Landsat MSS digital data format

Geoscience Australia

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CHAPTER 1

LANDSAT MSS PRODUCT DEFINITION

The following CCT products, conforming to the LGSOWG standard format, are to be offered by CCRS for LANDSAT 1, 2 and 3 MSS data after April 1980, and LANDSAT D MSS data after launch.

1.   Complete MSS frame in 4 [or 5] bands, Band Sequential (BSQ) organization, with radiometric and system geometric correction options.

2.   Complete MSS frame in 4 bands, Band Interleaved by Line (BIL) organization, with radiometric and system geometric correction options.

        The radiometric correction options are:

        1.   Raw

        2.   CAL2 linear

        3.   CAL2 logarithmic

        4.   CAL3 linear

        5.   CAL3 logarithmic

        The system geometric correction options are:

        1.   Raw

        2.   Earth Rotation

        3.   Mirror Velocity, Panoramic Distortion, Earth Curvature

        4.   Combined Corrections (2 and 3)

3.   Rectified subscenes in 4 bands in UTM projection, BSQ   organization, with radiometric correction options.

4.   Rectified subscenes in 4 bands in UTM projection, BIL organization, with radiometric correction options.

CHAPTER 2

LOGICAL VOLUME DEFINITIONS

The Landsat MSS product is recorded on CCTs at either 1600 bpi or 6250 bpi in a single logical volume which has either a BSQ or BIL organization. Both organizations will occupy one physical volume at 6250 bpi. At 1600 bpi, BIL 4 band data and BSQ 4 band data will occupy one physical tape. However, BSQ 5 band data at 1600 bpi will require two physical tapes, with 4 bands on the first tape and one band on the second tape. The logical volume definitions are based on the LGSOWG CCB documents titled: 'The CCT Family of Tape Formats' and Landsat-D User CCT Tape Format'.

2.1   BAND SEQUENTIAL LOGICAL VOLUME

The files required (see Figure 1) are:

1. The Volume Directory File

2. For each band: a Leader File, an Imagery File, and a Trailer File

3. The Null Volume Directory File

2.2   BAND INTERLEAVED BY LINE LOGICAL VOLUME

The files required (see Figure 2) are:

1. The Volume Directory File

2. A Leader File, an Imagery File, and a Trailer File

3. The Null Volume Directory File

FIGURE 1
LOGICAL VOLUME DEFINITION - BAND INTERLEAVED BY LINE STRUCTURES

FILE NUMBER	CONTENTS	FILE NAME
FILE V	VOLUME DESCRIPTOR FILE POINTER-file 1 FILE POINTER-file 2 FILE POINTER-file 3 TEXT RECORD	VOLUME DIRECTORY FILE
FILE 1	LEADER FILE DESCRIPTOR HEADER RECORD ANCILLARY RECORDS ANNOTATION RECORD	LEADER FILE-ALL BANDS
FILE 2	IMAGERY FILE DESCRIPTOR IMAGERY DATA RECORDS (1 record per band per scan line)	IMAGERY FILE-ALL BANDS
FILE 3	TRAILER FILE DESCRIPTOR TRAILER RECORDS	TRAILER FILE-ALL BANDS
FILE NULL	NULL VOLUME DESCRIPTOR RECORD	NULL VOLUME DIRECTORY FILE

FIGURE 2
LOGICAL VOLUME DEFINITION - BAND SEQUENTIAL STRUCTURES

FILE NUMBER	CONTENTS	FILE NAME
FILE V	VOLUME DESCRIPTOR FILE POINTER-File 1 FILE POINTER-File 2 　　!　　　! FILE POINTER-File 3N TEXT RECORD	VOLUME DIRECTORY FILE
FILE 1	LEADER FILE DESCRIPTOR HEADER RECORD ANCILLARY RECORDS ANNOTATION RECORD	LEADER FILE - BAND 1
FILE 2	IMAGERY FILE DESCRIPTOR IMAGERY DATA RECORDS (one record per scan line)	IMAGERY FILE - BAND 1
FILE 3	TRAILER FILE DESCRIPTOR TRAILER RECORD 　　!　　　! 　　!　　　! 　　!　　　!	TRAILER FILE - BAND 1
FILE 3N-2	LEADER FILE Contents as for File 1	LEADER FILE - BAND N
FILE 3N-1	IMAGERY FILE Contents as for File 2	IMAGERY FILE - BAND N
FILE 3N	TRAILER FILE Contents as for File 3	TRAILER FILE - BAND N
FILE NULL FILE	NULL VOLUME DESCRIPTOR RECORD	NULL VOLUME DIRECTORY

CHAPTER 3

LANDSAT MSS CCT FILE DEFINITIONS

3.1 VOLUME DIRECTORY FILE

The Volume Directory File is the first file of every logical volume and consists of a Volume Descriptor Record, File Pointer Records and a Text Record.

3.1.1 VOLUME DESCRIPTOR RECORD

The Volume Descriptor Record identifies the logical volume, its documentation and its number of files. This record is defined in Table 3.1.1.1, and explained in Table 3.1.1.2. Its contents are shown in Table 3.1.1.3.

3.1.2 FILE POINTER RECORDS

Each File Pointer Record references one data file of the logical volume, indicates that file's format and tells how to prepare to read the file. There are three file classes on these CCTs, and the File Pointer Records contain the names and codes of these file classes. The names and codes are as follows:

CLASS NAME	CLASS CODE	FILE CONTENT
LEADER FILE	LEAD	Header, Annotation, Ancillary records
IMAGERY FILE	IMGY	Image data records
TRAILER FILE	TRAI	Trailer records

The File Pointer Record is defined in Table 3.1.2.1 and explained in Table 3.1.2.2. The File Pointer Record contents for the Leader File are shown in Table 3.1.2.3, for the Imagery File in Table 3.1.2.4, and for the Trailer File in Table 3.1.2.5.

3.1.3 TEXT RECORD

For the standard Landsat MSS data product the Volume Directory File contains one and only one Text Record which is always the last record of the Volume Directory. The text record contains information identifying the physical tape, with a brief summary of its contents. The information is stored in free format in plain English or French so that it may readily be displayed at the terminal. Table 3.1.3.1 defines the text record, and its English contents are shown in Table 3.1.3.2 and explained in Table 3.1.3.3.

TABLE 3.1.1.1
VOLUME DESCRIPTOR RECORD - DEFINITION

NO	BYTE NOS	DESCRIPTION
1	1-4	Record Number
2	5	300(8) = Volume Directory code (1st record sub-type code) ***
3	6	Record Type Code = 300(8) = Superstructure
4	7	077(8) if Null Volume Directory File, 022(8) otherwise. (2nd record sub-type code)
5	8	022(8) (3rd record sub-type code)
6	9-12	Length of this record
7	13-14	ASCII/EBCDIC Flag
8	15-16	2 Blanks
9	17-28	Superstructure control document number
10	29-30	Superstructure control document revision number
11	31-32	Superstructure record format revision letter
12	33-44	Software release number
13	45-60 **	Tape ID for physical volume containing this volume descriptor
14	61-76 *	Logical Volume ID
15	77-92 *	Volume Set ID
16	93-94	Number of Physical Volumes in the Set
17	95-96	Physical Volume Number, Start of Logical Volume
18	97-98	Physical Volume Number, End of Logical Volume
19	99-100 **	Physical Volume Number containing this Volume Descriptor
20	101-104 **	First Referenced File Number in this Physical Volume
21	105-108	Logical Volume Number within Volume Set
22	109-112 **	Logical Volume Number within Physical Volume
23	113-120 *	Logical Volume Creation Date
24	121-128 *	Logical Volume Creation Time
25	129-140 *	Logical Volume Generating Country
26	141-148 *	Logical Volume Generating Agency
27	149-160 *	Logical Volume Generating Facility
28	161-164 *	Number of Pointer Records in Volume Directory
29	165-168 *	Number of Records in Volume Directory
30	169-260	Volume Descriptor Spare Segment
31	261-360	Local Use Segment

----

*	Undefined in Null Volume Directory File
**	Fields to be updated in a repeated Volume Directory File
***	Numbers followed by (8) are in OCTAL

TABLE 3.1.1.2
VOLUME DESCRIPTOR RECORD - EXPLANATION

Fields 1 to 6 are binary encoded fields. All other fields are in ASCII. Alphanumeric character strings are left-justified and numeric character strings are right-justified. Any fields not used are filled with ASCII blanks. Numbers which do not fill the field should be padded with leading blanks.

FIELD	EXPLANATION
1	A binary number containing the record number of this record within the file. For the Volume Descriptor Record, this number is always 1.
2	The first-sub-type code for this record. This code is 300(8) for the Volume Descriptor Record.
3	This is the record type code. This code is 300(8) for the Superstructure records.
4	This is the second sub-type code for the record. If this record is in the Null Volume Directory File, then this field is coded 077(8). For all other Volume Directories, this is coded 022(8).
5	This is the third sub-type code for the record. Since none of the Superstructure records use this code, the field contains 022(8), which is the default code.
6	This field contains a binary number giving the length of this record in bytes.
7	The ASCII/EBCDIC flag indicates if the alphanumeric information in the Volume Directory File is in ASCII or EBCDIC. For the LANDSAT MSS format, ASCII only will be used, so this field will contain A$, where $ denotes an ASCII blank (i.e. 040(8)). Unless otherwise specified, $ represents a blank character.
8	Two blanks.
9	12 characters giving the Superstructure Format Control Document identifying number.
10	2 characters indicating the revision number or letter of the Superstructure Formal Control Document. Coded $A, for the original draft.
11	2 characters indicating the revision letter of the Superstructure Record formats. Coded $A for the original draft. This code updates one letter

character, alphabetically, each time there is a change to the format of a Superstructure Record (as opposed to a change to the control document which may not have been a change in the actual record format). The 26th revision is coded AA, the 27th AB, and so on.

TABLE 3.1.1.2
VOLUME DESCRIPTOR RECORD - EXPLANATION

FIELD	EXPLANATION
12	12 characters identifying the software version used to write this Logical Volume (i.e. the program name and version number).
13	This is a 16 character code also written or printed externally on the Physical Volume and used to uniquely reference a particular CCT. Also called the Tape Identifier. When a Logical Volume spans more than one Physical Volume, this code is updated for the continuation Physical Volumes. For CCRS CCTs this consists of two characters followed by four digits: <CCNNNN>, e.g. IS1234.
14	This is a 16 character code which uniquely identifies the Logical Volume. The logical volume identification will be made up in the following way: <DDDDHHMMSSXXXXXX> where: DDDD = Day number since launch HHMMSS = hours, minutes and seconds GMT at which the centre point was imaged (for precision processed products, this relates to the original Landsat frame). XXXXXX = Subframe specifier
15	A second 16 character field for identifying the Volume Set. The volume set identifier is LANDSAT$<A>$MSS$$$ where <A> is 1,2,3 or 4 for Landsat MSS CCTs. For Landsat MSS data there will always be only one logical volume per physical volume, and one logical volume will always be contained within one physical volume.
16	An integer which indicates the total number of Physical Volumes in a Volume Set. A blank field indicates that the information was not available at the time the Logical Volume was recorded.
17	This indicates the sequence number of the Physical Volume within a Volume Set, which contains the 1st record of the Logical Volume. For this format, this will always be 1 (2 characters).
18	This field indicates the sequence number of the last Physical Volume of a Volume Set. It should be coded blank if unknown at the time of recording. If the Logical Volume is contained on one Physical Volume, this field will have the same value as field 17 (2 characters).
19	This is the sequence number within the Volume Set of the Physical Volume that contains this Volume Directory File. If a Logical Volume is

contained on one Physical Volume, then this value is the same as that for field 17. The value in this field must lie within the values for fields 17 and 18, inclusively (e.g. if field 17 has a 1 and field 18 has a 3, then the value in field 19 can be 1,2 or 3, only) (2 characters).

