.

PA may also account for any amplification needed to accommodate an analog to digital converter with a full scale value that is not a power of 2 in millivolts. For example, a 10 V (10,000 mV) converter may be preceded by an amplifier with a gain of 1.221 (10,000/8,192). This gain may be accounted for in PA . Alternatively, it could be considered part of the converter, making it appear to have a binary full scale.

Justifications for the Equations

The output of the analog-to-digital converter is written as the fractional portion of the data value. This is equivalent to dividing the value by the full scale of the converter. In order to compensate for this, the data value recorded on tape must be multiplied by the full scale value of the converter (2^{FS}). Thus FS appears in equations (1)-(4) with a positive sign.

The input signal was multiplied by the minimum system gain (2^{PA}) which, as mentioned, includes any preamplification gain, minimum floating point amplifier gain, or analog-to-digital converter adjustment gain. The data recorded on tape must be divided by this minimum system gain; thus, PA appears in the equations with a negative sign.

Large input signals converted at minimum floating point amplifier gain are written on tape with the maximum exponent for the data recording method used. Likewise, small signals converted at full gain are written with the maximum exponent. The data as written have been multiplied by the exponent base raised to C_{max} (or $C_{max} - 64$ in the excess 64 case). Thus C_{max} appears in the equations with a negative sign. MP is a power of 2 so the quaternary and hexadecimal C_{max} values are multiplied by 2 and 4, respectively ($4^c = 2^{2c}$ and $16^c = 2^{4c}$).

7.0 Header Tables

7.1 GENERAL HEADER #1

Bit No.	0	1	2	3	4	5	6	7	
BCD Value MSD	8	4	2	1	8	4	2	1	LSD
Binary Value MSB	128	64	32	16	8	4	2	1	LSB
File Number	F ₁	F ₁	F ₁	F ₁	F ₂	F ₂	F ₂	F ₂	1
	F ₃	F ₃	F ₃	F ₃	F ₄	F ₄	F ₄	F ₄	2
Format Code	Y ₁	Y ₁	Y ₁	Y ₁	Y ₂	Y ₂	Y ₂	Y ₂	3
	Y ₃	Y ₃	Y ₃	Y ₃	Y ₄	Y ₄	Y ₄	Y ₄	4
General Constants	K ₁	K ₁	K ₁	K ₁	K ₂	K ₂	K ₂	K ₂	5
	K ₃	K ₃	K ₃	K ₃	K ₄	K ₄	K ₄	K ₄	6
	K ₅	K ₅	K ₅	K ₅	K ₆	K ₆	K ₆	K ₆	7
	K ₇	K ₇	K ₇	K ₇	K ₈	K ₈	K ₈	K ₈	8
	K ₉	K ₉	K ₉	K ₉	K ₁₀	K ₁₀	K ₁₀	K ₁₀	9
	K ₁₁	K ₁₁	K ₁₁	K ₁₁	K ₁₂	K ₁₂	K ₁₂	K ₁₂	10
Year	YR ₁	YR ₁	YR ₁	YR ₁	YR ₂	YR ₂	YR ₂	YR ₂	11
# Additional Blks in Gen Hdr	GH ₃	GH ₂	GH ₁	GH ₀	DY ₁	DY ₁	DY ₁	DY ₁	12
Day (DY)	DY ₂	DY ₂	DY ₂	DY ₂	DY ₃	DY ₃	DY ₃	DY ₃	13
Hour	H ₁	H ₁	H ₁	H ₁	H ₂	H ₂	H ₂	H ₂	14
Minute	MI ₁	MI ₁	MI ₁	MI ₁	MI ₂	MI ₂	MI ₂	MI ₂	15
Second	SE ₁	SE ₁	SE ₁	SE ₁	SE ₂	SE ₂	SE ₂	SE ₂	16
Manufacture's Code	M ₁	M ₁	M ₁	M ₁	M ₂	M ₂	M ₂	M ₂	17
	M ₃	M ₃	M ₃	M ₃	M ₄	M ₄	M ₄	M ₄	18
	M ₅	M ₅	M ₅	M ₅	M ₆	M ₆	M ₆	M ₆	19
	O	O	O	O	O	O	O	O	20
	O	O	O	O	O	O	O	O	21
	O	O	O	O	O	O	O	O	22
Base Scan Interval	I ₃	I ₂	I ₁	I ₀	L ₁	L ₂	L ₃	L ₄	23
Polarity (P)	P	P	P	P	O	O	O	O	24
	O	O	O	O	O	O	O	O	25
Record Type (Z)	Z	Z	Z	Z	R ₁	R ₁	R ₁	R ₁	26
Record Length (R)	R ₂	R ₂	R ₂	R ₂	R ₃	R ₃	R ₃	R ₃	27
Scan Types/Record	ST/R ₁	ST/R ₁	ST/R ₁	ST/R ₁	ST/R ₂	ST/R ₂	ST/R ₂	ST/R ₂	28
Chan Sets/Scan Type	CS ₁	CS ₁	CS ₁	CS ₁	CS ₂	CS ₂	CS ₂	CS ₂	29
Skew Blocks	SK ₁	SK ₁	SK ₁	SK ₁	SK ₂	SK ₂	SK ₂	SK ₂	30
Extended Header Blk	EC ₁	EC ₁	EC ₁	EC ₁	EC ₂	EC ₂	EC ₂	EC ₂	31
External Header Blk	EX ₁	EX ₁	EX ₁	EX ₁	EX ₂	EX ₂	EX ₂	EX ₂	32

7.2 GENERAL HEADER, BLOCK #2

Bit No.	0	1	2	3	4	5	6	7	
BCD Value MSD	8	4	2	1	8	4	2	1	LSD
Binary Value MSB	128	64	32	16	8	4	2	1	LSB
Expanded File Number	EF ₂₃	EF ₂₂	EF ₂₁	EF ₂₀	EF ₁₉	EF ₁₈	EF ₁₇	EF ₁₆	1
	EF ₁₅	EF ₁₄	EF ₁₃	EF ₁₂	EF ₁₁	EF ₁₀	EF ₉	EF ₈	2
	EF ₇	EF ₆	EF ₅	EF ₄	EF ₃	EF ₂	EF ₁	EF ₀	3
Extended Channel Sets/ Scan Type	EN ₁₅	EN ₁₄	EN ₁₃	EN ₁₂	EN ₁₁	EN ₁₀	EN ₉	EN ₈	4
	EN ₇	EN ₆	EN ₅	EN ₄	EN ₃	EN ₂	EN ₁	EN ₀	5
Extended Header Blks	ECX ₁₅	ECX ₁₄	ECX ₁₃	ECX ₁₂	ECX ₁₁	ECX ₁₀	ECX ₉	ECX ₈	6
	ECX ₇	ECX ₆	ECX ₅	ECX ₄	ECX ₃	ECX ₂	ECX ₁	ECX ₀	7
External Header Blks	EH ₁₅	EH ₁₄	EH ₁₃	EH ₁₂	EH ₁₁	EH ₁₀	EH ₉	EH ₈	8
	EH ₇	EH ₆	EH ₅	EH ₄	EH ₃	EH ₂	EH ₁	EH ₀	9
	X	X	X	X	X	X	X	X	10
SEG-D Revision No. “major” and “minor”	RMJ ₇	RMJ ₆	RMJ ₅	RMJ ₄	RMJ ₃	RMJ ₂	RMJ ₁	RMJ ₀	11
	RMN ₇	RMN ₆	RMN ₅	RMN ₄	RMN ₃	RMN ₂	RMN ₁	RMN ₀	12
General Trailer, Number of Blks	GT ₁₅	GT ₁₄	GT ₁₃	GT ₁₂	GT ₁₁	GT ₁₀	GT ₉	GT ₈	13
	GT ₇	GT ₆	GT ₅	GT ₄	GT ₃	GT ₂	GT ₁	GT ₀	14
Extended Record Length	ERL ₂₃	ERL ₂₂	ERL ₂₁	ERL ₂₀	ERL ₁₉	ERL ₁₈	ERL ₁₇	ERL ₁₆	15
	ERL ₁₅	ERL ₁₄	ERL ₁₃	ERL ₁₂	ERL ₁₁	ERL ₁₀	ERL ₉	ERL ₈	16
	ERL ₇	ERL ₆	ERL ₅	ERL ₄	ERL ₃	ERL ₂	ERL ₁	ERL ₀	17
	X	X	X	X	X	X	X	X	18
Gen Header Blk #	0	0	0	0	0	0	1	0	19
	X	X	X	X	X	X	X	X	20
Sequence number	SN ₁₅	SN ₁₄	SN ₁₃	SN ₁₂	SN ₁₁	SN ₁₀	SN ₉	SN ₈	21
	SN ₇	SN ₆	SN ₅	SN ₄	SN ₃	SN ₂	SN ₁	SN ₀	22
	X	X	X	X	X	X	X	X	23
	X	X	X	X	X	X	X	X	24
	X	X	X	X	X	X	X	X	25
	X	X	X	X	X	X	X	X	26
	X	X	X	X	X	X	X	X	27
	X	X	X	X	X	X	X	X	28
	X	X	X	X	X	X	X	X	29
	X	X	X	X	X	X	X	X	30
	X	X	X	X	X	X	X	X	31
	X	X	X	X	X	X	X	X	32

