UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

LANDSAT MULTISPECTRAL SCANNER COMPUTER-COMPATIBLE TAPE FORMAT, VERSION 1.0

Prepared by Computer Services Branch, EROS Data Center

(E83-10227) LANDSAT MULTISPECTRAL SCANNER COMPUTER-COMPATIBLE TAPE FORMAT, VERSION 1.0 (EROS Data Center, Sioux Falls, S. Dak.) 151 p HC A08/MF A01 CSCL 05B

N83-21468

Unclas
G3/43 00227

Sioux Falls, South Dakota

1982

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ABBREVIATIONS

ANSI	American National Standards Institute
ASCII	American standard code for information exchange
BIL	band interleaved by line
BOT	beginning of tape
BPI	bits per inch
BSQ	band sequential
CCT	computer-compatible tape
CCT-AM	computer-compatible tape, archival MSS
CCT-PM	computer-compatible tape, processed MSS
CWV	calibration wedge value
DQI	digital quality indicator
EBCDIC	extended binary coded decimal interchange code
EDC	EROS Data Center
EOF	end of file
EOS	end of set
EOT	end of tape
EOV	end of volume
EROS	Earth Resources Observation System
FL	floating-point format, double precision
FLS	floating-point format, single precision
FP	fixed-point format
FPG	fixed-point grid value format
GMT	Greenwich mean time
GPS	global positioning system
HOM	Hotine Oblique Mercator
HRS	horizontal resampling

ID	identification number
IRG	inter-record gap
LGSOWG	Landsat Ground Station Operations Working Group
MSS	multispectral scanner
NASA	National Aeronautics and Space Administration
PS	Polar Stereographic
RCA	relative calibration accuracy
RMS	root mean square
SCD	systematic correction data
SOM	Space Oblique Mercator
UTM	Universal Transverse Mercator
VRS	vertical resampling
WRS	Worldwide Reference System

ILLUSTRATIONS

TABLES

DRAFT

1.0 INTRODUCTION

After digital processing systems for Landsat 3 became operational, discussion among personnel from several of the Landsat processing centers resulted in an agreement that a universal Computer Compatible Tape (CCT) format should be developed. This general agreement caused the formation of a Tape Standards Working Group as a subgroup of the international Landsat Ground Station Operations Working Group (LGSOWG). The format design began in 1978 with the objective of implementing the new format prior to or with the launch of Landsat 4. This document defines the EROS Data Center's Landsat CCT Version 1.0 product, conforming to the concepts of the "Standard" format as much as is possible using existing EDC systems.

Unlike previous Landsat CCT formats, the new CCT's will include a comprehensive field location and data description information "superstructure". This superstructure consists of:

- a volume directory file which generally describes the data configuration and provides pointers to each data file.
- a file descriptor record for each data file which describes the data structure within the file and provides pointers to certain fields within the file.

Once a data user becomes familiar with the superstructure, it becomes possible to read any CCT whose format conforms to the superstructure concept and identify the data type and source, locate and read desired data and support information, and, in most cases, use the data without need of further documentation or software modification.

The impact to the established Landsat CCT format of adding superstructure requirements is minor. In figure 1, the additional records required for a one-tape data set of one band of multispectral scanner (MSS) imagery are illustrated. The entire superstructure is composed of four records. Three records, the volume descriptor record, the text record, and the file pointer record, reside in a Volume Directory File. The fourth record is the file descriptor record which is the first record of each data file.

The four superstructure records are similar to one another in content as well as in format. The purpose of these records is to identify, describe, and locate data in the data files. Thus, superstructure records primarily supply information about the data on the CCT rather than carrying data themselves.

The data records within the data files will be very similar in format and content to those of previous Landsat CCT's with changes, for example, in record lengths, in data encoding, and in the addition of new special-purpose fields in the header and ancillary data records. Overall, however, the general type and format of the data will remain unchanged. Two types of MSS image data will continue to be offered:

- o fully processed MSS data with both geometric and radiometric corrections applied (CCT-PM)
- o partially processed MSS data with only radiometric corrections applied (CCT-AM).

These will be offered in either a Band-Interleaved-by-Line (BIL) or a Band-Sequential (BSQ) image data format.

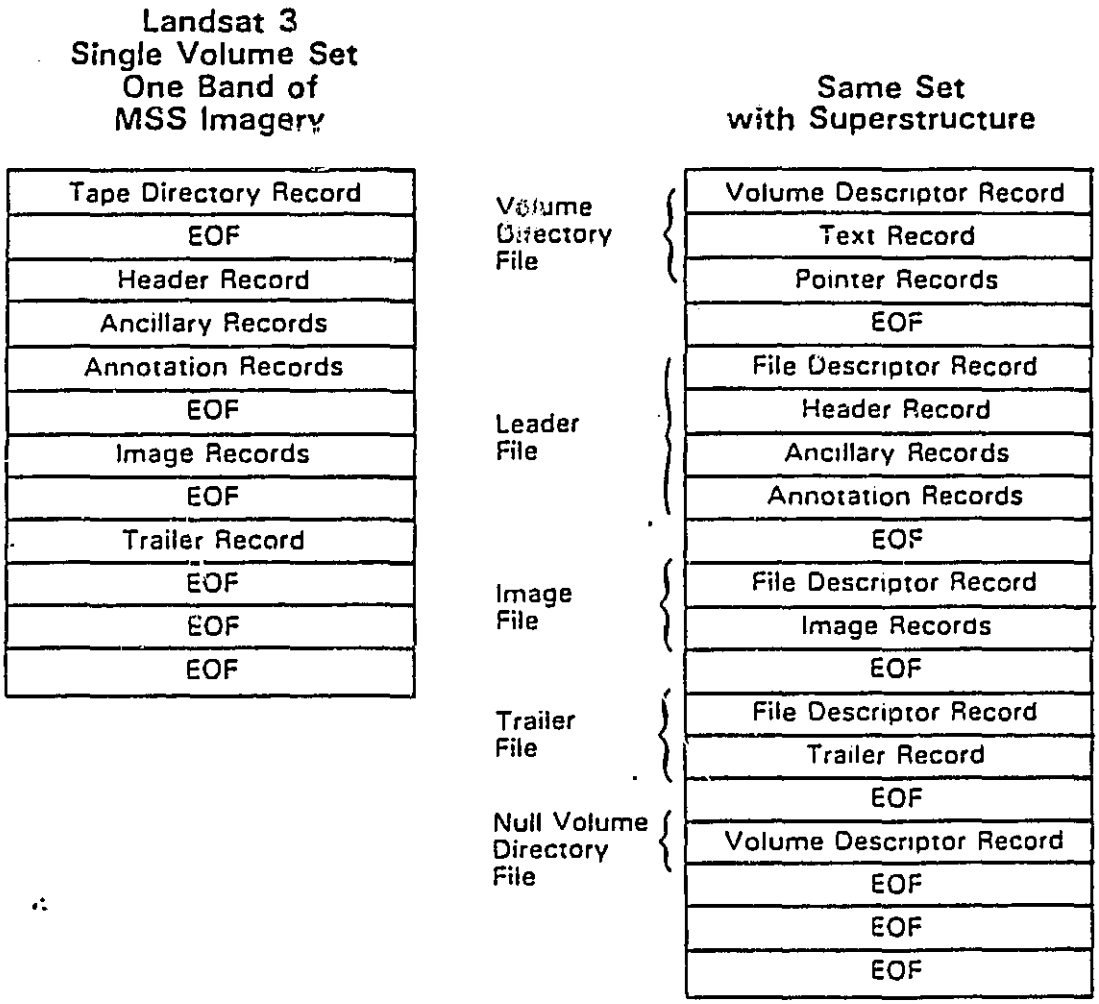


Figure 1. --Comparison of Tape Layout, Before and After Adding Superstructure Records

2.0 COMMON CONVENTIONS

2.1 Byte

A byte is eight bits in length and may contain any type of data. The most significant bit occurs first and is the left-most bit of the byte.

2.2 Image Data Representation

Image data will be right-justified in a byte with the most significant bit zero-filled. A data range from 0 to 127 is allowed with zero as low radiance.

2.3 Non-Image Data Representation

Non-image data fields are byte multiple in length and represented in one of several data types. "Alphanumeric" data fields are ASCII coded and left-justified within the field. "Numeric" data fields are ASCII coded and right-justified within the field. Unless otherwise specified, all fields referred to simply as "binary", are uncoded, unsigned, integer binary numbers. Many fields of the header and auxiliary data records are represented in one of four "special" fixed, and floating-point formats—fixed-point binary (FP), double precision floating-point binary (FL), single precision floating-point binary (FLS), or fixed-point binary grid value (FPG)—which are described in more detail in section 4.0.

2.4 Record, Logical and Physical

A logical record is a collection of related data items and is treated as a unit of information. A physical record is a physical collection of data written to or read from a tape as a unit in a single operation. On Landsat CCT's, a physical record is equivalent to a logical record. Volume descriptor, file pointer, file descriptor, header, ancillary, annotation, image, trailer, and text data are the different types of records. Records are structured to contain a record number, a record type code, the record length in bytes, data, and optional zero fill as shown in figure 2. Records are separated by inter-record gaps (IRG), and records are not split between physical tape volumes. These attributes are elaborated upon below.

2.4.1 Record Number

This is a four-byte binary number which indicates the sequence of the record within the file. The first record of the file is numbered one, and the record number increments by one per record.

2.4.2 Record Type Codes

Bytes five through eight of every record contain four one-byte codes which classify the data content of the record. The 12 basic record type codes which apply to Landsat Version 1.0 CCT's are listed in table 1.

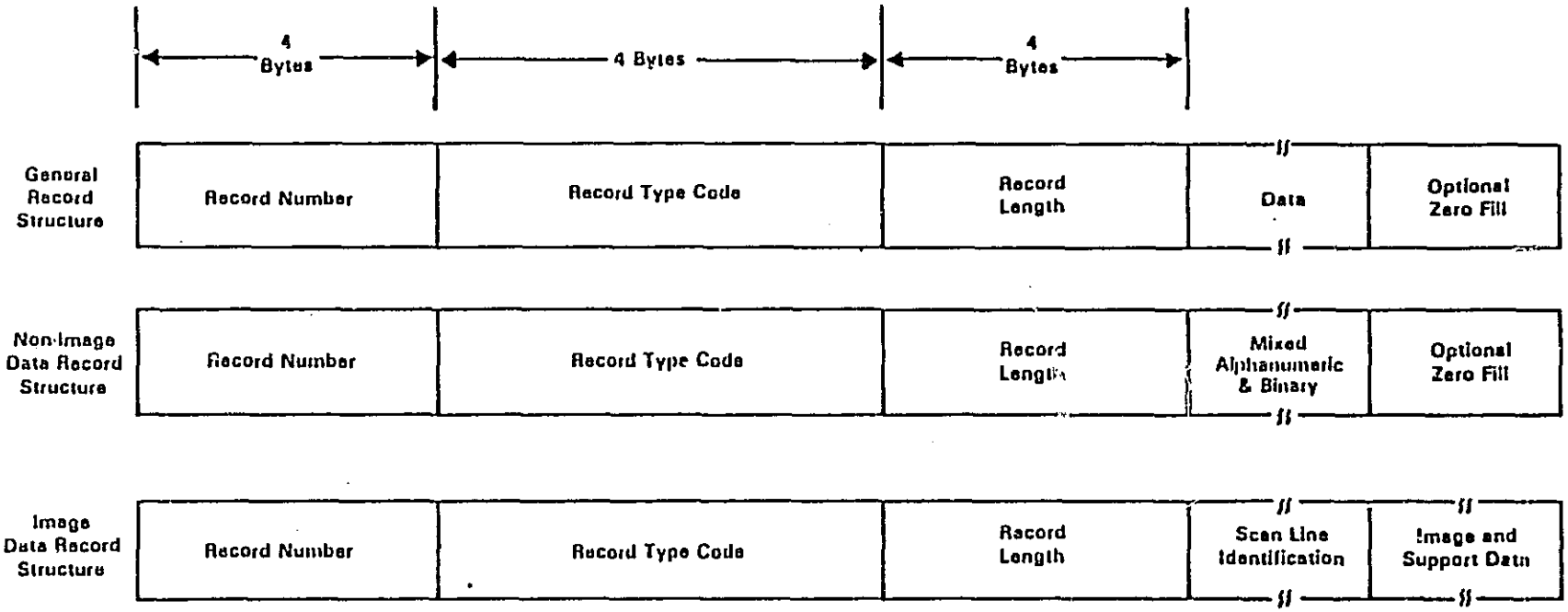


Figure 2.--CCT Record Structure

Table 1.--Record Type Codes

Record Type	Byte 5	Byte 6	Byte 7	Byte 8
Volume Descriptor	$300)_8$*	$300)_8$	$022)_8$	$022)_8$
File Pointer	$333)_8$	$300)_8$	$022)_8$	$022)_8$
File Descriptor	$077)_8$	$300)_8$	$022)_8$	$022)_8$
Null Volume Descriptor	$300)_8$	$300)_8$	$077)_8$	$022)_8$
Text	$022)_8$	$077)_8$	$022)_8$	$022)_8$
Header	$022)_8$	$022)_8$	$022)_8$	$022)_8$
Annotation	$022)_8$	$333)_8$	$022)_8$	$022)_8$
Ancillary, General	$022)_8$	$044)_8$	$022)_8$	$022)_8$
Ancillary, Universal Transverse Mercator or Polar Stereographic Map Projection Data	$044)_8$	$044)_8$	$333)_8$	$022)_8$
Ancillary, Space Oblique Mercator or Hotine Oblique Mercator Map Projection Data	$044)_8$	$044)_8$	$355)_8$	$022)_8$
Image	$355)_8$	$355)_8$	$022)_8$	$022)_8$
Trailer	$022)_8$	$366)_8$	$022)_8$	$022)_8$

*Denotes octal radix, $10)_8$ is actually a decimal 8.

2.4.3 Record Length

The record length in bytes for each record is recorded in bytes nine through 12. This is a binary, right-justified number with the left-most bit being the most significant. Volume directory and null volume directory records are 360 bytes in length. All other records on the CCT are 3600 bytes in length.

2.5 File, Logical and Physical

A file is a collection of physical records preceded and followed by end-of-file (EOF) indicators. All files, except for the volume directory, have a file descriptor record as the first record. This is followed by the data records of the file. All records of a file are of constant record length. On MSS CCT's there are four types of files:

- Volume Directory
- Leader (header, ancillary, and annotation)
- Image
- Trailer

A logical file is equivalent to a physical file except in the case of image files. An image file (and no other file) may be split between reels of CCTs on record boundaries. Thus, when image files are split between CCT reels, the logical image file is not equivalent to the physical image file. It should be pointed out that one image file equals either one image (one band) of data when the format is BSQ, or all bands in the BIL format. Recording methods for files spanning physical volumes are discussed in section 3.0.

2.6 File Classes and Codes

The volume directory file is described in section 4.2. The file pointer records of the volume directory file contain the names and codes of the data file classes which follow. There are three data file classes, named and coded as follows:

Class Name	Class Code	File Content
Leader File	LEAD	Header, annotation and ancillary records
Imagery File	IMGY	Image data record
Trailer File	TRAI	Trailer records

Each file class has associated with it a particular file format and file descriptor record variable segment. These are defined in section 4.

2.7 Logical Volume

A logical volume is a logical collection of one or more files recorded consecutively. A logical volume contains one scene of one or more images (bands).

All logical volumes have a volume directory as the first file. This is followed by leader, image and trailer data files and is concluded with a null volume directory. When a logical volume is split between physical volumes, the volume directory is repeated at the start of the continuation tape. (See section 3.0 for discussion on how logical volumes are split). All logical volumes conclude with a null volume directory (one per logical volume in all cases).

2.8 Physical Volume

A physical volume is a dismountable physical reel of magnetic medium. A physical volume may contain one, more than one, or part of one file. Physical volumes always start with a volume directory file. The last record of a physical volume is followed by an end-of-volume (EOV) indicator.

2.9 CCT Volume Set

A CCT volume set consists of one or more physical volumes and contains one logical volume.

2.10 Tape Gaps and Marks

American Nationals Standards Institute (ANSI) specifications define all tape gaps, marks, and indicators used on CCT's. A brief description of some of the housekeeping conventions used on CCT's follows. However, final and complete definitions are contained in the appropriate ANSI specification referenced in Section 5.0.

2.10.1 Beginning-of-Tape Marker

A small piece of reflective tape is located on the non-recording side of a CCT several feet from the beginning of each reel. This beginning-of-tape (BOT) indicates the beginning of the tape for reading and writing.

2.10.2 Initial Gap

An initial gap of 8 centimeters (3 inches) minimum, 7.62 meters (25 feet) maximum, separates the first record on a CCT from the BOT.

2.10.3 Interrecord Gap

An interrecord gap (IRG) of nominally 1.5 centimeters (0.6 inches) separates multiple records in a file.

2.10.4 End-of-File Mark

The end-of-file (EOF) mark is a specially coded block of data which separates files on a CCT. The EOF is the tape mark described in the referenced ANSI standard.