TABLE 3.1.1.2
VOLUME DESCRIPTOR RECORD - EXPLANATION

FIELD   EXPLANATION

20   This field gives the file number within the Logical Volume which follows this Volume Directory. If this is not the first Volume Directory of a Logical Volume, then this value may be greater than one. Volume Directory Files are not included in the file sequence number count (4 characters).

21   This indicates the sequence number of the present Logical Volume within a Volume Set. The Null Volume Directory is considered part of the current Logical Volume, and hence this field, for the Null Volume Descriptor record, is identical to that in the corresponding Volume Descriptor record (4 characters).

22   This is the sequence number of the present Logical Volume within a Physical Volume.

23   8 characters for the date the Logical Volume was recorded. The code is of the form: <YYYYMMDD>, where YYYY is year, MM is month, and DD is day (e.g. 19790622 is June 22, 1979).

24   8 characters for the time when the Logical Volume was recorded. The code is of the form: <HHMMSSXX>, where HH is hours, MM is minutes, SS is seconds, and XX is hundredths of seconds.

25   12 characters for the name of the country generating this Logical Volume.

26   8 characters for the laboratory or centre generating this Logical Volume.

27   12 characters identifying the comp   uter facility on which the Logical Volume was recorded.

28   The number of File Pointer Records in this Directory File. This gives the number of data files in the Logical Volume (4 characters).

29   Total number of records in this Volume Directory. This will be the number of File Pointer Records plus one (for this record) plus the number of Text Records (4 characters).

30   92 bytes reserved for future revisions of this record format. This is reserved by the LGSOWG-CCB. This field is currently blanked.

31   100 bytes available for local use. This format does not use this field, so it is filled with blanks.

TABLE 3.1.1.3
VOLUME DESCRIPTOR RECORD - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	1
B	2	300(8)
B	3	300(8)
B	4	022(8)
B	5	022(8)
B	6	360
A	7	A$
A	8	$$
A	9	CCB-CCT-0002
A	10	$A
A	11	$A
A	12	LGSOWGCVF01$
A	13 *	<CCNNNN>$$$$$$$$$$
A	14	<DDDDHHMMSSXXXXXX>
A	15	LANDSAT$<A>$MSS$$$
N	16 *	1
N	17	1
N	18 *	1
N	19 *	1
N	20 *	1
N	21	1
N	22	1
A	23	<YYYYMMDD>
A	24	<HHMMSSXX>
A	25	CANADA $$$$$$
A	26	CCRS$$$$
A	27	MIPS$$$$$$$$$ or PERGS$$$$$$$$ or IPS-TSS$$$$$ or DICS$$$$$$$$
N	28	3 for BIL; 12 [15] for BSQ
N	29	5 for BIL; 14 [17] for BSQ
A	30	Blanks
A	31	Blanks

----

*   These values assume a single Physical Volume organization

TABLE 3.1.2.1
FILE POINTER RECORD - DEFINITION

NO	BYTE NOS	DESCRIPTION
1	1-4	Record Number
2	5	333(8) = File Pointer Record (1st record sub-type code)
3	6	Record Type Code = 300(8) = Superstructure
4	7	022(8) (2nd record sub-type code)
5	8	022(8) (3rd record sub-type code)
6	9-12	Length of this record (360 bytes)
7	13-14	ASCII/EBCDIC Flag
8	15-16	2 Blanks
9	17-20	Referenced File Number
10	21-36	Referenced File Name
11	37-64	Referenced File Class
12	65-68	Referenced File Class Code
13	69-96	Referenced File Data Type
14	97-100	Referenced File Data Type Code
15	101-108	Number of Records in Referenced File
16	109-116	Referenced File 1st Record Length
17	117-124	Referenced File Maximum Record Length
18	125-136	Referenced File Record Length Type
19	137-140	Referenced File Record Length Type Code
20	141-142	Referenced File Physical Volume Number, Start of File
21	143-144	Referenced File Physical Volume Number, End of File
22	145-152 *	Referenced File Portion, 1st Record Number for this Physical Volume
23	153-260	Pointer Spare Segment
24	261-360	Local Use Segment

----

*   Field to be updated in a repeated Volume Directory if Logical Volume split within a file

TABLE 3.1.2.2
FILE POINTER RECORD - EXPLANATION

Fields 1 to 6 are binary encoded fields. All other fields are in ASCII. Alphanumeric character strings are left-justified and numeric character strings are right-justified. Any fields not used are filled with blanks.   Numbers which do not fill the field should be padded with leading blanks. The File Pointer Record occupies 360 bytes.

FIELD   EXPLANATION

1   A binary number containing the record number of this record within the file. This number will be between 2 and the number specified in field 29 of the Volume Descriptor Record.

2   The first sub-type code for this record. This code is 338(8) for the File Pointer Records.

3   This is the record type code. This code is 300(8) for the Superstructure records.

4   This is the second sub-type code for the record. For this record, the code is 022(8), the default code.

5   This is the third sub-type code for the record. Since none of the Superstructure records use this code, the field contains 022(8), which is the default code.

6   This field contains a binary number giving the length of this record in bytes. This value is 360 for this record.

7   The ASCII/EBCDIC flag indicates if the alphanumeric information in the referenced file is in ASCII or EBCDIC. For the LANDSAT MSS format, ASCII only will be used, so this field will contain A$.

8   Two blanks.

9   Sequence number within the Logical Volume of the file referenced by this pointer. This is also the sequence number of the File Pointer Record within the Volume Directory. The first file following the first Volume Directory (2nd file of the Logical Volume) is file number 1 (4 characters).

10   A 16 character name which is the unique identification provided when the volume directory is created in order to specify the file referenced by this pointer.

11   This is a 28 character description of the class to which the referenced file belongs. The class of a file is based on the nature of its content.

12   The 4-byte code for the class described in field 11.

TABLE 3.1.2.2
FILE POINTER RECORD - EXPLANATION

FIELD   EXPLANATION

13   This 28-character field indicates the data type contained in the referenced
               file.

14   The 4-byte code for the data type described in field 13.

15   This 8 character field indicates the number of records in the referenced
               file. If this number is not known at the creation time, then this field is
               blank.

16   8 characters for the length, in bytes, of the File   Descriptor Record in the
               referenced file. A blank field indicates that the information was not
               available at the time the Logical Volume was recorded.

17   8 character field for the length, in bytes, of the longest record in the
               referenced file other than the File Descriptor Record.

18   12 characters for the record length type. For this format, fixed length
               records are used, so this field will contain 'FIXED LENGTH'. The record
               length is given in field 17.

19   4-byte code for the record length type in field 18. For this format, this is
               'FIXD'.

20   2 characters for the Physical Volume sequence number which contains
               the first record of the referenced file. May be left blank if information
               unknown at time of recording.

21   2 characters for the Physical Volume sequence number which contains
               the last record of the referenced file. May be left blank if information
               unknown at time of recording.

22   When a portion of the referenced file is on the PREVIOUS Physical
               Volume, this 8 character number is the record number of the first record of
               the referenced file to be recorded on THIS Physical Volume. In all other
               conditions, this number is 1. This is the only field in a File Pointer Record
               to be changed on a repeated Volume Directory and is only changed in the
               File Pointer Record that refers to the split file.

23   108 bytes reserved for subsequent revisions. This is reserved by the
               LGSOWG-CCB.

24   100 bytes available for local use. This format does not use this field.

TABLE 3.1.2.3
FILE POINTER RECORD FOR LEADER FILE - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	2 for BIL; 2,5,8,11,[14] for BSQ
B	2	333(8)
B	3	300(8)
B	4	022(8)
B	5	022(8)
B	6	360
A	7	A$
A	8	$$
N	9	1 for BIL; 1,4,7,10[13] for BSQ
A	10 **	LS1$MSSRLEADBIL$
		2 S BSQ1
		3 P BSQ2
		4 BSQ3
		BSQ4
		BSQ5
A	11	LEADER$FILE
A	12	LEAD
A	13	MIXED$BINARY$AND$ASCII
A	14	MBAA
N	15	10 - BIL
		7 - BSQ
N	16	1800
N	17	1800
A	18	FIXED$LENGTH
A	19	FIXD
N	20 *	1
N	21 *	1
N	22 *	1
A	23	Blanks
A	24	Blanks

----

*   These values assume a single Physical Volume organization
**   This field can take as value 72 (4*3*6) combinations,   e.g.
         LS2$MSSPBSQ4$

TABLE 3.1.2.4
FILE POINTER RECORD FOR IMAGERY FILE - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	3 for BIL; 3,6,9,12,[15] for BSQ
B	2	333(8)
B	3	300(8)
B	4	022(8)
B	5	022(8)
B	6	360
A	7	A$
A	8	$$
N	9	2 for BIL; 2,5,8,11,[14] for BSQ
A	10 **	LS1$MSSRIMGYBIL$
		2 S BSQ1
		3 P BSQ2
		4 BSQ3
		BSQ4
		BSQ5
A	11	IMAGERY$FILE
A	12	IMGY
A	13	BINARY$ONLY
A	14	BINO
N	15	2341 for raw or system corrected - BSQ
		<1200 for precision processed - BSQ
		9361 for raw or system corrected - BIL
		<4800 for precision processed - BIL
N	16	3600 for raw or system corrected
		1980 for precision processed
N	17	3600 for raw or system corrected
		1980 for precision processed
A	18	FIXED$LENGTH
A	19	FIXD
N	20 *	1
N	21 *	1
N	22 *	1
A	23	Blanks
A	24	Blanks

----

*   These values assume a single Physical Volume organization

**   This field can take as value 72 (4*3*6) combinations,   e.g.
LS2$MSSPBSQ4$

TABLE 3.1.2.5
FILE POINTER RECORD FOR TRAILER FILE - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	4 for BIL; 4,7,10,13,[16] for BSQ
B	2	333(8)
B	3	300(8)
B	4	022(8)
B	5	022(8)
B	6	360
A	7	A$
A	8	$$
N	9	3 for BIL; 3,6,9,12,[15] for BSQ
A	10 **	LS1$MSSRTRAIBIL$
		2 S BSQ1
		3 P BSQ2
		4 BSQ3
		BSQ4
		BSQ5
A	11	TRAILER$FILE
A	12	TRAI
A	13	MIXED$BINARY$AND$ASCII
A	14	MBAA
N	15	5 - BIL
		2 - BSQ
N	16	1800
N	17	1800
A	18	FIXED$LENGTH
A	19	FIXD
N	20 *	1
N	21 *	1
N	22 *	1
A	23	Blanks
A	24	Blanks

----

*   These values assume a single Physical Volume organization
**   This field can take as value 72 (4*3*6) combinations,   e.g.
            LS2$MSSPBSQ4$

