430-11-06-009-B

LANDSAT 7 TO
INTERNATIONAL GROUND STATION (IGS)
INTERFACE CONTROL DOCUMENT

February 1998
Revision B

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

LANDSAT 7 TO

INTERNATIONAL GROUND STATION (IGS)

INTERFACE CONTROL DOCUMENT

Signature Page

Approved By:

P. Sabelhaus (Date)
Manager, Landsat 7 Project

Approved By:

J. Ellickson (Date)
Chief, NOAA Landsat Commercialization Office

Approved By:

R. Menrad (Date)
Manager, Landsat 7 Ground Systems

Approved By:

A. Obenschain (Date)
Manager, ESDIS Project

CHANGE INFORMATION PAGE

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Document History

Document Number	Status / Issue	Publication Date
430-11-06-009-00	Review / Revision 00	14 June 1996
430-11-06-009-00	Review / Revision 00	20 September 1996
430-11-06-009-00	Baseline / Revision 00	31 January 1997
430-11-06-009-A	Update / Revision A	30 September 1997
430-11-06-009-B	Update / Revision B	February 1998

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T 3-2	TBD	Interface facility between MOC and FUI	May 1998
T 3-2	TBD	Interface facility between MOC and HAJ	May 1998
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SECTION 1
SCOPE

1.1 IDENTIFICATION

This Interface Control Document (ICD) establishes the hardware, software, data transfer, and operations interface requirements between the International Ground Stations (IGS) and the Landsat 7 Project.

Landsat 6 documentation was used as the starting point for this ICD. However, modifications have been made to accommodate the Landsat 7 System architecture.

1.2 DOCUMENT ORGANIZATION

This document consists of 3 sections and 7 appendices:

Section 2 identifies documents related to this interface that might be of interest to the user.

Section 3 contains the interface requirements between the IGS and the Landsat 7 system.

Appendix A contains a glossary of terms and an acronym list.

Appendix B defines the message formats.

Appendix C contains the X-band communications link interface characteristics.

Appendix D defines the metadata format.

Appendix E defines the browse data format.

Appendix F describes the mechanism for data transfer from the IGS to the DAAC.

Appendix G describes the mechanism for data transfer between the MOC and the IGS.

SECTION 2
REFERENCE DOCUMENTS

The following documents are listed for the convenience of the user. These documents do not form a part of this ICD and are not controlled by their reference herein. In the event of a conflict between this ICD and the documents listed, the ICD shall govern.

1. CCSDS 701.0–B–1 October 1989 — Recommendations for Advanced Orbiting Systems, Networks and Data Links

   Source: CCSDS Secretariat
   Communications and Data Systems Div. (Code–TS)
   National Aeronautics and Space Administration
   Washington, DC 20546

2. 430-11-06-008 — Landsat 7 Data Format Control Book (DFCB) Volume I - Data Acquisition Plan

   Source: Landsat Commercialization Division
   NOAA/NESDIS
   FB-4 Rm 3301 E
   Washington, DC 20233

   Internet URL: http://ltpwww.gsfc.nasa.gov/IAS/htmls/l7_review.html

3. 23007702-IV — Landsat 7 System Data Format Control Book (DFCB) Volume IV - Wideband Data

   Source: Landsat Commercialization Division
   NOAA/NESDIS
   FB-4 Rm 3301 E
   Washington, DC 20233

   Internet URL: http://ltpwww.gsfc.nasa.gov/IAS/htmls/l7_review.html

4. 430-11-06-007 — Landsat 7 Data Format Control Book (DFCB) Volume V - Level 0R Product Distribution Format

   Source: Landsat Commercialization Division
   NOAA/NESDIS
   FB-4 Rm 3301 E
   Washington, DC 20233

   Internet URL: http://ltpwww.gsfc.nasa.gov/IAS/htmls/l7_review.html

5. JPL D-7669 Part 2 — Planetary Data System Standards Reference, Chapter 12, Object Description Language (ODL) Specification and Usage

Source: Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA 91109

Internet URL: http://pds.jpl.nasa.gov/stdref/chap12.htm

6. 430-15-01-003 — Landsat 7 Science Data Users Guide

Source: Landsat Commercialization Division
NOAA/NESDIS
FB-4 Rm 3301 E
Washington, DC 20233

Internet URL: http://ltpwww.gsfc.nasa.gov/IAS/htmls/l7_review.html

7. 430-14-01-006 — Landsat 7 Operations Agreement (OA) between the International Ground Stations (IGSs) and Landsat 7

Source: Landsat Commercialization Division
NOAA/NESDIS
FB-4 Rm 3301 E
Washington, DC 20233

Internet URL: future location - not yet available:
http://ltpwww.gsfc.nasa.gov/IAS/htmls/l7_review.html

8. (no doc. number) — Hierarchical Data Format (HDF) User's Guide

Source: University of Illinois at Urbana-Champaign
National Center for Supercomputing Applications (NCSA)

Internet URL: http://hdf.ncsa.uiuc.edu/doc.html

9. (no doc. number) — James Ellison and Jaime Milstein (1995) Improved Reduced-Resolution Satellite Imagery

Source: Landsat Commercialization Division
NOAA/NESDIS
FB-4 Rm 3301 E
Washington, DC 20233

Internet URL: http://lps-server.gsfc.nasa.gov/!Studies/Techinal_Studies.html

10. (no doc. number) A Report on LANDSAT Browse Generation using Wavelets for Image Reduction, Peña, Sept. 1994

Source: Landsat Commercialization Division
NOAA/NESDIS
FB-4 Rm 3301 E
Washington, DC 20233

Internet URL: http://lps-server.gsfc.nasa.gov/!Studies/Techinal_Studies.html

11. (no doc. number) Landsat 7 Long Term Plan (LTP) for Global Archive Refresh

Source: Landsat Commercialization Division
NOAA/NESDIS
FB-4 Rm 3301 E
Washington, DC 20233

Internet URL: future location - not yet available:
http://ltpwww.gsfc.nasa.gov/IAS/htmls/l7_review.html

SECTION 3
REQUIREMENTS

3.1 INTERFACE DESCRIPTIONS

The interaction between the Landsat 7 system and the IGSs is shown in Figure 3-1. These interfaces are described in more detail in the following sections.

3.1.1 Mission Operations Center

The Mission Operations Center (MOC), staffed by the Flight Operations Team (FOT), is responsible for command and control of the Landsat 7 satellite and for scheduling of data acquisitions, and serves as the focal point for the IGS interface.

The MOC receives service requests from the IGSs, performs acquisition scheduling, and provides contact schedules to the IGSs.

The MOC makes orbit parameters available in three standard formats: North American Air Defense (NORAD) Two Line Elements, Brouwer Mean Elements (BMEs) and Improved Inter-Range Vectors (IIRVs). Each IGS indicates the format they are equipped to process.

Other messages are exchanged with the IGSs to document problems, identify station capabilities, and handle miscellaneous administrative matters.

The MOC sends the Calibration Parameter File to the IGSs when it is received from the Image Assessment System. This is expected to be quarterly.

3.1.2 Landsat 7 Satellite

The Landsat 7 satellite provides a 150 Mbps downlink to the IGSs via one of three X-band data frequencies. The data is composed of Enhanced Thematic Mapper Plus (ETM+) image data and Payload Correction Data (PCD) telemetry.

3.1.3 Earth Resources Observation System (EROS) Data Center

The EROS Data Center (EDC) houses the Distributed Active Archive Center (DAAC), an element of the Earth Observing System (EOS) Data and Information System (EOSDIS). For Landsat 7, the DAAC archives Landsat 7 Level 0R data, metadata, and browse data. The DAAC supports users queries and distributes data to users. It maintains an online library of metadata and browse data for Landsat 7. The IGSs send metadata and browse data to the DAAC for inclusion in this library. The DAAC also maintains a library of calibration parameters and mission information for Landsat 7.

3.1.4 Mission Management Office

The Mission Management Office (MMO) is the top-level point of control for on-orbit Landsat 7 satellite and ground element operations. It acts on behalf of the Landsat Coordinating Group, which consists of the senior agency officials of the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Geological Survey (USGS) who oversee the Landsat program. The MMO interacts with the IGSs for non-routine items such as Memorandum of Understanding (MOU) negotiations, policy decisions, and special service requests.

3.1.5 International Ground Stations

The International Ground Stations (IGSs) receive real-time Landsat 7 data and archive and process it for their own use. They send service requests to the MOC to schedule ETM+ data transmission to their stations and return metadata to the EDC DAAC for data received and archived. The IGSs may also send browse data to the EDC DAAC. They receive the Calibration Parameter File from the MOC.