2.10.5 End-of-Volume Mark

The end-of-volume (EOV) indicator consists of two consecutive EOF's and marks the end of recorded data on the physical volume.

2.10.6 End-of-Tape Marker

A small piece of reflective tape is located on the non-recording side of a CCT several feet from the end of each reel. This end-of-tape (EOT) marker indicates the end of the permissible recording area.

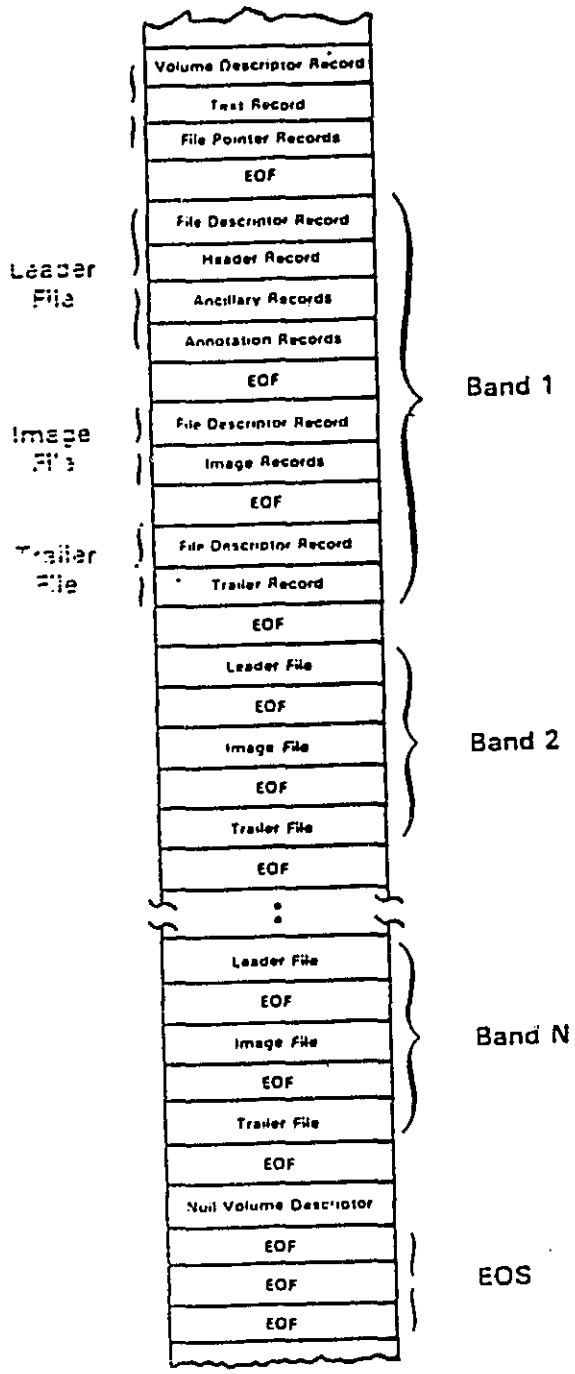
2.10.7 End-of-Set Mark

The end-of-set (EOS) mark consists of three consecutive EOF's and occurs on the last physical volume of a volume set.

3.0 TAPE LAYOUT

A standard Landsat MSS Version 1.0 CCT tape set contains image data for one MSS scene (one logical volume). If the tape set is one physical volume (that is, the data for one scene are contained on one tape reel) the tape format is as shown in figure 3. The physical and logical volume begin with a volume directory file followed by one or more sets of leader, image, and trailer files. The image data format of the CCT shown in figure 3 is BSQ, with as many sets of leader, image, and trailer files as there are images (bands) in the scene. If the CCT image data format is BIL, there is only one such file set. Records are separated by IRG's. Files are separated by EOF's. The logical volume is followed by an EOS.

When a logical volume requires more than one physical volume, the transition between tapes is accomplished in one of two ways: (1) the split between volumes occurs on file boundaries, or (2) the split occurs on record boundaries within an image data file. Figure 4 illustrates these two cases. When the break is between files, the last file before the break is followed by two EOF's (an EOV), and the next tape starts with another volume directory. This subsequent volume directory is the same as the one which initiated the logical volume but with appropriate fields updated to indicate the change of physical volume. After an EOF, the next data file then continues.



3. --Tape Layout of a CCT of N Bands of Band Sequential Data

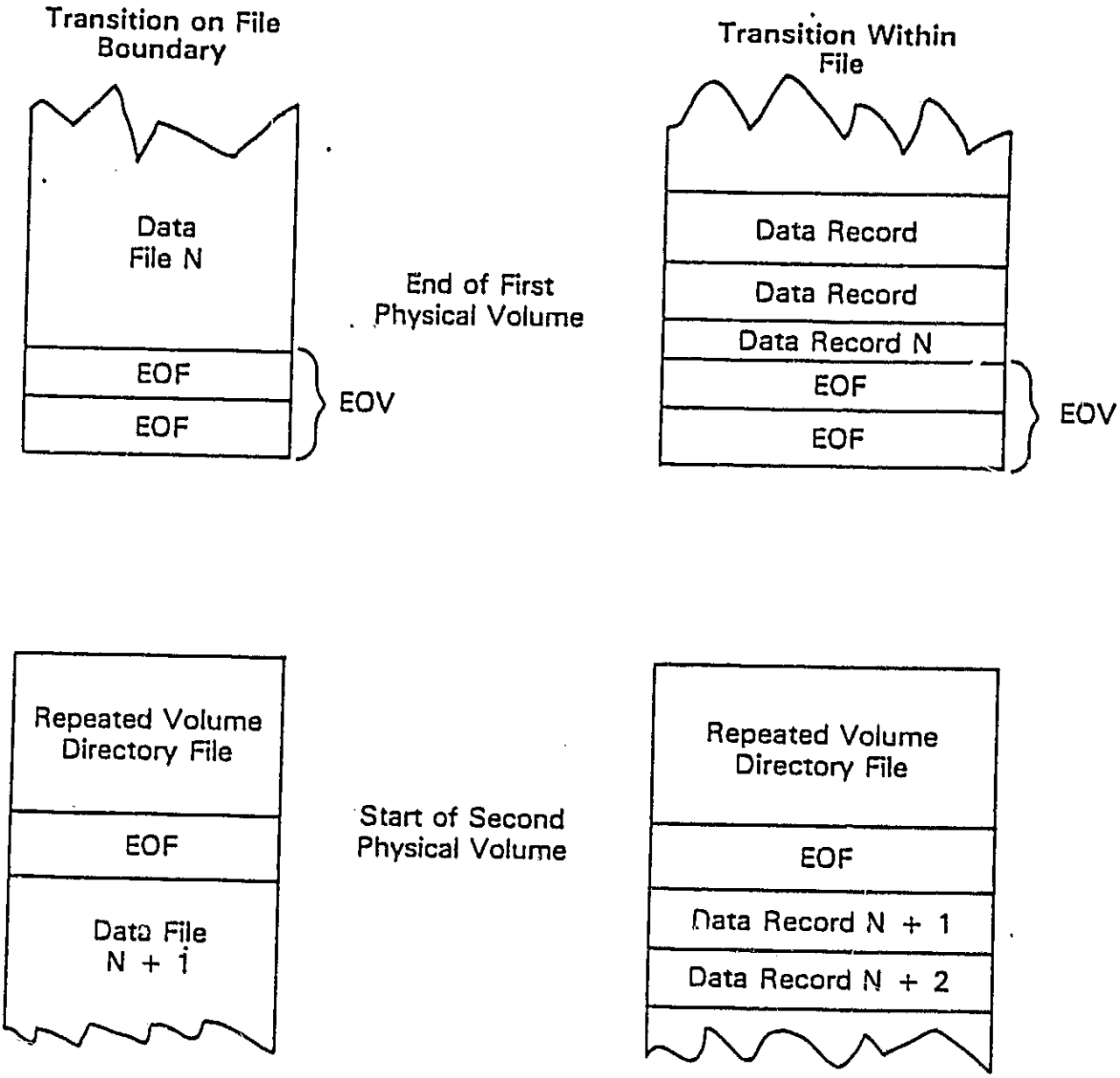


Figure 4.--Illustration of the Two Types of Transition Between Physical Volumes of a Logical Volume

When the break falls within an image file, the last record before the break is followed by an EOV. The next tape starts with the repeated, updated volume directory. This is followed by an EOF and the remaining image records of the previous file.

Table 2 is provided here as a reference guide on the distribution of MSS image data on CCTs. The MSS data are categorized by the type of interleaving, by whether or not geometric corrections are applied and by the number of bands of data. The distribution of these data types is then presented for CCT's with densities of 800, 1600 and 6250 bits-per-inch (BPI).

Table 2. --CCT Physical Volume Distribution of MSS Data

Data Type and Tape Number		Image Distribution by Density		
		800 BPI	1600 BPI	6250 BPI
MSS BSQ				
Geometrically Uncorrected				
(1 band)	Tape 1	entire image	entire image	entire image
(2 bands)	Tape 1	band 1	all images	all images
	Tape 2	band 2		
(3 bands)	Tape 1	bands 1 and 2	all images	all images
	Tape 2	band 3		
(4 bands)	Tape 1	bands 1 and 2	all images	all images
	Tape 2	Bands 3 and 4		
(5 bands)	Tape 1	bands 1 and 2	bands 1, 2 and 3	all images
	Tape 2	bands 3 and 4	bands 4 and 5	
	Tape 3	band 5		
Geometrically Corrected				
(1 band)	Tape 1	entire image	entire image	entire image
(2 bands)	Tape 1	band 1 and 1491 lines of band 2	all images	all images
	Tape 2	1492 lines of band 2		
(3 bands)	Tape 1	band 1 and 1491 lines of band 2	all images	all images
	Tape 2	1492 lines of band 2 and band 3		
(4 bands)	Tape 1	band 1 and 1491 lines of band 2	bands 1 and 2	all images
	Tape 2	1492 lines of band 2 and band 3	bands 3 and 4	
	Tape 3	band 4		
(5 bands)	Tape 1	band 1 and 1987 lines of band 2	bands 1, 2 and 3	all images
	Tape 2	996 of 2, band 3 and 966 of 4	bands 4 and 5	
	Tape 3	1987 lines of band 4 and band 5		
MSS BIL				
Geometrically Uncorrected				
(4 bands)	Tape 1	4800 lines	all lines	all lines
	Tape 2	4800 lines		
(5 bands)	Tape 1	4000 lines	6000 lines	all lines
	Tape 2	4000 lines	6000 lines	
	Tape 3	4000 lines		
Geometrically Corrected				
(4 bands)	Tape 1	3976 lines	5964 lines	all lines
	Tape 2	3976 lines	5968 lines	
	Tape 3	3980 lines		
(5 bands)	Tape 1	4970 lines	7455 lines	all lines
	Tape 2	4970 lines	7460 lines	
	Tape 3	4975 lines		

4.0 FILE FORMATS

A standard CCT with MSS data contains two general categories of records: superstructure records and data records. Combined, these categories provide nine types of records: volume descriptor, text, file pointer, file descriptor, header, ancillary, annotation, image, and trailer. These records are grouped into four file types: volume directory, leader, image and trailer. The grouping of these records into these file types is illustrated in table 3. Figure 5 shows the overall structure of Landsat CCT's in both BSQ and BIL data format. The remainder of this section is concerned with defining the format for each of these record and file types.

4.1 Record Rules and Content

4.1.1 Superstructure Records

The following rules apply to the record format and content of the volume descriptor, file pointer, file descriptor, and text records.

1. The first 12 bytes (3 fields) of all records contain only binary numbers and predefined bit-pattern codes.

2. The fields assigned to the first 16 bytes are similar for all four types of records.

3. From byte 13 to the end of the record, fields are numeric or alphanumeric and are coded in ASCII.

Table 3. --Record Groupings by File Type

FILE TYPE	RECORD TYPES CONTAINED
Volume Directory File	• Volume Descriptor Record • Text Record • File Pointer Records
Leader File	• File Descriptor Record • Header Record • Ancillary Records * • Annotation Record(s)
Image File	• File Descriptor Record • Image Records
Trailer File	• File Descriptor Record • Trailer Record(s)
Null Volume Directory File	• Volume Descriptor Record

*Present only on tapes of geometrically uncorrected imagery (CCT-AM).

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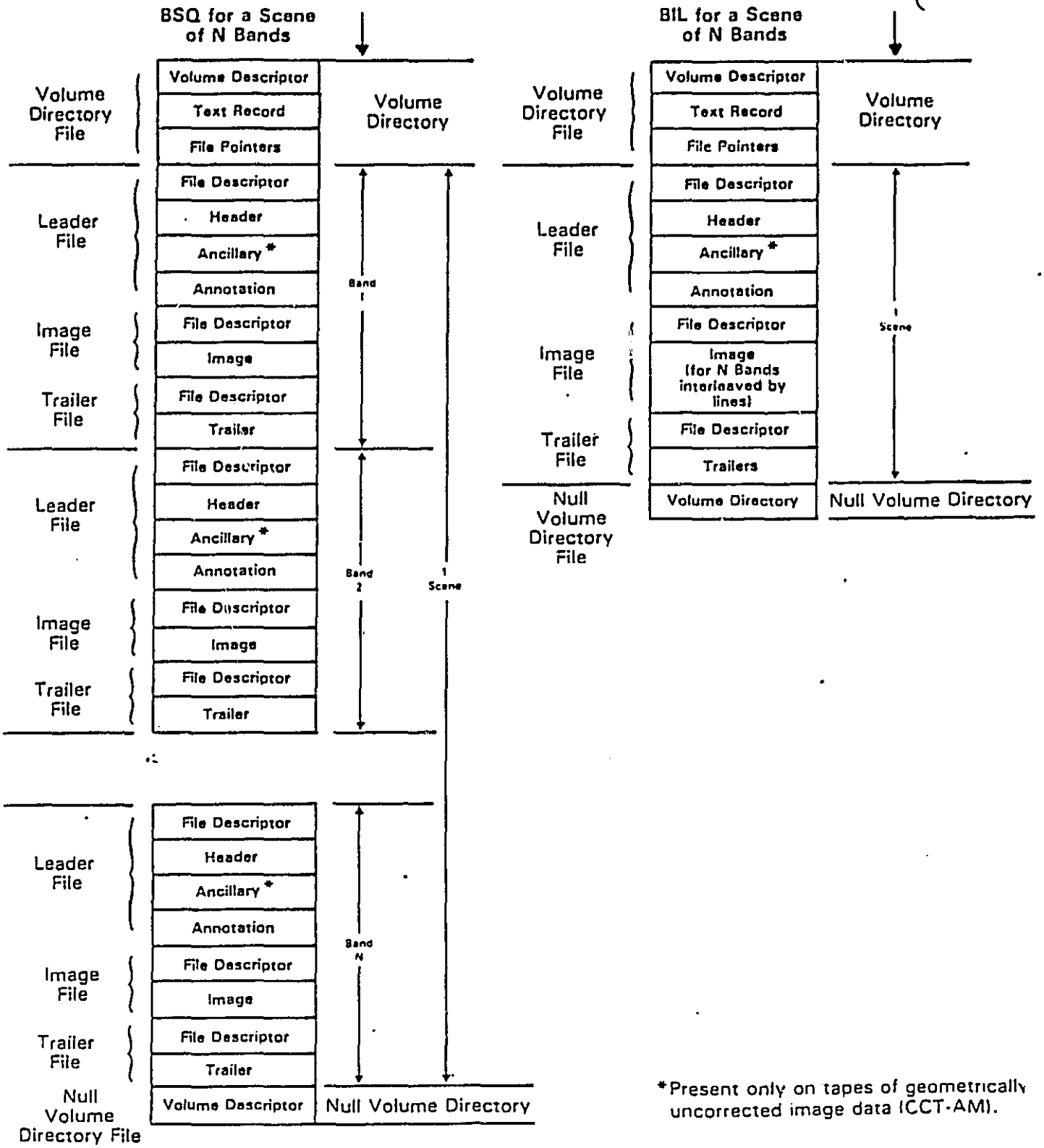
OF POOR QUALITY



*Present only on tapes of geometrically uncorrected image data (CCT-AM).

Figure 5. --Data Format of Landsat MSS

4. Numeric data are right-justified and alphanumeric data are left-justified.

5. In fields containing data and blanks, the blanks are represented by the ASCII blank character (Ø).

6. Data fields are assigned so as to follow 4-byte boundary alignments.

7. Records in the volume directory file and null directory file are 360 bytes in length. Records in the other files--leader, image, and trailer--are 3600 bytes in length.

The 12 bytes referred to in rule 1 are illustrated in figure 6. They contain record number, record type codes, and record length. These fields are as defined in section 2.4.

The similarity of the next four bytes among superstructure records (rule 2) can be seen in figure 6. The first two of these bytes (record bytes 13 and 14) are ASCII/EBCDIC flags. The next two (bytes 15 and 16) are blank. These fields will be described on a per-record basis in the sections which follow.