TABLE 3.1.3.1
TEXT RECORD - DEFINITION

NO	BYTE NOS	DESCRIPTION
1	1-4	Record Number
2	5	1st record sub-type code = 022(8)
3	6	record type code, always = 077(8)
4	7	2nd record sub-type code = 022(8)
5	8	3rd record sub-type code = 022(8)
6	9-12	Length of this record
7	13-14	ASCII/EBCDIC flag for this record
8	15-16	Continuation flag
9	17-66	Product type
10	67-124	Location and date/time of product creation
11	125-173	Scene identification
12	174-216	Physical tape identification
13	217-360	Blanks

TABLE 3.1.3.2
VOLUME DIRECTORY FILE TEXT RECORD - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	5 for BIL; 14 [17] for BSQ
B	2	022(8)
B	3	077(8)
B	4	022(8)
B	5	022(8)
B	6	360
A	7	A$
A	8	$$
A	9	Bytes 17 to 66:-

        PRODUCT:$$LANDSAT1MSS$BIL$$RAW$$$$
$$$$$$$$$$$$<CRLF>
2   BSQ4$SYSTEM$CORRECTED$$$
3   BSQ5$PRECISION$PROCESSED
4

| A | 10 | Bytes 67 to 124:- |

        PROCESSED:$$CANADA$CCRS$MIPS$$$$$ON$<
YYYYMMDD>AT<HHMMSSXX><CRLF>
        PERGS$$$$
        IPS-TSS$$
        DICS$$$$$

| A | 11 | Bytes 125 to 173:- |

        SCENE$$:$$<LDDDDHHMMSS>$<XXXXXX>$IMA
GEDON<YYYYMMDD><CRLF>

| A | 12 | Bytes 174 to 216:- |

        TAPE$ID:$$<XXNNNN>$$$$$$$$$$$TAPE$<MM>
OF<LL><CRLF>

| A | 13 | Blanks |

NOTE: <CRLF> denotes "carriage return, line feed"

TABLE 3.1.3.3
VOLUME DIRECTORY FILE TEXT RECORD - EXPLANATION

FIELD   EXPLANATION

1-6   The contents of fields 1 to 6 are defined by the LGSOWG standard
             format.

10   The date of recording the Logical Volume is stored in the form
             <YYYYMMDD>, where YYYY is the year, MM is the month and DD is the
             day (e.g. 19790622 is June 22, 1979).

11   The scene identification is made up in the following way:
                              <LDDDDHHMMSS>
             where:
                              L=Mission number 1,2,3 or 4
                              DDDD=Day number since launch
                              HHMMSS=Hours, minutes and seconds GMT at which the
             centre point was imaged. (For precision-processed products, this
             relates to the original Landsat frame).
                              <XXXXXX>=Subframe specifier
             In addition, the date of recording of the original Landsat image is stored
             in the form <YYYYMMDD>, where YYYY is the year, MM is the month, and
             DD is the day (e.g. 19790622 is June 22, 1979).

12   The physical tape identification is made up in the following way:
             16 character tape identification,   e.g. IS1234 ...., followed by the tape
             sequence number, <MM>, within the Physical Volume set containing a
             total of <LL> tapes.

3.2   LEADER FILE

Leader files precede image data files, supplying information associated with the image, such as image product identification and annotation, ephemeris and attitude data, processing information and other ancillary information. One leader file is associated with each imagery file. Hence for Band Sequential structures, which contain one imagery file for each band, there will be one leader file for each band. For Band Interleaved by Line structures, which contain one imagery file accommodating all bands, there will be only one leader file.

The leader file is of the class LEADER FILE with the class code LEAD. Each leader file contains the following record types:

1.   File Descriptor Record

2.   1 Header Record

3.   3 Ancillary Records (Geometric)

4.   'k' Ancillary Records (Radiometric), where 'k' is 1 for BSQ structures and 4 for BIL structures

5.   1 Annotation Record

The leader file is recorded in ASCII.

3.2.1   FILE DESCRIPTOR RECORD

All File Descriptor Records are composed of two segments, a fixed and a variable segment. The fixed segment provides information on how to read the file, and the variable segment indicates how to locate key data of the file. The File   Descriptor Record Fixed Segment is defined in Table 3.2.1.1 and explained in Table 3.2.1.2. Its contents, for the Leader File, are shown in Table 3.2.1.3. The File   Descriptor Record Variable Segment of the Leader file is defined in Table 3.2.1.4 and explained in Table 3.2.1.5. Its contents are shown in Table 3.2.1.6.

TABLE 3.2.1.1
FILE DESCRIPTOR RECORD - DEFINITION

NO	BYTE NOS	DESCRIPTION
1	1-4	Record Number
2	5	077(8) = File Descriptor Record (1st record sub-type code)
3	6	Record Type Code = 300(8) = Superstructure
4	7	022(8) (2nd record sub-type code)
5	8	022(8) (3rd record sub-type code)
6	9-12	Length of this record
7	13-14	ASCII/EBCDIC Flag
8	15-16	2 Blanks
9	17-28	Control Document Number for this Data File Format
10	29-30	Control Document Revision Number
11	31-32	File Design Descriptor Revision Letter
12	33-44	Software Release Number
13	45-48	File Number
14	49-64	File Name
15	65-68	Record Sequence and Location Type Flag
16	69-76	Sequence Number Location
17	77-80	Sequence Number Field Length
18	81-84	Record Code and Location Type Flag
19	85-92	Record Code Location
20	93-96	Record Code Field Length
21	97-100	Record Length and Location Type Flag
22	101-108	Record Length Location
23	109-112	Record Length Field Length
24	113	Flag indicating that data interpretation information is included within the file descriptor record
25	114	Flag indicating that data interpretation information is included within the file in record(s) other than the descriptor
26	115	Flag indicating that data display information is included within the file descriptor record
27	116	Flag indicating that data display information is included within the file in record(s) other than the file descriptor
28	117-180	Reserved Segment
29	181-EOR	File Descriptor Variable Segment (EOR = End-of-Record)

TABLE 3.2.1.2
FILE DESCRIPTOR RECORD - EXPLANATION

Fields 1 to 6 are binary encoded fields. All other fields are in ASCII. Alphanumeric character strings are left-justified and numeric character strings are right-justified. Any fields not used are filled with blanks. Numbers which do not fill the field are padded with leading blanks.

FIELD	EXPLANATION
1	A binary number containing the record number of this record within the file. For the File Descriptor Record, this number is always 1.
2	The first sub-type code for this record. This code is 077(8) for the File Descriptor Record.
3	This is the record type code. This code is 300(8) for the Superstructure records.
4	This is the second sub-type code for the record. For this record, the code is 022(8), the default code.
5	This is the third sub-type code for the record. Since none of the Superstructure records use this code, the field contains 022(8), which is the default code.
6	This field contains a binary number giving the length of this record in bytes.
7	The ASCII/EBCDIC flag indicates if the alphanumeric information in the Referenced File is in ASCII or EBCDIC. For the LANDSAT MSS format, ASCII only will be used, so this field will contain A$.
8	Two blanks.
9	12 characters containing the number for the document t hat controls this file format.
10	2-bytes giving the revision number of the control document defining the current file format.
11	2-bytes giving the revision letter of the file format (as opposed to revisions which affect the control document without affecting the file format).
12	12 characters identifying the software version used to write this file.

13   4-byte sequence number of this file within the Logical Volume, excluding the volume directory.

TABLE 3.2.1.2
FILE DESCRIPTOR RECORD - EXPLANATION

FIELD	EXPLANATION
14	This is the unique 16 character iodentification of the present file as stated in field 10 of the File Pointer Record of the Volume Directory File.
15	This 4-byte field indicates if the other records in the file have sequence numbers.
16	These eight bytes give the location of the start of the sequence number field. They give the record byte number of the first byte of the field.
17	Four bytes indicating the length, in bytes, of the record sequence number field.
18	4-byte flag to indicate if the other records in the file have a record type code, and if the location of the code is fixed or variable.
19	These eight bytes give the location of the start of the record type code field. They give the record byte number of the first byte of the field.
20	Four bytes, indicating the length, in bytes, of the record type code field.
21	4-byte flag to indicate if the other records in the file contain their record lengths.
22	These eight bytes give the location of the start of the record lengt h field. They give the record byte number of the first byte of the field.
23	Four bytes, indicating the length, in bytes, of the record length field.
28	64 bytes for future expansion. Reserved by the LGSOWG-CCB.
29	File descriptor variable segment (see Tables 3.2.1.4, 3.3.1.2 and 3.4.1.2).

TABLE 3.2.1.3
LEADER FILE - FILE DESCRIPTOR RECORD FIXED SEGMENT - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	1
B	2	077(8)
B	3	300(8)
B	4	022(8)
B	5	022(8)
B	6	1800
A	7	A$
A	8	$$
A	9	DPDTM$79-103
A	10	$A
A	11	$A
A	12	LGSOWGCVF01$
N	13	1 for BIL; 1,4,7,10,[13] for BSQ
A	14 **	LS1$MSSRLEADBIL$
		2 S BSQ1
		3 P BSQ2
		4 BSQ3
		BSQ4
		BSQ5
A	15	FSEQ
N	16	1
N	17	4
A	18	FTYP
N	19	5
N	20	4
A	21	FLGT
N	22	9
N	23	4
A	24	Y
A	25	N
A	26	N
A	27	N
A	28	Blanks

**   This field can take as value 72 (4*3*6) combinations,   e.g. LS2$MSSPBSQ4$

TABLE 3.2.1.4
LEADER FILE - FILE DESCRIPTOR RECORD VARIABLE SEGMENT - DEFINITION

NO	BYTE NOS	DEFINITION
1	1-6 *	Number of Header Records
2	7-12	Header Record length
3	13-18	Number of Ancillary Records
4	19-24	Ancillary Record Length
5	25-30	Number of Annotation Records
6	31-36	Annotation Record length
7	37-52	Scene Identification Field locator
8	53-68	WRS Identification Field locator
9	69-84	Mission Identification Field locator
10	85-100	Sensor Identification Field locator
11	101-116	Exposure date-time Field locator
12	117-132	Geographic Reference Field locator
13	133-148	Image Processing Performed Field locator
14	149-164	Imagery Format (Interleaving) Indicator locator
15	165-180	Band Indicator locator
16	181-196	Subscene Indicator locator
17	197-1620	Blanks

----

*   Byte 1 of variable segment is byte 181 of record

TABLE 3.2.1.5
LEADER FILE - FILE DESCRIPTOR RECORD VARIABLE SEGMENT   -
EXPLANATION

FIELD   EXPLANATION

1-6   Number of records of each of up to three record types. It is assumed that
               records of a given type are grouped together. This necessitates that text
               records be located at the end of the file.