3.1.6 Associated Elements

The following two elements are occasionally referenced in the ICD. They do not have a direct interface with the IGSs.

The Landsat 7 Processing System (LPS) is the image processing facility, located at EDC, that performs Level 0R processing on data acquired by the U.S. It generates metadata and browse data which is archived at the EDC DAAC.

The Image Analysis System (IAS) is the facility that monitors image quality and ETM+ sensor performance. It generates the Calibration Parameter File which is distributed to the IGSs by the MOC.

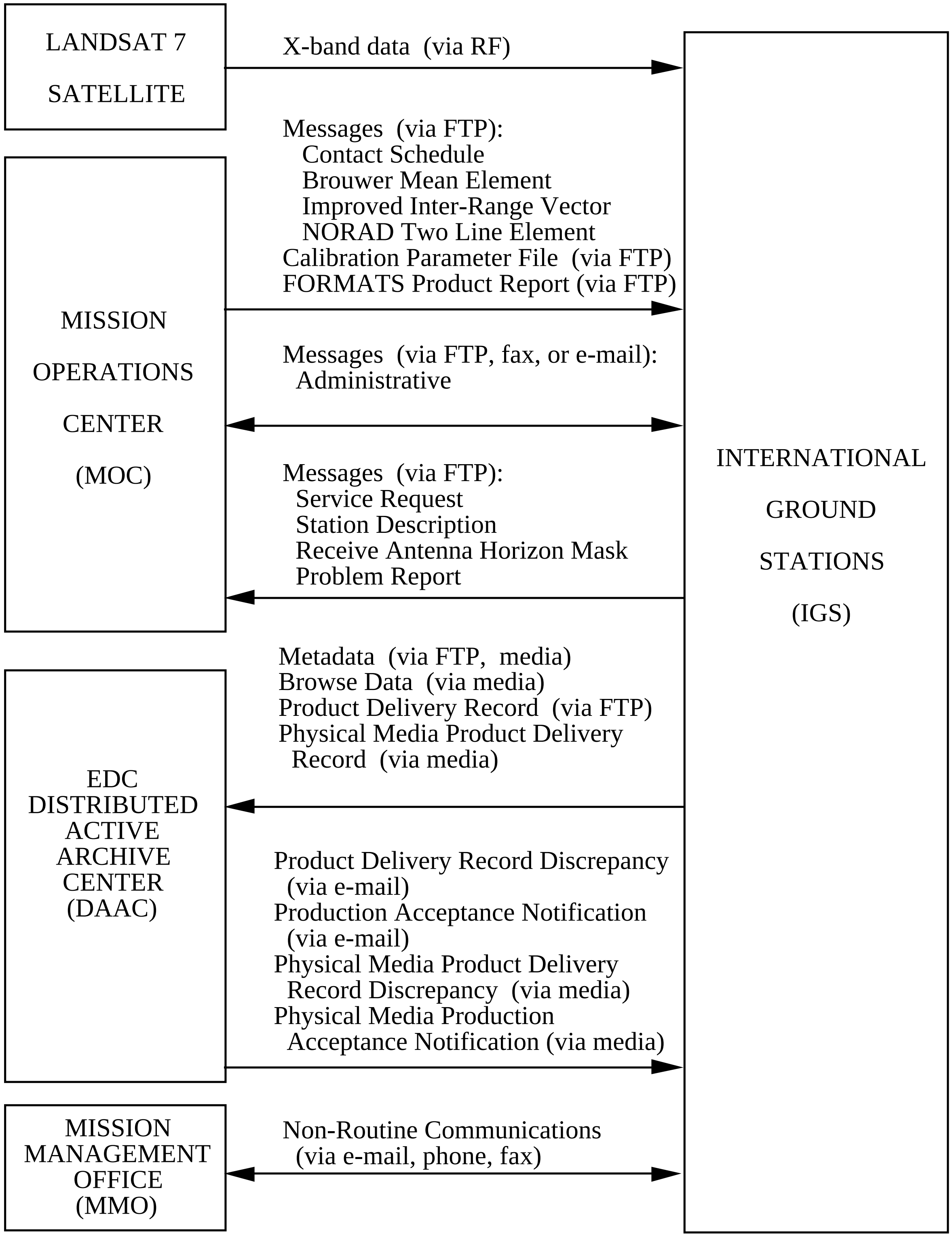


Figure 3-1 Interaction Between Landsat 7 System and the IGSs

3.2 DATA TRANSFER MESSAGES

The following messages have been identified for this interface. For each message, a brief description is given of its source, destination, content and usage. Detailed formats are contained in Appendices B, F, and G. The file naming conventions for these messages is described at the end of this section.

3.2.1 Administrative

The Administrative (ADM) message is a free form message used to handle situations which are not covered by any other predefined message format. ADM messages sent to the MOC will be read and responded to by the MOC's Flight Operations Team personnel. Uses of this message now include: asking for the cancellation of a requested service; inquiring about a message sent for which no acknowledgment was received; notifying IGSs of spacecraft status changes, service request validation errors, impacts to imaging, or availability of a new Calibration Parameter File. Files being transmitted as ADM messages must conform to the file naming conventions specified in section 3.6.

3.2.2 Problem Report

The Problem Report (PRB) message is used by the IGSs to report potential satellite-related problems which may have occurred during scheduled transmissions of image data to a ground station. Sufficient information is provided to allow the MOC to analyze the problem and take whatever remedial actions are appropriate. The Problem Report message is sent as soon as possible but no later than 24 hours following a problem with an acquisition event.

3.2.3 Service Request

The Service Request (REQ) message is used by the IGSs to ask the MOC to schedule the transmission of data to a ground station. Each message describes up to 10 swaths of data which Landsat 7 is to acquire and transmit to the requesting ground station one or more times.

The Service Request message is validated by the MOC upon receipt. If an error is found, it is reported in the acknowledgment message (FORMATS Product Report) sent to the IGS for every file received.

An IGS can request any image data that can be transmitted from the satellite to itself in real-time. The request is stated in terms of the Landsat Worldwide Reference System (WRS). The REQ message must be received in the MOC at least 36 hours prior to the start of the requested acquisition.

3.2.4 Contact Schedule

The Contact Schedule (SCH) message is used by the MOC to notify a ground station of a scheduled X-band data transmission. It is sent to a ground station after every scheduling run that included a request from that ground station.

3.2.5 Station Description

The Station Description (DES) message is used by the IGSs to provide information needed for site to site communication. From time to time, as individual stations modify their equipment, capabilities, phone numbers, or data preferences, they are required to submit this message to the MOC, along with the effective date and time of the information. Note that the voice or FAX telephone numbers are used only as an emergency backup for the normal message distribution system unless specific agreements between the Landsat 7 Project and the IGSs are negotiated.

The DES message is sent once to establish the station baseline, and thereafter whenever the baseline changes. It must be sent at least 7 days prior to the effective date of change for any information.

3.2.6 Receive Antenna Horizon Mask

The Receive Antenna Horizon Mask (MSK) message is used by the IGSs to specify the minimum elevation angles at which the ground station has an unobstructed view of the Landsat 7 satellite. The MOC develops contact schedules using ground station to satellite access information. The access is based upon either IGS-provided elevation mask data or an access limit of five (5) degrees minimum local elevation angle as a default value for those stations that do not provide mask data.

The MSK message is sent once to establish the station profile, and thereafter whenever the profile changes. It must be sent at least 7 days prior to the effective date of change for any profile information.

3.2.7 Brouwer Mean Element

The Brouwer Mean Element (BME) message is used by the MOC to provide satellite orbit definition. It is sent daily.

3.2.8 Improved Inter-Range Vector

The Improved Inter-Range Vector (IRV) message is used by the MOC to provide satellite orbit definition. It is sent on Mondays / Wednesdays / Fridays only.

3.2.9 NORAD Two Line Element

The NORAD Two Line Element (NOR) message is used by the MOC to provide satellite orbit definition. It is sent daily.

3.2.10 FORMATS Product Report

The Flight Dynamics Facility Orbit and Mission Aids Transformation System (FORMATS) software manages file transfers across the firewall between the open server and the closed servers in the MOC. The FORMATS Product Report is generated as an acknowledgment to the IGS that the file was received and successfully transferred into the MOC from the open server. In addition, it reports any errors found during validation of the Service Request message.

The FORMATS Product Report is generated within 5 minutes of product receipt on the open server.

3.2.11 Product Delivery Record (PDR) and Physical Media PDR

The Product Delivery Record (PDR) is used by the IGS to identify and describe each metadata file being electronically transferred to the DAAC. A Physical Media PDR is used by the IGS to identify and describe the metadata and browse data files being delivered to the DAAC on physical media.