The three non-text superstructure records are similar in content as well as in format. The purpose of these records is to identify, describe, and locate data in the data files. The general blocking of this type of information within superstructure records is also shown in figure 6. Superstructure records primarily supply information about the data on the CCT, rather than carrying data themselves.

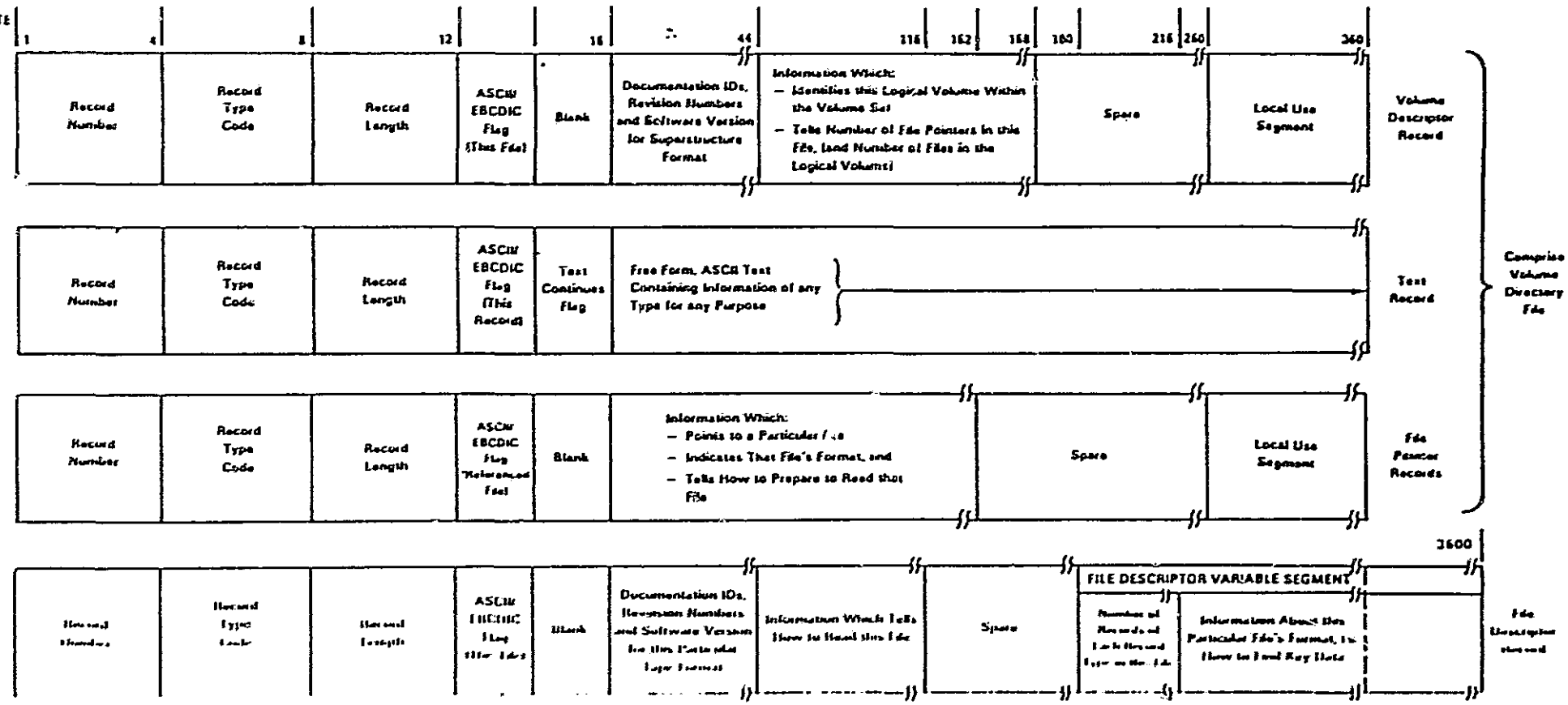


Figure 6.--Layout of Superstructure Records

4.1.2 Data Records

The following rules apply to the record format and content of the header, ancillary, annotation, image, and trailer records.

1. The first 12 bytes (3 fields) of all data records contain only binary numbers and predefined bit-pattern codes of record introduction information.

2. The remainder of all data records contain data, blank fill,or zero fill.

3. All data records are 3600 bytes in length.

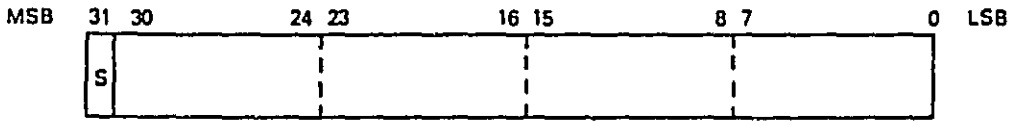
4. Numeric data are right-justified and alphanumeric data are left-justified.

5. In alphanumeric fields containing data and blanks, the blanks are represented by the ASCII blank character (ℬ).

6. Binary fields representing values containing fractional components are given in one of the four formats shown in figure 7, unless a unique data representation format is designated for a specific field.

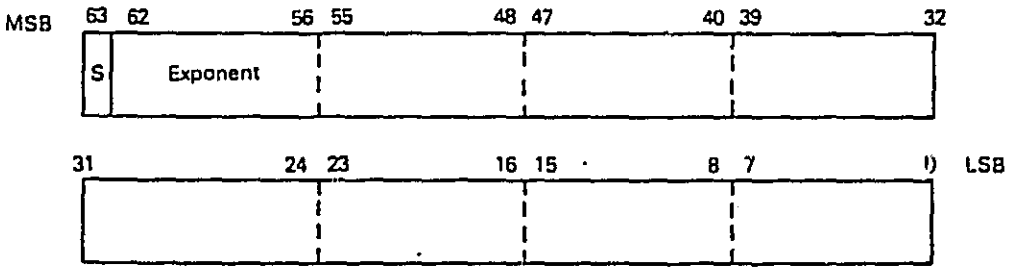
The 12 bytes referred to in rule 1 contain the record number, record type code, and record length. They are as defined in section 2.4.

Fixed Point Binary Format (FP),
a number is represented in four bytes, as follows:



Bit 31 S(Sign) = 0(+), 1(−)
Bits 30:0 Magnitude

Floating Point Binary Format (FL),
a number is represented in eight bytes, as follows:

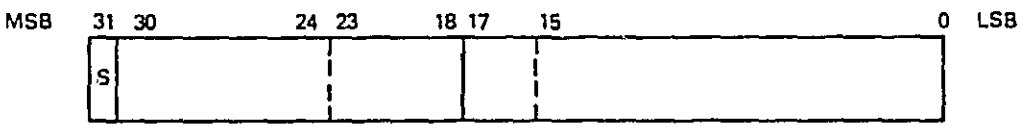


Bit 63 S(Sign) = 0(+), 1(−)
Bits 62:56 Exponent, Range of −64 Through +63. Treated as Excess 64.
Bits 55:0 Fraction Magnitude, 14 Hexidecimal Digits. The Value is found by Multiplying the Factional Part by the Power of 16.

Single Precision Floating Point Binary Format (FLS),
a number is represented in four bytes, as follows:

Bit 31 S(Sign) = 0(+), 1(−)
Bits 30:24 Exponent, Range of −64 Through +63. Treated as Excess 64
Bits 30:24 Fraction Magnitude, 6 Hexidecimal Digits. The Value is Found by Multiplying the Fractional Part by the Power of 16.

Fixed Point Grid Format (FPG) for Resampling Grid Coordinates, and Fill Counts; a number is represented in four bytes, as follows:



Bit 31 − (Sign) = 0(+), 1(−)
Bits 30:18 −Integer Magnitude (two's compliment)
Bits 17:0 −Fraction Magnitude (two's compliment)
Fixed Binary Point Between Bits 18 and 17.

Figure 7. --Data Representation Formats for Fractional Binary Numbers

4.2 Volume Directory File

The volume directory file is the first file of every logical volume. It is composed of a volume descriptor record, a text record, and a series of file pointer records. Every physical volume (tape) also starts with a volume directory file since the tape is either the start of a logical volume or else a logical volume is continued on the tape, in which case the updated volume directory is recorded at the start of the physical volume. The volume descriptor record identifies the logical volume and the number of files the logical volume contains. A text record follows the volume descriptor record and identifies the type of data contained in the logical volume. There is a file pointer record for each data file of the logical volume, indicating each file's class, format, and attributes.

4.2.1 The Volume Descriptor Record

The volume descriptor is the first record of the volume directory file. This record identifies the logical volume and the number of files the logical volume contains. It is composed of five segments. The first segment (bytes 1-16) contains record identification information. The second segment (bytes 17-44) gives format documentation and software identification for the format in which the superstructure is recorded on tape. The third segment (bytes 45-168) provides basic information about the logical volume and gives the number of pointer records in the volume directory file. The fourth segment (bytes 169-260) is spare and is reserved for expansion of control information in future volume descriptor record format revisions. The fifth segment (bytes 261-360), the local use segment, provides space for whatever notation or information the tape user wants to place in it. A breakdown of the individual data items of the volume descriptor record is given in table 4.

Table 4.—Volume Descriptor Record Format

Byte	Type*	Description
1-4	B	Record number = $1)_{10}$.
5-8	B	Record type code: byte 5 = $300)_8$ byte 6 = $300)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9-12	B	Length of this record = $360)_{10}$.
13-14	A	ASCII/EBCDIC Flag for this file = "AƄ" for ASCII. (EBCDIC not available.)
15-16	A	Blank.
17-28	A	Superstructure control document number: 12 bytes, always CCB-CCT-0002.
29-30	A	Superstructure control document revision number: 2 bytes indicating the revision letter of the document identified in bytes 17-28, coded "ƄC" initially.

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 4.--Volume Descriptor Record Format--Continued

Byte	Type*	Description
31-32	A	Superstructure record format revision: 2 bytes, coded "ƀA" unless this record format is modified.
33-44	A	Software release number for this logical volume.
45-60***	A	ID for physical volume containing this volume descriptor: 16 character tape ID of the form: LNSTTYYDDDXXNVƀƀ where L = Mission designator coded 'L' for Landsat N = Mission number, '2', '3' or '4' S = Sensor type, coded 'M' for MSS TT = Tape type, coded 'CP' (data with geometric correction) or 'CA' (data without geometric correction).

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Fields to be updated when a volume directory is repeated on a subsequent physical volume

Table 4.--Volume Descriptor Record Format--Continued

Byte	Type*	Description
		YY = Last two digits of year in date of generation DDD= Julian day of generation XX = Sequence number within day for each tape type N = Physical volume number V = Number of volumes in set.
61-76**	A	Logical volume ID, 16 characters of the form: ADDDDHHMMSbbbbbbbb where A = Landsat mission number DDDD = Day number, relative to launch, at time of observation HH = Hour at time of observation MM = Minutes at time of observation S = Tens of seconds

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Blank filled in a null volume descriptor record.

Table 4.—Volume Descriptor Record Format--Continued

Byte	Type*	Description
77-92	A	Volume set ID: 16 character coded "LANDSATNbMSSbXXX" where N is the mission number and XXX is either BIL or BSQ.
93-94	N	Number of physical volumes in the set: 2 bytes indicating 1, 2 or 3 tapes per set ("b1", or "b2" or "b3").
95-96	N	Physical volume number, start of logical volume: always "b1".
97-98	N	Physical volume number, end of logical volume: same as bytes 93-94.
99-100**	N	Physical volume number containing this volume descriptor: sequence number of this tape within tape set = "b1", "b2" or "b3".

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Fields to be updated when a volume directory is repeated on a subsequent physical volume.

Table 12.--Ancillary Map Project Record Formats--Continued

Records 12 and 20.--Continued

Bytes	Type*	Description
5-8	B	Record type code: byte 5 = $044)_8$ byte 6 = $044)_8$ byte 7 = $333)_8$ for UTM/PS $355)_8$ for SOM/HOM byte 8 = $022)_8$
9-12	B	Record length = $3600)_{10}$.
13-2940	FPG**	VRS Coordinates (Row numbers 33-44).
2941-3084	B	Zero Fill (not used).
3085-3086	B	Pixel number of WRS center in fully processed image.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Each coordinate and grid line fill count (for all rows) is in the Fixed Point Grid Format (given in Figure 7).

Table 4.--Volume Descriptor Record Format--Continued

Byte	Type*	Description
101-104**	N	First referenced file number in this physical volume: this 4 byte field gives the file number of the first data file which follows this volume directory file. If a file spans two or more physical volumes each portion of the file is referenced by the same number (because each portion is using the same file pointer record). Volume directory files are not included in the file sequence number count.
105-108	N	Logical volume number within volume set: coded "ØØØ1" except for null volume descriptor which is coded "ØØØ2".

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Fields to be updated when a volume directory is repeated on a subsequent physical volume.

Table 4.—Volume Descriptor Record Format--Continued

Byte	Type*	Description
109-112***	N	Logical volume number within physical volume: same as bytes 105-108.
113-120**	A	Logical volume creation date: 8 bytes of form YYYYMMDD.
121-128**	A	Logical volume creation time: 8 bytes of form HHMMSSXX, where XX indicates hundredths of seconds.
129-140**	A	Logical volume generating country: "USAbbbbbbbbb".
141-148**	A	Logical volume generating agency: coded "USGSbbbb".
149-160**	A	Logical volume generating facility: coded "EDCbbbbbbbbb".

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Blank filled in a null volume descriptor record.

***Fields to be updated when a volume directory is repeated on a subsequent physical volume.

Table 4.--Volume Descriptor Record Format--Continued

Byte	Type*	Description
161-164**	N	Number of pointer records in volume directory: equals number of data files in CCT tape set: coded $3)_{10}$ for BIL; up to three times number of bands for BSQ.
165-168**	N	Number of records in volume directory: the number of pointer records + 2.
169-260	A	Volume descriptor spare segment (reserved) (Blank filled).
261-360	A	Local use segment (Blank filled).

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Blank filled in a null volume descriptor record.

4.2.2 Text Record

A text record occurs as the second record of the volume directory file. After the first 16 bytes of basic superstructure record identification information, the remainder of the record is free-form ASCII text. It may be used to carry any type of information for any purpose. Standard Landsat CCT products will carry information about the contents of the tape such as sensor, scene ID, date, and type of processing. These are intended for the convenience of the user. The format and content of the text record are given in table 5.

Table 5.--Text Record Format

Bytes	Type*	Description
1-4	B	Record number = the sequence number of this record within this file = $2)_{10}$.
5-8	B	Record type code: byte 5 = $022)_8$ byte 6 = $077)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9-12	B	Record length = $360)_{10}$.
13-14	A	ASCII/EBCDIC flag for this record, indicating whether the alphanumeric information of this record is coded ASCII or EBCDIC. Coded "Aƀƀ" for ASCII (EBCDIC not available).
15-16	A	Blank filled.
17-360	A	Field to be used for free-form text (alphanumeric information of any kind desired by the tape producer).

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

4.2.3 File Pointer Record

File pointer records reside in the volume directory file. There is one file pointer record for each data file of the logical volume; it identifies the file by class, indicates that file's format, and provides file attribute information such as record lengths and data type. These file pointer records are recorded in the same sequence as the files to which they point.

After the first 16 byte segment of record identification information, there are three data segments. The second segment (bytes 17-152) supplies specific file attribute information such as file class, format and data type. The third segment (bytes 153-260) is spare and is reserved for expansion of the file pointer information segment in future format revisions. The fourth segment (bytes 261-360) is provided for local use. The format of a file pointer record is given in table 6.

Table 6.--File Pointer Record Format

Bytes	Type*	Description
1-4	B	Record number: sequence number of this record in this file; first pointer record = $3)_{10}$.
5-8	B	Record type code: byte 5 = $333)_8$ byte 6 = $300)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9-12	B	Length of this record = $360)_{10}$.
13-14	A	ASCII/EBCDIC flag for the referenced file: coded "AØ" for ASCII (EBCDIC not available).
15-16	A	Blank.
17-20	N	Referenced file number: sequence number of data file within logical volume; 1st data file is numbered $1)_{10}$.

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 6.--File Pointer Record Format--Continued

Bytes	Type*	Description
21-36	A	Referenced file identification: 16 characters indicating nature of the data of the form: LLNbSSSTFFFFXXXB, where LL = Satellite coded 'LS' N = Mission number, coded '2', '3', or '4' SSS = Sensor type, coded 'MSS' T = Data type, coded 'A' for geometrically uncorrected data or 'P' for geometrically corrected data FFFF = File type, coded: 'LEAD' for leader file 'IMGY' for imagery file 'TRAI' for trailer file XXX = Image data format, coded 'BIL' or 'BSQ'.

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 6.--File Pointer Record Format--Continued

Bytes	Type*	Description
		B = Band number associated with file, coded 'b' for BIL or '1','2','3' or '4' for Landsat-4 BSQ or '4', '5', '6', '7', or '8' for Landsat-2/3 BSQ.
37-64	A	Referenced file name: 28 bytes coded "LEADER FILE", "IMAGE FILE", or "TRAILER FILE" with trailing blanks.
65-68	A	Referenced file class code: coded 'IMGY' for files containing image data 'LEAD' or 'TRAI' for all other files.
69-96	A	Referenced file data type: 28 bytes coded 'BINARY ONLY' (with trailing blanks) for files of image data, and 'MIXED BINARY AND ASCII' (with trailing blanks) for all other files.