1   The number of group 1 (first record type) records in the file.

2   The length, in bytes, of group 1 records.

3   The number of group 2 records in the file.

4   The length, in bytes, of group 2 records.

5   The number of group 3 records in the file.

6   The length, in bytes, of group 3 records.

7-16   While the first 6 fields of this variable segment provide actual information,
               the remaining nine fields are locator fields which point to the position in
               the file where various information may be found. The location of the
               desired field is given in 16 bytes, coded as follows:

                       6 bytes - the record number of the record containing the
               field

                       6 bytes - the record byte number of the first byte of the
               field

                       3 bytes - length of the field in bytes

                       1 byte - a code for the type of data in the field

               Codes are:

                       A=Alphanumeric in ASCII or EBCDIC
                       B=Binary
                       N=numeric in ASCII or EBCDIC

7   Location of the scene identification.

8   Location of the WRS identification.

9   Location of the mission identification.

10   Location of the sensor identification.

11   Location of the image exposure date and time field.

TABLE 3.2.1.5
LEADER FILE - FILE DESCRIPTOR RECORD VARIABLE SEGMENT   -
EXPLANATION

FIELD	EXPLANATION
12	Location of the field which references the image geographically.
13	Location of the field which indicates what processing has been performed on the image data, e.g. whether radiometric or geometric corrections have been applied.
14	Location of the field which tells if the data are Band-Interleaved-by-Line or Band-Sequential, etc.
15	Location of the field which indicates which image(s) [band(s)] is (are) given in the image set.
16	Location of the field which indicates the subscene recorded in this CCT.
17	Blanks to fill the record.

TABLE 3.2.1.6
LEADER FILE - FILE DESCRIPTOR RECORD VARIABLE SEGMENT - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
N	1	1
N	2	1800
N	3	7 for BIL; 4 for BSQ
N	4	1800
N	5	1
N	6	1800
A	7	2,37,16,A
A	8	2,165,16,A
A	9	2,309,16,A
A	10	2,325,16,A
A	11	2,117,32,A
A	12	2,213,32,N
A	13	2,1477,96,A
A	14	2,1781,16,A
A	15	2,1653,64,A
A	16	2,197,16,A
A	17	Blanks

3.2.2   HEADER RECORD

The Header Record contains four sets of information   : the first defines the scene contained in this logical volume, the second relates to fixed information about the mission, the third defines the sensor parameters and the fourth indicates the processing options. The Header Record is defined and explained in Tables 3.2.2.1 and 3.2.2.2 respectively.

TABLE 3.2.2.1
HEADER RECORD DEFINITION

FIELD TYPE	FIELD NUMBER	BYTE	DESCRIPTION
B	1	1-4	Record Sequence Number = 2
B	2	5	First subtype code = 022(8)
B	3	6	Record type code = 022(8)
B	4	7	Second subtype code = 022(8)
B	5	8	Third subtype code = 022(8)
B	6	9-12	Record length = 1800
N	7	13-16	Header record sequence number
A	8	17-20	Blanks
			SCENE PARAMETERS
A	9	21-36	Product identification
A	10	37-52	Input scene identification
N	11	53-68	Input scene centre latitude in degrees
N	12	69-84	Input scene centre longitude in degrees
N	13	85-100	Line number at input scene centre
N	14	101-116	Pixel number at input scene centre
A	15	117-148	Input scene centre time
N	16	149-164	Time offset from WRS frame in milliseconds
A	17	165-180	WRS designator (path and row)
N	18	181-196	WRS cycle
A	19	197-212	Processed scene identification
N	20	213-228	Processed scene centre latitude in degrees
N	21	229-244	Processed scene centre longitude in degrees
N	22	245-260	Line number at processed scene centre
N	23	261-276	Pixel number at processed scene centre
A	24	277-292	Spare
A	25	293-308	Spare
			MISSION PARAMETERS
A	26	309-324	Mission identification
A	27	325-340	Sensor identification
N	28	341-356	Orbit number
A	29	357-372	Spare
			SENSOR PARAMETERS
N	30	373-388	Spare
N	31	389-1412	Upper and lower limits of wavelength range in nanometres, 8 bytes per limit, 16 bytes per channel

N	32	1413-1428	Number of active channels in the processed image
N	33	1429-1444	Number of scene pixels per line in the processed image
N	34	1445-1460	Number of scene lines in the processed image

TABLE 3.2.2.1
HEADER RECORD DEFINITION

FIELD TYPE	FIELD NUMBER	BYTE	DESCRIPTION
			PROCESSING PARAMETERS
A	35	1461-1476	Spare
A	36	1477-1492	Radiometric calibration designator
N	37	1493-1508	Radiometric resolution designator
A	38	1509-1524	Scenic radiometric correction designator
A	39	1525-1540	Geometric correction designator
A	40	1541-1556	Resampling designator
A	41	1557-1572	Map projection identifier
A	42	1573-1588	Spare
N	43	1589-1604	Number of Map Projection ancillary records
N	44	1605-1620	Number of Ground Control Points ancillary records
N	45	1621-1636	Number of Ephemeris and Attitude ancillary records
N	46	1637-1652	Number of Radiometric ancillary records
N	47	1653-1716	Active channels (one byte per channel, maximum of 64 channels)
A	48	1717-1780	Spare
N	49	1781-1796	Interleaving indicator
N	50	1797-1800	Spare

TABLE 3.2.2.2
HEADER RECORD - EXPLANATION

FIELD   EXPLANATION

NOTE: From field 9, all fields in the Header record are multiples of 16 bytes long, and are in either Numeric or Alphanumeric format. All Numeric fields are right-justified and the default format is F16.7 unless otherwise specified. All Alphanumeric fields are left-justified.

1-6   The contents of fields 1 to 6 are defined by the LGSOWG Standard format.

7   The header record sequence number is always 1.

9   Product identification:
                           CCRS$MIPS$RAW$$$
                           CCRS$MIPS$SYSCOR
                           CCRS$PERG$RAW$$$
                           CCRS$PERG$SYSCOR
                           CCRS$IPTS$RAW$$$
                           CCRS$IPTS$SYSCOR
                           CCRS$DICS$UTMCOR

10   The input scene identification is made up as follows
                 <LDDDDHHMMSS>$$$$$, where:
                           L=Mission number 1,2,3 or 4
                           DDDD=Day number since launch
                           HHMMSS=Hours, minutes and seconds GMT at which the
                 centre point was imaged.

13   This is the line number which is designated at the input scene centre
                           Landsat-1 = 1170.5
                           Landsat-2 = 1170.5
                           Landsat-3 = 1170.5
                           Landsat-4 = TBD

14   This is the pixel number which is designated at the input scene centre
                           Landsat-1 = 1605.5
                           Landsat-2 = 1620.5
                           Landsat-3 = 1595.5
                           Landsat-4 = TBD

15   The input scene centre time is made up as follows:
                 <YYYYNNDDHHMMSSFFF>, followed by 15 blanks, where
                           YYYY=year

44

NN=month
DD=day
HH=hours (00 to 23)
MM=minutes (00 to 59)
SS=seconds (00 to 59)
FFF=milliseconds (000 to 999)

TABLE 3.2.2.2
HEADER RECORD - EXPLANATION

FIELD   EXPLANATION

16   Time offset in milliseconds from standard framing corresponding to
               Worldwide Reference System.

17   WRS Designator, made up as follows:

               <MPPPRRR>$, followed by 8 blanks, where:
                           M=A (for ascending node)
                           M=D (for descending node)
                           PPP=WRS nominal path number (001-251)
                           RRR=WRS nominal row number (001-248)

               For non-standard framing, this refers to the standard frame containing the
               scene centre.

18   Number of orbital cycles since launch.

19   The processed scene identifier is the same as the input scene identifier
               for raw and system-corrected data. For precision processed imagery it
               identifies the National Topographic System quadrangles covered by the
               processed scene as follows:
               <QQQLSSBB>, followed by 8 blanks
               where:
                           QQQ is a 3-digit binary quadrangle
                           L is a 1-letter quadrangle designator
                           SS is a 2-digit designator for one sixteenth of a lettered
                           quadrangle
                           BB are two blanks

22   This is the line number which is designated as the processed scene
               centre.

23   This is the pixel number which is designated as the processed scene
               centre.

24   Spare

25   Spares

26   LS1$, LS2$, LS3$, LS4$, followed by 12 blanks, for   Landsat 1,2,3 or 4
               respectively.

27   Sensor identification will be MSS$, followed by 12 blanks, for the Multispectral Scanner.

28   This is the total number of orbits since launch.

TABLE 3.2.2.2
HEADER RECORD - EXPLANATION

FIELD   EXPLANATION

29   Spares

30   Spare

31   These are the wavelength limits sensed by the MSS, 1024 bytes.

32   The total number of active channels is n. All subsequent reference to
               channel number is by "logical channel number", where each of the active
               channels, in ascending order, is assigned a "logical channel number" in
               the range l to n.

33   This is the actual number of scene   pixels per line in the imagery file
               following this Leader file.

               For raw and system-corrected products, the value will be:
                       Landsat 1 - 3240
                       Landsat 2 - 3210
                       Landsat 3 - 3192

34   This is the actual number of scene lines in the imagery file following this
               Leader file.

35   Spares

36-41   The processing options are stored as sixteen-byte designators, as
               follows:

36   Radiometric (sensor) calibration

               The first four bytes take the following values:
                       NONE - no radiometric calibration
                       CAL1 - striping removal only
                       CAL2 - CAL2 radiometric calibration
                       CAL3 - CAL3 radiometric calibration

               The second four bytes take the following values, to indicate the data
               representation:

                       RAW$ - raw (compressed) representation
                       LIN$ - linear (decompressed) representation
                       LOG$ - logarithmic representation

The third four bytes take the following values to indicate the   destriping method:

NONE - raw
MNSD - mean and standard deviations

TABLE 3.2.2.2
HEADER RECORD - EXPLANATION

FIELD   EXPLANATION

The radiometric calibration designator will be formed by combining one from each of the three sets.   E.g. for CAL2 radiometric calibration in a logarithmic representation, the radiometric calibration designator would be: CAL2LOG$MNSD. For   radiometrically raw data the radiometric designator would be: NONERAW$NONE.

The last 4 bytes are blank.

37   Radiometric resolution

The number of bits required to store the maximum data range:
        6 - for 6-bit data which has not been radiometrically
calibrated
        8 - for 8-bit radiometrically calibrated data

38   Scenic radiometric correction
        NONE - none

Scenic radiometric corrections will be indicated by any combination of the following codes:
        S - Sun illumination angle correction
        H - Haze correction

E.g. for sun illumination angle correction and haze correction, the scenic radiometric correction designator will be: SH followed by 14 blanks.

39   Geometric correction
        NONE - none
        PRECISION - NTS compatible precision correction

System corrections will be indicated by any combination of the following byte codes, preceded by the characters SYSTEM:
        E - Earth rotation correction
        P - Panoramic distortion and earth curvature correction
        M - Mirror scan velocity correction
        L - Line length correction

E.g. for earth rotation correction, panoramic distortion and earth curvature correction and mirror scan velocity correction, the geometric correction designator would be: SYSTEMEPM followed by 7 blanks.

TABLE 3.2.2.2
HEADER RECORD - EXPLANATION

FIELD	EXPLANATION

40   Resampling algorithm
            NONE - None (always applicable to raw products)
            NN - Nearest neighbour (usually applicable to system
corrected products)
            CC - Cubic convolution
            S8 - 8-point (sin x)/x
            DS8 - 8-point damped (sin x)/x
            S16 - 16-point (sin x)/x
            DS16 - 16-point damped (sin x)/x

41   Map projection four-byte designator for precision processed data.
            NONE - None (always applicable to raw or system-
corrected products)
            UTM - UTM projection

42   Spares

43,44,45   These fields specify the number of ancillary records of each type.