7.3 GENERAL HEADER, BLOCK N

Bit No.	0	1	2	3	4	5	6	7	
BCD Value MSD	8	4	2	1	8	4	2	1	LSD
Binary Value MSB	128	64	32	16	8	4	2	1	LSB
Expanded File No.	EF ₂₃	EF ₂₂	EF ₂₁	EF ₂₀	EF ₁₉	EF ₁₈	EF ₁₇	EF ₁₆	1
	EF ₁₅	EF ₁₄	EF ₁₃	EF ₁₂	EF ₁₁	EF ₁₀	EF ₉	EF ₈	2
	EF ₇	EF ₆	EF ₅	EF ₄	EF ₃	EF ₂	EF ₁	EF ₀	3
Source Line No. (INTEGER)	SLN _s	SLN ₂₂	SLN ₂₁	SLN ₂₀	SLN ₁₉	SLN ₁₈	SLN ₁₇	SLN ₁₆	4
	SLN ₁₅	SLN ₁₄	SLN ₁₃	SLN ₁₂	SLN ₁₁	SLN ₁₀	SLN ₉	SLN ₈	5
	SLN ₇	SLN ₆	SLN ₅	SLN ₄	SLN ₃	SLN ₂	SLN ₁	SLN ₀	6
Source Line No. (FRACTION)	SLN ₋₁	SLN ₋₂	SLN ₋₃	SLN ₋₄	SLN ₋₅	SLN ₋₆	SLN ₋₇	SLN ₋₈	7
	SLN ₋₉	SLN ₋₁₀	SLN ₋₁₁	SLN ₋₁₂	SLN ₋₁₃	SLN ₋₁₄	SLN ₋₁₅	SLN ₋₁₆	8
Source Point No. (INTEGER)	SPN _s	SPN ₂₂	SPN ₂₁	SPN ₂₀	SPN ₁₉	SPN ₁₈	SPN ₁₇	SPN ₁₆	9
	SPN ₁₅	SPN ₁₄	SPN ₁₃	SPN ₁₂	SPN ₁₁	SPN ₁₀	SPN ₉	SPN ₈	10
	SPN ₇	SPN ₆	SPN ₅	SPN ₄	SPN ₃	SPN ₂	SPN ₁	SPN ₀	11
Source Point No. (FRACTION)	SPN ₋₁	SPN ₋₂	SPN ₋₃	SPN ₋₄	SPN ₋₅	SPN ₋₆	SPN ₋₇	SPN ₋₈	12
	SPN ₋₉	SPN ₋₁₀	SPN ₋₁₁	SPN ₋₁₂	SPN ₋₁₃	SPN ₋₁₄	SPN ₋₁₅	SPN ₋₁₆	13
Source Point Index	SPI ₇	SPI ₆	SPI ₅	SPI ₄	SPI ₃	SPI ₂	SPI ₁	SPI ₀	14
Phase Control	PC ₇	PC ₆	PC ₅	PC ₄	PC ₃	PC ₂	PC ₁	PC ₀	15
Type Vibrator	V ₇	V ₆	V ₅	V ₄	V ₃	V ₂	V ₁	V ₀	16
Phase Angle	PA _s	PA ₁₄	PA ₁₃	PA ₁₂	PA ₁₁	PA ₁₀	PA ₉	PA ₈	17
	PA ₇	PA ₆	PA ₅	PA ₄	PA ₃	PA ₂	PA ₁	PA ₀	18
Gen.Header Blk #	BN ₇	BN ₆	BN ₅	BN ₄	BN ₃	BN ₂	BN ₁	BN ₀	19
Source Set No.	SS ₇	SS ₆	SS ₅	SS ₄	SS ₃	SS ₂	SS ₁	SS ₀	20
	X	X	X	X	X	X	X	X	21
	X	X	X	X	X	X	X	X	22
	X	X	X	X	X	X	X	X	23
	X	X	X	X	X	X	X	X	24
	X	X	X	X	X	X	X	X	25
	X	X	X	X	X	X	X	X	26
	X	X	X	X	X	X	X	X	27
	X	X	X	X	X	X	X	X	28
	X	X	X	X	X	X	X	X	29
	X	X	X	X	X	X	X	X	30
	X	X	X	X	X	X	X	X	31
	X	X	X	X	X	X	X	X	32

7.4 SCAN TYPE HEADER (Channel Set Descriptor)

Bit No.	0	1	2	3	4	5	6	7	
BCD Value MSD	8	4	2	1	8	4	2	1	
Binary Value MSB	128	64	32	16	8	4	2	1	
Scan Type No.	ST ₁	ST ₁	ST ₁	ST ₁	ST ₂	ST ₂	ST ₂	ST ₂	1
Channel Set No.	CN ₁	CN ₁	CN ₁	CN ₁	CN ₂	CN ₂	CN ₂	CN ₂	2
Channel Set Start Time	TF ₁₆	TF ₁₅	TE ₁₄	TF ₁₃	TF ₁₂	TF ₁₁	TF ₁₀	TF ₉	3
	TF ₈	TF ₇	TF ₆	TF ₅	ETF ₄	TF ₃	TF ₂	TF ₁	4
Channel Set End Time	TE ₁₆	TE ₁₅	TE ₁₄	TE ₁₃	TE ₁₂	TE ₁₁	TE ₁₀	TE ₉	5
	TE ₈	TE ₇	TE ₁₃	TE ₁₂	TE ₁₁	TE ₁₀	TE ₉	TE ₈	6
Descaler Multiplier	MP ₋₃	MP ₋₄	MP ₋₅	MP ₋₆	MP ₋₇	MP ₋₈	MP ₋₉	MP ₋₁₀	7
	MP ₅	MP ₄	MP ₃	MP ₂	MP ₁	MP ₀	MP ₋₁	MP ₋₂	8
No. of Channels	C/S ₁	C/S ₁	C/S ₁	C/S ₁	C/S ₂	C/S ₂	C/S ₂	C/S ₂	9
	C/S ₃	C/S ₃	C/S ₃	C/S ₃	C/S ₄	C/S ₄	C/S ₄	C/S ₄	10
Channel Type	C ₁	C ₁	C ₁	C ₁	0	0	0	0	11
Sample/Channel - Channel Gain	S/C	S/C	S/C	S/C	J	J	J	J	12
Alias Filter Frequency	AF ₁	AF ₁	AF ₁	AF ₁	AF ₂	AF ₂	AF ₂	AF ₂	13
	AF ₃	AF ₃	AF ₃	AF ₃	AF ₄	AF ₄	AF ₄	AF ₄	14
Alias Filter Slope	0	0	0	0	AS ₁	AS ₁	AS ₁	AS ₁	15
	AS ₂	AS ₂	AS ₂	AS ₂	AS ₃	AS ₃	AS ₃	AS ₃	16
Low Cut Filter	LC ₁	LC ₁	LC ₁	LC ₁	LC ₂	LC ₂	LC ₂	LC ₂	17
	LC ₃	LC ₃	LC ₃	LC ₃	LC ₄	LC ₄	LC ₄	LC ₄	18
Low Cut Filter Slope	0	0	0	0	LS ₁	LS ₁	LS ₁	LS ₁	19
	LS ₂	LS ₂	LS ₂	LS	LS ₃	LS ₃	LS ₃	LS ₃	20
First Notch Filter	NT ₁	NT ₁	NT ₁	NT ₁	NT ₂	NT ₂	NT ₂	NT ₂	21
	NT ₃	NT ₃	NT ₃	NT ₃	NT ₄	NT ₄	NT ₄	NT ₄	22
Second Notch Filter	NT ₁	NT ₁	NT ₁	NT ₁	NT ₂	NT ₂	NT ₂	NT ₂	23
	NT ₃	NT ₃	NT ₃	NT ₃	NT ₄	NT ₄	NT ₄	NT ₄	24
Third Notch Filter	NT ₁	NT ₁	NT ₁	NT ₁	NT ₂	NT ₂	NT ₂	NT ₂	25
	NT ₃	NT ₃	NT ₃	NT ₃	NT ₄	NT ₄	NT	NT ₄	26
Extended Channel Set No.	ECS ₁₅	ECS ₁₄	ECS ₁₃	ECS ₁₂	ECS ₁₁	ECS ₁₀	ECS ₉	ECS ₈	27
	ECS ₇	ECS ₆	ECS ₅	ECS ₄	ECS ₃	ECS ₂	ECS ₁	ECS ₀	28
Extended Header Flag/Trace Header Extension	EFH ₃	EFH ₂	EFH ₁	EFH ₀	THE ₃	THE ₂	THE ₁	THE ₀	29
Vertical Stack	VS ₇	VS ₆	VS ₅	VS ₄	VS ₃	VS ₂	VS ₁	VS ₀	30
Streamer No.	CAB ₇	CAB ₆	CAB ₅	CAB ₄	CAB ₃	CAB ₂	CAB ₁	CAB ₀	31
Array Forming	ARY ₇	ARY ₆	ARY ₅	ARY ₄	ARY ₃	ARY ₂	ARY ₁	ARY ₀	32