A PDR or Physical Media PDR accompanies each delivery of data to the DAAC. Data deliveries are not processed until a corresponding PDR or Physical Media PDR is received.

3.2.12 PDR Discrepancy and Physical Media PRD Discrepancy

The PDR Discrepancy is used by the DAAC to report processing errors encountered during ingest of the PDR from the staging server. The Physical Media PDR Discrepancy is used by the DAAC to report processing errors encountered during ingest of the Physical Media PDR from the physical media.

These files are only sent when errors are found.

3.2.13 Production Acceptance Notification (PAN) and Physical Media PAN

The Production Acceptance Notification (PAN) is used by the DAAC to report the results of ingest and archival processing of the metadata placed on the staging server by the IGS. The Physical Media PAN is used by the DAAC to report the results of ingest and archival processing of the metadata and browse on physical media sent in by the IGS.

These files are always generated for each delivery.

3.3 X-BAND DOWNLINK DATA

The Landsat 7 satellite has the capability to transmit one data stream to up to three ground stations simultaneously. The satellite is capable of transmitting an X-band link to ground stations located on the horizon of the earth as viewed by the satellite. Each data stream contains sensor image data, sensor calibration data, and Payload Correction Data (PCD).

The downlink data is transmitted in accordance with the times and frequencies specified in the Contact Schedule message.

Appendix C contains the X-band communications link interface characteristics. Volume IV of the Landsat 7 Data Format Control Book (Reference Document 3) describes the X-band data format in detail.

3.4 IGS METADATA AND BROWSE DATA

The IGSs send metadata to the EDC DAAC for all Landsat 7 data they receive and archive. Metadata is sent to the EDC DAAC on at least a monthly basis. The IGSs also may send browse data to the DAAC.

The metadata provides information about each ETM+ scene acquired by the ground station. A partial list of the information contained in metadata is listed below:

- Geographic area coverage
- Date of image collection
- Station identification
- Sun elevation angle
- Summarization of non-nominal data
- Gain
- Data quality estimate
- Cloud cover assessment

Appendix D contains a detailed description of the metadata format.

The browse data provides a reduced volume representation of an image scene which can be viewed to determine general ground area coverage and spatial relationships between ground area coverage and cloud coverage.

Appendix E contains a detailed description of the browse data format.

3.5 CALIBRATION PARAMETER FILE

The initial Calibration Parameter File (CPF) is provided by the MOC to the IGSs before launch. After launch, the MOC sends the Calibration Parameter File to the IGSs as updates are periodically made available by the Landsat 7 Image Assessment System. The data is also available at the EDC DAAC. The nominal update frequency is every 90 days and is driven by the inclusion of 90 days of predictions for UT1-UTC correction parameters.

The Calibration Parameter File includes but is not limited to the following:

- Geometric parameters:
  - orbit parameters
  - scan mirror profile coefficients
  - time data rate, parameters and corrections
  - scan line corrector parameters
  - focal plane parameters
  - modulation transfer function
  - detector offsets and adjustments
  - spacecraft attitude bias
  - engineering coefficients
- Radiometric parameters:
  - gains
  - offsets
  - biases
  - scaling parameters

Refer to Volume V of the Landsat 7 Data Format Control Book (Reference Document 4) for a detailed description of the Calibration Parameter File.

3.6 FILE NAMING CONVENTIONS

The file naming convention for all message files exchanged with the MOC is:

L7yyyydddxxxfff.Snn or .Vnn

where:	L7	= constant for Landsat 7
	yyyy	= 4-digit year of file creation
	ddd	= 3-digit day of year of file creation
	xxx	= 3-letter station id as defined in Table 3-2
	fff	= 3-letter file type as defined in Table 3-1
	.Snn	= sequence number of the file type for this day of creation; e.g., L71999333DKISCH.S01 is the second SCH file sent to DKI on day 333 in 1999
	.Vnn	= version number of the file type; used for DES and MSK file types e.g., L71999333CUBDES.V03 is the fourth version of the Brazil station description to be issued for the mission (V00 is the first, pre-launch baseline version)

The file naming convention for Calibration Parameters Files sent to the IGSs is:

L7CPFyyyymmdd_yyyymmdd.nn

where:	L7	= constant for Landsat 7
	CPF	= identifies this as a Calibration Parameter File
	yyyy	= 4-digit effectivity starting year
	mm	= 2-digit effectivity starting month
	dd	= 2-digit effectivity starting day
	_	= separator
	yyyy	= 4-digit effectivity ending year
	mm	= 2-digit effectivity ending month
	dd	= 2-digit effectivity ending day
	.nn	= sequence number for this file; the 00 sequence number is a reserve sequence number uniquely identifying the pre-launch CPF; sequence numbers for subsequent 90-day time periods all begin with 01; sequence numbers for new versions or updates within the 90-day time period are incremented by one.

The file naming convention for the FORMATS Product report file sent to the IGS is:

[Original file name]xRPT

where:	[Original file name]	= the name of the file that was transferred into the MOC and is being acknowledged, including the file extension
	x	= severity of the message: I = informational, no errors are being reported E = error(s) is(are) being reported
	RPT	= constant, identifies this as a Report file

The file naming convention for metadata files sent to the DAAC is:

L7xxxppprrryyyymmddf.MTA

where:	L7	= constant for Landsat 7
	xxx	= 3-letter station id as defined in Table 3-2
	ppp	= WRS Path of the first scene
	rrr	= WRS Row of the first scene
	yyyy	= 4-digit year of acquisition
	mm	= month of acquisition
	dd	= day of month of acquisition
	f	= format included in the file: 0 = both formats 1 and 2 1 = format 1 only 2 = format 2 only
	.MTA	= identifies this as a metadata file

The file naming convention for browse files sent to the DAAC is:

L7xxxppprrryyyymmdd.Rnn

where:	L7	= constant for Landsat 7
	xxx	= 3-letter station id as defined in Table 3-2
	ppp	= WRS Path
	rrr	= WRS Row
	yyyy	= 4-digit year of acquisition
	mm	= month of acquisition
	dd	= day of month of acquisition
	.Rnn	= identifies this as a browse file where nn = sequence number of this scene in the original subinterval

The file naming convention for transfer management files exchanged with the DAAC is:

ORIGINATING_SYSTEM.yyyymmddhhmmss.ext

where: ORIGINATING_SYSTEM. = value of originating system provided in PDR
(IGSxxx where xxx is 3-letter station id, as defined in Table 3-2)

yyyymmdd	= date of file creation	
hhmmss	= time of file creation	
.ext	= file type:	
	.PDR	= Product Delivery Record file
	.PDRD	= PDR Discrepancy file
	.PAN	= Production Acceptance Notification file
	.PMPDR	= Physical Media Product Delivery Record file
	.PMPDRD	= Physical Media PDR Discrepancy file
	.PMPAN	= Physical Media Production Acceptance Notification file

The file names are listed in Table 3-1. The three-letter station designation is always in the file name (the one exception to this statement is the Calibration Parameters File), and identifies the station sending a file to the MOC/DAAC or receiving a file from the MOC/DAAC. Table 3-2 lists the IGS site three-letter designations and identifies which is used for communication with the MOC, and for communication with the DAAC. The table is sorted by Country and Location. The station description message will identify the appropriate e-mail and Internet IP addresses for MOC/DAAC message and file exchange.