43   Total number of Map Projection ancillary records in the Leader file.

44   Total number of Ground Control Points ancillary records in the Leader file.

45   Total number of Ephemeris and Attitude ancillary records in the Leader
            file.

46   Total number of Radiometric ancillary records in the Leader file.

47   This field may be considered as 64 bytes, where the n'th byte is set to 1 if
            the channel is active, and to 0 otherwise.

48   Spare

49   This field takes the value 'BIL', followed by 13 blank bytes, if the data is
            Band Interleaved by Line, or 'BSQ', followed by 13 blank bytes, if the
            organization is Band Sequential.

3.2.3 ANCILLARY RECORDS

There are four types of ancillary records. They are:

1. Map Projection Record, (one)

2. Ground Control Points Record, (one or more)

3. Ephemeris and Attitude Record, (one)

4. Radiometric Ancillary Record, (one or four)

To maintain compatibility between Leader files of different products, there will always be (at least) one record of each type, although its contents may be blank, due to the particular type of processing carried out. For raw and system-corrected products, the Ground Control Points Ancillary record will contain no Ground Control Point definitions. For Landsat 1,2 and 3 archival data, it is not anticipated that there will be any Ephemeris and Attitude data, but this record is included for upward compatibility with Landsat 4. All records are in ASCII and are 1800 bytes long.

3.2.3.1 MAP PROJECTION ANCILLARY RECORD -

The Map Projection Ancillary Record provides information about the geometric characteristics of the input (raw) and processed imagery data, as described in Table 3.2.3.1.1, and explained in Table 3.2.3.1.2. All data fields are in FORTRAN format F16.7.

3.2.3.2 GROUND CONTROL POINTS ANCILLARY RECORD -

Each Ground Control Points (GCP) ancillary record contains a maximum of 10 GCPs. The format allows for one or more such record in the leader file. For raw and system corrected CCTs the leader file has only one GCP ancillary record and it contains a count of zero GCPs, with the rest of the record being blank filled. For the precision processed CCT it usually consists of one record containing less than 10   GCPs. The Ground Control Points ancillary record is defined in Table 3.2.3.2.1 and explained in Table 3.2.3.2.2. Fields which are undefined are left blank.

3.2.3.3 EPHEMERIS AND ATTITUDE ANCILLARY RECORD -

This record will be blank-filled for   Landsat 1,2 and 3 raw, system-corrected and precision processed products. The format is shown in Table 3.2.3.3.1.

3.2.3.4 RADIOMETRIC ANCILLARY RECORDS -

There is one Radiometric Ancillary Record for each of the bands accommodated in the accompanying image data file. Thus, given a Leader file there will be four for BIL

structures and one for BSQ structures. Each Radiometric Ancillary Record contains radiometric calibration tables used in converting the raw data to the form stored on this tape, for all six detectors within the band. In addition it contains the information required to convert linear digital data to the scene radiance in watts/m2sr. It is shown in Table 3.2.3.4.1 and explained in Table 3.2.3.4.2.

3.2.4   ANNOTATION RECORD

Annotation records are used to define the alphanumeric   information which is to be printed on film products. Each character string to be printed is defined in a unique Annotation Segment within the Annotation record. Each Annotation Segment contains position, size and colour coding information for one character string. Annotation segments may not cross record boundaries. However, sufficient records, with identical structure, may be defined in order to accommodate all the character strings. The format of the Annotation record is given in Table 3.2.4.1 and explained in Table 3.2.4.2. Its contents are shown in Table 3.2.4.3.

TABLE 3.2.3.1.1
MAP PROJECTION ANCILLARY RECORD - DEFINITION

FIELD TYPE	FIELD NUMBER	BYTE	DESCRIPTION
B	1	1-4	Record sequence number = 3
B	2	5	First record sub-type code = 044(8)
B	3	6	Record type code = 044(8)
B	4	7	Second record sub-type code = 022(8)
B	5	8	Third record sub-type code = 022(8)
B	6	9-12	Record length = 1800
N	7	13-16	Map projection ancillary record sequence number
N	8	17-20	Blanks
			MAP PROJECTION DATA
N	9	21-36	Nominal number of scene data pixels per input line
N	10	37-52	Nominal number of scene data lines per input image
N	11	53-68	Nominal scale of input inter-pixel distance in metres
N	12	69-84	Nominal scale of input inter-line distance in metres
N	13	85-100	UTM zone number for input image
N	14	101-116	Northing of input image centre in metres
N	15	117-132	Easting of input image centre in metres
N	16	133-148	Orientation of input image centre in degrees
N	17	149-164	Number of pixels per line of processed image
N	18	165-180	Number of lines per processed image
N	19	181-196	Scale of processed inter-pixel distance in metres
N	20	197-212	Scale of processed inter-line distance in metres
N	21	213-228	UTM zone number for processed image
N	22	229-292	Spare
N	23	293-356	Spare
N	24	357-420	Spare
N	25	421-436	Orientation of processed image centre in degrees
N	26	437-452	Nominal altitude in metres
N	27	453-468	Nominal ground speed in metres per second
N	28	469-484	Satellite heading in degrees
N	29	485-500	Angle of drift at centre in degrees
N	30	501-516	Sun elevation angle at centre in degrees

N	31	517-532	Sun azimuth angle at centre in degrees
N	32	533-548	Cross-track field of view in degrees
N	33	549-564	Sensor scan rate in scans per second

TABLE 3.2.3.1.1
MAP PROJECTION ANCILLARY RECORD - DEFINITION

FIELD TYPE	FIELD NUMBER	BYTE	DESCRIPTION
N	34	565-580	Sensor active sa mpling rate in samples per second
N	35	581-708	Precise UTM coordinates for processed image four corners in metres
N	36	709-836	Precise latitude and longitude for processed image four corners in degrees
N	37	837-964	Precise coordinates for processed image four corners expressed in input pixels and lines
A	38	965-1800	Spare

TABLE 3.2.3.1.2
MAP PROJECTION ANCILLARY RECORD - EXPLANATION

FIELD   EXPLANATION

28   This is the real subsatellite track direction angle, including earth rotation, in degrees at the centre of the image

29   This is the angle of drift (skew) at the centre of the image due to earth rotation

34   This is the internal clock sampling rate in samples per second

35   UTM coordinates of the four corners are given in the following order:
Northing of top left corner
Easting of top left corner
Northing of top right corner
Easting of top right corner
Northing of bottom right corner
Easting of bottom right corner
Northing of bottom left corner
Easting of bottom left corner

36   Latitude and longitude of the four corners are given in the following order:
Latitude of top left corner
Longitude of top left corner
Latitude of top right corner
Longitude of top right corner
Latitude of bottom right corner
Longitude of bottom right corner
Latitude of bottom left corner
Longitude of bottom left corner

37   Pixel and line coordinates of the four corners are given in the following order:

Pixel number of top left corner
Line number of top left corner
Pixel number of top right corner
Line number of top right corner
Pixel number of bottom right corner
Line number of bottom right corner
Pixel number of bottom left corner
Line number of bottom left corner

TABLE 3.2.3.2.1
GROUND CONTROL POINTS ANCILLARY RECORD - DEFINITION

FIELD TYPE	FIELD NUMBER	BYTE NUMBER	DESCRIPTION
B	1	1-4	Record sequence number = 4
B	2	5	First record sub-type code = 011(8)
B	3	6	Record type code = 044(8)
B	4	7	Second record sub-type code = 022(8)
B	5	8	Third record sub-type code = 022(8)
B	6	9-12	Record length = 1800
N	7	13-16	GCP ancillary record sequence number
N	8	17-20	Number of GCPs in this record
			GROUND CONTROL POINT DATA
A	9	21-80	Spare
A	10	81-252	Definition of 1st GCP in this record
A	10.1		81-88 Topographic map type
A	10.2		89-96 Topographic map identification
N	10.3		97-100 UTM zone of GCP
N	10.4		101-112 Northing of GCP
N	10.5		113-124 Easting of GCP
N	10.6		125-136 Northing location error of GCP
N	10.7		137-148 Easting location error of GCP
N	10.8		149-152 Elevation of GCP
A	10.9		153-164 Reference image identification
A	10.10		165-168 Reference image type
N	10.11		169-176 Reference image pixel coordinate
N	10.12		177-184 Reference image line coordinate
A	10.13		185-216 GCP description
N	10.14		217-224 GCP coordinate
N	10.15		225-232 GCP coordinate
A	10.16		233-236 GCP flags
A	10.17		237-252 Spare
A	11	253-424	Definition of 2nd GCP in this record
A	12	425-596	Definition of 3rd GCP in this record
A	13	597-768	Definition of 4th GCP in this record
A	14	769-940	Definition of 5th GCP in this record
A	15	941-1112	Definition of 6th GCP in this record
A	16	1113-1284	Definition of 7th GCP in this record
A	17	1285-1456	Definition of 8th GCP in this record
A	18	1457-1628	Definition of 9th GCP in this record
A	19	1629-1800	Definition of 10th GCP in this record

TABLE 3.2.3.2.2
GROUND CONTROL POINTS ANCILLARY RECORD - EXPLANATION

FIELD	EXPLANATION
1-6	The contents of fields 1 to 6 are defined by the LGSOWG format.
7	This is the GCP ancillary record sequence number, usually 1 for Landsat MSS CCT products, FORTRAN format I4.
8	This indicates the number of GCPs in this record, the value is always between 0 and 10, FORTRAN format I4.
10.1	For CCRS products the topographic map type is CNUTM050 and CNUTM250 for Canadian NTS maps in the UTM projection at 1:50,000 and 1:250,000 scale respectively.
10.2	The NTS maps in Canada are identified by <QQQLDD>$$ where QQQ is the 3-digit quadrangle identification, L is a letter used to specify maps at 1:50,000 and 1:250,000 scale and DD is the 2-digit identifier for maps at 1:50,000 scale otherwise it is blank.
10.3	The UTM zone number ranges from 7 to 22 for Canada, FORTRAN format I4.
10.4	The Northing of the GCP centre in metres, FORTRAN format F12.2.
10.5	The Easting of the GCP centre in metres, FORTRAN format F12.2.
10.6	The Northing location error is the difference between the measured and the modelled GCP location in metres, FORTRAN format F12.2.
10.7	The Easting location error is the difference between the measured and the modelled GCP location in metres, FORTRAN format F12.2.
10.8	This is the elevation of the GCP centre in metres, FORTRAN format I4.
10.9	This is the identification of the reference image when the GCP is obtained from a reference image: <MMMPPPRRRCCC>; MMM is LS2, LS2, LS3, LS4 for the mission, PPP is the path number, RRR is the row number, and CCC is the orbital cycle number.
10.10	The reference image type is a 4-byte flag: FFFF. The first (leftmost) byte can take the values P, U, F, W for Spring, Summer, Fall and Winter respectively to indicate the season at the time the image was recorded. The second and third byte indicate the sensor and the band number: M4,

M5, M6, M7 for MSS band 4, 5, 6, 7 respectively. The fourth byte gives the processing status of the reference image : R, S, P for raw, system-corrected and precision processed data.