7.5 DEMUX TRACE HEADER

Bit No.	0	1	2	3	4	5	6	7	
File Number	F ₁	F ₁	F ₁	F ₁	F ₂	F ₂	F ₂	F ₂	1
	F ₃	F ₃	F ₃	F ₃	F ₄	F ₄	F ₄	F ₄	2
Scan Type Number	ST ₁	ST ₁	ST ₁	ST ₁	ST ₂	ST ₂	ST ₂	ST ₂	3
Channel Set Number	CN ₁	CN ₁	CN ₁	CN ₁	CN ₂	CN ₂	CN ₂	CN ₂	4
Trace Number	TN ₁	TN ₁	TN ₁	TN ₁	TN ₂	TN ₂	TN ₂	TN ₂	5
	TN ₃	TN ₃	TN ₃	TN ₃	TN ₄	TN ₄	TN ₄	TN ₄	6
First Timing Word	T ₁₅	T ₁₄	T ₁₃	T ₁₂	T ₁₁	T ₁₀	T ₉	T ₈	7
	T ₇	T ₆	T ₅	T ₄	T ₃	T ₂	T ₁	T ₀	8
	T ₋₁	T ₋₂	T ₋₃	T ₋₄	T ₋₅	T ₋₆	T ₋₇	T ₋₈	9
Trace Header Extension	THE ₇	THE ₆	THE ₅	THE ₄	THE ₃	THE ₂	THE ₁	THE ₀	10
Sample Skew	SSK ₋₁	SSK ₋₂	SSK ₋₃	SSK ₋₄	SSK ₋₅	SSK ₋₆	SSK ₋₇	SSK ₋₈	11
Trace Edit	TR ₇	TR ₆	TR ₅	TR ₄	TR ₃	TR ₂	TR ₁	TR ₀	12
Time Break Window	TW ₁₅	TW ₁₄	TW ₁₃	TW ₁₂	TW ₁₁	TW ₁₀	TW ₉	TW ₈	13
	TW ₇	TW ₆	TW ₅	TW ₄	TW ₃	TW ₂	TW ₁	TW ₀	14
	TW ₋₁	TW ₋₂	TW ₋₃	TW ₋₄	TW ₋₅	TW ₋₆	TW ₋₇	TW ₋₈	15
Extended Channel Set Number	EN ₁₅	EN ₁₄	EN ₁₃	EN ₁₂	EN ₁₁	EN ₁₀	EN ₉	EN ₈	16
	EN ₇	EN ₆	EN ₅	EN ₄	EN ₃	EN ₂	EN ₁	EN ₀	17
Extended File Number	EFN ₂₃	EFN ₂₂	EFN ₂₁	EFN ₂₀	EFN ₁₉	EFN ₁₈	EFN ₁₇	EFN ₁₆	18
	EFN ₁₅	EFN ₁₄	EFN ₁₃	EFN ₁₂	EFN ₁₁	EFN ₁₀	EFN ₉	EFN ₈	19
	EFN ₇	EFN ₆	EFN ₅	EFN ₄	EFN ₃	EFN ₂	EFN ₁	EFN ₀	20

7.6 TRACE HEADER EXTENSION

Bit No.	0	1	2	3	4	5	6	7	
Receiver Line Number	RLN _s	RLN ₂₂	RLN ₂₁	RLN ₂₀	RLN ₁₉	RLN ₁₈	RLN ₁₇	RLN ₁₆	1
	RLN ₁₅	RLN ₁₄	RLN ₁₃	RLN ₁₂	RLN ₁₁	RLN ₁₀	RLN ₉	RLN ₈	2
	RLN ₇	RLN ₆	RLN ₅	RLN ₄	RLN ₃	RLN ₂	RLN ₁	RLN ₀	3
Receiver Point Number	RPN _s	RPN ₂₂	RPN ₂₁	RPN ₂₀	RPN ₁₉	RPN ₁₈	RPN ₁₇	RPN ₁₆	4
	RPN ₁₅	RPN ₁₄	RPN ₁₃	RPN ₁₂	RPN ₁₁	RPN ₁₀	RPN ₉	RPN ₈	5
	RPN ₇	RPN ₆	RPN ₅	RPN ₄	RPN ₃	RPN ₂	RPN ₁	RPN ₀	6
Receiver Point Index	RPI _s	RPI ₆	RPI ₅	RPI ₄	RPI ₃	RPI ₂	RPI ₁	RPI ₀	7
# of Samples per Trace	NBS ₂₃	NBS ₂₂	NBS ₂₁	NBS ₂₀	NBS ₁₉	NBS ₁₈	NBS ₁₇	NBS ₁₆	8
	NBS ₁₅	NBS ₁₄	NBS ₁₃	NBS ₁₂	NBS ₁₁	NBS ₁₀	NBS ₉	NBS ₈	9
	NBS ₇	NBS ₆	NBS ₅	NBS ₄	NBS ₃	NBS ₂	NBS ₁	NBS ₀	10
Extended Receiver Line Number	ERLN _s	ERLN ₂₂	ERLN ₂₁	ERLN ₂₀	ERLN ₁₉	ERLN ₁₈	ERLN ₁₇	ERLN ₁₆	11
	ERLN ₁₅	ERLN ₁₄	ERLN ₁₃	ERLN ₁₂	ERLN ₁₁	ERLN ₁₀	ERLN ₉	ERLN ₈	12
	ERLN ₇	ERLN ₆	ERLN ₅	ERLN ₄	ERLN ₃	ERLN ₂	ERLN ₁	ERLN ₀	13
	ERLN ₋₁	ERLN ₋₂	ERLN ₋₃	ERLN ₋₄	ERLN ₋₅	ERLN ₋₆	ERLN ₋₇	ERLN ₋₈	14
	ERLN ₋₉	ERLN ₋₁₀	ERLN ₋₁₁	ERLN ₋₁₂	ERLN ₋₁₃	ERLN ₋₁₄	ERLN ₋₁₅	ERLN ₋₁₆	15
Extended Receiver Point #	ERPNS	ERPNS ₂₂	ERPNS ₂₁	ERPNS ₂₀	ERPNS ₁₉	ERPNS ₁₈	ERPNS ₁₇	ERPNS ₁₆	16
	ERPNS ₁₅	ERPNS ₁₄	ERPNS ₁₃	ERPNS ₁₂	ERPNS ₁₁	ERPNS ₁₀	ERPNS ₉	ERPNS ₈	17
	ERPNS ₇	ERPNS ₆	ERPNS ₅	ERPNS ₄	ERPNS ₃	ERPNS ₂	ERPNS ₁	ERPNS ₀	18
	ERPNS ₋₁	ERPNS ₋₂	ERPNS ₋₃	ERPNS ₋₄	ERPNS ₋₅	ERPNS ₋₆	ERPNS ₋₇	ERPNS ₋₈	19
	ERPNS ₋₉	ERPNS ₋₁₀	ERPNS ₋₁₁	ERPNS ₋₁₂	ERPNS ₋₁₃	ERPNS ₋₁₄	ERPNS ₋₁₅	ERPNS ₋₁₆	20
Sensor Type	SEN ₇	SEN ₆	SEN ₅	SEN ₄	SEN ₃	SEN ₂	SEN ₁	SEN ₀	21
	X	X	X	X	X	X	X	X	22
	X	X	X	X	X	X	X	X	23
	X	X	X	X	X	X	X	X	24
	X	X	X	X	X	X	X	X	25
	X	X	X	X	X	X	X	X	26
	X	X	X	X	X	X	X	X	27
	X	X	X	X	X	X	X	X	28
	X	X	X	X	X	X	X	X	29
	X	X	X	X	X	X	X	X	30
	X	X	X	X	X	X	X	X	31
	X	X	X	X	X	X	X	X	32

X = This field undefined by the format and may have any value.

7.7 GENERAL TRAILER

Bit No.	0	1	2	3	4	5	6	7	
BCD Value MSD	8	4	2	1	8	4	2	1	LSD
Binary Value MSB	128	64	32	16	8	4	2	1	LSB
General Trailer Number	GT ₁₅	GT ₁₄	GT ₁₃	GT ₁₂	GT ₁₁	GT ₁₀	GT ₉	GT ₈	1
	GT ₇	GT ₆	GT ₅	GT ₄	GT ₃	GT ₂	GT ₁	GT ₀	2
	X	X	X	X	X	X	X	X	3
	X	X	X	X	X	X	X	X	4
	X	X	X	X	X	X	X	X	5
	X	X	X	X	X	X	X	X	6
	X	X	X	X	X	X	X	X	7
	X	X	X	X	X	X	X	X	8
	X	X	X	X	X	X	X	X	9
	X	X	X	X	X	X	X	X	10
Channel Type	C ₃	C ₂	C ₁	C ₀	X	X	X	X	11
	X	X	X	X	X	X	X	X	12
	X	X	X	X	X	X	X	X	13
	X	X	X	X	X	X	X	X	14
	X	X	X	X	X	X	X	X	15
	X	X	X	X	X	X	X	X	16
	X	X	X	X	X	X	X	X	17
	X	X	X	X	X	X	X	X	18
	X	X	X	X	X	X	X	X	19
	X	X	X	X	X	X	X	X	20
	X	X	X	X	X	X	X	X	21
	X	X	X	X	X	X	X	X	22
	X	X	X	X	X	X	X	X	23
	X	X	X	X	X	X	X	X	24
	X	X	X	X	X	X	X	X	25
	X	X	X	X	X	X	X	X	26
	X	X	X	X	X	X	X	X	27
	X	X	X	X	X	X	X	X	28
	X	X	X	X	X	X	X	X	29
	X	X	X	X	X	X	X	X	30
	X	X	X	X	X	X	X	X	31
	X	X	X	X	X	X	X	X	32

8.0 HEADER BLOCK PARAMETERS

8.1 GENERAL HEADER, BLOCK #1

All values are in packed BCD unless otherwise specified.