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 6.--File Pointer Record Format--Continued

Bytes	Type*	Description
97-100	A	Referenced file data type code: coded 'BINO' for image data or 'MBAA' for all other files.
101-108	N	Number of records in referenced file including file descriptor record.
109-116	N	Referenced file 1st record length: always = $3600)_{10}$.
117-124	N	Referenced file maximum record length: always = $3600)_{10}$.
125-136	A	Referenced file record length type: always coded "FIXED LENGTH".
137-140	A	Referenced file record length type code: always coded "FIXD".
141-142	N	Referenced file physical volume number, start of file: coded "b1", "b2" or "b3", indicating the sequence number of the tape of a tape set containing the 1st record of the file.

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 6.--File Pointer Record Format--Continued

Bytes	Type*	Description
143-144	N	Referenced file physical volume number, end of file: coded "Þ1", "Þ2", or "Þ3", indicating the sequence number of the tape of the tape set containing the last record of the file; will be the same as field directly above unless the file is split across physical volumes (tapes).
145-152**	N	Referenced file portion, the sequence number of the file on this physical volume: coded "ÞÞÞÞÞÞÞ1" for all files unless the referenced file is a continuation (that is, was started on a previous tape). In this case, the field contains the sequence number of the first record of the file recorded on this tape.

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Updated in repeated volume directory if logical volume is split within a file

Table 6.--File Pointer Record Format--Continued

Bytes	Type*	Description
153-160**	N	Referenced file portion, the sequence number of the last record of the file on this physical volume.
161-260	A	Pointer spare segment (Blank filled)
261-360	A	Local use segment (Blank filled)

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Updated in repeated volume directory if logical volume is split within a file

4.3 Leader File

The leader file is composed of a file descriptor record and up to three types of data records: header, ancillary, and annotation. The leader file is the first file of a block of data which represents a single band of a scene for a BSQ tape or the entire scene for a BIL tape. This was illustrated earlier in figure 5. The leader file preceeds image data files and supplies information associated with the image such as image product annotation, ephemeris/attitude data, processing information, and other support information.

4.3.1 File Descriptor Record

The file descriptor record is the first record of a leader file, and introduces that file. (It is also the first record of an image data file and a trailer file). Following the first 16 byte segment of record identification information are four data segments. The second segment (bytes 17-44) identifies the format, and the software version used to produce the file. The third segment (bytes 45-116) provides basic information necessary to locate and read the data records of the file. The fourth segment (bytes 117-180) is a spare which is reserved for expansion in future file descriptors revisions. These first four segments are known as the file descriptor fixed segments. They provide information on how to read the particular file being introduced by the file descriptor record.

The fifth segment (bytes 181-3600) is referred to as the file descriptor variable segment because its format varies with the type of file being described. The fifth segment starts with values indicating the number of records of each record type in the file. This is followed with locator information particular to the format of the data file, that is, how to access and display essential data. Specific field locator information in bytes 217 through 360 is given in a series of 16-byte codes, each of which are structured as follows:

Bytes	Description
1-6	The record number of the record containing the field
7-12	The record byte number of the first byte of the field
13-15	Length of the field in bytes
16	A code indicating the type of data in the field, coded 'A' for alphanumeric; 'N' for numeric; 'B' for binary.

The format of the fixed and variable segments of the leader file descriptor record is given in table 7.

Table 7.—File Descriptor Record for Leader File

Bytes	Type*	Description
1-4	B	Record number = $1)_{10}$.
5-8	B	Record type code: byte 5 = $077)_8$ byte 6 = $300)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9-12	B	Length of this record = $3600)_{10}$.
13-14	A	ASCII/EBCDIC flag for this file = "Aƀ" indicating ASCII. (EBCDIC not available).
15-16	A	Blanks.
17-28	A	Control document number for this embodiment (that is, this document's number).
29-30	A	Control document revision number.

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 7.--File Descriptor Record for Leader File--Continued

Bytes	Type*	Description
31-32	A	File design descriptor revision letter: 2-bytes giving the revision letter of the file format (as opposed to revisions which affect the control document without affecting the file format). Coded "bA" unless this record format is modified.
33-44	A	Software release number for this file.
45-48	N	File number: sequence number of this file within the logical volume. The volume directory file is not included in this count.
49-64	A	File identification: same as file pointer record, bytes 21-36.
65-68	A	Record sequence and location type flag: always coded "FSEQ" indicating a fixed record location of record sequence number.

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 7.--File Descriptor Record for Leader File--Continued

Bytes	Type*	Description
69-76	N	Record number location: always coded "ßßßßßßß1" indicating that record number starts in record byte one.
77-80	N	Record number field length: always coded "ßßß4" indicating a 4 byte record number field.
81-84	A	Record code and location type flag: always coded "FTYP" indicating a fixed record location of the type code field.
85-92	N	Record code location: always coded "ßßßßßßß5" indicating that record code starts in record byte five.
93-96	N	Record code field length: always coded "ßßß4" indicating a 4 byte record field.

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 7.--File Descriptor Record for Leader File--Continued

Bytes	Type*	Description
97-100	A	Record length and location type flag: always coded "FLGT" indicating a fixed record location of the record length field.
101-108	N	Record length location: always coded "ßßßßßßß9" indicating that record length field starts in record byte nine.
109-112	N	Record length field length: always coded "ßßß4" indicating a 4 byte record length field.
113	A	Flag indicating that data interpretation information is included within file descriptor record: coded "N" indicating NO.
114	A	Flag indicating that data interpretation information is included within records other than the file descriptor record: coded "N".

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 7.--File Descriptor Record for Leader File--Continued

Bytes	Type*	Description
115	A	Flag indicating that data display information is included with the file descriptor record: coded "N".
116	A	Flag indicating that data display information is included within the file in record(s) other than the file descriptor: coded "N".
117-180	A	Reserved segment (Blank filled)
181-186	N	Number of header records: always = $1)_{10}$.
187-192	N	Header record length: always = $3600)_{10}$.
193-198	N	Number of ancillary records: coded $0)_{10}$ for leader files preceding imagery that has been geometrically corrected; coded $18)_{10}$ if imagery is geometrically uncorrected.
199-204	N	Ancillary record length: always = $3600)_{10}$.

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 7.--File Descriptor Record for Leader File--Continued

Bytes	Type*	Description
205-210	N	Number of annotation records: coded = $1)_{10}$ for fully processed data; $2)_{10}$ for partially processed.
211-216	N	Annotation record length: always = $3600)_{10}$.
		Field Locator Information
217-232	A	Scene identification field locator: coded "ßßßßß2ßßßß13ß11A".
233-248	A	World Reference System identification locator: coded "ßßßßß2ßßßß25ßß8A".
249-264	A	Mission identification field locator: coded "ßßßßß2ßßßß49ßß4N".
265-280	A	Sensor identification field locator: coded "ßßßßß2ßßßß45ßß4A".
281-296	A	Exposure date-time field locator: coded "ßßßßß2ßßß109ß16N".

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 7.--File Descriptor Record for Leader File--Continued

Bytes	Type*	Description
		Field Locator Information--Continued
297-312	A	Geographic reference field locator (format center): coded "ßßßßß3ßßßß21ß17A" for geometrically corrected imagery and "ßßßß21ßßßß21ß17A" for geometrically uncorrected imagery.
313-328	A	Image processing performed field locator: coded "ßßßßß2ßßß169ßß1A".
329-344	A	Imagery format (interleaving) indicator: coded "ßßßßß2ßßß173ßß4A"
345-360	A	Band indicator locator: coded "ßßßßß2ßßß206ßß1A".
361-3600	A	Blanks.

*Denotes field type:

A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

4.3.2 Header Record

The header record identifies the content and format of the data of the leader file and of the image and trailer files that follow. There is only one header record per leader file. Header record data are subdivided into six groups:

a) Record Introduction: record number, type, and length.

b) Image Identification: scene ID, and WRS path/row indicator.

c) Spacecraft Description: sensor, mission number, and detector status.

d) Time of Exposure: WRS frame center location and exposure time.

e) Data Identification/Characteristics: general header, annotation, ancillary, image and trailer data characteristics such as number of records, interleaving type, resampling technique, map projection, and WRS offset.

f) Special Purpose Fields: transmission mode, temporal registration data, overlap mark information, geometric correction quality codes, radiometric correction accuracy, telemetry and control point quality indicators, and image enhancement indicators.

The header record format is given in table 8. It should be noted that significant modifications in the format of the header record have been made from the previous Landsat CCT format. The general order of appearance of specific data fields, however, has not changed. Attempts have been made to convert as many binary fields as possible to ASCII and to place the fields on 4-byte boundaries to ease field access and interpretation.

Table 8.--Header Record Format

Bytes	Type*	Description
A. Record Introduction		
1-4	B	Record number = $2)_{10}$
5-8	B	Record type code: byte 5 = $022)_8$ byte 6 = $022)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9-12	B	Record length = $3600)_{10}$
B. Image Identifiers		
13-24	A	Image Identification (ASCII) - unique image identifier of the form: ßNDDDDHHMMSB where N = Landsat mission number: 2, 3, or 4 DDDD = Days after launch at time of observation HH = Hour at time of observation MM = Minute at time of observation S = Tens of seconds at time of observation, where time of observation is universal time (GMT)

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
B. Image Identifiers—Continued		
		B = Band Identification Code: 1, 2, 3, or 4 for Landsat-4 BSQ; 4, 5, 6, 7, or 8 for Landsat-2/3 BSQ; or blank for BIL
25-32	A	WRS Designator - unique terrestrial image identifier of the form: ØMPPPRRR where M = A (for ascending node) or D (for descending node) PPP = WRS path number RRR = WRS row number
33-38	A	Date of Tape Generation of the form: DDMMYY where DD= day, MM = month, YY = last two digits of year.
39-44	A	Blank Fill (not used)
C. Spacecraft Description		
45-48	A	Sensor Identification: always coded "MSSØ"
49-50	N	Mission Number: $2)_{10}$, $3)_{10}$, or $4)_{10}$

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
C. Spacecraft Description—Continued		
51–56	N	Spacecraft orbit number during which the image was acquired
57–84	A	Active Detector Status - contains detector status for the 24 (26 for Landsat-3) MSS detectors. One byte per detector, six detectors for each of the four bands starting with the status of detector 1 of the first band in byte 57 through detector 6 of the fourth band in byte 80. In the case of Landsat-3, band 8 detectors A and B are in bytes 81 and 82, respectively. Bytes not used are blank filled. A "1" in the byte indicates the detector is active. If a detector was disabled or inactive during the data acquisition pass, the status will be "0".
85–88	N	Active Detector Count - the number of active detectors

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 2.—Header Record Format—Continued

Bytes	Type*	Description
C. Spacecraft Description--Continued		
89-92	N	Nominal number of image data pixels per scan line in original geometrically uncorrected image
93-96	A	Blank fill (not used)
D. Time of Exposure/WRS Designator		
97-100	A	Blank fill (not used)
101-104	N	Scan line number containing WRS frame center in fully processed image
105-108	N	Pixel number of WRS frame center in fully processed image. (Blank filled in partially processed CCT-AM.)
109-124	A	Center picture exposure time, in GMT: Last 2 digits of year (00-99) Day of year (3 digits: 001-366) Hour (2 digits: 00-23) Minutes (2 digits: 00-59) Seconds (2 digits: 00-59) Milliseconds (3 digits: 000-999) Blanks (2 digits)

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 8.—Header Record Format--Continued

Bytes	Type*	Description
E. Data Identification and Characteristics		
		Header Data Characteristics
125-128	N	Header record length = $3600)_{10}$
129-132	N	Number of header records = $1)_{10}$
133-136	N	Number of bytes of Group "F" (special purpose fields) header data
		Annotation Data Characteristics
137-140	N	Annotation record length = $3600)_{10}$
141-144	N	Number of annotation records = $1)_{10}$ for fully processed data; $2)_{10}$ for partially processed data
		Ancillary Data Characteristics
145-148	N	Ancillary record length = $3600)_{10}$
149-152	N	Number of ancillary records = $18)_{10}$ for partially processed imagery; = $0)_{10}$ for fully processed imagery
153	A	Geometric corrections applied, "Y" = Yes; "N" = No
154	A	Geometric correction data present, "Y" = Yes; "N" = No

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
E. Data Identification and Characteristics—Continued		
		Ancillary Data Characteristics—Continued
155	A	Radiometric correction applied, "Y" = Yes; "N" = No
156	A	Radiometric correction data present, "Y" = Yes; "N" = No
157-160	N	Image record length = $3600)_{10}$.
161-166	N	Number of image records = $2400)_{10}$ for partially processed BSQ imagery; = $2983)_{10}$ for fully processed BSQ; = $11,932)_{10}$ for fully processed Landsat-2/4 four band BIL imagery; = $14,915)_{10}$ for fully processed Landsat-3 five band BIL imagery; = $9600)_{10}$ for partially processed Landsat-2/4 four band BIL imagery; = $12,000)_{10}$ for partially processed Landsat-3 five band BIL imagery.
167-168	N	Number of calibration/quality support data bytes per scan line of image data = $28)_{10}$ for fully processed imagery, = 0 for partially processed.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
E. Data Identification and Characteristics—Continued		
		Image Data Characteristics
169	A	Image data format = "A" for partially processed data, = "P" for fully processed data
170-172	A	Blank Fill (not used)
173-176	A	Interleaving type indicator, "BSQb" or "BILb"
177	N	Line interleaving count, = $0)_{10}$ for noninterleaved (BSQ) data; = $4)_{10}$ for Landsat-2/4 BIL data; = $5)_{10}$ for Landsat-3 BIL data
178	N	Number of bits per pixel, always $8)_{10}$
179-180	A	Resampling Applied: "bb" = none "CU" = cubic convolution "NN" = nearest neighbor

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
E. Data Identification and Characteristics—Continued		
181-184	A	Map projection: corresponds to that applied to fully processed data (UTM, PS or SOM) or to the first map projection set in the ancillary and annotation sections for partially processed data (UTM or PS) "UTMb" = Universal Transverse Mercator (UTM) "PSbb" = Polar Stereographic (PS) "SOMb" = Space Oblique Mercator (SOM) "HOMb" = Hotine Oblique Mercator (HOM).
185-190	N	WRS offset from fully processed image center. Contains right (positive) or left (negative) pixel displacement of the WRS designation with respect to the picture center pixel (scan line 1492, pixel 1774). (Zero filled for partially processed data).

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
E. Data Identification and Characteristics—Continued		
191-192	A	Blank Fill (not used).
193	A	Image data justification, always "R" indicating right justification.
194-196	N	Location of most significant bit, always 0, indicating left.
197-200	N	Number of pixels per scan line, in both partially processed and fully processed image data, always $3548)_{10}$ (including fill pixels).
201-204	A	Blank Fill (not used).
205	N	Number of usable images per scene: = $1)_{10}$, $2)_{10}$, $3)_{10}$, $4)_{10}$, or $5)_{10}$.
206	N	MSS band number = $1)_{10}$, $2)_{10}$, $3)_{10}$ or $4)_{10}$ for Landsat-4 BSQ data; = $4)_{10}$, $5)_{10}$, $6)_{10}$, $7)_{10}$ or $8)_{10}$ for Landsat-2/3 BSQ data, = $0)_{10}$ if BIL data.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
E. Data Identification and Characteristics—Continued		
207-212	A	Blank Fill (not used).
		Trailer Data Characteristics
213-216	N	Trailer record length = $3600)_{10}$.
217	N	Number of Trailer Records: $1)_{10}$ for BSQ, $4)_{10}$ or $5)_{10}$ for BIL.
218-224	A	Blank Fill (not used).
F. Special Purpose Fields		
225	A	Orbital direction: "D" = descending node "A" = ascending node
226-228	A	Lat./Long. tick mark flag: a code of 'ƀƀX' in the bytes indicates that the latitude and longitude tick marks are provided in the annotation record. (Blank fill indicates exclusion of lat./long.)

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see figure 7 for explanation)

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
F. Special Purpose Fields		
229-236	FL	Image Orientation Angle: Orientation of map projection coordinate system with respect to center line of fully processed image (in radians). (Zero filled for partially processed data as is contained in ancillary data records).
237-240	A	Sensor mode: "LLbb" = low gain linear "LCbb" = low gain compressed "HLbb" = high gain linear "HCbb" = high gain compressed.
(241-356)		Blank fill for partially processed imagery (CCT-AM) OR Temporal Registration Data for fully processed imagery (CCT-PM). Byte assignments 241-356 are as follows:

* Denotes field type:
A = Aphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see figure 7 for explanation)

Table 8.—Header Record Format—Continued

Bytes	Type*	Description

F. Special Purpose Fields—Continued

241-252	A	Scene ID of reference image used for temporal registration processing of the form: ÞADDDDHHMMSB where A = Landsat mission 2, 3, or 4 DDDD = Day number, relative to launch, at time of observation HH = Hour at time of observation MM = Minute at time of observation S = Tens of seconds at time of observation B = Band ID code: 1, 2, 3, or 4 for Landsat-4 BSQ; 4, 5, 6, 7, or 8 for Landsat-2/3 BSQ; or blank for BIL.