TABLE 3.2.3.2.2
GROUND CONTROL POINTS ANCILLARY RECORD - EXPLANATION

FIELD   EXPLANATION

10.11   This is the pixel coordinate of the GCP centre in the reference image,
               FORTRAN format F8.2.

10.12   This is the line coo   rdinate of the GCP centre in the reference image,
               FORTRAN format F8.2

10.13   This is a 32-character free format description of the GCP.

10.14   This is the pixel coordinate of the GCP centre in the following image file,
               FORTRAN format F8.2.

10.15   This is the line coordinate of the GCP centre in the following image file,
               FORTRAN format F8.2.

10.16   This is a 4-byte flag: FFFF. The first (leftmost) byte can take the value N
               (i.e. NONE) for no GCP matching, L   (i.e. LIBRARY) for map and
               reference image GCP matching, M (i.e. MAP) for map and current image
               GCP matching, and R (i.e. REFERENCE IMAGE) for reference image
               and current image GCP matching. The second byte indicates the
               modelling technique used to estimate the residual error   :   N (i.e. NONE)
               for no model, A (i.e. ATTITUDE) for attitude and orbital polynomial model,
               B (i.e. BIVARIATE) for   bivariate polynomial model. The third byte
               indicates the order of the least-square model   :   0 (i.e. NONE), 1   (i.e.
               AFFINE), 2 (i.e. QUADRATIC), 3 (i.e. CUBIC). The fourth byte is blank.

TABLE 3.2.3.3.1
EPHEMERIS AND ATTITUDE ANCILLARY RECORD - DEFINITION

FIELD TYPE	FIELD NUMBER	BYTE NUMBER	DESCRIPTION
B	1	1-4	Record sequence number = 5
B	2	5	First record sub-type code = 366(8)
B	3	6	Record type code = 044(8)
B	4	7	Second record sub-type code = 022(8)
B	5	8	Third record sub-type code = 022(8)
B	6	9-12	Record length = 1800
N	7	13-16	Ephemeris and attitude ancillary record sequence number
N	8	17-20	Blanks
			EPHEMERIS AND ATTITUDE DATA
N	9	21-1800	Blanks for Landsat 1,2 and 3 TBD for Landsat 4

TABLE 3.2.3.4.1
RADIOMETRIC ANCILLARY RECORD - DEFINITION

FIELD TYPE	FIELD NUMBER	BYTE NUMBER	DESCRIPTION
B	1	1-4	Record sequence number = 6 for BSQ, and 6,7,8,9 for BIL
B	2	5	First record sub-type code = 077(8)
B	3	6	Record type code = 044(8)
B	4	7	Second record sub-type code = 022(8)
B	5	8	Third record sub-type code = 022(8)
B	6	9-12	Record length = 1800
N	7	13-16	Radiometric ancillary record sequence number
N	8	17-20	Blanks
			RADIOMETRIC DATA
N	9	21-1556	Radiometric calibration transformation tables for all six detectors in the band
N	10	1557-1576	A0 coefficient
N	11	1577-1596	A1 coefficient
A	12	1597-1800	Spare

TABLE 3.2.3.4.2
RADIOMETRIC ANCILLARY RECORD - EXPLANATION

FIELD   EXPLANATION

1-6   The contents of fields 1 to 6 are defined by the LGSOWG format.

9   This field contains 6 logical data sets, where each data set contains the
             transformation for one detector. Each data set consists of 64 data items
             where each data item can take a value between 0 and 255, and occupies
             4 bytes in the FORTRAN format I4.

10-11   The A0 and A1 coefficient may be used in conjunction with the expression
$$R' = A0 + V'A1$$
             to convert linear digital values, V', in the current band to scene radiance,
             R' (in watts/m2sr). Each coefficient is stored in 20 bytes corresponding to
             the FORTRAN format E20.10. (The value of these coefficients is
             dependent on the radiometric calibration option and on the particular
             Landsat satellite).

TABLE 3.2.4.1
ANNOTATION RECORD - DEFINITION

FIELD TYPE	FIELD NUMBER	BYTE NUMBER	DESCRIPTION	
B	1	1-4	Record number	
B	2	5	First record sub-type code = 022(8)	
B	3	6	Record type code = 333(8)	
B	4	7	Second record sub-type code = 022(8)	
B	5	8	Third record sub-type code = 022(8)	
B	6	9-12	Record length = 1800	
N	7	13-16	Annotation record sequence number	
N	8	17-20	Number of annotation segments defined in this record = M	
			ANNOTATION DATA	
A	9	21-52	Spare	
A	10		First annotation segment definition	
			_____	
			Each annotation segment is constru cted as follows:	
N	10.1		53-56	Length of this annotation segment
N	10.2		57-60	Number of characters in the annotation string
A	10.3		61-64	Character size code
A	10.4		65-68	Colour code
A	10.5		69-72	Justification code
A	10.6		73-76	Positioning code
N	10.7		77-80	X-coordinate of start of string
N	10.8		81-84	Y-coordinate of start of string
A	10.9		85-92	Direction code
A	10.10		93-108	Background colour composition
A	10.11		109-120	Spare
A	10.12		121---	Character string
A	10.13			Blanks to fill the segment
A	11		Definition of second annotation segment in this record	
A	12		Definition of third annotation segment in this record	
A	M+9		Definition of M'th annotation segment in this record	
A	M+10	-1800	Blanks to fill the record	

TABLE 3.2.4.2
ANNOTATION RECORD - EXPLANATION

FIELD	EXPLANATION
1-6	The contents of fields 1 to 6 are defined by the LGSOWG format.
7	Annotation record sequence number.
8	The maximum number, M, of annotation segments defined in this record is limited only by the record size of 1800 bytes.
9	Spare
10	Field 10 is the first annotation segment definition, and is composed of 13 sub-fields. It is repeated M times.
10.1	The total number of bytes in this annotation segment, including the character string and pad characters.
10.2	Number of characters in the string to be printed on the film product.
10.3	Character size code The letters A through Z are assigned in order of decreasing size. A$$$ denotes the largest size.

10.4	Code for the colour and intensity in which the string is to be pri nted. The first character denotes the colour.
	    B - blue
	    G - green
	    R - red
	    K - black
	    W - white
	The last three characters denote intensity, in the range 000 to 255.

10.5-10.9	These five fields are used to define the starting position and direction of the character string on the film product. The position may be indicated in 1 of 2 ways:
	    1. The X, Y coordinates may be defined
	    2. The character string will be placed in the next available line with the specified justification.

10.5	Justification code The following codes may be used to indicate that the X ,Y coordinates of the start of the character string are given. XY$$ - X and Y coordinates are given

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The following codes may be used to indicate justification within   lines which are printed horizontally.

LJ$$ - Left justify
RJ$$ - Right justify
CJ$$ - Center justify

TABLE 3.2.4.2
ANNOTATION RECORD - EXPLANATION

FIELD   EXPLANATION

                         AP$$ - Append
               The following codes may be used to indicate justification within   lines
               which are printed vertically
                         TJ$$ - Top justify
                         BJ$$ - Bottom justify
                         MJ$$ - Middle justify
                         AP$$ - Append

10.6   Positioning code
               The following code may be used to indicate that the X   ,Y coordinates of
               the start of the character string are given
                         XY$$ - X and Y coordinates are given
               The following codes may be used to indicate whether   horizontally-printed
               lines should occupy the next available top or bottom margin line
                         TM$$ - Top margin
                         BM$$ - Bottom margin
               The following codes may be used to indicate whether   vertically-printed
               lines should occupy the next available left or right margin line
                         LM$$ - Left margin
                         RM$$ - Right margin

10.7   X-coordinate of the start of the character string must be given if the
               Justification Code and Positioning Code are "XY". The values range
               from 0 (left margin) to 9999 (right margin). Otherwise, it will contain zeros.

10.8   Y-coordinate of the start of the character string must be given if the
               Justification code and Positioning code are "XY". The values range from
               0 (left margin) to 9999 (right margin). Otherwise, it will contain zeros.

10.9   The Direction Code indicates the direction in which the character string is
               to be written, measured clockwise in degrees from the horizontal. The
               format is F8.2.

10.10   The first flag may take the value
                         O$$$ - overwrite
                         S$$$ - superimpose
               The next 3 4-byte flags indicate the background intensity in Blue, Green
               and Red respectively
                         e.g. S$$$$000$000$255 indicates "Superimpose on a
               solid Red background".

10.12   All characters (including leading spaces) within the character string will be printed on the film product.

TABLE 3.2.4.2
ANNOTATION RECORD - EXPLANATION

<u>FIELD</u>   <u>EXPLANATION</u>

10.13   Sufficient blanks are added to the end of the annotation segment to that it occupies a multiple of 4 bytes.

TABLE 3.2.4.3
ANNOTATION RECORD - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	Record sequence number = 7 for BSQ or 10 for BIL
B	2	022(8)
B	3	333(8)
B	4	022(8)
B	5	022(8)
B	6	1800
N	7	1
N	8	3
N	9	Blanks
A	10	Annotation segment for first character string
		_____
N	10.1	0116
N	10.2	0048
A	10.3	B$$$
A	10.4	K$$$
A	10.5	LJ$$
N	10.6	TM$$
N	10.7	0000
N	10.8	0000
N	10.9	00000.00
A	10.10	O$$$$000$255$000
A	10.11	Blanks
A	10.12	

PRODUCT:$$LANDSAT1MSS$BIL$$RAW$$$$$$$$$$$$$$$$

	2	BSQ1$SYSTEM$CORRECTED$$$
	3	BSQ2$PRECISION$PROCESSED
	4	BSQ3$
		BSQ4$
		BSQ5$

A	10.13	Not present
A	11	Annotation segment for second character string
		_____
N	11.1	0124
N	11.2	0055
A	11.3	A$$$
A	11.4	K$$$
A	11.5	CJ$$
A	11.6	TM$$
N	11.7	0000
N	11.8	0000

N	11.9	00000.00
A	11.10	O$$$$000$000$255
A	11.11	Blanks
A	11.12	

PROCESSED:$$CANADA$CCRS$$MIPS$$
$$$ON$<YYYYMMDD>$AT$<HHMMSS>
PERGS$$$$
IPS-TSS$$

TABLE 3.2.4.3
ANNOTATION RECORD - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
		DICS$$$$$
A	11.13	$
A	12	Annotation segment for third character string
		_____
N	12.1	0116
N	12.2	0047
A	12.3	B$$$
A	12.4	K$$$
A	12.5	RJ$$
A	12.6	TM$$
N	12.7	0000
N	12.8	0000
A	12.9	00000.00
A	12.10	O$$$$255$000$000
A	12.11	Blanks
A	12.12	SCENE$$:$$<LDDDDHHMMSS>$<XXXXX X>$IMAGEDON<YYYYMMDD>
A	12.13	$

3.3   IMAGERY FILE

For Band Sequential structures, there will be one imagery file for each band. For Band Interleaved by Line structures, there will be only   one imagery file accommodating all bands. The imagery file is of class IMAGERY FILE, with the class code IMGY.

Each imagery file contains the following records:

1.   File descriptor record.

2.   Image records.

3.3.1   FILE DESCRIPTOR RECORD

The file   descriptor record is composed of two segments, a fixed and a variable segment. The fixed segment provides information on how to read the file, and the variable segment indicates how to locate key data of the file. The file descriptor record fixed segment is defined in Table 3.2.1.1, and its contents, for the imagery file, are shown in Table 3.3.1.1. The variable segment is defined in Table 3.3.1.2 and its contents are shown in Table 3.3.1.3. The imagery file   descriptor record variable segment gives the number and length of image records; describes the data format in terms of the pixel grouping; locates the image within the physical record; and gives the location of significant data fields in the record prefix and suffix.