INDEX BYTE	ABBREVIATION	DESCRIPTION	
1	F ₁ , F ₂	File number of four digits (0 - 9999), set to FFFF when the file number is greater than 9999. The expanded file number is contained in Bytes 1, 2, & 3 of General Header, Block #2.	
2	F ₃ , F ₄		
3	Y ₁ , Y ₂	Format code: 8015 20 bit binary demultiplexed 8022 8 bit quaternary demultiplexed 8024 16 bit quaternary demultiplexed 8036 24 bit 2's compliment integer demultiplexed 8038 32 bit 2's compliment integer demultiplexed 8042 8 bit hexadecimal demultiplexed 8044 16 bit hexadecimal demultiplexed 8048 32 bit hexadecimal demultiplexed 8058 32 bit IEEE demultiplexed 0200 Illegal, do not use 0000 Illegal, do not use	
4	Y ₃ , Y ₄		
5	K ₁ , K ₂		General constants, 12 digits
6	K ₃ , K ₄		
7	K ₅ , K ₆		
8	K ₇ , K ₈		
9	K ₉ , K ₁₀		
10	K ₁₁ , K ₁₂		
11	YR ₁ , YR ₂		Last two digits of year (0-99)
12	GH		Number of <u>additional</u> Blocks in General Header (unsigned binary). This number will be 1 or greater for SEG-D Rev 1., or Rev. 2 (e.g. If only GH Blk #1 and GH Blk #2 are present then GH = 1. For each additional block, the value is increased by one.)
13	DY ₁ , DY ₂ , DY ₃	Julian day 3 digits (1-366)	
14	H ₁ , H ₂	Hour of day 2 digits (0-23) (UTC Time)	
15	MI ₁ , MI ₂	Minute of hour 2 digits (0-59)	
16	SE ₁ , SE ₂	Second of minute 2 digits (0-59)	
17	M ₁ , M ₂	Manufacturer's code 2 digits Note: See Appendix A for the current assignments	
18	M ₃ , M ₄	Manufacturer's serial number, 4 digits	
19	M ₅ , M ₆		

20	0	Not used. Record as zero																																				
21	0	Not used. Record as zero																																				
22	0	Not used. Record as zero																																				
23	I ₃ thru I ₄	Base scan interval. --This is coded as a binary number with the LSB equal to 1/16 msec. This will allow sampling intervals from 1/16 through 8 msec in binary steps. Thus, the allowable base scan intervals are 1/16, 1/8, 1/4, 1/2, 1, 2, 4, and 8 msec. The base scan interval is always the difference between successive timing words. Each channel used will be sampled one or more times per base scan interval.																																				
24	P	Polarity. --These 4 binary bits are measured on the sensors, cables, instrument, and source combination and are set into the system manually. The codes are: 0000 Untested 0001 Zero 0010 45 degrees 0011 90 degrees 0100 135 degrees 0101 180 degrees 0110 225 degrees 0111 270 degrees 1000 315 degrees 1100 unassigned																																				
24	X	Not used																																				
25	X	Not used																																				
26	Z,	Record type <table border="0"> <thead> <tr> <th>Bits</th> <th>0</th> <th>1</th> <th>2</th> <th>3</th> <th></th> </tr> </thead> <tbody> <tr> <td></td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>Test record</td> </tr> <tr> <td></td> <td>0</td> <td>1</td> <td>0</td> <td>0</td> <td>Parallel channel test</td> </tr> <tr> <td></td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>Direct channel test</td> </tr> <tr> <td></td> <td>1</td> <td>0</td> <td>0</td> <td>0</td> <td>Normal record</td> </tr> <tr> <td></td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> <td>Other</td> </tr> </tbody> </table>	Bits	0	1	2	3			0	0	1	0	Test record		0	1	0	0	Parallel channel test		0	1	1	0	Direct channel test		1	0	0	0	Normal record		0	0	0	1	Other
Bits	0	1	2	3																																		
	0	0	1	0	Test record																																	
	0	1	0	0	Parallel channel test																																	
	0	1	1	0	Direct channel test																																	
	1	0	0	0	Normal record																																	
	0	0	0	1	Other																																	
27	R ₁ , R ₂ , R ₃	Record length from time zero (in increments of 0.5 times 1.024 sec). This value can be set from 00.5 to 99.5 representing times from 0.512 sec. to 101.888 sec. A setting of 00.0 indicates the record length is indeterminate. These three nibbles must be set to FFF when using the Extended Record Length (record length in milliseconds), bytes 15-17, in General Header Block #2.																																				
28	ST/R ₁ , ST/R ₂	Scan types per record. This 2 digit code is the number of scan types per record (1-99). (Zero is invalid.)																																				
29	CS ₁ , CS ₂	Number of channel sets per scan type (1-99). (Zero is invalid; set to FF when using Extended channel sets/scan types.) This 2 digit code is the number of channel sets per scan. If multiple scan types are used (such as in a switching sampling interval environment), this number is equal to the number of channel sets contained in the scan type with the largest number of channel sets. If scan types also exist with less than this maximum number of channel sets per scan type, dummy channel set descriptors will have to be recorded in the scan type header. This can be done by setting the number of channels in the dummy																																				

channel set descriptor to zero (reference Bytes 9 and 10 of the scan type header description). Example 6 illustrates this requirement.

30	SK_1, SK_2	Number of 32 byte fields added to the end of each scan type header in order to record the sample skew of all channels (0-99). (See Appendix E3 of the SEG-D Standard). Zero indicates that skew is not recorded.
31	EC_1, EC_2	Extended header length. The extended header is used to record additional equipment parameters. The two digits (0-99) in this field specify the number of 32 byte extensions. If more than 99 extensions, then these bytes are set to FF. Bytes 6 and 7 of General Header Block #2 contain the number of 32 byte extensions.
32	EX_1, EX_2	External header length. The external header is used to record additional user supplied information in the header. The two digits (0-99) in this field specify the number of 32 byte extensions. If more than 99 extensions, then these bytes are set to FF. Bytes 8 and 9 of General Header Block #2 contain the number of 32 byte extensions.

8.2 GENERAL HEADER BLOCK #2

INDEX BYTE	ABBREVIATION	DESCRIPTION
1,2,3	$EF_{23} - EF_0$	Extended File Number (three bytes, unsigned binary). For file numbers greater than the 9999, bytes 1 and 2 of the General Header Block #1 must be set to FFFF.
4,5	$EN_{15} - EN_0$	Extended Channel Sets/Scan Types (two bytes, unsigned binary). Allows the number of Channel Sets/Scan Types to be greater than the 99 allowed in the standard General Header (byte 29). When using the Extended Channel Sets/Scan Types, byte 29 of General Header Block #1 must be set to FF.
6,7	$ECX_{15} - ECX_0$	Extended Header Blocks (two bytes, unsigned binary). Allows the number of Extended Header Blocks (of 32 bytes each) to be greater than the 99 allowed by the standard General Header (byte 31). To use more than 99 Extended Header Blocks, set byte 31 of General Header Block #1 to FF, and use these two bytes.
8,9	$EH_{15} - EH_0$	External Header Blocks (two byte, unsigned binary). Allows the number of 32 byte External Header Blocks to be greater than the 99 allowed by the General Header (byte 32). To use more than 99 External Header Blocks, set byte 32 of General Header Block #1 to FF, and use these two bytes.
10	X	These fields are undefined by the format and may have any value.
11	$RMJ_7 - RMJ_0$	Major SEG-D Revision Number, one byte unsigned binary. Set to 02 (Hex).
12	$RMN_7 - RMN_0$	Minor SEG-D Revision Number, one byte unsigned binary. Set to 01 (Hex). Revisions 0 to 0.N are not valid. This version is Rev 2.1.
13,14	$GT_{15} - GT_0$	Number of Blocks of General Trailer (two bytes, unsigned binary). The number of 32 byte blocks to be used for General Trailers.

15,16,17	ERL ₂₃ - ERL ₀	Extended Record Length (three bytes, unsigned binary) indicates the record length in milliseconds. When using extended record length, the record length in the General Header Blk #1, Bytes 26 & 27 must be set to FFF.
18	X	These fields are undefined by the format and may have any value.
19	BN ₇ - BN ₀	General Header Block Number. (one byte unsigned binary) Set to 2 for this block. Zero is not valid.
20	X	These fields are undefined by the format and may have any value.
21-22	SN ₁₅ - SN ₀	Sequence number, e.g the lines unique sequence number, (two bytes unsigned binary). Set to 0 if not valid.
23 - 32	X	These fields are undefined by format and may have any value.