* Denotes field type:
A = Aphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
F. Special Purpose Fields—Continued		
253-260	A	WRS Designator - 8 bytes of unique terrestial identifier of the form: ⅛MPPPRRR where M = A (for ascending node) or D (for descending node) PPP = nominal WRS path number RRR = nominal WRS row number.
261-324	N	Scan line and pixel numbers of the common temporal registration region of the reference image and current image (image under processing, see figure 8). Temporal registration points P_1 through P_4 are in the tabular form given below. Entries denote byte assignments scan line numbers and pixel numbers.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 8.--Header Record Format--Continued

Bytes	Type*	Description

F. Special Purpose Fields--Continued

Temporal Registration	Current Image		Reference Image	
	Scan Line Number	Pixel Number	Scan Line Number	Pixel Number
P_1	261-264	265-268	269-272	273-276
P_2	277-280	281-284	285-288	289-292
P_3	293-296	297-300	301-304	305-308
P_4	309-312	313-316	317-320	321-324

Overlap Data: scan line and pixel numbers (in fully processed image) of the four overlap marks (see figure 9) as follows:

325-328	N	Scan Line of First Overlap Mark (Upper Left).
329-332	N	Pixel Number of First Overlap Mark.
333-336	N	Scan Line of Second Overlap Mark (Upper Right).
337-340	N	Pixel Number of Second Overlap Mark.

*Denotes field type:

A = Alphanumeric

N = Numeric

B = Binary

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
F. Special Purpose Fields—Continued		
341-344	N	Scan Line of Second Overlap Mark (Lower Left).
345-348	N	Pixel Number of Third Overlap Mark.
349-352	N	Scan Line of Fourth Overlap Mark (Lower Right).
353-356	N	Pixel Number of Fouth Overlap Mark.
357-360	N	Nominal overlap mark pixel offset in fully processed image data (see figure 9).
361-364	A	Geometric correction quality code: quality assessment of appended (CCT-AM) or applied (CCT-PM) geometric modeling data. For Landsat-2/3, coded as "9" for highest to "0" for lowest quality based on the number of control points applied by setting the code equal to the truncated integer value of the expression $\frac{N+7}{8}$ where 'N' is the number of control points. For Landsat-4, represents the number of parameters modeled in the processing (see table below).

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 8.--Header Record Format--Continued

Bytes	Type*	Description

F. Special Purpose Fields--Continued

Code	Parameters Modeled	Geometric Correction Quality
0	None, correction is SCD only	Acceptable
2	Along track, across track (control points used to calculate translation errors)	Good
3	Along track, across track and yaw	Good
4	Along track, across track yaw, altitude	Excellent
6	Along track, across track, yaw, altitude, along track rate, across track rate	Excellent

365-368	N	Actual number of Tick Marks for Top (T), Left (L), Right (R) and Bottom (B) Annotation zones (Blank fill for partially processed data).
(369-3568)		" filled for Landsat-2/3, following [illegible] Landsat-4:

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 8.--Header Record Format--Continued

Bytes	Type*	Description
F. Special Purpose Fields--Continued		
369-372	A	Overall Band Quality Indicator (see table 9). The assessment of the overall quality of a band of imagery based on the combined geometric, radiometric and image data quality. Four bytes, one code for each of four bands starting with band 1 in byte 369. Bytes not used are blank filled.
373-376	A	Radiometric Calibration Method "ØØØØ" = No corrections applied (engineering test mode) "HIST" = Histogram method "CALW" = Cal wedge values only (no histograms) "NSTA" = Non-standard corrections applied (engineering test mode).

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

FP, FLS, FL (see figure 7 for explanation)

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
F. Special Purpose Fields—Continued		
377-380	FLS	Relative Calibration Accuracy (RCA), maximum difference between detector means for the image. 0 ≤ RCA ≤ 1.0 Excellent 1.0 < RCA ≤ 2.0 Good 2.0 < RCA Acceptable
381-384	A	Blank filled.
		Input Data Quality Indicators Telemetry:
385-388	N	Number of ephemeris data points sampled in the telemetry interval.
389-392	N	Number of rejected (outlier) ephemeris data points in the telemetry interval.
393-396	N	Number of attitude data points sampled in the telemetry interval.
397-400	N	Number of rejected (outlier) attitude data points in the telemetry interval.
401-404	FLS	Length of telemetry interval in seconds.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see figure 7 for explanation)

Table 8.—Header Record Format--Continued

Byte	Type*	Description
F. Special Purpose Fields--Continued		
405-408	A	Blank filled.
409-420	FLS	Accuracy of ephemeris fit, RMS difference in meters between fit and data points. 3 four-byte values, one each for altitude, along-track position, and across-track position.
421-424	A	Blank filled.
425-436	FLS	Accuracy of attitude fit, RMS difference in radians between fit and data points. 3 four-byte value, one each for pitch, roll and yaw.
		Control Points:
437-440	A	Overall Band Quality codes of reference scene from which control points were extracted (see table 9); four bytes giving one code for each of four bands starting with band 1 in byte 437. Bytes not used are blank filled.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see figure 7 for explanation)

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
F. Special Purpose Fields—Continued		
		Control Points--Continued
441-444	N	Number of geodetic control points used to correct reference image control point extraction process (control point library build).
445-448	N	Average** previous registration success; average percent previous successful registrations of control points.
449-452	A	Blank filled.
453-456	FLS	Average** autocorrelation peak value in control point generation process
457-464	FLS	Ninety percent error ellipse of geodetic control point location in corrected reference image from which control points are extracted; two values, along-track and across-track, (in meters).

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see figure 7 for explanation)

**Average of only those control points used in calculations for present scene

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
F. Special Purpose Fields—Continued		
		Control Points--Continued
465-468	FLS	Correlation Factor; average** autocorrelation peak values of control points used in the correction of the reference image from which control points are extracted
469-472	FLS	Average** control point suitability measure; average of autocorrelation surface peak curvatures
473-484	A	Blank filled (not used)
485	A	Data Source (ASCII) "G" = GSTDN, "W" = TDRSS/White Sands, "T" = Transportable Ground Station
486	A	Blank filled (reserved for processing anomaly indicator)
487-492	A	Blank filled

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see Figure 7 for explanation)

**Average of only those control points used in calculations for present scene

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
F. Special Purpose Fields—Continued		
493-496	FP	Uncorrectable ECC count for the scene; total count accumulated during input of data in HDT-AM creation process.
497-500	FP	Indication of bit error rate for the scene; number of sweeps which had a least one minor frame sync loss (more than three consecutive minor frame sync words containing at least one bit error). There are 6 bits per sync word, including calibration data. There are about 2100 sync words per sweep.
501-504	A	Blank filled.
505-508	N	Use of Nominal Calibration Wedge values (CWV) $0)_{10}$ = Not used $1)_{10}$ = Used for comparison only $2)_{10}$ = Used to replace CWV's outside window and used in radiometric calibration.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
F. Special Purpose Fields—Continued		
509-512	N	Window Size; the neighborhood of the nominal values to which the actual CWVs are compared.
(513-1088)		Nominal Calibration Wedge Values; 144 four-byte values, six values for each of six detectors per each of four bands. Fields for bands not present are blank filled.
513-656	N	Band 1 Nominal Calibration Wedge Values.
657-800	N	Band 2 Nominal Calibration Wedge Values.
801-944	N	Band 3 Nominal Calibration Wedge Values.
945-1088	N	Band 4 Nominal Calibration Wedge Values.
(1089-1664)		Calibration Wedge Quality; total number of times CWV did not fall into nominal (±) window neighborhood. 144 four-byte values, one for each cal. wedge sample. Fields for bands not present are blank filled.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see figure 7 for explanation)

Table 8.--Header Record Format—Continued

Bytes	Type*	Description
F. Special Purpose Fields—Continued		
1089-1232	N	Band 1 Calibration Wedge Quality.
1233-1376	N	Band 2 Calibration Wedge Quality.
1377-1520	N	Band 3 Calibration Wedge Quality.
1521-1664	N	Band 4 Calibration Wedge Quality.
1665-1672	FL	WRS scene center latitude in radians.
1673-1680	FL	WRS scene center longitude in radians.
1681-3568	A	Blank filled.
3569	A	EDIPS performed contrast stretch; coded: "F" = False, "T" = True.
3570	A	EDIPS performed haze removal; coded: "F" = False, "T" = True.
3571	A	EDIPS performed edge enhancement; coded: "F" = False, "T" = True.
3572	A	Blank filled.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary.

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
F. Special Purpose Fields—Continued		
(3573-3600)		Blank filled for MSS BSQ. The following for MSS BIL:
3573-3577	A	Indication of data present by band—actual data is indicated as present by an "X" in the proper byte location starting with band 1 (Landsat-4) or band 4 (Landsat-2/3) in byte 3573. When data for a given band is not present, it's position will contain a blank rather than an "X".
3578-3580	A	Blank filled.
3581-3585	A	A five-byte field, with one byte for each of the MSS bands to indicate sensor gain options, coded: "H" = High Gain "L" = Low Gain.
3586-3588	A	Blank filled.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 8.—Header Record Format—Continued

Bytes	Type*	Description
F. Special Purpose Fields—Continued		
3589-3593	A	A five-byte field, with one byte for each of the MSS bands to indicate the type of MSS transmission, coded: "1" = Linear Mode "2" = Compressed Mode.
3594-3600	A	Blank filled.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 9. --Overall Band Quality Codes

Code	Relative Quality	Geometric* Correction Quality Code (Bytes 361-364 of Header)	Radiometric* Correction Quality Code (Bytes 377-380 of Header)	Image** Data Quality Code
C	Best	E	E	E
B		E	E	G
A		E	G	E
9		G	E	E
8		E	G	G
7		G	E	G
6		G	G	E
5		G	G	G
4		A	E	E
3		A	E	G
2		A	G	E
1		A	G	G
0		A	E or G or A	A
0	Acceptable	A	A	E or G or A

*E = EXCELLENT
G = GOOD
A = ACCEPTABLE

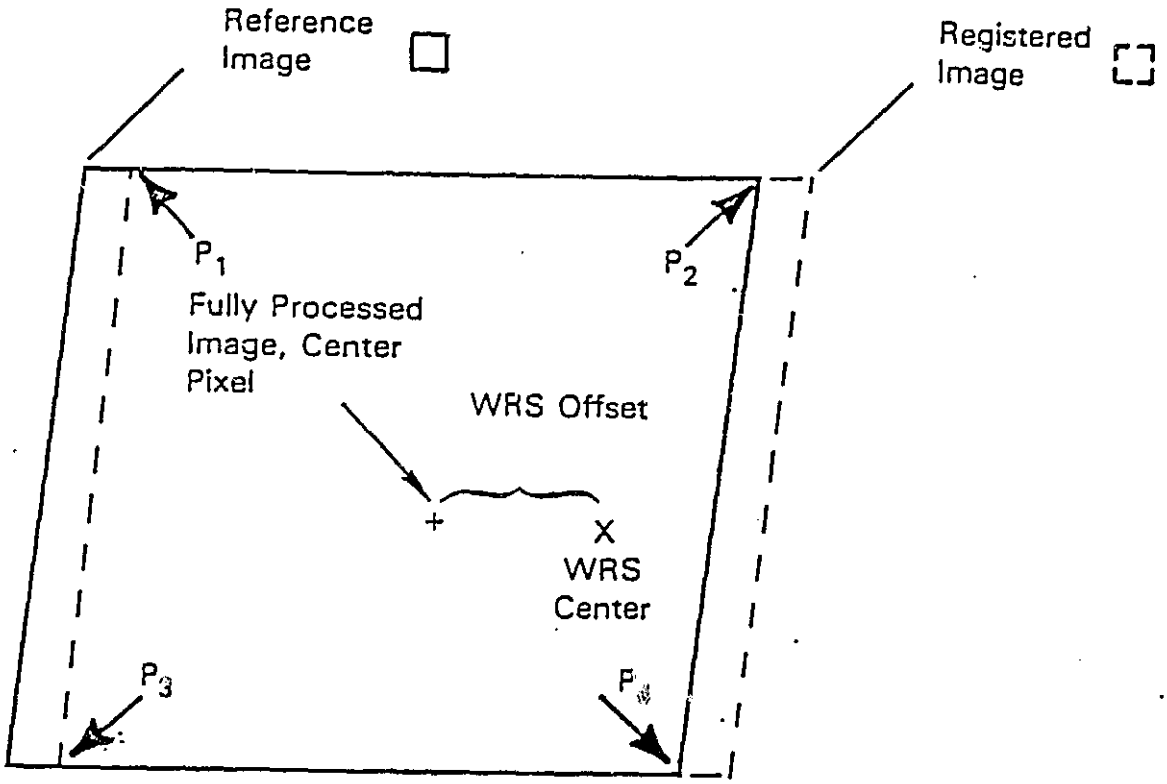
**The Image Quality Code is defined as follows:

$0 \leq DQI \leq 1.5 = E$

$1.5 < DQI \leq 4.5 = G$

$4.5 < DQI = A$

Where DQI is defined as DQI = Major frame synch losses + Minor frame synch losses/20 + Unrecoverable ECC count errors/20.



Where:

P_1, P_2, P_3, P_4
Are the Corners of the Overlapping Region of the Reference Image and the Registered Image

Figure 8. --Symbolic Representation of Temporal Registration

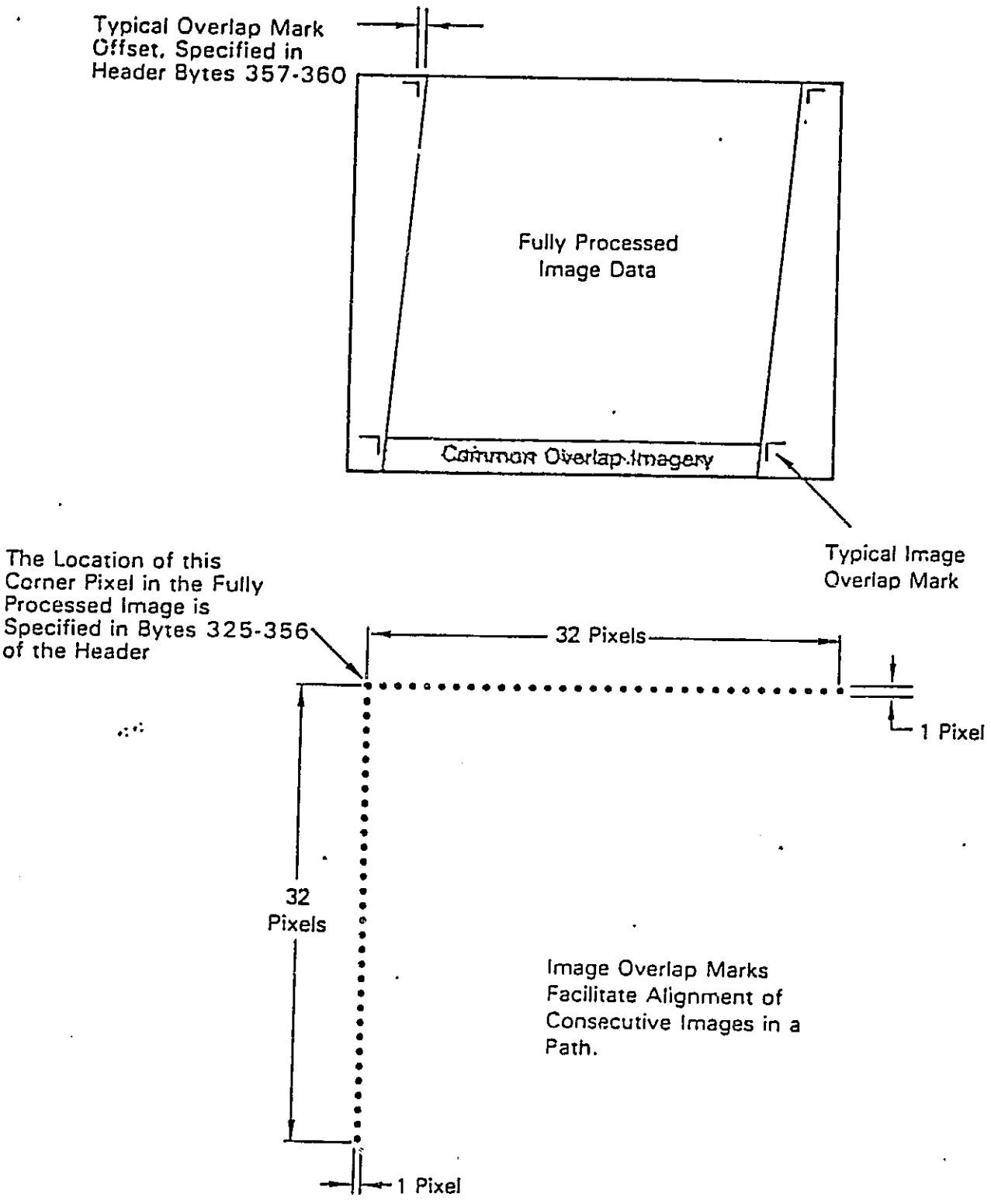


Figure 9. --Image Overlap Marks and Common Overlapping Imagery

4.3.3 Ancillary Record

Ancillary records occur only on partially processed CCT's (data without geometric corrections applied). The ancillary records contain various kinds of correction data which can be applied to the image data to produce a geometrically correct image. For each image, ancillary information for two map projections is provided with the first projection being either Polar Stereographic (PS) or Universal Transverse Mercator (UTM) and the second projection being either Hotine Oblique Mercator (HOM) or Space Oblique Mercator (SOM). There are a total of 18 ancillary records arranged on the tape in the following order:

1. Two general ancillary records.
2. Eight PS/UTM map projection records.
3. Eight HOM/SOM map projection records.

The two general ancillary records contain geometric modeling data. The first of the two general records contains a set of spacecraft dependent constants, whereas, the second record contains image dependent spacecraft parameters. The format and content of the general ancillary records are given in tables 10 and 11.