3.3.2   IMAGE RECORD

The raw and and system-corrected products contain full scan lines and sensor related data while the precision processed product has shorter lines that are parallel to the Easting direction of the UTM grid. Each image record contains the following groups of data:

1.   The 12 bytes of standard record introductory data   (i.e. record number, record type and sub-types, and record length).

2.   20 bytes of prefix data.

3.   3500 bytes for raw and system-corrected image   data, or 1800 bytes for precision processed image data. It includes left-fill and right-fill pixels. It consists of all of the image data of one scan line of one band.

4.   68 bytes of suffix data for raw and system-corrected data, 148 bytes of suffix data for precision processed data. The suffix data requirements for raw and system-corrected products differ from those for precision processed products. Common fields are in

identical byte numbers within the suffix data segment, and fields relevant only to one product are zero-filled for the other product.

Most of the prefix and suffix data are located by the file descriptor record variable segment for the imagery file. The content of imagery records for raw or system-corrected products is defined in Table 3.3.2.1 and explained in Table 3.3.2.2. The content of imagery records for precision processed products is defined in Table 3.3.2.3 and explained in Table 3.3.2.4.

TABLE 3.3.1.1
IMAGERY FILE - FILE DESCRIPTOR RECORD FIXED SEGMENT - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	1
B	2	077(8)
B	3	300(8)
B	4	022(8)
B	5	022(8)
B	6	3600 - Raw or system corrected
		1980 - Precision processed
A	7	A$
A	8	$$
A	9	DPDTMS$79-103
A	10	$A
A	11	$A
A	12	LGSOWGCVF01$
N	13	2 for BIL; 2,5,8,11,[14] for BSQ
A	14	LS1$MSSRIMGYBIL$
		2 S BSQ1
		3 P BSQ2
		4 BSQ3
		BSQ4
		BSQ5
A	15	FSEQ
N	16	1
N	17	4
A	18	FTYP
N	19	5
N	20	4
N	21	FLGT
N	22	9
N	23	4
A	24	Y
A	25	N
A	26	Y
A	27	N
A	28	Blanks

TABLE 3.3.1.2
IMAGERY FILE - FILE DESCRIPTOR RECORD VARIABLE SEGMENT - DEFINITION

NO	BYTE NOS	DEFINITION
1	1-6 *	Number of image records
2	7-12	Image record length
3	13-36	Reserved (blanks)
		PIXEL GROUP DATA
4	37-40	Number of bits per pixel
5	41-44	Number of pixels per data group
6	45-48	Number of bytes per data group
7	49-52	Justification and order of pixels within data group
		IMAGE DATA
8	53-56	Number of bands of imagery in this file
9	57-64	Number of lines per image (one band) excluding top and bottom border lines
10	65-68	Number of left border pixels
11	69-76	Number of image pixels per line
12	77-80	Number of right border pixels
13	81-84	Number of top border lines
14	85-88	Number of bottom border lines
15	89-92	Interleaving indicator
		RECORD DATA
16	93-94	Number of physical records per line
17	95-96	Number of physical records per multispectral line in this file
18	97-100	Number of bytes of prefix data per record
19	101-108	Number of bytes of image data per record
20	109-112	Number of bytes of suffix data per record
21	113-116	Prefix/suffix repeat flag
		PREFIX/SUFFIX DATA LOCATORS
22	117-124	Scan line number locator
23	125-132	Image (band) number locator
24	133-140	Time of scan line locator
25	141-148	Left-fill count locator
26	149-156	Right-fill count locator
27	157-188	Blanks
28	189-196	Scan line quality code locator
29	197-204	Calibration information locator
30	205-212	Gain values field locator
31	213-220	Bias values field locator
32	221-252	Blanks

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* Byte 1 of the variable segment is byte 181 of the record

TABLE 3.3.1.2
FILE DESCRIPTOR RECORD VARIABLE SEGMENT - DEFINITION

NOTE: LOCATORS for the Imagery File   consist of 8 bytes, made up as follows:
Bytes 1-4 : Byte number within prefix (or suffix) of the start of the field being located
Bytes 5-6: Length in bytes of the field being located
Byte 7: P for prefix, S for suffix
Byte 8: Type of field: A (alphanumeric), B (binary), N (numeric)

33	253-256	Number of left fill bits within pixel
34	257-260	Number of right fill bits within pixel
35	261-268	Maximum data range of pixel values (starting from zero)
36	269-3420	[Raw or system corrected] Blanks
	269-1800	[Precision processed] Blanks

TABLE 3.3.1.3
IMAGERY FILE - FILE DESCRIPTOR RECORD VARIABLE SEGMENT - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
N	1	2340 - Band Sequential, raw or system-corrected
		9360 = Band Interleaved by Line, raw or system-corrected
		<1200 - Band Sequential, precision-processed
		<4800 - Band Interleaved by Line, precision processed
N	2	3600 - Raw or system-corrected
		1980 - Precision processed
A	3	Blanks
N	4	8
N	5	1
N	6	1
N	7	$$$$
N	8	1 - Band Sequential; 4 - Band Interleaved by Line
N	9	2340 - Raw or system-corrected
		<1200 - Precision processed
N	10	0
N	11	3500 - Raw or system-corrected
		1800 - Precision processed
N	12	0
N	13	0
N	14	0
A	15	BSQ$ - Band Sequential
		BIL$ - Band Interleaved by Line
N	16	1
N	17	1 - Band Sequential
		4 - Band Interleaved by Line
N	18	20
N	19	3500 - Raw or system-corrected
		1800 - Precision processed
N	20	68 - Raw or system-corrected
		148 - Precision processed
N	21	$$$$
		LOCATORS
A	22	1,4,P,B
A	23	5,4,P,B
A	24	9,4,P,B - Raw or system-corrected
		$$$$$$$$ - Precision processed
A	25	13,4,P,B
A	26	17,4,P,B
A	27	Blanks

```
A              28            1,4,S,B
A              29            5,20,S,B
                             $$$$$$$$ - Precision processed
```

TABLE 3.3.1.3
IMAGERY FILE - FILE DESCRIPTOR RECORD VARIABLE SEGMENT - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
A	30	$$$$$$$$
A	31	$$$$$$$$
A	32	Blanks
N	33	0 - for radiometrically calibrated data
		2 - for data which is not radiometrically calibrated
N	34	0
N	35	255 - for radiometrically calibrated data
		63 - for data which is not radiometrically calibrated
A	36	Blanks

TABLE 3.3.2.1
RAW OR SYSTEM CORRECTED IMAGE DATA RECORD - DEFINITION

FIELD TYPE	FIELD NUMBER	BYTE NUMBER	DESCRIPTION
B	1	1-4	Record sequence number = 2,3,4,...
B	2	5	First record sub-type code = 355(8)
B	3	6	Record type code = 355(8)
B	4	7	Second record sub-type code = 022(8)
	5	8	Third record sub-type code = 022(8)
B	6	9-12	Record length = 3600
			PREFIX DATA
B	7	13-16	Scan line number
B	8	17-20	Image (channel) number
B	9	21-24	Time in GMT at start of scan in milliseconds. Each byte set to 377(8) if GMT is not available
B	10	25-28	Count of left fill pixels
B	11	29-32	Count of right fill pixels
			IMAGE DATA
B	12	33-3532	Image pixels
			SUFFIX DATA
B	13	3533-3536	Scan line quality
			3533 - sync loss indicator
			3534 - bad data use indicator
			3535 - spare
			3536 - spare
B	14	3537-3556	Calibration information
			3537-3540 Band identity of calwedge data
			3541-3544 Detector identify of calwedge data
			3545-3556 Calibration wedge data for identified detector (2 bytes per sample)
B	15	3557-3560	Line length (number of pixels of image data)
B	16	3561-3600	Spare

TABLE 3.3.2.2
RAW OR SYSTEM CORRECTED IMAGE DATA RECORD - EXPLANATION

FIELD	EXPLANATION
1-6	The contents of fields 1 to 6 are defined by the LGSOWG Standard Format.
4	Second record subtype code for image data is 022(8).
9	Each byte of this field will be set to 377(8) if GMT timing information is not available.
10	The count of left fill pixels for raw or system-corrected products includes: 1) 244 standard left fill pixels 2) band to band registration pixels 3) earth rotation system correction fill pixels
13	Byte 3533 is the sync loss indicator for the current scan line. It is set to 1 if sync was lost, and to 0 otherwise. Byte 3534 is set to 1 if the sync loss indicator was set to 1 for the current line and the data was used in the radiometric calibration process. Byte 3535 - $ Byte 3536 - $
14	Six samples of calibration wedge data are given in field 14 for the detector within the band identified within this field. The calibration wedge values are given in their RAW form: 0 - 77(8).
15	This is the number of scene pixels following the left fill pixels. Field 10 + Field 11 + Field 15 = Field 11 of Table 3.3.1.2.

TABLE 3.3.2.3
PRECISION PROCESSED IMAGE DATA RECORD - DEFINITION

FIELD TYPE	FIELD NUMBER	BYTE NUMBER	DESCRIPTION
B	1	1-4	Record sequence number = 2,3,4,...
B	2	5	First record sub-type code = 355(8)
B	3	6	Record type code = 355(8)
B	4	7	Second record sub-type code = 022(8)
B	5	8	Third record sub-type code = 022(8)
B	6	9-12	Record length = 1980
			PREFIX DATA
B	7	13-16	Scan line number
B	8	17-20	Image (channel) number
B	9	21-24	Zeros
B	10	25-28	Count of left fill pixels
B	11	29-32	Count of right fill pixels
			IMAGE DATA
B	12	33-1832	Image pixels
			SUFFIX DATA
B	13	1833-1836	Scan line quality
			1833 - sync loss indicator
			1834 - bad data use indicator
			1835 - spare
			1836 - spare
B	14	1837-1856	Zeros
B	15	1857-1860	Line length (number of pixels of image data)
B	16	1861-1900	Spares
B	17	1901-1904	Sun azimuth angle at centre of scan line in thousandths of degrees
B	18	1905-1908	Sun elevation angle at centre of scan line in thousandths of degrees
B	19	1909-1912	Latitude at centre of scan line in millionths of degrees
B	20	1913-1916	Longitude at centre of scan line in millionths of degrees
B	21	1917-1920	Northing of first pixel of current scan line in metres
B	22	1921-1924	Northing of last pixel of current scan line in metres
B	23	1925-1928	Easting of first pixel of current scan line in metres

B	24	1929-1932	Easting of last pixel of current	scan line in
			metres	
B	25	1933-1936	Pixel width in metres	
B	26	1937-1940	Pixel length in metres	
B	27	1941-1980	Spare	

TABLE 3.3.2.4
PRECISION PROCESSED IMAGE DATA RECORD - EXPLANATION

FIELD   EXPLANATION

1-6   The contents of fields 1 to 6 are defined by the LGSOWG Standard
             format.

4   Second record sub-type code for image data is 022(8).

10   The count of left fill pixels for precision processed product is non-zero only
             when a portion of the scan line is missing, (outside the input image).

15   This is the number of scene pixels following the left fill pixels. Field 10 +
             Field 11 + Field 15 = Field 11 of Table 3.3.1.2.