TYPE	DESCRIPTION	FULL FILE NAME *
ADM	Administrative	L7yyyydddxxxADM.Snn
PRB	Problem Report	L7yyyydddxxxPRB.Snn
REQ	Service Request	L7yyyydddxxxREQ.Snn
SCH	Contact Schedule	L7yyyydddxxxSCH.Snn
DES	Station Description	L7yyyydddxxxDES.Vnn
MSK	Receive Antenna Horizon Mask	L7yyyydddxxxMSK.Vnn
BME	Brouwer Mean Element	L7yyyydddxxxBME.Snn
IRV	Improved Inter-Range Vector	L7yyyydddxxxIRV.Snn
NOR	NORAD Two Line Element	L7yyyydddxxxNOR.Snn
CPF	Calibration Parameter File	L7CPFyyyymmdd_yyyymmdd.nn
—	FORMATS Product Report	[Original file name]xRPT
—	Metadata File	L7xxxppprrryyyymmddf.MTA
—	Browse Data File	L7xxxppprrryyyymmdd.Rnn
—	Product Delivery Record File	IGSxxx.yyyymmddhhmmss.PDR
—	PDR Discrepancy File	IGSxxx.yyyymmddhhmmss.PDRD
—	Production Acceptance Notification File	IGSxxx.yyyymmddhhmmss.PAN
—	Physical Media Product Delivery Record File	IGSxxx.yyyymmddhhmmss.PMPDR
—	Physical Media PDR Discrepancy File	IGSxxx.yyyymmddhhmmss.PMPDRD
—	Physical Media Production Acceptance Notification File	IGSxxx.yyyymmddhhmmss.PMPAN

* xxx is the three character station designation as defined in Table 3-2
FORMATS Product Report file name is fully defined in Appendix G
Metadata and browse file names are fully defined in Appendices D and E
PDR, PDR Discrepancy, PAN, Physical Media PDR, Physical Media PDR Discrepancy, Physical Media PAN file names are fully defined in Appendix F

Table 3-1 File Types and Names

3.7 COMMUNICATIONS ARCHITECTURE

There are five modes of communication used for the IGS interface:

1. Electronic transfer (FTP "put" and "get")
2. Physical media transfer
3. Electronic mail (e-mail)
4. Fax
5. Telephone

3.7.1 Electronic Transfer (FTP "put" and "get")

Electronic transfer applies to the IGS interface with both the MOC and DAAC. In each case of electronic transfer, there is a firewall that protects the MOC and DAAC from access by outside elements. On the open side of the firewall is a server that is accessible by the IGSs and on which incoming files are placed by the IGSs. On the closed side of the firewall is software that polls the server on the open side and transfers files from the open side to a server on the closed side. The files are then processed as appropriate.

Figure 3-2 shows the communications architecture for electronic file transfer between the MOC and the IGSs. The specifics for IGS electronic file exchange with the MOC is described in detail in Appendix G.

Figure 3-3 shows the communications architecture for electronic file transfer between the DAAC and the IGSs. The specifics for IGS electronic file exchange with the DAAC are described in detail in Appendix F.

Frequency of polling, account names, password management, and directory/file cleanup for both the MOC and DAAC server interfaces are addressed in detail in the Operations Agreement (Reference Document 7).

3.7.2 Physical Media Transfer

This is applicable only to the IGS interface with the DAAC. Figure 3-4 shows the architecture for physical media transfer to the DAAC. The specifics for IGS physical media transfer to the DAAC are described in detail in Appendix F.

3.7.3 Electronic Mail (e-mail)

Some administrative messages (ADM) may be sent to the IGSs via electronic mail (e-mail) as well as via electronic transfer if they are of a time-critical or urgent nature. All messages from the DAAC to the IGSs are via e-mail.

3.7.4 Fax

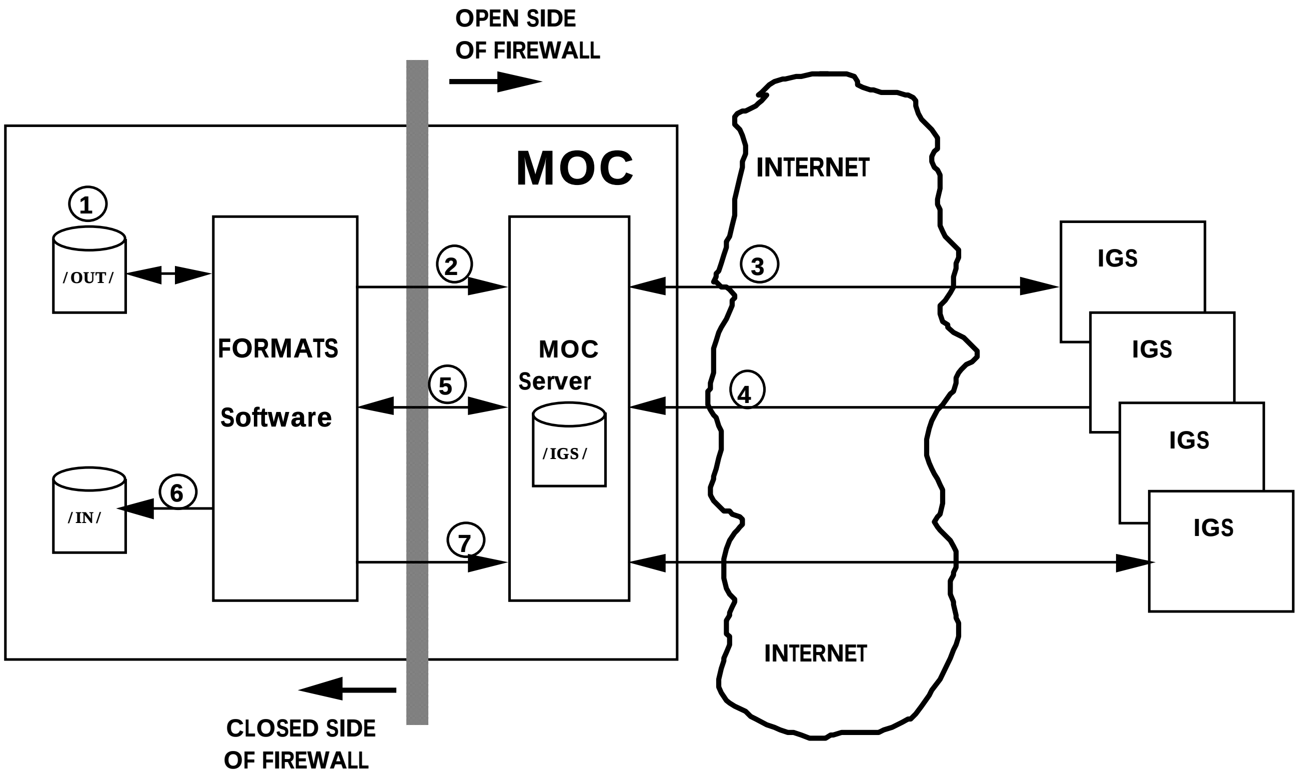
This is used primarily for non-routine communications with the Mission Management Office. It may also be used for emergency communications with the MOC, and to resubmit a PMPDR to the DAAC that was found to be missing or unreadable.

3.7.5 Telephone

This is used primarily for non-routine communications with the Mission Management Office. It may also be used for emergency communications with the MOC.

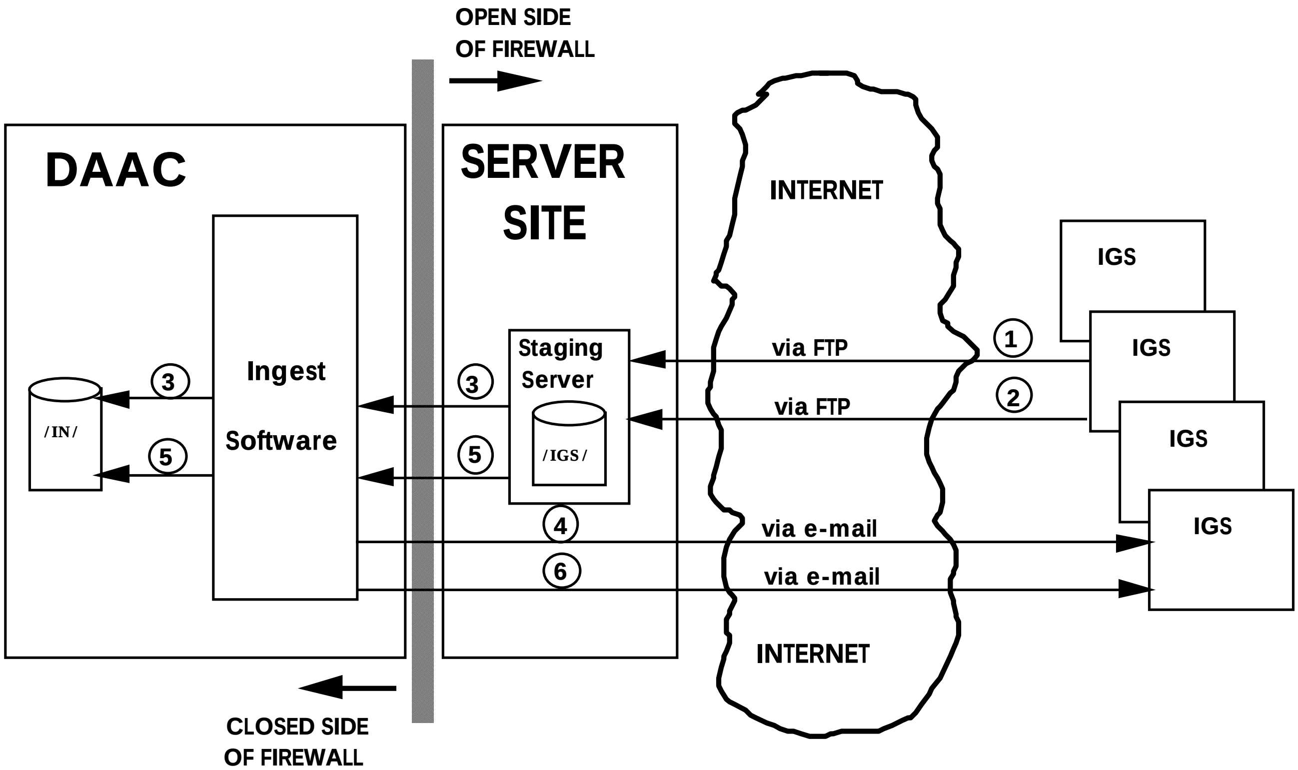
COUNTRY	LOCATION	STATION ID	INTERFACE DIRECTLY WITH MOC?	INTERFACE DIRECTLY WITH DAAC?
Argentina	Cordoba	COA	YES	YES
Australia	Alice Springs	ASA	YES	YES
Australia	Hobart	HOA	NO, through Alice Springs	YES
Brazil	Cuiaba	CUB	YES	YES
Canada	Gatineau	GNC	NO, through Ottawa	YES
Canada	Prince Albert	PAC	NO, through Ottawa	YES
Chile	Santiago	SGC	YES	YES
Ecuador	Cotopaxi	CPE	YES	YES
Germany	Neustrelitz	NSG	NO, through **TBD**	YES
India	Shadnagar	SGI	YES	YES
Indonesia	Parepare	DKI	YES	YES
Italy	Fucino	FUI	NO, through **TBD**	YES
Japan	Hatoyama	HAJ	NO, through **TBD**	YES
Japan	Kumomoto	KUJ	NO, through **TBD**	YES
Malaysia	Kuala Lumpur	KLM	YES	YES
Pakistan	Islamabad	ISP	YES	YES
Peoples Republic of China	Beijing	BJC	YES	YES
Saudi Arabia	Riyadh	RSA	YES	YES
South Africa	Johannesburg	JSA	YES	YES
Spain	Maspalomas	MPS	NO, through **TBD**	YES
Sweden	Kiruna	KIS	NO, through **TBD**	YES
Taipei, China	Chung-Li	CLT	YES	YES
Thailand	Bangkok	BKT	YES	YES