NOTES:

1. Where the range of allowable numbers is not indicated, the follow ranges apply.
 Two byte unsigned binary, range is 0 - FF,
 Four byte unsigned binary, range is 0 - FFFF,
 Three byte, two's complement, signed binary; range is -7FFFFFFF to +7FFFFFFF

8.3 GENERAL HEADER BLOCK #N (N Greater than 2)

INDEX BYTE	ABBREVIATION	DESCRIPTION
1,2,3	EF ₂₃ - EF ₀	Expanded File Number (three bytes, unsigned binary). For file numbers greater than the 9999, bytes 1 and 2 of the General Header Block #1 must be set to FFFF.
4,5,6	SLN _S ,SLN ₂₂ -SLN ₀	Source Line Number, Integer (three bytes, two's complement, signed binary). General Header Block #2 contains the source location for one Source Set. Additional General Header Blocks may be used to provide position information for additional source sets.
7,8	SLN ₋₁ - SLN ₋₁₆	Source Line Number, Fraction
9,10,11	SPN _S ,SPN ₂₂ - SPN ₀	Source Point Number, Integer (three bytes, two's complement, signed binary).
12,13	SPN ₋₁ - SPN ₋₁₆	Source Point Number, Fraction.
14	SPI ₇ - SPI ₀	Source Point Index (one byte, unsigned binary). This index allows several locations for the source in the grid, the original value is one and that value is incremented by one every time the source is moved, even when it is moved back to a previous location. Zero value means that the Source Point Index is not recorded.
15	PC ₇ - PC ₀	Phase Control (unsigned binary). Identifies the signal used to control the phase of the vibrator output. Assumes following the 1991 Vibrator Polarity Stds. Phase Control not recorded 00

Baseplate accelerometer	01
Reaction Mass	02
Weighted sum (baseplate acceleration times mass plus reaction mass acceleration times its mass).	03
Direct force measurement	04

It is anticipated that additional codes will be added later. If Phase Control is set to Zero then the Phase Angle (Bytes 17, 18) is undefined.

16	$V_7 - V_0$	Type Vibrator (unsigned binary). Type not recorded 00 P wave vibrator 01 Shear wave vibrator 02 Marine vibrator 03 Other types may be added later.
17,18	$PA_S, PA_{14} - PA_0$	Phase Angle (two bytes, two's complement, signed binary). The Phase angle of the intercept of the pilot signal with respect to the phase feedback signal, measured in degrees. Phase Angle is set to zero when Phase Control (Byte 15) is zero (Phase Control not recorded).
19	$BN_7 - BN_0$	General Header Block Number (one byte unsigned binary). Set to N for this block. Zero is not valid.
20	$SS_7 - SS_0$	Source Set Number (unsigned binary). Used to allow multiple sets of sources. Zero is not valid.
21-32	X	These fields are undefined by format and may have any value.

8.4 SCAN TYPE HEADER (channel set descriptor)

The scan type header is determined by the system configuration and consists of one or more channel set descriptors each of 32 bytes followed by a series of 32 byte sample skew fields. A channel set is defined as a group of channels operating with the same set of parameters and being sampled as part of a scan of data. A scan type header can be composed of from 1 to 99 channel set descriptors. If dynamic parameter changes are required during the recording, additional scan type headers must be added, each containing the channel set descriptors necessary to define the new parameters. Each scan type header must have the same number of channel set descriptors (see Appendix E.4).

8.5 CHANNEL SET DESCRIPTOR

INDEX BYTE	ABBREVIATION	DESCRIPTION
1	ST_1, ST_2	These two digits (1-99) identify the number of the scan type header to be described by the subsequent bytes. The first scan type header is 1 and the last scan type header number is the same value as Byte 28 (ST/R) of the General Header Block #1. If a scan type header contains more than one channel set descriptor, the scan type header number will be repeated in each of its channel set descriptors. If the system does not have dynamic parameter changes during

the record, such as switched sampling intervals, there will only be one scan type header required.

2	CN ₁ , CN ₂	These two digits (1-99) identify the channel set to be described in the next 30 bytes within this scan type header. The first channel set is "1" and the last channel set number is the same number as Byte 29 (CS) of the General Header Block #1. If the scan actually contains fewer channel sets than CS, then dummy channel set descriptors are included as specified in Byte 29 of General Header Block #1. Set to FF when using Channel Sets beyond 99.
3	TF ₁₆ thru TF ₉	Channel set starting time. This is a binary number where TF ₁ =
4	TF ₈ thru TF ₁	2 ¹ msec (2-msec increments). This number identifies the timing word of the first scan of data in this channel set. In a single scan type record, this would typically be recorded as a zero (an exception might be deep water recording). In multiple scan type records, this number represents the starting time, in milliseconds, of the channel set. Start times from 0 to 131,070 msec (in 2-msec increments) can be recorded.
5	TE ₁₆ thru TE ₉	Channel set end time. This is a binary number where TE ₁ = 2 ¹
6	TE ₈ thru TE ₁	milliseconds (2 millisecond increments). These two bytes represent the record end time of the channel set in milliseconds. TE may be used to allow the termination of a particular channel set shorter than other channel sets within its scan type. In a single scan type record, Bytes 5 and 6 would be the length of the record. End times up to 131,070 msec (in 2-msec increments) can be recorded.
7	MP ₋₃ , MP ₋₁₀	Optional byte which extends the resolution available for MP factor.
8	MP ₈ , MP ₄ thru MP ₂	This sign magnitude binary number is the exponent of the base 2 multiplier to be used to descale the data on tape to obtain input voltage in millivolts. The radix point is between MP ₀ and MP ₋₁ . This multiplier has a range of 2 ^{31.75} to 2 ^{-31.75} . (See Appendix E7 of the SEG-D Standard.)
9	C/S ₁ , C/S ₂	This is the number of channels in this channel set. It can assume
10	C/S ₃ , C/S ₄	a number from 0-9999.
11	C ₁ , 0	Channel type identification:

Bits	0	1	2	3	
	0	1	1	1	Other
	0	1	1	0	External Data
	0	1	0	1	Time counter
	0	1	0	0	Water break
	0	0	1	1	Up hole
	0	0	1	0	Time break
	0	0	0	1	Seis
	0	0	0	0	Unused
	1	0	0	0	Signature/unfiltered
	1	0	0	1	Signature/filtered
	1	1	0	0	Auxiliary Data Trailer

12	S/C	This packed BCD number is an exponent of 2. The number (2 ^{S/C}) represents the number of subscans of this channel set in the base scan. Possible values for
----	-----	--

this parameter ($2^{S/C}$) are 1 to 512 (2^0 to 2^9). Reference Byte 23 of the General Header Block #1.

12	J	Channel gain control method.																																								
		<table border="0"> <thead> <tr> <th colspan="4">Bits</th> <th>Gain mode</th> </tr> <tr> <th><u>4</u></th> <th><u>5</u></th> <th><u>6</u></th> <th><u>7</u></th> <th></th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> <td>1</td> <td>(1) Individual AGC</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>(2) Ganged AGC</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>(3) Fixed gain</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>0</td> <td>(4) Programmed gain</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>0</td> <td>(8) Binary gain control</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>1</td> <td>(9) IFP gain control</td> </tr> </tbody> </table>	Bits				Gain mode	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>		0	0	0	1	(1) Individual AGC	0	0	1	0	(2) Ganged AGC	0	0	1	1	(3) Fixed gain	0	1	0	0	(4) Programmed gain	1	0	0	0	(8) Binary gain control	1	0	0	1	(9) IFP gain control
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13	AF ₁ , AF ₂	Alias filter frequency. It can be coded for any frequency from 0 to 9999 Hz.																																								
14	AF ₃ , AF ₄																																									
15	O, AS ₁	Alias filter slope in dB per octave. It can be coded from 0 to 999 dB in 1-dB steps. A zero indicates the filter is out (see Appendix E3 for definition).																																								
16	AS ₂ , AS ₃																																									
17	LC ₁ , LC ₂	Low-cut filter setting. It can be coded for any frequency from 0 to 9999 Hz.																																								
18	LC ₃ , LC ₄																																									
19	0, LS ₁	Low-cut filter slope. It can be coded for any slope from 0 to 999 dB per octave. A zero slope indicates the filter is out. (See Appendix E3 for definition.)																																								
20	LS ₂ , LS ₃																																									
21	NT ₁ , NT ₂	Notch frequency setting. It can be coded for any frequency from 0 to 999.9 Hz. The out filter is written as 000.0 Hz.																																								
22	NT ₃ , NT ₄																																									

The following notch filters are coded in a similar manner:

23	NT ₁ , NT ₂	Second notch frequency
24	NT ₃ , NT ₄	
25	NT ₁ , NT ₂	Third notch frequency
26	NT ₃ , NT ₄	
27,28	ECS ₁₅ -ECS ₀	Extended Channel Set Number (two byte unsigned binary). Contains the complete value that is (or should have been) contained in byte two (CN ₁ ,CN ₂). Allows additional Channel Sets, beyond the 99 which can be described in byte two. When using Channel sets beyond 99, or when using binary numbers for the Channel Set Number, set byte 2 (CN ₁ , CN ₂) to FF.
29	EFH ₃ -EFH ₀	Extended Header flag (one nibble, four bits, unsigned binary). Set to 1 to indicate that the extended header contains additional information on the channel set.
29	THE ₃ -THE ₀	Trace Header Extensions. 4 bits, unsigned binary. Must match byte 10 of the Demux Trace Header.
30	VS ₇ -VS ₀	Vertical Stack (one byte, unsigned binary). Effective stack order. Set to zero if the trace data was intentionally set to real zero. Set to one if no stack. Set to the effective stack order if the data is the result of stacked data (with or without processing).

31	CAB ₇ -CAB ₀	Streamer Cable number (8 bit unsigned binary). Required for streamer data only. Identifies the number of the streamer cable that will be identified in this block. The starboard-most cable is identified as cable 1 while the Port most cable is N. Zero means that the Streamer Cable number has not been recorded.
32	ARY ₇ -ARY ₀	Array Forming (8 bit binary). Identifies whether the data in this channel set is the result of array forming.
	01 Hex	No array forming.
	02 Hex	2 groups summed, no weighting.
	03 Hex	3 groups summed, no weighting.
	04 Hex	4 groups summed, no weighting.
	0N Hex	N groups summed, no weighting.
	1N Hex	N groups weighted, overlapping, summation.