The 16 map projection records contain horizontal resampling (HRS) and vertical resampling (VRS) geometric transformation grids as well as other projection dependent information. Since the eight PS/UTM and eight HOM/SOM projection records are identical in format and different only in content, their format and content description are given in a single table 12. Note that table 12 begins with records 5 and 13, due to the occurrence of four prior records (file descriptor, header, and two general ancillary) in the leader file.

Table 10.—General Ancillary Record #1 Format.

Bytes	Type*	Description
1-4	B	Record number = $3)_{10}$.
5-8	B	Record type code: byte 5 = $022)_8$ byte 6 = $044)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9-12	B	Record Length = $3600)_{10}$.
13-16	FP	Nominal number of pixels per input image scan line.
17-20	FP	Number of scan lines in the partially processed input image.
21-28	FL	Nominal scale of inter-pixel distance in meters per pixel in the partially processed input image.
29-36	FL	Nominal scale of inter-line distance in meters per pixel in the partially processed input image.
37-40	FP	Number of pixels per line of fully processed output image.

*Denotes field Type:

A = Alphanumeric (ASCII)

N = Numeic (ASCII)

B = Binary

FP, FLS, FL (see figure 7 for explanation)

Table 10.—General Ancillary Record #1 Format--Continued

Bytes	Type*	Description
41-44	FP	Number of lines per band of fully processed output image.
45-52	FL	Scale of inter-pixel distance in meters per pixel in fully processed output image.
53-60	FL	Scale of inter-line distance in meters per pixel in fully processed output image.
61-68	FL	Nominal spacecraft altitude in meters.
69-76	FL	Nominal input swath width in meters.
77-108	FL	MSS mirror model coefficients (4 values, 8 bytes each).
109-116	FL	MSS maximum mirror angle in radians.
117-124	FL	Scan skew constant (as a result of finite scan time).
125-132	FL	Time between successive MSS mirror sweeps in seconds.
133-140	FL	Time for the active portion of an MSS mirror sweep in seconds.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see figure 7 for explanation)

Table 10.--General Ancillary Record #1 Format--Continued

Bytes	Type*	Description
141-148	FL	Semi-major axis of Earth ellipsoid (International Spheroid) in meters.
149-156	FL	Semi-minor axis of Earth ellipsoid (International Spheroid) in meters.
157-164	FL	Earth curvature constant (dependent on spacecraft's nominal altitude and Earth radius) in meters $^{-2}$ (one over square meters).
165-268	FLS	MSS sampling delay constants (up to 26 values, one for each detector) measured in input image along-scan pixel units (4 bytes each).
269-288	FLS	MSS band-to-band offsets with respect to band 1 (Landsat-4) or band 4 (Landsat-2/3) measured in input image along-scan pixel units. For Landsat-4, 3 values, 4 bytes each starting at byte 269 (one value for each of bands 2, 3, and 4). For Landsat-2/3, 5 values, 4 bytes each (one value each for 5, 6, 7, 8A and 8B).

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

FP, FLS, FL (see figure 7 for explanation)

Table 10.—General Ancillary Record #1 Format--Continued

Bytes	Type*	Description
289-3600	B	Zero Fill (not used).

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 11.—General Ancillary Record #2 Format.

Bytes	Type*	Description
1-4	B	Record number = $4)_{10}$.
5-6	B	Record type code: byte 5 = $022)_8$ byte 6 = $044)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9-12	B	Record length = $3600)_{10}$.
13-20	A	WRS path and row numbers: eight characters in the form "bPPPbRRR" where PPP = path number, RRR = row number.
21-28	FL	WRS frame center latitude in radians.
29-36	FL	WRS frame center longitude in radians.
37-52	A	Spacecraft time of frame center (Universal time), same format as bytes 109-124 in Header.
53-60	B	Zero Fill (not used).

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see Figure 7 for explanation)

Table 11.—General Ancillary Record #2 Format—Continued

Bytes	Type*	Description
61-68	FL	Scene center latitude in radians.
69-76	FL	Scene center longitude in radians.
77-100	FL	Scene center in Earth-centered, Earth-fixed coordinates in meters (3 values X, Y and Z, 8 bytes each).
101-108	FL	Spacecraft heading angle at scene center (beta) in radians.
109-116	FL	Scan line coordinate of scene center in partially processed input image.
117-124	FL	Pixel coordinate of scene center in partially processed input image.
125-132	FL	Normalized spacecraft velocity error from nominal at nadir.
133-140	FL	Earth rotation velocity at nadir in meters per second.
141-144	FLS	Earth rotation parameter (image skew), in radians.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see figure 7 for explanation)

Table 11.--General Ancillary Record #2 Format--Continued

Bytes	Type*	Description
		Spacecraft state vector at scene center:
145-152	FL	Pitch in radians.
153-160	FL	Roll in radians.
161-168	FL	Yaw in radians.
169-176	FL	X in Km.
177-184	FL	Y in Km.
185-192	FL	Z in Km.
193-200	FL	Delta pitch in radians/sec.
201-208	FL	Delta roll in radians/sec.
209-216	FL	Delta yaw in radians/sec.
217-224	FL	Delta X in Km/sec.
225-232	FL	Delta Y in Km/sec.
233-240	FL	Delta Z in Km/sec.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see figure 7 for explanation)

Table 11.—General Ancillary Record #2 Format—Continued

Bytes	Type*	Description
		Spacecraft state vector at scene center:
241-256	FL	Zero fill.
257-260	FP	Total number of control points used in geometric correction model.
(261-3600)		Zero filled for Landsat-2/3. Following for Landsat-4:
261-264	FP	Number of geodetic control points used in geometric correction model.
265-268	FP	Total number of control point correlations attempted.
269-272	FP	Number of correlated control points rejected during modeling process (that is, outside predefined limits, indicating an undesirable control point for some reason).

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

FP, FLS, FL (see figure 7 for explanation)

Table 11.—General Ancillary Record #2 Format—Continued

Bytes	Type*	Description
273-276	FP	RMS along-track geometric modeling error (that is, how well the geometric model matched the control point data), in meters.
277-280	FP	RMS across-track geometric modeling error, in meters.
281-287	B	Zero fill.
288-312	B	Distribution of control points used. The number of control points in each zone of the WRS frame (used in the geometric correction model) is given (one byte per zone).
313-512	A	Identification of control points used. Up to 25 control points, each using eight bytes of the format ßBtXXYYY where ß = blank; B = band number 1, 2, 3 or 4; T = Type (G,S,R); XX = Zone 01-25; YYY = Sequence within Scene 001-999.
513-672	B	Zero fill.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see figure 7 for explanation)

Table 11.--General Ancillary Record #2 Format--Continued

Bytes	Type*	Description
		Geometric Correction Parameters
		Ephemeris Data:
673-686	A	Time of the first set of ephemeris entries of the form: "YYDDDHHMMSSmmm" where YY = last two digits of year DDD = julian day of year HH = Hour MM = minutes SS = seconds mmm = micro-seconds
687-690	FLS	Time interval between successive sets of ephemeris entries (in seconds).
691-694	FP	Number of sets of ephemeris entries.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see figure 7 for explanation)

Table 11.--General Ancillary Record #2 Format—Continued

Bytes	Type*	Description
645-1142	FLS, FP	Up to 16 sets of ephemeris entries, each set consists of seven values: spacecraft location (x,y,z) in FLS format, spacecraft velocity (V_x, V_y, V_z) in FLS format and a data quality indicator Q in FP format. Where Q can take on the values: $0)_{10}$ - corresponding input data—valid. $1)_{10}$ - no corresponding input data. $2)_{10}$ - corresponding input data—not valid. Coordinate system is Earth-centered, Earth-fixed.
		Attitude Data:
1143-1156	A	Time of the first set of attitude entries of the form: "YYDDDHHMMSSmmm" where YY = last two digits of year DDD = julian day of year HH = hour MM = minutes SS = seconds mmm = micro-seconds

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

FP, FLS, FL (see figure 7 for explanation)

C-2

Table 11.—General Ancillary Record #2 Format—Continued

Bytes	Type*	Description
		Attitude Data:
1157-1160	FLS	Time interval between successive sets of attitude entries, in seconds.
1161-1164	FP	Number of sets of attitude entries.
1165-2124	FLS, FP	Up to 60 sets of attitude entries, each set consists of four values: pitch angle (radians) in FLS format, roll angle (radians) in FLS format, yaw angle (radians in FLS format, and a data quality indicator Q in FP format. Where Q can take on the values: $0)_{10}$ - valid data. $1)_{10}$ - angular increment data not valid; replaced by last good value. $2)_{10}$ - angular increment data not valid; replaced by 0. $3)_{10}$ - no valid drift bias; replaced by 0. $4)_{10}$ - angular increment data not available; initial attitude information used. $5)_{10}$ - initial attitude information not available; replaced by 0.

*Denotes field type:
FP, FLS, FL (see figure 7 for explanation)

Table 11.—General Ancillary Record #2 Format—Continued

Bytes	Type*	Description
		Attitude Data.—Continued
2125-2844	FLS	Partial derivatives for SOM projection. There are 12 matrices, each matrix is 3x5. The 12 matrices are partial derivatives of X and Y with respect to each of six spacecraft parameters; along-track location; across-track location, altitude, pitch, roll, yaw.
2845-3012	B	Zero fill - not used.
(3013-3204)	FLS	Multiplicative gain and additive (bias) radiometric correction constants, two values for each of six detectors in the order: Detector 1 multiplicative constant, Detector 1 additive constant, Detector 2 multiplicative constant, etc. Fields for bands not present are zero filled.
3013-3060	FLS	Band 1 multiplicative and additive radiometric correction constants.
3061-3108	FLS	Band 2 multiplicative and additive radiometric correction constants.

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

FP, FLS, FL (see figure 7 for explanation)

Table 11.—General Ancillary Record #2 Format—Continued

Bytes	Type*	Description
		Attitude Data.—Continued
3109-3156	FLS	Band 3 multiplicative and additive radiometric correction constants.
3157-3204	FLS	Band 4 multiplicative and additive radiometric correction constants.
3205-3600	B	Zero fill.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FLS, FL (see figure 7 for explanation)

Table 12.—Ancillary Map Projection Record Formats.
(records numbered 5 through 12 refer to UTM/PS, records numbered 13 through 20 refer to SOM/HOM)

Records 5 and 13

Bytes	Type*	Description
1-4	B	Record number = $5)_{10}$ for UTM/PS; = $13)_{10}$ for SOM/HOM.
5-8	B	Record type code: byte 5 = $044)_8$ byte 6 = $044)_8$ byte 7 = $333)_8$ for UTM/PS $355)_8$ for SOM/HOM byte 8 = $022)_8$
9-12	B	Record length = $3600)_{10}$.
13-256	FPG**	HRS Pixel Coordinates (Row number 1).
257-260		Line Fill Left Count (Row number 1).
261-264		Line Fill Right Count (Row number 1).
265-508		HRS Pixel Coordinates (Row number 2).
509-512		Line Fill Left Count (Row number 2).
513-516		Line Fill Right Count (Row number 2).

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Each coordinate and grid line fill count (for all rows) is in the Fixed Point Grid Format (see figure 7).

Table 12.--Ancillary Map Projection Record Formats--Continued

Records 5 and 13.--Continued

Bytes	Type*	Description
517-768	FPG**	HRS Coordinates and Fill Counts (Row number 3.
769-3036		HRS Coordinates and Fill Counts (Row numbers 4-12).
3037-3600	B	Zero Fill (not used).

Records 6 and 14

Bytes	Type*	Description
1-4	B	Record number = $6)_{10}$ for UTM/PS; = $14)_{10}$ for SOM/HOM.
5-8	B	Record type code: byte 5 = $044)_8$ byte 6 = $044)_8$ byte 7 = $333)_8$ for UTM/PS $355)_8$ for SOM/HOM byte 8 = $022)_8$

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

**Each coordinate and grid line fill count (for all rows) is in the Fixed Point Grid Format (see figure 7).

Table 12.--Ancillary Map Projection Record Formats--Continued

Records 6 and 14.--Continued

Bytes	Type*	Description
9-12	B	Record length = $3600)_{10}$.
13-3036	FPG**	HRS Coordinates and Fill Counts (Row numbers 13-24).
3037-3600	B	Zero Fill (not used).

Records 7 and 15

Bytes	Type*	Description
1-4	B	Record number = $7)_{10}$ for UTM/PS; = $15)_{10}$ for SOM/HOM.
5-8	B	Record type code: byte 5 = $044)_8$ byte 6 = $044)_8$ byte 7 = $333)_8$ for UTM/PS $355)_8$ for SOM/HOM byte 8 = $022)_8$
9-12	B	Record length = $3600)_{10}$.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Each coordinate and grid line fill count (for all rows) is in the Fixed Point Grid Format (see figure 7).

Table 12.—Ancillary Map Projection Record Formats—Continued

Records 7 and 15.—Continued

Bytes	Type*	Description
13-3036	FPG**	HRS Coordinates and Fill Counts (Row numbers 25-36).
3037-3600	B	Zero Fill (not used).

Records 8 and 16

Bytes	Type*	Description
1-4	B	Record number = $8)_{10}$ for UTM/PS; = $16)_{10}$ for SOM/HOM.
5-8	B	Record type code: byte 5 = $044)_8$ byte 6 = $044)_8$ byte 7 = $333)_8$ for UTM/PS byte 8 = $355)_8$ for SOM/HOM
9-12	B	Record length = $3600)_{10}$.
13-3036	FPG**	HRS Coordinates and Fill Counts (Row numbers 37-48).
3037-3600	B	Zero Fill (not used).

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

**Each coordinate and grid line fill count (for all rows) is in the Fixed Point Grid Format (see figure 7).

Table 12.—Ancillary Map Projection Record Formats--Continued

Records 9 and 17

Bytes	Type*	Description
1-4	B	Record number = $9)_{10}$ for UTM/PS; = $17)_{10}$ for SOM/HOM.
5-8	B	Record type code: byte 5 = $044)_8$ byte 6 = $044)_8$ byte 7 = $333)_8$ for UTM/PS $355)_8$ for SOM/HOM byte 8 = $022)_8$
9-12	B	Record length = $3600)_{10}$.
13-768	FPG**	HRS Coordinates and Fill Counts (Row numbers 49-51).
769-1020	B	Zero Fill (not used).
1021-1264	FPG**	VRS Line Coordinates (Row number 1).
1265-2972		VRS Coordinates (Row numbers 2-8).
2973-3600	B	Zero Fill (not used).

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Each coordinate and grid line fill count (for all rows) is in the Fixed Point Grid Format (see figure 7).

Table 12.--Ancillary Map Projection Record Formats--Continued

Records 10 and 18

Bytes	Type*	Description
1-4	B	Record number = $10)_{10}$ FOR UTM/PS; = $18)_{10}$ for SOM/HOM.
5-8	B	Record type code: byte 5 = $044)_8$ byte 6 = $044)_8$ byte 7 = $333)_8$ for UTM/PS $355)_8$ for SOM/HOM byte 8 = $022)_8$
9-12	B	Record length = $3600)_{10}$.
13-2940	FPG**	VRS Coordinates (Row numbers 9-20).
2941-3600	B	Zero Fill (not used).

Records 11 and 19

Bytes	Type*	Description
1-4	B	Record number = $11)_{10}$ for UTM/PS; = $19)_{10}$ for SOM/HOM.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Each coordinate and grid line fill count (for all rows) is in the Fixed Point Grid Format (see Figure 7).

Table 12.—Ancillary Map Projection Record Formats—Continued

Records 11 and 19.—Continued

Bytes	Type*	Description
5-8	B	Record type code: byte 5 = $044)_8$ byte 6 = $044)_8$ byte 7 = $333)_8$ for UTM/PS $355)_8$ for SOM/HOM byte 8 = $022)_8$
9-12	B	Record length = $3600)_{10}$.
13-2940	FPG**	VRS Coordinates (Row numbers 21-32).
2941-3600	B	Zero Fill (not used).