Table 3-2 Potential IGS Site Designations



1. Files (messages) to be sent from the MOC to the IGSs are placed in MOC output directories for pickup by FORMATS.
2. FORMATS polls the MOC output directories for IGS files and places them on the open server in the appropriate IGS output directory.
3. The IGSs poll the open server and "get" files via FTP.
4. Files to be sent from the IGSs to the MOC are "put" on the open server in the appropriate IGS input directory.
5. FORMATS polls the open server and "get"s files via FTP.
6. Files are validated and transferred to the appropriate MOC server.
7. FORMATS generates Product Report as acknowledgment of files received from the IGS and transferred into the MOC, or to report errors found during validation of the Service Request message.

Figure 3-2 MOC Communications Architecture and Message Flow



1 Metadata file(s) are sent to the staging server from the IGS via FTP and "put" in the /DATA directory.

2 The associated Product Delivery Record file is then sent to the staging server from the IGS via FTP, and "put" in the /PDR directory.

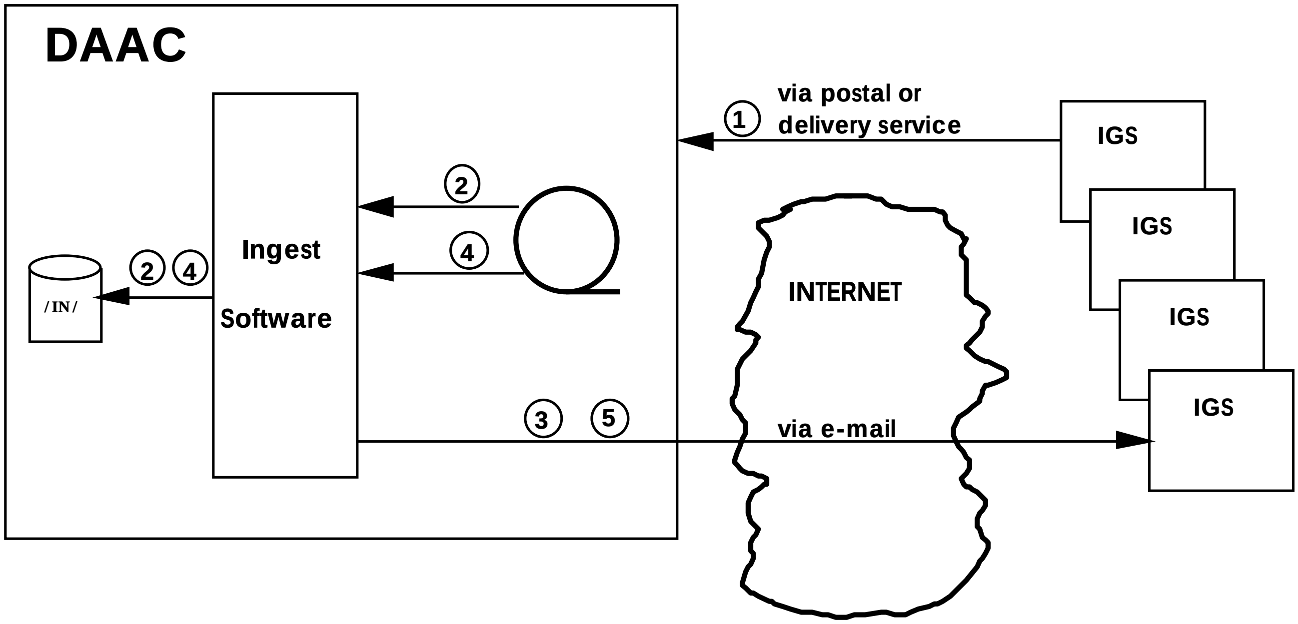
3 The Product Delivery Record is processed first.

4 If errors are found in the Product Delivery Record, they are reported in the Product Delivery Record Discrepancy file which is sent via e-mail to the IGS.

5 After no errors are found in the Product Delivery Record, metadata is ingested and processed.

6 Results of metadata processing are reported in the Production Acceptance Notification file which is sent to the IGS via e-mail.

Figure 3-3 DAAC Communications Architecture and Data Flow for Electronic Transfer



1. Metadata file(s), browse files, and associated Physical Media Product Delivery Record file are sent to the DAAC from the IGS on physical media via postal or delivery service.

2. The Physical Media Product Delivery Record is processed first.

3. If errors are found in the Physical Media Product Delivery Record, they are reported in the Physical Media PDR Discrepancy file which is sent via e-mail to the IGS.

4. After no errors are found in the Physical Media Product Delivery Record, metadata and browse data are ingested and processed.

5. Results of metadata and browse data processing are reported in the Physical Media Production Acceptance Notification file which is sent to the IGS via e-mail.

Figure 3-4 DAAC Architecture and Data Flow for Physical Media Transfer

APPENDIX A
GLOSSARY AND ACRONYM LIST

A.1 GLOSSARY OF TERMS

Browse data	A reduced data volume representation of an image scene which can be viewed to determine general ground area coverage and spatial relationships between ground area coverage and cloud coverage. Browse data typically consists of three spectral bands.
ETM+ Format 1	The ETM+ Format 1 major frames contain all data (e.g., imaging and calibration) from and associated with Bands 1–6. The Mirror Scan Correction Data and Payload Correction Data are duplicated in both ETM+ formats.
ETM+ Format 2	The ETM+ Format 2 major frames contain all data (e.g., imaging and calibration) from and associated with Bands 6–8. The Mirror Scan Correction Data and Payload Correction Data are duplicated in both ETM+ formats.
Full Scene	A standard WRS scene with 375 scans.
Interval	The time duration between the start and end of an imaging operation (land observation) by the ETM+ instrument on board the Landsat 7 spacecraft. The raw wideband data collected during an interval consists of a contiguous set of WRS scenes. An interval may be from one to 35 full scenes in length.
Level 0R product	A US data product in which the data has been spatially reformatted but the data values remain unchanged. No radiometric or geometric corrections have been performed on the data. The reformatting is fully reversible. The data is band sequential. Attached to the image data is radiometric calibration image data, payload correction data, quality data, and metadata.
Metadata	A set of descriptive information about the scene data contained in the archive. The information is sufficient for a user, during the process of scene query and selection, to determine at a minimum geographic coverage, date of collection, sensor gain mode, time of acquisition, cloud cover, and other quality measurements.
Partial Scene	A partial scene (less than 375 scans) may exist at the beginning or end of a subinterval due to the fact that imaging events do not always start or end on WRS scene boundaries. If generated, browse and scene metadata for these occurrences accurately reflect their partial scene nature and geographic extent.
Payload Correction Data (PCD)	Imaging support data imbedded in the wideband data stream. Includes satellite attitude, ephemeris, time, angular displacement sensor (ADS) data, and payload state.