8.6 DEMUX TRACE HEADER

INDEX BYTE	ABBREVIATION	DESCRIPTION
1,2	F ₁ - F ₄	File Number (two byte, four digit, BCD). These bytes must be set to FFFF when the Extended File Number (bytes 18,19,20) is used.
3	ST ₁ - ST ₂	Scan Type Number (one byte, two digit, BCD). This byte must be set to FF when the Extended Channel Set Number (bytes 16 & 17) is used.
4	CN ₁ -CN ₂	Channel Set Number (one byte, two digit, BCD).
5,6	TN ₁ - TN ₄	Trace Number (two byte, four digit, BCD).
7,8,9	T ₁₅ - T ₈	First Timing Word. These bytes comprise the timing word that would accompany the first sample if these data were written in the multiplexed format. To obtain the exact sample timing, the actual sample skew time (byte 11 multiplied by the base can interval) must be added to the time recorded in bytes 7,8,9.
10	THE ₇ - THE ₀	Trace Header Extensions (one byte, unsigned binary). Indicates the number of Trace Header Extension blocks (32 bytes each). Set to zero when no extensions are used. Maximum allowed is 15. Channels within the same channel set must have the same number of Trace Header Extensions.
11	SSK ₁ - SSK ₈	Sample Skew (one byte binary fraction). The fractional skew value represents the fractional part of the base Scan Interval (Byte 23 of General Header Block #1).
12	TR ₇ - TR ₀	Trace edit (one byte, unsigned binary). TR=00 No edit applied to this trace. TR=01 Trace part of dead channels for roll-on or roll-off spread. Trace intentionally zeroed. TR=02 Trace intentionally zeroed. TR=03 Trace has been edited. This flag will indicate that the acquisition system has modified one or more samples of this trace. Other codes are undefined at Rev 2.1 and 2.0.

13,14,15	TW ₁₅ - TW _{.8}	Time Break Window (three byte, unsigned binary. two bytes integer with one byte fraction). Bytes 13, 14, and 15 are included as an integrity check on time break. They comprise the timing word of the scan in which TWI changed to a one.
16,17	EN ₁₅ - EN ₀	Extended Channel Set Number (two byte, unsigned binary). Allows Channel Set Numbers beyond the 99 which can be indicated in byte 4. To allow Channel Set Numbers greater than 99, or to allow use of a binary channel set number, set byte 4 to FF and use bytes 16 and 17 for the Channel Set Number.
18,19,20	EFN ₂₃ - EFN ₀	Extended File Number (three byte, unsigned binary). Allows File Numbers beyond the 9999 which can be indicated in bytes 1 and 2. To allow File Numbers greater than 9999, or to allow use of a binary file numbers, set bytes 1 and 2 to FFFF and use bytes 18, 19, and 20 for the File Number.

8.7 TRACE HEADER EXTENSION

INDEX BYTE	ABBREVIATION	DESCRIPTION
1,2,3	RLN _S , RLN ₂₂ - RLN ₀	Receiver Line Number (three bytes, two's complement, signed binary).
4,5,6	RPN _S , RPN ₂₂ - RPN ₀	Receiver Point Number (three bytes, two's complement, signed binary).
7	RPI _S , RPI ₆ - RPI ₀	Receiver Point Index (one byte, two's complement, signed binary). This index allows several locations for the receiver group in the grid, the original value is 1 and that value is incremented by 1 every time the receiver is moved, even when it is moved back to the previous location).
8,9,10	NBS ₂₃ - NBS ₀	Number of Samples per Trace (three bytes, unsigned binary).
11-15	ERLN	Extended Receiver Line Number. Allows fractional Receiver Line Numbers. Only valid if bytes 1-3 in this Trace Header Extension are set to FFFFFFFF. Signed binary, three bytes integer, two bytes fractional.
16-20	ERPN	Extended Receiver Point Number. Allows fractional Receiver Point Numbers. Only valid if bytes 4-6 in this Trace Header Extension are set to FFFFFFFF. Signed binary, three bytes integer, two bytes fractional.
21	SEN	Sensor Type recorded on this trace (one byte unsigned binary) <ul style="list-style-type: none"> 00 Not defined 01 Hydrophone (pressure sensor) 02 Geophone (velocity sensor) Vertical 03 Geophone, Horizontal, inline 04 Geophone, Horizontal, cross-line 05 Geophone, Horizontal, other 06 Accelerometer, Vertical 07 Accelerometer, Horizontal, inline 08 Accelerometer, Horizontal, cross-line 09 Accelerometer, Horizontal, other other values are not defined at the present time.

8.8 GENERAL TRAILER

This type header allows provisions for recording auxiliary seismic system and real-time navigation related data in the trailer. The trailer is optional and typically follows all other recorded data.

The addition of the trailer will allow the accumulation of system faults, data QC information, and real-time navigation position and timing information on the same tape, and contiguous with, the shotpoint that it relates to. By recording this data after all of the other data, additional time is provided for collecting the data and transferring it to the recording system.

The Trailer blocks take the same general form as the Channel Set Descriptor. Byte 11 uses the "Channel Type Identification" set to 1100 to indicate a Trailer block.

Bytes 1 and 2 indicate the number of the General Trailer block, with the first block numbered as 1.

All other information in the trailer is optional and may be formatted as desired by the manufacturer/user.

The number of General Trailer blocks is indicated in bytes 13 and 14 of General Header Block #2.

INDEX BYTE	ABBREVIATION	DESCRIPTION
1,2	GT ₁₅ -GT ₀	General Trailer Number (two bytes unsigned binary). The first block is 1. The last General Trailer block should contain the same number in this field as in bytes 13 and 14 of General Header Block #2.
3 - 10	X	These fields are undefined by format. They may have any value.
11	C ₁ , 0	Channel Type Identification (one nibble, unsigned binary). Set to 1100 for General Trailers. The second nibble of this byte is undefined and may have any value.
12 - 32	X	These fields are undefined by format. They may have any value.

Appendix A: Manufacturers of Seismic Field Recorders

<u>Code No.</u>	<u>Manufacturer Name and Address</u>
01	Alpine Geophysical Associates, Inc. (Obsolete) 65 Oak St. Norwood, New Jersey
02	Applied Magnetics Corporation (See 09) 75 Robin Hill Rd. Goleta, California 93017
03	Western Geophysical Exploration Products (formerly Litton Resources Systems) 3600 Briarpark Drive, Houston, Texas 77042
04	SIE, Inc. (Obsolete) 5110 Ashbrook Houston, Texas 77036
05	Dyna-Tronics Mfg. Corporation (Obsolete) 5820 Star Ln., Box 22202 Houston, Texas 77027
06	Electronic Instrumentation, Inc. (Obsolete) 601 Dooley Rd., Box 34046 Dallas, Texas 75234
07	Halliburton Geophysical Services, Inc.,(formerly, Electro-Technical Labs, Div.of Geosource, Inc.) 6909 Southwest Freeway Houston, Texas 77074
08	Fortune Electronics, Inc. (Obsolete) 5606 Parkersburg Dr. Houston, Texas 77036
09	Geo Space Corporation 7334 Gessner Houston, Texas 77040
10	Leach Corporation (Obsolete) 405 Huntington Dr. San Marino, California

- 11 Metrix Instrument Co. (Obsolete)
8200 Westglen
Box 36501
Houston, Texas 77063
- 12 Redcor Corporation (Obsolete)
7800 Deering Ave., Box 1031
Canoga Park, California 91304
- 13 Sercel (Societe d'Etudes, Recherches Et Constructions Electroniques)
25 X, 44040 Nantes Cedex,
France
- 14 Scientific Data Systems (SDS), (Obsolete)
1649 Seventeenth St.
Santa Monica, California 90404
- 15 Texas Instruments, Inc.
P.O. Box 1444
Houston, Texas 77001
- 17 GUS Manufacturing, Inc.
P.O. Box 10013
El Paso, Texas 79991
- 18 Input/Output, Inc.
12300 Parc Crest Dr.
Stafford, Texas 77477
- 19 Geco-Prakla
Transition Zone Product Development
(formerly Terra Marine Engineering)
10420 Miller Road
Dallas, Texas 75238
- 20 Fairfield Industries, Incorporated
10627 Kinghurst
Houston, Texas 77099
- 22 Geco-Prakla
Buckingham Gate, Gatwick Airport
West Sussex, RH6 ONZ, UK
- 31 Japex Geoscience Institute 1991
Akasaka Twin Towers Bldg. 2;
2-17-22, Akasaka
Minato-ku; Tokyo 107, Japan
- 32 Halliburton Geophysical Services, Inc. 1991
6909 Southwest Freeway
Houston, Texas 77074

33	Compuseis, Inc. 8920 Business Park Dr, Ste 275, Austin, Texas 78759	1993
34	Syntron, Inc. 17200 Park Row Houston, Texas 77084	1993
35	Syntron Europe Ltd. Birchwood Way Cotes Park Industrial Estates Somercotes, Alfreton, Dergyshire DE55 4QQ, U.K.	1993
36	Opseis 7700 E. 38th St. Tulsa, OK 74145	1994
39	Grant Geophysical 16850 Park Row Houston, Tx 77084	1995
40	Geo-X Suite 900, 425 1st St SW Calgary, Alberta, Canada T2P3L8	1996
41	PGS Inc. 16010, Barkers Point Lane, Houston Texas 77079	2001
42	SeaMap UK Ltd. Unit 31 The Maltings Charlton Estate Shepton Mallet BA4 5QE UK	2003
43	Hydroscience Hydroscience Technologies, Inc. 5101 Airport Road Mineral Wells, Texas 77478 USA	2004
44	JSC “SPECIAL DESIGN BUREAU FOR SEISMIC INSTRUMENTATION” 129, Krainyaya Str., 410019 Saratov, RUSSIA	2006

45	Fugro Hoffsveien 1C N-0213 Oslo NORWAY	2006
46	ProFocus Systems AS Spelhaugen 20 5147 Fyllingsdalen NORWAY	2006
47	Optoplan AS Haakon VII's gate 17 7041 Trondheim NORWAY	2008
48	Wireless Seismic Inc. 12996 Somerset Drive Grass Valley, CA 95945	2008

Appendix B: Glossary

Attribute - A named item of information or data pertaining to an object.