Records 12 and 20

Bytes	Type*	Description
1-4	B	Record Number = $12)_{10}$ FOR UTM/PS = $20)_{10}$ for SOM.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Each coordinate and grid line fill count (for all rows) is in the Fixed Point Grid Format (see figure 7).

Table 12.--Ancillary Map Project Record Formats--Continued

Records 12 and 20.--Continued

Bytes	Type*	Description
3087-3088	B	Offset of WRS center from fully processed image center pixel (in pixel units). Displacement of the WRS designation with respect to the picture center pixel (scan line 1492, pixel 1774). Most significant bit indicates the sign; "0" = positive with WRS center to right of picture center and 1" = negative with WRS center to left of picture center.
3089-3108	A	Temporal Registration Scene Identification. Same format as bytes 241-260 of Header.
3109-3140	B	Scan line and pixel numbers for temporal registration marks for referenced image and current image (image under processing, see Header bytes 261-324 and figure 8).
3141-3156	B	Overlap Data: scan line and pixel numbers (in binary) of the four overlap marks as given in Header bytes 325-356, table 8.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary
FP, FL, FLS (see figure 7 for explanation)

Table 12.—Ancillary Map Project Record Formats--Continued

Records 12 and 20.—Continued

Bytes	Type*	Description
3157-3160	B	Actual number of tick marks. One byte for each edge: top, left, right and bottom.
3161-3168	B	Input sample value of four corner points in output image (band independent).
3169-3176	FLS	Image Orientation Angle - orientation of map projection coordinate system with respect to center line of fully processed image in radians.
3177-3178	B	NSWEEPS - number of sweeps prior to scene center at which the HRS, VRS grid points begin.
3179-3600	B	Zero Fill (not used).

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

FP, FL, FLS (see figure 7 for explanation)

4.3.4 Annotation Record

The annotation record data contain the alphanumeric information printed by the film recorder at the bottom of the film product and the tick mark information that surrounds the corrected and framed image. For partially processed data, there will be two annotation records, the first with tick marks given in either the UTM or PS formats and the second with tick marks given in either the SOM or HOM formats. The format of the annotation record is given in table 13.

Segment C (bytes 413-3600) of the annotation record contains tick mark coordinates in either UTM, PS, SOM, or HOM projection formats. As indicated in header bytes 226-228, it may also include tick mark coordinates in latitude-longitude format with one tick mark coordinate value for each of the top, left, right and bottom tick mark zones (see figures 10, 11 and 12 for allowed tick mark formats).

Table 13.—Annotation Record Format

Bytes	Type*	Description
A. Record Introduction		
1-4	B	Record number = $3)_{10}$ for files preceeding fully processed image data: = $21)_{10}$ and $22)_{10}$ for files preceding partially processed image data.
5-8	B	Record type code: byte 5 = $022)_8$ byte 6 = $333)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9-12	B	Record length = $3600)_{10}$.
B. Image Annotation Data		
13-20	A	Day, month and year of image acquisition: 8 bytes of the form "DDMMMYYb" where MMM is a standard alpha abbreviation for month (ASCII).
21-37	A	Image format center - latitude and longitude of the center of the MSS image format in degrees and minutes; for example "CbN33-05/W115-18".

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 13.--Annotation Record Format--Continued

Bytes	Type*	Description

B. Image Annotation Data—Continued

38-46	A	WRS path and row identifier and orbital direction indicator: of form "XPPP-RRRb" where X indicates ascending (A) or descending (D) node, and PPP-RRR indicates WRS path & row numbers.
47-63	A	Nominal WRS center latitude and longitude; for example: "NbN33-03/W115-42".
64-73	A	Sensor (MSS) and spectral band identification code of the form "SbBBBBbbN" where: S = sensor, coded 'M' BBBB = Band by position, e.g., b2bb indicates band 2 N = node; 'A' for ascending, 'D' for descending

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 13.—Annotation Record Format--Continued

Bytes	Type*	Description
B. Image Annotation Data—Continued		
74-87	A	Sun Angles - the sun elevation angle and sun azimuth angle measured clockwise from true North at time of midpoint of MSS frame is specified to the nearest degree (blank for ascending node coverage), for example "SUNbEL30bA015".
(88-99)		Processing Codes. These codes apply to the geometric correction matrix values and to the final geometrically corrected image data, and are as follows:

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 13.—Annotation Record Format—Continued

Bytes	Type*	Description
B. Image Annotation Data—Continued		
88	A	Defines the type of geometric correction applied to the data: "U" = uncorrected (engineering test mode) "S" = system level corrected (Systematic Correction Data (SCD) only, no control point correction applied) "G" = geometrically corrected based on geodetic information (no temporal registration performed since geodetic control points used were not from a single reference image) "T" = temporal registration to a single reference image (reference image corrected using geodetic control points) "R" = temporal registration to a single reference image (no geodetic information available when correcting reference image)
89	A	Blank (ß).

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 13.--Annotation Record Format--Continued

Bytes	Type*	Description
B. Image Annotation Data--Continued		
90	A	Defines the map projection: "P" = Polar Stereographic projection "S" = Space Oblique Mercator projection "U" = Universal Transverse Mercator projection "H" = Hotine Oblique Mercator projection
91	A	"-"
92	A	Indicates the resampling algorithm applied: "C" = cubic convolution "N" = nearest neighbor "b" = geometrically uncorrected imagery
93	A	Indicates the type of ephemeris data used to compute the geometric correction matrices: "P" = predictive "D" = definitive "G" = Global Positioning System (GPS)
94	A	"-"

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 13.—Annotation Record Format—Continued

Bytes	Type*	Description
B. Image Annotation Data—Continued		
95	A	Gives the processing procedure: "N" = normal processing procedure "A" = abnormal processing procedure (engineering test mode)
96	A	Blank (b).
97	A	Indicates the sensor gain: "H" = high gain "L" = low gain
98	A	Shows the type of MSS transmission: 1 = linear mode 2 = compressed mode
99	A	Blank (b).
100-112	A	Agency and Project Identification: alpha characters, coded "NASAbLANDSATb".

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 17.--Annotation Record Format--Continued

Bytes	Type*	Description
B. Image Annotation Data--Continued		
113-127	A	Frame identification number - each image or frame will have a unique identifier which will contain encoded information consisting primarily of time of acquisition (Universal Time) relative to launch. Its format is E-NDDDD-HHMMS-B and is interpreted as follows: E = Encoded project identifier N = Landsat mission number DDDD = Day number relative to launch, at time of observation HH = Hour at time of observation MM = Minute at time of observation S = Tens of seconds at time of observation B = Band identification code: 1, 2, 3 or 4 for Landsat-4; 4, 5, 6, 7 or 8 for Landsat-2/3
128-412	B	Zero Fill (not used).

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 13.—Annotation Record Format—Continued

Bytes	Type*	Description
C. Tick Mark Coordinate Data		
413-556	B,A	Top edge tick mark data.
557-812	B	Zero Fill (not used).
813-976	B,A	Left side tick mark data, first.
977-1212	B	Zero Fill (not used).
1213-1275	B,A	Left side tick mark data, concluding.
1276-1612	B	Zero Fill (not used).
1613-1772	B,A	Right side tick mark data, first.
1773-2008	B	Zero Fill (not used).
2009-2071	B,A	Right side tick mark data, concluding.
2072-2408	B	Zero Fill (not used).
2409-2552	B,A	Bottom edge tick mark data.
2553-3600	B	Zero Fill (not used).

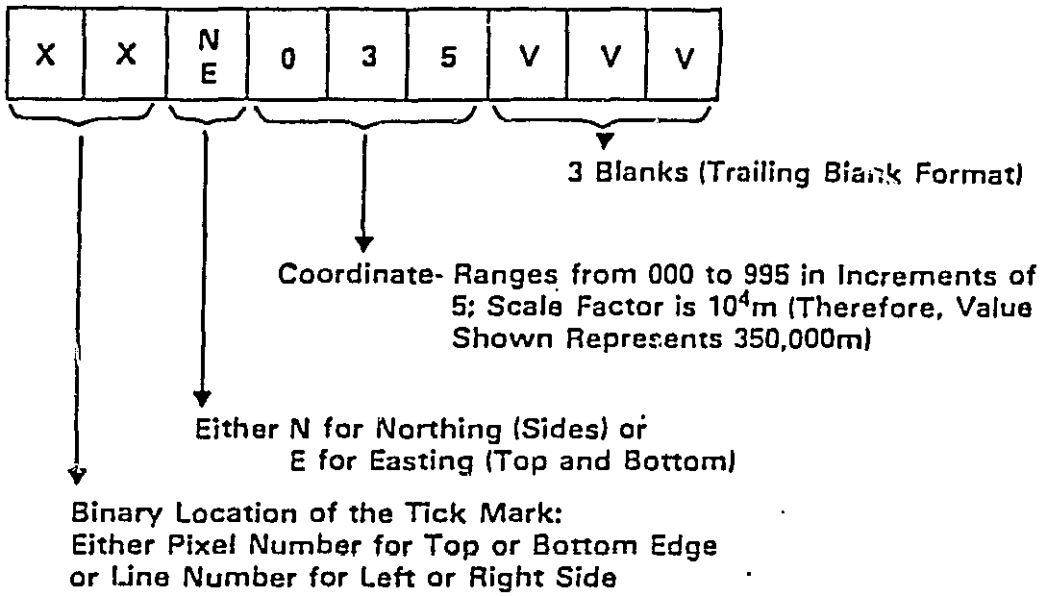
*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

UTM Tick Mark (ASCII Notation)



Polar Stereographic Tick Mark (ASCII Notation)

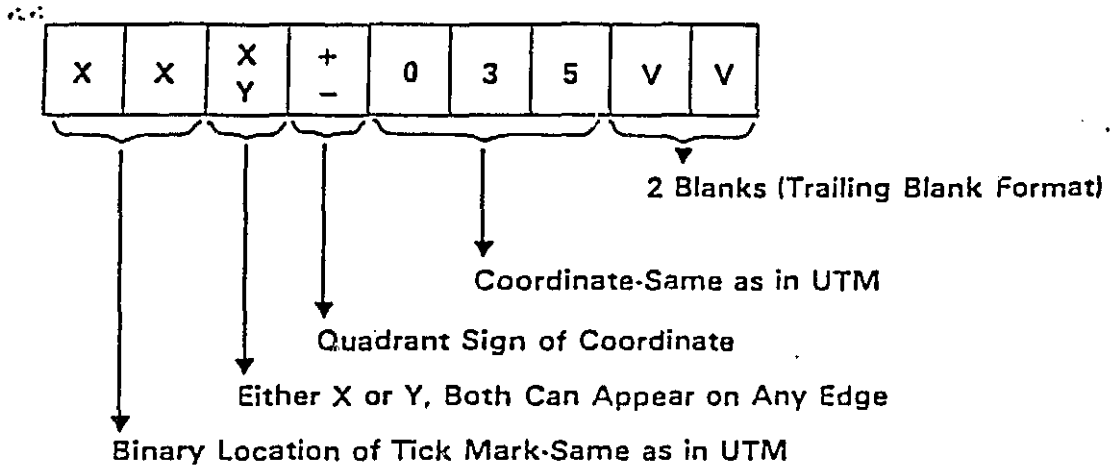


Figure 10. --Annotation Tick Mark Formats for UTM and PS

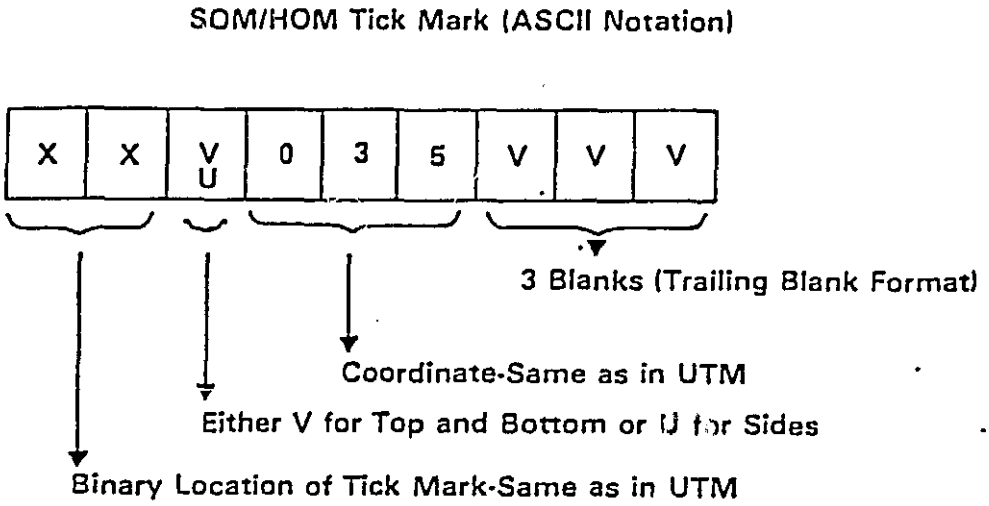


Figure 11. --Annotation of Tick Mark Formats for SOM/HOM

Latitude, Longitude Tick Mark

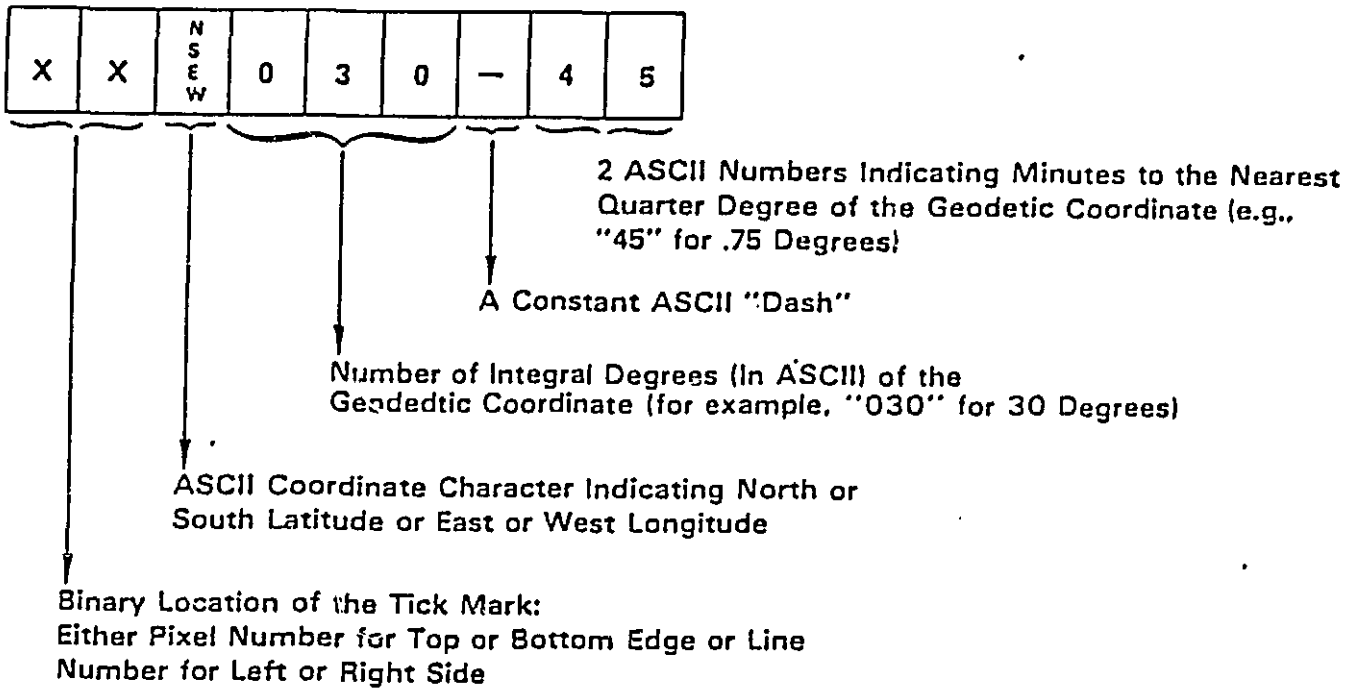


Figure 12. --Annotation Tick Mark Formats for Latitude and Longitude

4.4 Image File

The image file is composed of a file descriptor record and image data records. It follows the leader file as illustrated in figure 5. The image file contains the actual image data, along with data format information and per-line support data such as quality codes, fill pixel counts, and scan line identifications.

4.4.1 File Descriptor Record

The file descriptor record is the first record of each image file, and it introduces that file. The image file descriptor record variable segment (bytes 181-448) gives the number and length of the image records; describes the data format in terms of the pixel group, the data content, and the overall image; and gives the location of significant data fields in the record prefix and suffix. Specific field locator information in bytes 297 through 448 is given in a series of 8-byte codes each of which are structured as follows:

Bytes	Description
1-4	The byte number within the prefix or suffix of the first byte of the field.
5-6	The length, in bytes, of the field.
7	Coded "P" or "S" indicating that the information is in the scan line prefix or suffix, respectively.
8	Indicates the type of data in the field. Codes "A" for alphanumeric; "N" for numeric; "B" for binary.