Scene Corners - Upper	The upper corners of a scene are the corners associated with the trailing edge (first scan) of a scene. For descending path scenes, the upper left corner corresponds to the north-west corner of a scene and the upper right corner corresponds to the north-east corner of a scene. For ascending path scenes, the upper left corner corresponds to the south-east corner of a scene and the upper right corner corresponds to the south-west corner of a scene. These mappings hold for the band file geolocation fields and the metadata file. See Figure A-1 for the context of the corners with respect to the spacecraft and the image display.
Scene Corners - Lower	The lower corners of a scene are the corners associated with the leading edge (last scan) of a scene. For descending path scenes, the lower left corner corresponds to the south-west corner of a scene and the lower right corner corresponds to the south-east corner of a scene. For ascending path scenes, the lower left corner corresponds to the north-east corner of a scene and the lower right corner corresponds to the north-west corner of a scene. These mappings hold for the band file geolocation fields and the metadata file. See Figure A-1 for the context of the corners with respect to the spacecraft and the image display.
Site	The physical location of an International Ground Station (IGS) or the Mission Operations Center (MOC).
Subinterval	A contiguous segment of a raw wideband data interval received during a Landsat 7 contact period. Subintervals are caused by breaks in the wideband data stream due to communication dropouts and/or the inability of the spacecraft to transmit a complete observation (interval) within a single Landsat 7 contact period. The largest possible subinterval can be as long as a full imaging interval (a set of contiguous WRS scenes) transmitted during an uninterrupted contact period. The smallest possible subinterval can be as small as a single partial WRS scene.

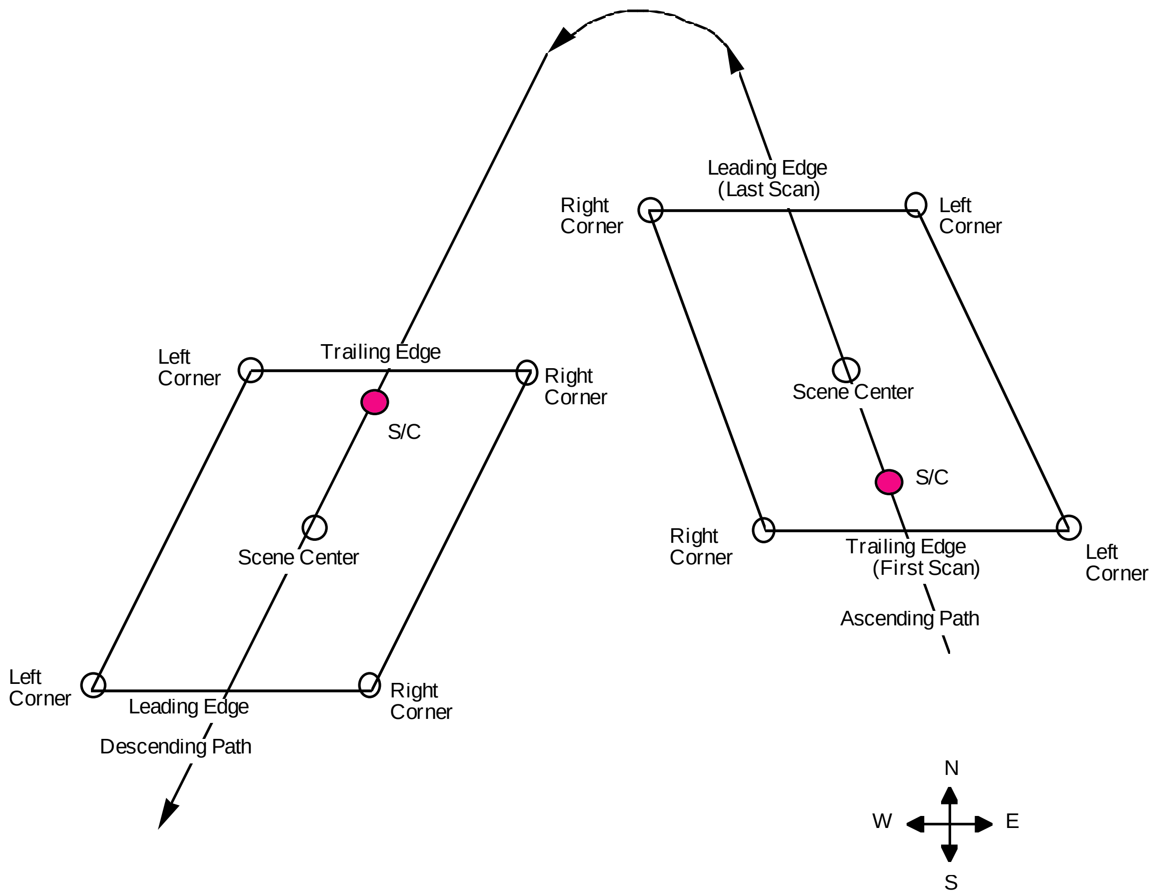
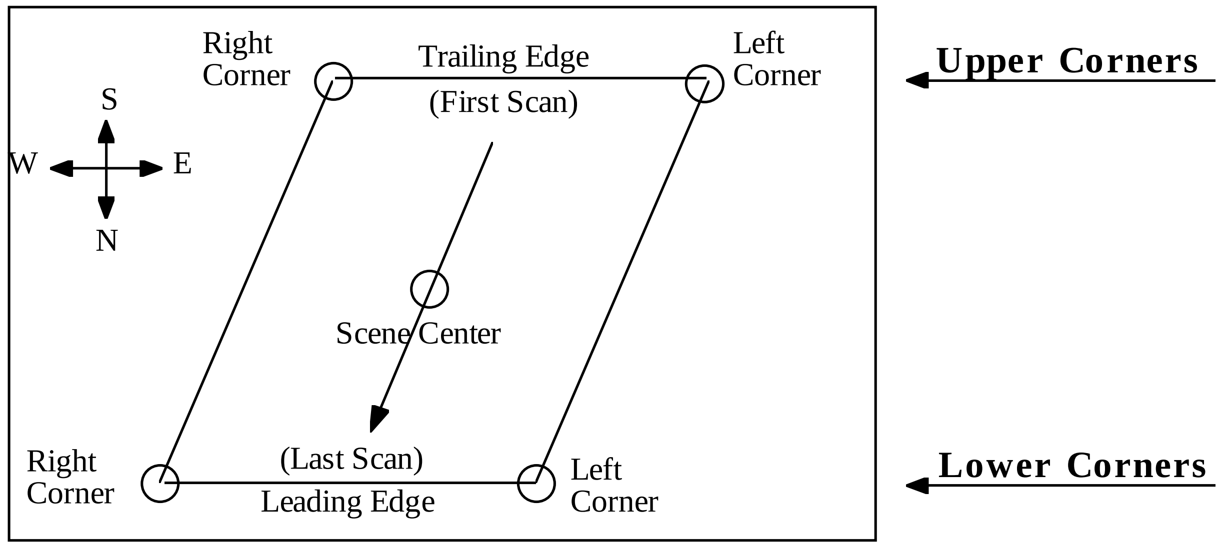
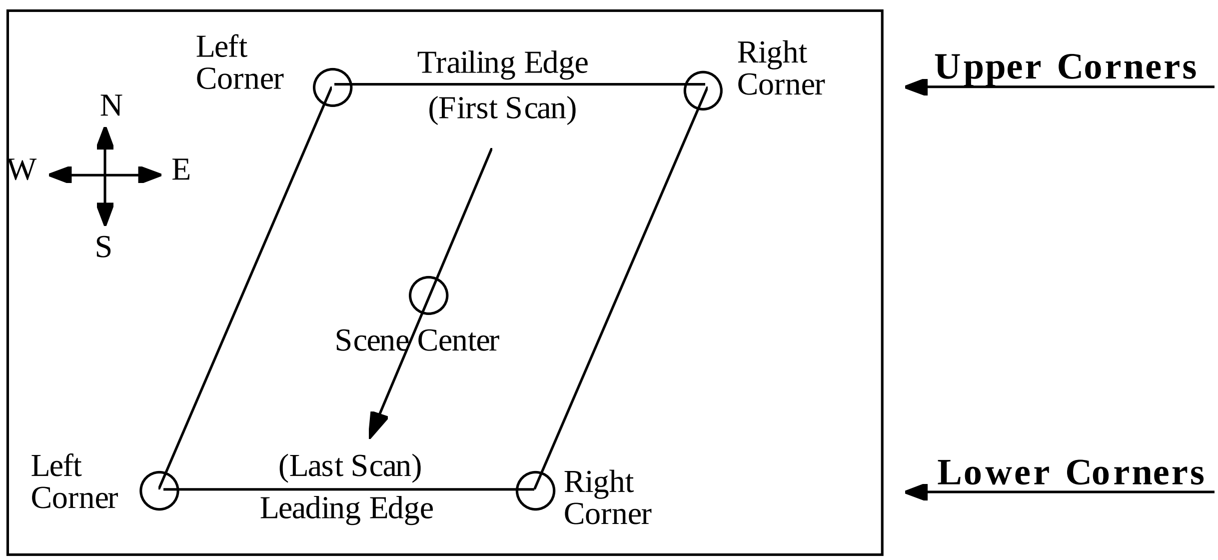