Base scan interval - The time between timing words. A base scan interval usually contains one scan but under some conditions may contain multiple subscans.

Beginning of tape mark (BOT) - An indelible mark (e.g., reflector) near the beginning of the tape that indicates the start of the region in which recorded data is permitted.

Block - The data between gaps on tape.

Channel set - One or more channels sampled at the same sampling interval and containing the same filter, fixed gain, and other fixed parameter information.

Channel set descriptor - A unit of the scan type header describing the parameters of a channel set.

Data recording method - The arrangement of bits to represent samples on tape.

End of data flag (EOD) - A special record or condition on the tape used to indicate the end of data on the tape.

End of file mark (EOF) - A special record or condition on the tape that indicates the end of a tape file. Also called File Mark.

End of tape warning (ETW) - An indelible mark (e.g., reflector), located a required minimum distance from the physical end of the tape that serves as a warning.

File - All data recorded from a single energy impulse or sweep. It may also be the sum of a number of energy impulses or sweeps. Literally, it is all of the blocks between file marks.

Filemark - A special record or state of a media index that indicates the end of a physical file.

Format Data - recording method combined with a multiplexed/demultiplexed indicator (see general header Bytes 3 and 4).

General header - The first header in the header block. It contains information common to the entire record.

Index byte - The byte number of some particular parameter within the general or scan type header.

Organization code - A number assigned by the Energistics to an organization that identifies the organization and represents schemas and dictionaries defined and administered by the organization.

Packed BCD - Binary coded decimal digits represented by four data bits.

Partition - An independent recording area resulting from physical formatting of the media that can be mounted as though it were a single volume.

Physical blocks (on tape) - A collection of contiguous bytes recorded as a unit on a longitudinal tape or a track set on helical scan tape. Physical blocks on longitudinal tape are separated by interblock gaps.

Sample skew - The fraction of the base scan interval between the timing word and the actual time the sample was taken in a base scan interval (not related to position on tape).

Sampling interval - The interval between readings such as the time between successive samples of a digital seismic trace.

Scan - One complete sequence of events, such as sampling all channels. Data recorded during a base scan interval.

Scan interval - The interval between readings of all samples contained in a scan type.

Scan type - One complete set of channel sets which make up a scan. A seismic record contains multiple scans, and may or may not contain more than one scan type.

Scan type header - A header containing one or more channel set descriptors and the skew information.

Schema - A formalized description of the encoding of information defined by a logical model, typically in terms of a data model.

Storage set - An ordered set of storage units, the position in the set is specified in the storage unit label.

Storage unit - A logical volume of data containing one or more logical files.

Subscan - A set of samples containing one sample for each channel in a channel set.

Tape file - Is the data contained between two File Marks or between an File Mark at its beginning and an EOD at its end. A typical implementation of EOD is an empty tape file, i.e., two consecutive File Marks. Some systems implement EOD as two or more (possibly many) File Marks.

Tape record - A sequence of data bytes treated as a unit by the tape I/O subsystem. The application provides the number of bytes in the tape record when writing and is returned the number of bytes in the tape record when reading. A tape record has an identifiable beginning on the tape, which need not be on the boundary of a physical block, and which is locatable by the tape I/O subsystem.

Time break window - Time interval in which time break is expected. If time break does not occur by the end of the window, internal time break is generated.

Trace - A record of one seismic channel within a scan type. A collection of a sequential set of points from one seismic channel.

Trace block - A block containing the data of one trace or a part of a trace with constant parameters.

Appendix C: API Producer Organization Code

C.1 Scope

Table 1 below contains a list of *organization codes* assigned by Energistics — formerly the Petrotechnical Open Standards Consortium (POSC) — for use in API Recommended Practice 66. *Several of the organization codes in this appendix are historical in nature and reflect the well log origins of API Recommended Practice 66.*

This specification was originally prepared by the Subcommittee on Standard Format for Digital Well data. In June 1996 it was designated a recommended practice by the American Petroleum Institute Exploration & Production Department's Executive Committee on Drilling and Production Practices. In June 1998 stewardship of the document was transferred from API to Petroleum Open Standards Consortium, relaunched in December 2006 as Energistics.

C.2 Assignment of Organization Codes

Organization codes are assigned by Energistics, which maintains the current list of codes. To request a new organization code, contact:

Energistics
24 Greenway Plaza
Suite 1315
Houston, TX 77046 USA
+1 713 784-1880 telephone
+1 713 784-9219 fax
www.energistics.org

The following is copied from

http://www.posc.org/technical/data_exchange/RP66/V2/rp66v2.html

This document, [POSC RP66 V2](#), is a specification of Petrotechnical Open Standards Consortium.

This specification is based on and is equivalent in content to the document *Recommended Practices for Exploration and Production Data Digital Interchange: API RECOMMENDED PRACTICE 66, V2: Second Edition, June 1996* published by the American Petroleum Institute ([API](#)). The acronym **RP66V2** is retained for historical reasons; Energistics does not designate specifications as "Recommended Practices".

http://www.posc.org/technical/data_exchange/RP66/V2/rp66v2_appa.html

Last Updated 3 Mar 2003

Table 1— Organization Codes

Table 1 - Organization Codes	
Code	Organization

0	Subcommittee On Recommended Format For Digital Well Data, Basic Schema
1	Operator
2	Driller
3	Mud Logger
9	Amerada Hess
10	Analysts, The
15	Baker Hughes Inteq
20	Baroid
30	Birdwell
40	Reeves (1 Jan 99; formerly BPB)
50	Brett Exploration
60	Cardinal
65	Center Line Data
66	Subcommittee On Recommended Format For Digital Well Data, DLIS Schema
70	Century Geophysical
77	CGG Logging, Massey France
80	Charlene Well Surveying
90	Compagnie de Services Numerique
95	Comprobe
100	Computer Data Processors
110	Computrex
115	COPGO Wood Group
120	Core Laboratories
125	CRC Wireline, Inc.
126	Crocker Data Processing Pty Ltd
127	Tucker Wireline Services (formerly Davis Great Guns Logging, Wichita, KS)
130	Digigraph
137	Tucker Technologies (formerly Digital Logging Inc.), Tulsa, OK.
140	Digitech
145	Deines Perforating
148	Drillog Petro-Dynamics Limited
150	Baker Atlas (formerly Dresser Atlas)
160	Earthworm Drilling
170	Electronic Logging Company
180	Elgen
190	El Toro
200	Empire
205	Encom Technology, Ltd.
206	Ensign Geophysics, Ltd.
210	Frontier
215	Geolog
217	Geoshare

218	GEO-X Systems Ltd.
220	G O International
230	Gravilog
240	Great Guns Servicing
250	Great Lakes Petroleum Services
260	GTS
268	Guardian Data Seismic Pty. Ltd.
270	Guns
280	Halliburton Logging
285	Horizon Production Logging
290	Husky
300	Jetwell
305	Landmark Graphics
310	Lane Wells
315	Logicom Computer Services (UK) Ltd
320	Magnolia
330	McCullough Tool
332	Mitchell Energy Corporation
335	Paradigm Geophysical (formerly Mincom Pty Ltd)
337	MR-DPTS Limited
338	NRI On-Line Inc
339	Oilware, Inc.
340	Pan Geo Atlas
342	Pathfinder Energy Services
345	Perfco
350	Perfojet Services
360	Perforating Guns of Canada
361	Petcom, Inc.
362	Petroleum Exploration Computer Consultants, Ltd.
363	Petrologic Limited
366	Phillips Petroleum Company
368	Petroleum Geo-Services (PGS)
370	Petroleum Information
380	Petrophysics
390	Pioneer
392	The Practical Well Log Standards Group
395	IHS Energy Log Services (formerly Q. C. Data Collectors)
400	Ram Guns
410	Riley's Datashare
418	RODE
420	Roke

430	Sand Surveys
440	Schlumberger
450	Scientific Software
460	Seismograph Service
462	SEGDEF
463	SEG Technical Standards High Density Media Format Subcommittee
464	Shell Services Company
465	Stratigraphic Systems, Inc.
467	Sperry-Sun Drilling Services
468	SEPTCO
469	Sercel, Inc.
470	Triangle
475	Troika International
480	Welex
490	Well Reconnaissance
495	Wellsite Information Transfer Specification (WITS)
500	Well Surveys
510	Western
520	Westronics
525	Winters Wireline
530	Wireline Electronics
540	Worth Well
560	Z & S Consultants Limited
999	<i>Reserved for local schemas</i>
1000	POSC