The format of the image file descriptor record is given in table 14.

Table 14.--The File Descriptor Record Format for the Image File.

Bytes	Type*	Description
1-4	B	Record number = $1)_{10}$
5-8	B	Record type code: byte 5 = $077)_8$ byte 6 = $300)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9-12	B	Length of this record = $3600)_{10}$.
13-14	A	ASCII/EBCDIC flag for this file = "AØ" indicating ASCII. (EBCDIC not available.)
15-16	A	Blanks.
17-28	A	Control document number for this embodiment (i.e., this document's number)
29-30	A	Control document number for this embodiment revision number (i.e., this documents revision number).

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 14.--The file Descriptor Record Format for the Image File--Continued

Bytes	Type*	Description
31-32	A	File design descriptor revision letter: 2-bytes giving the revision letter of the file format (as opposed to revisions which affect the control document without affecting the file format). Coded "ÞA" unless this record format is modified.
33-44	A	Software release number for this file.
45-48	N	File number: sequence number of this file within the logical volume. The volume directory file is not included in this count.
49-64	A	File identification: same as file pointer record, bytes 21-36.
65-68	A	Record sequence and location type flag: always coded "FSEQ" indicating a fixed record location of record numbers.
69-76	N	Sequence number location: always coded "ÞÞÞÞÞÞÞ1" indicating that record number starts in record byte one.

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 14.—The File Descriptor Record Format for the Image File—Continued

Bytes	Type*	Description
77-80	N	Sequence number field length: always coded "ßßß4" indicating a 4 byte record number field.
81-84	A	Record code and location type flag: always coded "FTYP" indicating a fixed record location of the type code field.
85-92	N	Record code location: always coded "ßßßßßßß5" indicating that record code starts in record byte five.
93-96	N	Record code field length: always coded "ßßß4" indicating a 4 byte record code.
97-100	A	Record length and location type flag: always coded "FLGT" indicating a fixed record location of the record length field.
101-108	N	Record length location: always coded "ßßßßßßß9" indicating that record length field starts in record byte nine.

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 14.—The File Descriptor Record Format for the Image File--Continued

Bytes	Type*	Description
109-112	N	Record length field length: always coded "ƀƀƀ4" indicating a 4 byte record length field.
113	A	Flag indicating that data interpretation information is included within file descriptor record: coded "N" indicating NO.
114	A	Flag indicating that data interpretation information is included within records other than the file descriptor record: coded "N".
115	A	Flag indicating that data display information is included with the file descriptor record: coded "N".
116	A	Flag indicating that data display information is included within the file in record(s) other than the file descriptor: coded "N".
117-180	A	Reserved segment (Blank filled).

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 14.--The File Descriptor Record Format for the Image File--Continued

Bytes	Type*	Description
181-186	N	Number of image records = $2983)_{10}$ for fully processed BSQ; = $2400)_{10}$ for partially processed BSQ; = $11,932)_{10}$ for fully processed Landsat-2/4 BIL; = $14,915)_{10}$ for fully processed Landsat-3 BIL; = $9600)_{10}$ for partially processed Landsat-2/4 BIL; = $12,000)_{10}$ for partially processed Landsat-3 BIL.
187-192	N	Image record length = $3600)_{10}$.
193-216	A	Reserved (blanks).
		Pixel Group Data
217-220	N	Number of bits per pixel = 8.
221-224	N	Number of pixels per data group = 1.
225-228	N	Number of bytes per data group = 1.
229-232	A	Justification and order of pixels within data group: coded "RJLR".

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 14.—The File Descriptor Record Format for the Image File--Continued

Bytes	Type*	Description
		Image Data in this File
233-236	N	Number of (images) bands = 1 for BSQ; = 4 for Landsat-2/4 BIL; 5 for Landsat-3 BIL.
237-244	N	Number of lines per image (excluding border lines) = 2983 for fully processed image data; = 2400 for partially processed image data.
245-248	N	Number of left border pixels per line: coded zero indicating no constant border.
249-256	N	Number of image pixels per line (includes pad pixels).
257-260	N	Number of right border pixels per line: coded zero indicating no constant border.
261-264	N	Number of top border lines: coded zero indicating no constant border.
265-268	N	Number of bottom border lines: coded zero indicating no constant border.

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 14.—The File Descriptor Record Format for the Image File--Continued

Bytes	Type*	Description
		Image Data in this File—Continued
269-272	A	Interleaving indicator coded "BSQb" or "BILb".
		Record Data in this File
274-274	N	Number of physical records per line = 1.
275-276	N	Number of physical records per multispectral line in this file = $4)_{10}$ if Landsat-2/4 BIL; = $5)_{10}$ if Landsat-3 BIL; = $1)_{10}$ if BSQ.
277-280	N	Number of bytes of prefix data per record = $12)_{10}$.
281-288	N	Number of bytes of image data per record = $3548)_{10}$ (includes pad pixels).
289-292	N	Number of bytes of suffix data per record $28)_{10}$ (note that suffix is "Ø" filled for fully processed imagery)
293-296	A	Blanks

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 14.--The File Descriptor Record Format for the Image File--Continued

Bytes	Type*	Description
		Prefix/Suffix Data Locators:
297-304	A	Scan line number locator: coded "ƀƀƀ1b2PB" for fully processed image data or blanks for partially processed image data.
305-312	A	Image (band) number locator: coded blanks for fully processed image data or "ƀƀ11ƀ1PB" for partially processed image data.
313-320	A	Time of scan line locator: coded blanks for fully processed image data or "ƀƀƀ11OPA" for partially processed image data.
321-328	A	Left-fill count locator: coded blanks for partially processed image data, "ƀƀƀ5ƀ4PB" for fully processed image data.
329-336	A	Right-fill count locator: coded blanks for partially processed image data, "ƀƀƀ9ƀ4PB" for fully processed image data.

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 14.—The File Descriptor Record Format for the Image File—Continued

Bytes	Type*	Description
		Prefix/Suffix Data Locators—Continued
337-368	A	Blanks
369-376	A	Scan line quality code locator: coded "ßßß3ß2PA" for fully processed image data or "ßßß4ß1SB" for partially processed image data.
377-384	A	Calibration information field locator: coded blanks for fully processed image data or "ßßß5ß6SB" for partially processed image data.
385-392	A	Gain values field locator: coded blanks for fully processed image data or "ßß13ß2SB" for partially processed image data.
393-400	A	Bias values field locator: coded blanks for fully processed image data or "ßß17ß2SB" for partially processed image data.
401-432	A	Blanks

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 14.--The File Descriptor Record Format for the Image File--Continued

Bytes	Type*	Description
		Prefix/Suffix Data Locators--Continued
433-436	N	Number of left fill bits within pixel: coded "ßßß1".
437-440	N	Number of right fill bits within pixel: coded "ßßß0".
441-448	N	Maximum data range of pixel values: coded "ßßßßß127".
449-3600	A	Blanks.

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

4.4.2 Image Data Records

An image data record contains one scan line of MSS imagery plus associated support data such as calibration, pad pixels, and quality. The 12 bytes of standard record introductory data (record number, record type code and record length) are followed by a 12-byte scan line identifier. The scan line identifier has a different format depending on whether the image data have or have not been geometrically corrected. The scan line identifier is followed by image data, and these are followed by support data when the image has not been geometrically corrected. The per-scan-line support data are defined in the file descriptor record variable segment and described in the header record, as are the length, justification, and pixel content of image data groups. It should be repeated that end-of-line support (suffix) data only accompany data that do not have geometric corrections applied; the support-data section of geometrically corrected image data is zero-filled (that is, not used). The format and content of the image data record are given in table 15 for geometrically uncorrected image data (CCT-AM) and table 16 for geometrically corrected image data (CCT-PM).

Table 15.--Image Record Format for Geometrically Uncorrected Data (CCT-AM).

Bytes	Type*	Description
A. Record Introduction		
1-4	B	Record number = $2)_{10}$ for 1st image record and incremented by one for each subsequent record.
5-8	B	Record type code: byte 5 = $355)_8$ byte 6 = $355)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9-12	B	Record length = $3600)_{10}$.
B. Prefix Data		
13-22	A	Scan line time in the form: "DDDHHMMSST" where DDD = day of year HH = hour MM = minutes SS = seconds T = tenths of second
23	B	Band indicator.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 15.--Image Record Format for Geometrically Uncorrected Data (CCT-AM)--Continued

Bytes	Type*	Description
B. Prefix Data--Continued		
24	B	Scan line count reset to 1 every other mirror sweep cycling $1\text{-}12)_{10}$ throughout image.
C. Image Data		
25-3572	B	Image pixels.
D. Suffix (Support) Data		
3573-3574	B	Original line length - the actual number of pixels in the original geometrically uncorrected image scan line.
3575	B	Time Code Indicator - contains a $1)_{10}$ if time code in SLID was calculated (i.e., was not obtained from video data stream) otherwise zero.
3576	B	Quality Code: $0)_{10}$ - Good Quality $1)_{10}$ - Not used in Landsat 4 $2)_{10}$ - Filled line on Input $3)_{10}$ - Filled line on Output

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 15.--Image Record Format for Geometrically Uncorrected Data (CCT-AM)--Continued

Bytes	Type*	Description
D. Suffix (Support) Data--Continued		
3577-3582	B	Selected Calibration Wedge Values (CWV's) - six 1 byte binary numbers; one for each Calibration Wedge sample (Binary values ranging from 0 to 63).
3583	B	Nominal Cal. Indicator of Calibration Wedge substitution: of the form $\emptyset\emptyset X_1X_2X_3X_4X_5X_6$ where bits X_1 thru X_6 are flags for each wedge sample, e.g., 00000100 indicates that sample #4 was replaced by a nominal value.
3584	B	Zero fill.
3585-3586	B	Calibration Wedge Gain Value applied in the radiometric correction process. A 16-bit binary number** with bit 15 being the left-most bit and bit 0 the right-most. The value has a fixed binary point between bits 10 and 9.
3587-3588	B	Zero fill.

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

**Negative numbers (bit 15=1) are represented in two's complement form.

Table 15.--Image Record Format for Geometrically Uncorrected Data (CCT-AM)--Continued

Bytes	Type*	Description
D. Suffix (Support) Data--Continued		
3589-3590	B	Calibration Wedge Bias Value applied in the radiometric correction process. A 16-bit binary number** with bit 15 the left-most bit and bit Ø the right-most. The value has a fixed binary point between bits 2 and 1.
3591-3592	B	Zero fill
(3593-3600)		Zero filled for Landsat-2/3. Following for Landsat-4:
3593-3594	B	Histogram Gain Value - (same format as Calibration Wedge Gain Value).
3595-3596	B	Zero fill
3597-3598	B	Histogram Bias Value - (same format as Calibration Wedge Bias Value).
3599-3600	B	Zero fill

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

**Negative numbers (bit 15=1) are represented in two's complement form.

Table 16.--Image Record Format for Geometrically Corrected Data (CCT-PM).

Bytes	Type*	Description
A. Record Introduction		
1-4	B	Record number = $2)_{10}$ for 1st record incremented by one for each subsequent record.
5-8	B	Record type code: byte 5 = $355)_8$ byte 6 = $355)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9-12	B	Record length = $3600)_{10}$.
B. Prefix Data		
13-14	B	Scan line count, $1\text{-}2983)_{10}$.
15-16	A	Scan line quality code of the form: "QØ" - Good Quality "Q1" - Synthetically generated on input (not used in Landsat 4) "Q2" - Filled line on Input "Q4" - Filled line on Output
17-20	B	Left fill pixel count.
21-24	B	Right fill pixel count.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 16.—Image Record Format for Geometrically Corrected Data (CCT-PM)—Continued

Bytes	Type*	Description
C. Image Data		
25-3572	B	Image pixels.
D. Suffix (Support) Data		
3573-3600	B	Zero fill.

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

4.5 Trailer File

The trailer file follows the image data file. The trailer file is composed of a file descriptor record and one trailer record in the case of BSQ or one trailer record for each band in the case of BIL.

A trailer file descriptor record (the first record of each trailer file), introduces and describes the trailer file. The general record format and content of the trailer file descriptor record is given in table 17.

Following the file descriptor, the trailer data records provide space for user information and/or control fields. The first 12 bytes are the standard introductory data (record number, record type code, and record length). The format for a trailer record is given in table 18.

Table 17.—The File Descriptor Record Format for the Trailer File.

Bytes	Type*	Description
1–4	B	Record number = $1)_{10}$.
5–8	B	Record type code: byte 5 = $077)_8$ byte 6 = $300)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9–12	B	Length of this record = $3600)_{10}$.
13–14	A	ASCII/EBCDIC flag for this file = "Aƀ" indicating ASCII (EBCDIC not available).
15–16	A	Blanks.
17–28	A	Control document number for this embodiment (i.e., this document's number).
29–30	A	Control document number for this embodiment revision number (i.e., this documents revision number).

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 17.—The File Descriptor Record Format for the Trailer File—Continued

Bytes	Type*	Description
31-32	A	File design descriptor revision letter: 2-bytes giving the revision letter of the file format (as opposed to revisions which affect the control document without affecting the file format). Coded "bA" unless this record format is modified.
33-44	A	Software release number for this file.
45-48	N	File number: sequence number of this file within the logical volume. The volume directory file is not included in this count.
49-64	A	File identification: same as file pointer record, bytes 21-36.
65-68	A	Record sequence and location type flag: always coded "FSEQ" indicating a fixed record location of record numbers.

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 17.—The File Descriptor Record Format for the Trailer File—Continued

Bytes	Type*	Description
69-76	N	Sequence number location: always coded "ßßßßßßß1" indicating that record number starts in record byte one.
77-80	N	Sequence number field length: always coded "ßßß4" indicating a 4 byte record number field.
81-84	A	Record code and location type flag: always coded "FTYP" indicating a fixed record location of the type code field.
85-92	N	Record code location: always coded "ßßßßßßß5" indicating that record code starts in record byte five.
93-96	N	Record code field length: always coded "ßßß4" indicating a 4 byte record field.
97-100	A	Record length and location type flag: always coded "FLGT" indicating a fixed record location of the record length field.

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 17.--The File Descriptor Record Format for the Trailer File--Continued

Bytes	Type*	Description
101-108	N	Record length location: always coded "ßßßßßßß9" indicating that record length field starts in record byte nine.
109-112	N	Record length field length: always coded "ßßß4" indicating a 4 byte record length field.
113	A	Flag indicating that data interpretation information is included within file descriptor record: coded "N" indicating NO.
114	A	Flag indicating that data interpretation information is included within records other than the file descriptor record: coded "N".
115	A	Flag indicating that data display information is included with the file descriptor record: coded "N".

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 17.--The File Descriptor Record Format for the Trailer File--Continued

Bytes	Type*	Description
116	A	Flag indicating that data display information is included within the file in record(s) other than the file descriptor: coded "N".
117-180	A	Reserved segment (Blank filled).
181-186	N	Number of trailer records = $1)_{10}$ for BSQ, $4)_{10}$ for Landsat-2/4 BIL, or $5)_{10}$ for Landsat-3 BIL.
187-192	N	Trailer record length = $3600)_{10}$
193-3600		Reserved (blanks)

*Denotes field type:
A = Alphanumeric (ASCII)
N = Numeric (ASCII)
B = Binary

Table 18.--Trailer Record Format

Bytes	Type*	Description
1-4	B	Record number = $2)_{10}$ (also records 3, 4, 5 and/or 6 if BIL).
5-8	B	Record type code: byte 5 = $022)_8$ byte 6 = $366)_8$ byte 7 = $022)_8$ byte 8 = $022)_8$
9-12	B	Record length = $3600)_{10}$.
13	A	Flag indicating last scene (each image) in a data acquisition interval: "N" = No "Y" = Yes
14-3580	B	Zero fill.
3581-3582	A	Destriping indicator: "N" = none applied "Y" = applied.
3583-3584	A	Units of following contrast stretch values: "P" = percentage "G" = gray levels.

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

Table 18.—Trailer Record Format--Continued

Bytes	Type*	Description
3585-3588	B	Minimum cut-off value of contrast stretch
3589-3592	B	Maximum cut-off value of contrast stretch
3593-3596	B	Radiance value used for atmospheric scatter compensation (haze bias value).
3597 - 3600	B	Edge enhancement kernel size X,Y. Two values two bytes each.

*Denotes field type:

A = Alphanumeric (ASCII)

N = Numeric (ASCII)

B = Binary

4.6 Null Volume Directory File

The file which terminates a logical volume is the null volume directory file. This file is referred to as "null" because it defines a non-existant (empty) logical volume. This file consists of a volume descriptor record only. The format and content of a volume descriptor record is described in section 4.2.1.

5.0 APPLICABLE DOCUMENTS

American National Standards Institute, 1973a, Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI): ANSI X3.22-1973.

American National Standards Institute, 1973b, Recorded Magnetic Tape for Information Interchange (1600 CPI, PE): ANSI X3.39-1973.

Landsat Ground Station Operations Working Group, 1979, The Standard CCT Family of Tape Formats: LGSOWG Doc. CCB-CCT-0002-C.