Figure A-1 WRS Scene Corners Context (1 of 2)



Descending Path - Image Display



Ascending Path - Image Display

Figure A-1 WRS Scene Corners Context (2 of 2)

A.2 ACRONYM LIST

ACCA	Automated Cloud Cover Assessment
ADM	Administrative message
ADS	Angular Displacement Sensor
ANSI	American National Standards Institute
AOS	Acquisition Of Signal
API	Application Programming Interface
AQPSK	Asynchronous Quadrature Phase Shift Keying
AR	Axial Ratio
ASCII	American Standard Code for Information Interchange
BCH	Bose–Chaudhuri–Hocquenghem error detection and correction
BER	Bit Error Rate
BME	Brouwer Mean Element
BPSK	Biphase Shift Key
BSTAR	Drag-related parameter in the NORAD two-line element message
BSU	Baseband Switching Unit
C	Centigrade
CADU	Channel Access Data Unit
CCA	Cloud Cover Assessment
CCSDS	Consultative Committee for Space Data Systems
CCT	Computer Compatible Tape
CD-ROM	Compact Disk - Read Only Memory
cm	centimeter
CPF	Calibration Parameter File
DAAC	Distributed Active Archive Center
DB	Data Block
dB-Hz	Decibel-Hertz
dB/K	Decibel per Degree Kelvin

dBi	Decibel above isotropic
dBW	Decibel Relative to 1 Watt
DCT	Digital Cassette Tape
DES	Station Description message
DFCB	Data Format Control Book
DLT	Digital Linear Tape
DR	Delivery Record
DTG	Day Time Group
e-mail	Electronic mail
E_b	Energy per bit
EDAC	Error Detection And Correction
EDC	EROS Data Center
EIRP	Effective Isotropic Radiated Power
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
EROS	Earth Resources Observation System
ETM+	Enhanced Thematic Mapper Plus
FAX	Facsimile Transmission
FORMATS	Flight Dynamics Facility Orbit and Mission Aids Transformation System
FOT	Flight Operations Team
FTP	File Transfer Protocol
G/T	Gain over Temperature
GAQD	Originator routing code for IIRV messages
GB	GigaByte
GMT	Greenwich Mean Time
GP4	General perturbations theory
GSFC	Goddard Space Flight Center
GXA	Gimballed X-Band Antenna

HDF	Hierarchical Data Format
HDT	High Density Tape
Hz	Hertz
I	In-Phase channel
I/O	Input/Output
IAS	Image Assessment System
ICD	Interface Control Document
ID	Identification
IGS	International Ground Station
IIRV	Improved Inter-Range Vector
IRV	Improved Inter-Range Vector message
ISO	International Standards Organization
JPEG	Joint Photographic Experts Group
JPL	Jet Propulsion Laboratory
K	Degrees Kelvin
KB	Kilobyte
kHz	Kilohertz
km	Kilometer
LAT	Latitude
LL	Lower Left
LON	Longitude
LOS	Loss Of Signal
LPS	Landsat 7 Processing System
LR	Lower Right
LS7	Landsat 7
LTP	Long Term Plan
LTWG	Landsat Technical Working Group
MB	Megabyte

Mbps	Mega bits–per–second
MHz	MegaHertz
mm	Millimeter
mm/hr	Millimeters per Hour
MMO	Mission Management Office
MOC	Mission Operations Center
MOU	Memorandum of Understanding
MSK	Receive Antenna Horizon Mask message
MSS	Multispectral Scanner
MTA	Metadata
mW	milliWatt
N/A	Not Applicable
N_0	Noise Density
NASA	National Aeronautics and Space Administration
NCSA	National Center for Supercomputing Applications
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
NOR	NORAD Two-Line Element Message
NORAD	North American Air Defense
NRZ-L	Non Return to Zero–Level
ODL	Object Description Language
PAN	Production Acceptance Notification
PCD	Payload Correction Data
PDR	Product Delivery Record
PDRD	Product Delivery Record Discrepancy
PL–DRO	Phase Locked Dielectric Resonance Oscillator
PN	Pseudorandom Noise
PRB	Problem Report message

PVL	Parameter Value Language
Q	Quadrature channel
QPSK	Quadrature Phase Shift Keying
REQ	Service Request message
RF	Radio Frequency
RGB	Red, Green, Blue
RHC	Right-hand Circular
RIS24	24-bit Raster Image
S/C	Spacecraft
SCH	Contact Schedule message
SL	Scan Line
sr	steradian
SSPA	Solid State Power Amplifier
SW	Switch
T	Temperature
TBD	To Be Determined
TBR	To Be Resolved
TBS	To Be Supplied
TCP/IP	Transmission Control Protocol/Internet Protocol
TM	Thematic Mapper
UL	Upper Left
UR	Upper Right
URL	Uniform Resource Locator
US	United States
USGS	United States Geological Survey
UT	Universal Time
UTC	Coordinated Universal Time
VCDU	Virtual Channel Data Unit
WRS	Worldwide Reference System
Z	Zulu time

APPENDIX B
MESSAGE FORMATS

All message lines are formatted as   KEYWORD : VALUE

All message lines (KEYWORD:VALUE) end with an ASCII carriage return followed by an ASCII line feed, unless otherwise noted. The carriage return and line feed must be after the full KEYWORD:VALUE phrase.

All messages are written in the English language.

B.1 ADMINISTRATIVE MESSAGE

The Administrative (ADM) message contains four (4) keywords. Figure B-1 shows the format and description of the Administrative message.

```
TYPE:          ADM
DTG:           yyyy/ddd:hh:mm:ss
TEXT:          xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
               xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
               xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
               xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
TEXTEND:
```

KEYWORD	**VALUE**	**DESCRIPTION**
TYPE:	ADM	Identifies this as an Administrative message
DTG:	yyyy/ddd:hh:mm:ss where yyyy = 1997 - 2100 (year) ddd = 001 - 366 (day of year) hh = 00 - 23 (hours) mm = 00 - 59 (minutes) ss = 00 - 59 (seconds)	Date-Time Group; identifies the date and time of creation of the message
TEXT:	free-form text; ASCII line feeds may be used to enhance readability; last two characters of this field must be carriage return and line feed	One or more sentences.
TEXTEND:		Indicates the end of the message

Figure B-1 Administrative Message Format

B.2 PROBLEM REPORT MESSAGE

The Problem Report (PRB) message contains six (6) keywords. Figure B-2 shows the format and description of the Problem Report message.

If there is more than one problem to report, the station may repeat these three keywords (SCHEDULED EVENT, OBSERVATION, COMMENTS) for each subsequent problem to be reported. The TEXTEND keyword should be the last keyword of the message.