Appendix D: Header Descriptors

ABBREV	HEADER	DESCRIPTION
AF	Channel Set Descriptor	ALIAS FILTER FREQUENCY
ARY	Channel Set Descriptor	ARRAY FORMING
AS	Channel Set Descriptor	ALIAS FILTER SLOPE
BN	General Header Blk #2, General Header Blk #N	GENERAL HEADER BLOCK NUMBER GENERAL HEADER BLOCK NUMBER
C	Channel Set Descriptor, General Trailer	CHANNEL TYPE IDENTIFICATION CHANNEL TYPE IDENTIFICATION
CAB	Channel Set Descriptor	STREAMER NUMBER
CN	Demux Trace Header Channel Set Descriptor	CHANNEL SET NUMBER CHANNEL SET NUMBER
CS	General Header Blk #1	CHANNEL SETS PER SCAN TYPE
C/S	Channel Set Descriptor	CHANNELS IN THIS CHANNEL SET
DY	General Header Blk #1	DAY OF YEAR
EC	General Header Blk #1	EXTENDED HEADER BLOCK
ECS	Channel Set Descriptor	EXTENDED CHANNEL SET NUMBER
ECX	General Header Blk #2	EXTENDED HEADER BLOCKS
EF	General Header Blk #2	EXPANDED FILE NUMBER
EFH	Channel Set Descriptor	EXTENDED HEADER FLAG
EFN	Demux Trace Header	EXTENDED FILE NUMBER
EH	General Header Blk #2	EXTERNAL HEADER BLOCKS
EN	Demux Trace Header General Header Blk #2	EXTENDED CHANNEL SETS AND SCAN TYPE EXTENDED CHANNEL SETS AND SCAN TYPE
EX	General Header Blk #1	EXTERNAL HEADER LENGTH
ERL	General Header Blk #2	EXTENDED RECORD LENGTH
ERLN	Trace Header Extension	EXTENDED RECEIVER LINE NUMBER
ERP	Trace Header Extension	EXTENDED RECEIVER POINT NUMBER
F	Demux Trace Header	FILE NUMBER

	General Header Blk #1	FILE NUMBER
GH	General Header Blk #1	NUMBER BLOCKS IN GENERAL HEADER
GT	General Trailer, General Header Blk #2	GENERAL TRAILER NUMBER GENERAL TRAILER NUMBER
H	General Header Blk #1	HOUR OF DAY
I	General Header Blk #1	BASE SCAN INTERVAL
J	Channel Set Descriptor	GAIN CONTROL METHOD
K	General Header Blk #1	GENERAL CONSTANTS
LC	Channel Set Descriptor	LOW CUT FILTER FREQUENCY
LS	Channel Set Descriptor	LOW CUT FILTER SLOPE
M	General Header Blk #1	MANUFACTURER'S CODE & SERIAL NUMBER
MI	General Header Blk #1	MINUTE OF HOUR
MP	Channel Set Descriptor	DESCALING EXPONENT
NBS	Trace Header Extension	NUMBER OF SAMPLES PER TRACE
NT	Channel Set Descriptor	NOTCH FILTER FREQUENCY
P	General Header Blk #1	POLARITY
PA	General Header Blk #N	PHASE ANGLE
PC	General Header Blk #N	PHASE CONTROL
R	General Header Blk #1	RECORD LENGTH
RMJ	General Header Blk #2	Major SEG-D REVISION NUMBER
RMN	General Header Blk #2	Minor SEG-D REVISION NUMBER
RLN	Trace Header Extension	RECEIVER LINE NUMBER
RPI	Trace Header Extension	RECEIVER POINT INDEX
RPN	Trace Header Extension	RECEIVER POINT NUMBER
S/C	Channel Set Descriptor	SAMPLE/CHANNEL GAIN
SE	General Header Blk #1	SECOND
SK	General Header Blk #1	SKEW BLOCKS
SLN	General Header Blk #N	SOURCE LINE NUMBER
SN	General Header Blk #2	SEQUENCE NUMBER
SPI	General Header Blk #N	SOURCE POINT INDEX
SPN	General Header Blk #N	SOURCE POINT NUMBER
SS	General Header Blk #N	SOURCE SET NUMBER

SSK	Demux Trace Header	SAMPLE SKEW
ST	Demux Trace Header	SCAN TYPES
	Channel Set Descriptor	SCAN TYPES
ST/R	General Header Blk #1	SCAN TYPES PER RECORD
T	Demux Trace Header	FIRST TIMING WORD
TE	Channel Set Descriptor	CHANNEL SET END TIME
TF	Channel Set Descriptor	CHANNEL SET START TIME
THE	Demux Trace Header	TRACE HEADER EXTENSIONS
TN	Demux Trace Header	TRACE NUMBER
TR	Demux Trace Header	TRACE EDIT
TW	Demux Trace Header	TIME BREAK WINDOW
V	General Header Blk #N	TYPE VIBRATOR
VS	Channel Set Descriptor	VERTICAL STACK
Y	General Header Blk #1	FORMAT CODE
YR	General Header Blk #1	YEAR
Z	General Header Blk #1	RECORD TYPE

Appendix E: Examples and Calculations

E.1 Samples per scan type

$$S/S = \sum_{\uparrow}^{CS} C/S \times 2^{SC}$$

where

S/S = samples per scan type

C/S = channels in this channel set (channel set descriptor Bytes 9 and 10)

2^{SC} = samples per channel (in this channel set) (channel set descriptor Byte 12)

CS = number of channel sets in this scan type (general header Byte 29)

For example, for a 2-msec base scan interval with 4 auxiliary channels at 2 msec, 96 channels at 2 msec and 12 channels at 1/2 msec. There are three channel sets, so CS = 3.

$$S/S = C/S \times 2^{SC} \quad \left| \begin{array}{c} + C/S \times 2^{SC} \\ cs = 1 \end{array} \right| + \dots \left| \begin{array}{c} + C/S \times 2^{SC} \\ cs = 2 \end{array} \right|$$

$$S/S = 4 \times 1 + 96 \times 1 + 12 \times 4$$

$$S/S = 4 + 96 + 48 = 148$$

Note that all scan types must have the same number of data samples.

E.2 Skew fields per scan type

$$SK = \frac{S/S}{32} \quad (\text{If the quotient is not a whole number, round up to the next largest whole number})$$

where

SK = skew fields (of 32 bytes each) per scan type (general header Byte 30)

S/S = samples per scan (Appendix E1)

Substituting for S/S from Appendix E.1:

$$SK = \frac{1}{32} \sum_{\uparrow}^{CS} C/S \times 2^{SC}$$

(If the quotient is not a whole number, round up to the next largest whole number.)

where

CS = the number of channel sets in each scan type (general header Byte 29)

C/S = channels in this channel set (channel set descriptor Bytes 9 and 10)

2^{SC} = samples per channel in this channel set (channel set descriptor Byte 12).

For example, for a 2-msec base scan with 4 auxiliary channels at 2 msec, 96 channels at 2 msec and 12 channels at ½ msec

$$SK = \frac{4 \times 1 + 96 \times 1 + 12 \times 4}{32}$$

$$= \frac{148}{32} = 4 \frac{20}{32} \text{ roundup} = 5 \text{ fields of 32 bytes each}$$

E.3 Filter slope calculation

Modern filters may not have a constant slope, so it is necessary to define this parameter. The slope is defined as the asymptote of effective performance as it would be in a constant slope filter. This slope is zero dB attenuation at the cut-off frequency and a specific attenuation at the beginning of the stop band. The chosen values are 40 dB for a low-cut filter and 60 dB for an anti-alias filter.

Low-cut filter slope calculation.--

$$LS = \frac{40}{\log_2 f_{LCO}/f_{40}} = \frac{40}{3.322 \log_{10} f_{LCO}/f_{40}} = \frac{12.04}{\log_{10} f_{LCO}/f_{40}}$$

LS = low-cut filter slope (channel set descriptor Bytes 19 and 20),

f_{40} = the frequency of 40 dB low-cut filter attenuation,

f_{LCO} = low-cut filter cut-off frequency usually 6 or 12 dB attenuation.

Alias-filter slope calculation.--

$$AS = \frac{60}{\log_2 f_{60}/f_{ACO}} = \frac{60}{3.322 \log_{10} f_{60}/f_{ACO}} = \frac{18.06}{\log_{10} f_{60}/f_{ACO}}$$

AS = alias filter slope (channel set descriptor Bytes 15 and 16)

f_{60} = the frequency of 60 dB alias-filter attenuation

f_{ACO} = alias-filter cut-off frequency usually 3 or 6 dB attenuation

The resultant slope in the above calculation is rounded to the nearest whole number and is written in the channel set descriptor.

Appendix F: Maximum Block Sizes

The table below indicates the maximum allowable block size for various types of media. Many tape drives in this appendix are historical in nature and are no longer used in seismic acquisition.

Device Type	Maximum Block Size
3480	128 Kilobytes
3490, 3490E	256 Kilobytes
3590 B	512 Kilobytes
3590 E	2 Megabytes
IBM 3592 (Jaguar-1)	2,097,152 Bytes (2 Megabytes)
IBM TS1120 (Jaguar-2)	2,097,152 Bytes (2 Megabytes)
DST	1,199,840 Bytes
Redwood	256 Kilobytes
STK 9940B	256 Kilobytes
1/2" Round Tape	64 Kilobytes

Kilobyte is defined as 1024 bytes.

Megabyte is defined as 1024x1024 bytes (=1,048,576 bytes)