17,18   Sun azimuth and sun elev ation angles at the centre of the scan line are
             expressed in thousandths of degrees and represented as 32 bit integers.

19,20   Latitude and longitude at the centre of the scan line are provided in
             millionths of degrees and represented as 32 bit integers.

21,22   The Northing coordinate expressed in metres is represented as a 32 bit
             integer.

23   The Easting coordinate expressed in metres   is represented as a 32 bit
             integer. This always corresponds to the first pixel of the scan line,
             whether the pixel value is defined or not. This number is constant for all
             scan lines within the file.

24   The Easting coordinate expressed in metres   is represented as a 32 bit
             integer. This always corresponds to the last pixel of the current scan line
             whether the pixel value is defined dor not.

25,26   The pixel width and length expressed in metres are represented as 32 bit
             integers.

3.4   TRAILER FILE

Trailer files follow image data files, supplying information associated with the   image which could not be ascertained before writing the image data. This includes data quality, recording quality, (e.g. parity errors) and data summaries. One trailer file is associated with (and follows) each imagery file. Hence, for Band Sequential structures which contain one imagery file for each band, there will be one trailer file for each band. For Band Interleaved by Line structures, which contain one imagery file accommodating all bands, there will be only one trailer file.
The trailer file is of the class TRAILER FILE with the class code TRAI. Each trailer file contains the following record types:

          1.   File Descriptor Record

          2.   Trailer Record(s)

3.4.1   FILE DESCRIPTOR RECORD

The file descriptor record is composed of two segments: a fixed and variable segment. The fixed segment provides information on how to read the file and the variable segment indicates how to locate key data of the file. The File   Descriptor record fixed segment is defined in Table 3.2.1.1 and its contents, for the Trailer File, are shown in Table 3.4.1.1. The variable segment is defined in Table 3.4.1.2, explained in Table 3.4.1.3, and its contents are given in Table 3.4.1.4.

3.4.2   TRAILER RECORD

There is one trailer record for each of the bands accommodated in the accompanying image data file. Thus, there will be 4 for BIL structures and 1 for BSQ structures. Each trailer record contains raw data histograms for all 6 detectors within the band. In addition, it contains the parity error count and a quality summary. It is defined in Table 3.4.2.1, and explained in Table 3.4.2.2.

TABLE 3.4.1.1
TRAILER FILE - FILE DESCRIPTOR RECORD FIXED SEGMENT - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE		
B	1	1		
B	2	077(8)		
B	3	300(8)		
B	4	022(8)		
B	5	022(8)		
B	6	1800		
A	7	A$		
A	8	$$		
A	9	DPDTM$79-103		
A	10	$A		
A	11	$A		
A	12	LGSOWGCVF01$		
A	13	3 for BIL; 3,6,9,12,[15] for BSQ		
A	14	LS1$MSSRTRAIBIL$		
		2	S	BSQ1
		3	P	BSQ2
		4		BSQ3
				BSQ4
				BSQ5
A	15	FSEQ		
N	16	1		
N	17	4		
A	18	FTYP		
N	19	5		
N	20	4		
A	21	FLGT		
N	22	9		
N	23	4		
A	24	Y		
A	25	N		
A	26	N		
A	27	N		
A	28	Blanks		

TABLE 3.4.1.2
TRAILER FILE - FILE DESCRIPTOR RECORD VARIABLE SEGMENT - DEFINITION

FIELD	BYTE NOS	DEFINITION
1	1-6*	Number of trailer records
2	7-12	Trailer record length
3	13-36	Reserved (blanks)
4	37-52	Parity error count field locator
5	53-68	Quality code summary map field locator
6	69-1620	Blanks

----

* Byte 1 of the variable segment is byte 181 of the record

TABLE 3.4.1.3

TRAILER FILE - FILE DESCRIPTOR RECORD VARIABLE SEGMENT   -
EXPLANATION

FIELD   EXPLANATION

1   The number of group 1 records in the file.

2   The length, in bytes, of group 1 records in the file.

3   Reserved

4-5   While the first 2 fields of this variable segment provide actual information,
               the remaining 2 fields are locator fields which point to the position in the
               file where various information may be found. The location of the desired
               field is given in 16 bytes, coded as follows:

               6 bytes - the record number of the record containing the field

               6 bytes - the record byte number of the first byte of the field

               3 bytes - length of the field in bytes

               1 byte - a code for the type of data in the field

               The codes are:

               A=alphanumeric in ASCII or EBCDIC

               B=binary

               N=numeric in ASCII or EBCDIC

4   Location of the parity error count field

5   Location of the quality code summary map field

TABLE 3.4.1.4
TRAILER FILE - FILE DESCRIPTOR RECORD VARIABLE SEGMENT - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
N	1	4 - BIL
		1 - BSQ
N	2	1800
A	3	Blanks
A	4	2,1557,4,N - Band Sequential
		5,1557,4,N - Band Interleaved by Line
A	5	2,1601,200,A - Band Sequential
		5,1601,200,A - Band Interleaved by Line
A	6	Blanks

TABLE 3.4.2.1
TRAILER RECORD DEFINITION

FIELD TYPE	FIELD NUMBER	BYTE NUMBER	DESCRIPTION
B	1	1-4	Record sequence number = 2 for BSQ, 2,3,4,5 for BIL
B	2	5	First record sub-type code = 022(8)
B	3	6	Record type code = 366(8)
B	4	7	Second record sub-type code = 022(8)
B	5	8	Third record sub-type code = 022(8)
B	6	9-12	Record length = 1800
N	7	13-16	Trailer record sequence number
A	8	17-20	Blanks
			TRAILER DATA
B	9	21-1556	Histograms for all 6 detectors in the band
N	10 *	1557-1560	Parity error count
A	11	1561-1600	Spare
A	12 *	1601-1800	Quality summary

----

* Blanks for records 2, 3 and 4 in Band Interleaved by Line structures

TABLE 3.4.2.2
TRAILER RECORD - EXPLANATION

FIELD   EXPLANATION

1-6   The contents of fields 1 to 6 are defined by the LGSOWG format.

9   This field contains six logical data sets, where each data set contains the histogram of the RAW data for one detector. Each data set consists of 64 data items, where each data item occupies 4 bytes and contains the count of number of occurrences of that value (range 0 to 77(8)) in the RAW scene.

12   This field may be used for a free format description of the quality of the data.

3.5   NULL VOLUME DIRECTORY FILE

The last file of the logical volume is the Null Volume Directory File, consisting of one record only, the Null Volume Descriptor Record. Its purpose is two-fold : firstly, to mark the end of the logical volume, and secondly to facilitate the addition of data to a tape which already contains data. In the latter case, the Null Volume Directory File would be converted to a Volume Directory File by overwriting the Null Volume Descriptor Record with a Volume Descriptor Record and appending the appropriate File PointerRecords. In its role as terminator of the current Logical Volume, it takes the same Logical Volume number within Volume set as the associated Volume Descriptor record.

3.5.1   NULL VOLUME DESCRIPTOR RECORD

The null volume descriptor record identifies the physical volume and its documentation. Its definition and contents are shown in Tables 3.1.1.1 and 3.5.1.1, respectively.

TABLE 3.5.1.1
NULL VOLUME DIRECTORY - VOLUME DESCRIPTOR RECORD - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	1
B	2	300(8)
B	3	300(8)
B	4	077(8)
B	5	022(8)
B	6	350
A	7	A$
A	8	A$
A	9	CCB-CCT-0002
A	10	$A
A	11	$A
A	12	LGSOWGCVF01$
A	13	<CCNNNN>$$$$$$$$$$
A	14	Blanks
A	15	Blanks
N	16	1
N	17	1
N	18	1
N	19	1
N	20	1
N	21	1
N	22	1
A	23	Blanks
A	24	Blanks
A	25	Blanks
A	26	Blanks
A	27	Blanks
A	28	Blanks
A	29	Blanks
A	30	Blanks

TABLE A.1
LANDSAT-1 RECORD TYPE CODES

BYTE 5 OCTAL	BYTE 6 OCTAL	BYTE 7 OCTAL	BYTE 8 OCTAL	DESCRIPTION
300	300	022	022	Volume Descriptor
300	300	077	022	Null Volume Descriptor
333	300	022	022	File Pointer
077	300	022	022	File Descriptor
022	077	022	022	Text Record
022	011	022	022	Tape Directory
022	022	022	022	Header
022	333	022	022	Annotation
011	044	022	022	Ancillary (Ground Control Point)
044	044	022	022	Ancillary (Map Projection)
366	044	022	022	Ancillary (Ephemeris and Attitude)
022	044	022	022	Ancillary (General)
077	044	022	022	Ancillary (Radiometric Calibration)
355	355	022	022	Imagery
022	366	022	022	Trailer

TABLE A.2
LANDSAT-2 RECORD TYPE CODES

BYTE 5 OCTAL	BYTE 6 OCTAL	BYTE 7 OCTAL	BYTE 8 OCTAL	DESCRIPTION
300	300	022	022	Volume Descriptor
300	300	077	022	Null Volume Descriptor
333	300	022	022	File Pointer
077	300	022	022	File Descriptor
022	077	022	022	Text Record
022	011	022	022	Tape Directory
022	022	022	022	Header
022	333	022	022	Annotation
011	044	022	022	Ancillary (Ground Control Point)
044	044	022	022	Ancillary (Map Projection)
366	044	022	022	Ancillary (Ephemeris and Attitude)
022	044	022	022	Ancillary (General)
077	044	022	022	Ancillary (Radiometric Calibration)
355	355	022	022	Imagery
022	366	022	022	Trailer

TABLE A.3
LANDSAT-3 RECORD TYPE CODES

BYTE 5 OCTAL	BYTE 6 OCTAL	BYTE 7 OCTAL	BYTE 8 OCTAL	DESCRIPTION
300	300	022	022	Volume Descriptor
300	300	077	022	Null Volume Descriptor
333	300	022	022	File Pointer
077	300	022	022	File Descriptor
022	077	022	022	Text Record
022	011	022	022	Tape Directory
022	022	022	022	Header
022	333	022	022	Annotation
011	044	022	022	Ancillary (Ground Control Point)
044	044	022	022	Ancillary (Map Projection)
366	044	022	022	Ancillary (Ephemeris and Attitude)
022	044	022	022	Ancillary (General)
077	044	022	022	Ancillary (Radiometric Calibration)
355	355	022	022	Imagery
022	366	022	022	Trailer

TABLE A.4
LANDSAT-D RECORD TYPE CODES

BYTE 5 OCTAL	BYTE 6 OCTAL	BYTE 7 OCTAL	BYTE 8 OCTAL	DESCRIPTION
300	300	022	022	Volume Descriptor
300	300	077	022	Null Volume Descriptor
333	300	022	022	File Pointer
077	300	022	022	File Descriptor
022	077	022	022	Text Record
022	011	022	022	Tape Directory
022	022	022	022	Header
022	333	022	022	Annotation
011	044	022	022	Ancillary (Ground Control Point)
044	044	022	022	Ancillary (Map Projection)
366	044	022	022	Ancillary (Ephemeris and Attitude)
022	044	022	022	Ancillary (General)
077	044	022	022	Ancillary (Radiometric Calibration)
355	355	022	022	Imagery
022	366	022	022	Trailer