TYPE:	PRB
DTG:	yyyy/ddd:hh:mm:ss
SCHEDULED EVENT:	7 yyyy-mm-dd:hh:mm:ss hh:mm:ss yyyy-mm-dd:hh:mm:ss hh:mm:ss xx x
OBSERVATION:	xxxxxxxxxxxxxxxxxxxx
COMMENTS:	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxx
TEXTEND:	

KEYWORD	**VALUE**	**DESCRIPTION**
TYPE:	PRB	Identifies this as a Problem Report message
DTG:	yyyy/ddd:hh:mm:ss where yyyy = 1997 - 2100 (year) ddd = 001 - 366 (day of year) hh = 00 - 23 (hours) mm = 00 - 59 (minutes) ss = 00 - 59 (seconds)	Identifies the date and time of creation of the message
SCHEDULED EVENT:	7 fields as defined below, separated by ASCII space	Exact copy of the SCHEDULED EVENT line from the appropriate Contact Schedule message
	7	Source of the data (Landsat 7)
	yyyy-mm-dd:hh:mm:ss where: yyyy = 1997 - 2100 (year) mm = 01 - 12 (month) dd = 01 - 31 (day) hh = 00 - 23 (hour) mm = 00 - 59 (minute) ss = 00 - 59 (second)	GMT date and time that the satellite transmitter was to be turned on (AOS)
	hh:mm:ss (same as above)	GMT time that the first data block was to be received
	yyyy-mm-dd:hh:mm:ss (same as above)	GMT date and time that the last data block was to be received
	hh:mm:ss (same as above)	GMT time that the satellite transmitter was to be turned off (LOS)
	xx = XL (low freq., 8082.5 MHz) = XM (mid freq., 8212.5 MHz) = XH (high freq., 8342.5 MHz)	Carrier frequency that was to be used
	x = 1, 2 or 3	Satellite antenna that was to be used
OBSERVATION:	10 to 20 characters, see Table B-1 for the pre-defined values	Basic observation of the ground station during the event
COMMENTS:	free-form text, any length; line feeds may be used to enhance readability; last two characters of this field must be carriage return and line feed	Additional comments which relate to the specific event; should include frequencies on which reception was attempted and any other information which would help in problem analysis
TEXTEND:		Indicates the end of the message

Figure B-2 Problem Report Message Format

OBSERVATION VALUE	DEFINITION
NO CARRIER	The satellite X-band carrier was not received.
NOISY SIGNAL	The satellite X-band signal was too noisy to record and process.
STATION DOWN	The station was unable to operate during the scheduled event.
SEVERE WEATHER	Severe local weather prevented or interfered with station operations.
OTHER – SEE COMMENTS	See the comments for a description of the problem.

Table B-1 Values for the Observation Keyword

B.3 SERVICE REQUEST MESSAGE

The Service Request (REQ) message contains thirteen (13) keywords. Figure B-3 shows the format and description of the Service Request message.

Characteristics of the ETM+ instrument are defined in the Landsat 7 Science Data Users Guide (Reference Document 6).

Each service request message describes a single interval (a set of contiguous scenes from a single WRS path) which Landsat 7 is requested to acquire and transmit to the ground station. If there is more than one interval to request, the station may stack requests in a single file by repeating the keywords from S/C ID through REQ. TYPE as many times as there are intervals to request, up to a total of 10 intervals per file. The header keywords of TYPE and DTG and the trailer keyword of TEXTEND should appear only once in the file.

TYPE:	REQ
DTG:	yyyy/ddd:hh:mm:ss
S/C ID:	7
START PATH:	xxx
START ROW:	xxx
STOP ROW:	xxx
EFFECTIVE DATE:	yyyy-mm-dd
EXPIRATION DATE:	yyyy-mm-dd
ACQ. RATE:	x
MINIMUM GAP:	xxx
MAX. SOLAR ZENITH ANGLE:	xx
REQ. TYPE:	xxx
TEXTEND:	

KEYWORD	VALUE	DESCRIPTION
TYPE:	REQ	Identifies this as a Service Request message
DTG:	yyyy/ddd:hh:mm:ss where yyyy = 1997 - 2100 (year) ddd = 001 - 366 (day of year) hh = 00 - 23 (hours) mm = 00 - 59 (minutes) ss = 00 - 59 (seconds)	Identifies the date and time of creation of the message
S/C ID:	7	Landsat 7
START PATH:	xxx = 001 - 233	The WRS path associated with the first scene being requested
START ROW:	xxx = 001 - 248	The WRS row associated with the first scene being requested
STOP ROW:	xxx = 001 - 248	The WRS row associated with the last scene being requested. Must be greater than or equal to START ROW value.
EFFECTIVE DATE:	yyyy-mm-dd where yyyy = 1997 - 2100 (year) mm = 01 - 12 (month) dd = 01 - 31 (day)	The date on which the request becomes active for scheduling.

Figure B-3 Service Request Message Format (1 of 2)

KEYWORD	VALUE	DESCRIPTION
EXPIRATION DATE:	yyyy-mm-dd (same as above)	The last date on which the request is eligible for scheduling. Acquisitions will not be scheduled after this date.
ACQ. RATE:	x where x = 0 for acquire every opportunity x = 1 for acquire once only	The rate at which acquisitions should be made. Used in conjunction with MINIMUM GAP.
MINIMUM GAP:	xxx = 000 - 366	The minimum acceptable number of days between acquisitions.
MAX. SOLAR ZENITH ANGLE:	xx where xx = 00 - 90 degrees xx = blank (use the default values)	Maximum acceptable solar zenith angle. If desired, this field may be left blank to trigger use of the default maximum solar zenith angle (85_). The default setting is documented in the Long Term Plan (Reference Document 11). During scheduling, the request will not be scheduled if the calculated solar zenith angle on the day of acquisition exceeds the maximum angle specified in the request.
REQ. TYPE:	xxx where xxx = 3-letter station id from Table 3-2	Identifies the IGS submitting the request.
		Repeat keywords S/C ID through REQ. TYPE for each successive interval being requested, up to a total of 10 intervals.
TEXTEND:		Indicates the end of the message.

Figure B-3 Service Request Message Format (2 of 2)

B.4 CONTACT SCHEDULE MESSAGE

The Contact Schedule (SCH) message contains four (4) keywords. Figure B-4 shows the format and description of the Contact Schedule message.

If there is more than one scheduled acquisition to report, the MOC may repeat the SCHEDULED EVENT keyword for each subsequent acquisition to be reported. The TEXTEND keyword should be last keyword of the message.

If there are no scheduled acquisitions to report (i.e., acquisitions were requested but not scheduled), the file will be generated with the TYPE, DTG, and TEXTEND keywords only.

The message covers 48 hours of events; however, the second 24 hours is for information only and may change when the scheduling is performed on the next day.

Note that some of the information in the message is not needed by the ground station to perform their operations. However, the additional information may be of value in resolving operational problems.

```
TYPE:               SCH
DTG:                yyyy/ddd:hh:mm:ss
SCHEDULED EVENT:    7 yyyy-mm-dd:hh:mm:ss hh:mm:ss yyyy-mm-dd:hh:mm:ss
                    hh:mm:ss xx x
TEXTEND:
```

KEYWORD	VALUE	DESCRIPTION
TYPE:	SCH	Identifies this as a Contact Schedule message
DTG:	yyyy/ddd:hh:mm:ss where yyyy = 1997 - 2100 (year) ddd = 001 - 366 (day of year) hh = 00 - 23 (hours) mm = 00 - 59 (minutes) ss = 00 - 59 (seconds)	Identifies the date and time of creation of the message
SCHEDULED EVENT:	7 fields as defined below, separated by ASCII space	Defines the parameters of a scheduled downlink to the IGS
	7	Source of the data (Landsat 7)
	yyyy-mm-dd:hh:mm:ss where: yyyy = 1997 - 2100 (year) mm = 01 - 12 (month) dd = 01 - 31 (day) hh = 00 - 23 (hour) mm = 00 - 59 (minute) ss = 00 - 59 (second)	GMT date and time that the satellite transmitter will be turned on (AOS). The AOS is 6 seconds prior to the first data block.
	hh:mm:ss (same as above)	GMT time that the first data block will be received. This includes any PCD preamble required to process the first requested WRS row.
	yyyy-mm-dd:hh:mm:ss (same as above)	GMT date and time that the last data block will be received. This includes any PCD postamble required to process the last requested WRS row.

Figure B-4 Contact Schedule Message Format (1 of 2)

KEYWORD	**VALUE**	**DESCRIPTION**
	hh:mm:ss (same as above)	GMT time that the satellite transmitter will be turned off (LOS). The LOS is 1 second after the last data block.
	xx = XL (low freq., 8082.5 MHz) = XM (mid freq., 8212.5 MHz) = XH (high freq., 8342.5 MHz)	Carrier frequency that will be used
	x = 1, 2 or 3	Satellite antenna that will be used
TEXTEND:		Indicates the end of the message

Figure B-4 Contact Schedule Message Format (2 of 2)

B.5 STATION DESCRIPTION MESSAGE

The Station Description (DES) message contains twenty-three (23) keywords. Figure B-5 shows the format and description of the Station Description message.

A Station Description message is required for each site that will be receiving X-band data. For example, Canada must submit two Station Description messages, one for the Prince Albert site and one for the Gatineau site.

TYPE:	DES
DTG:	yyyy/ddd:hh:mm:ss
EFFECTIVITY:	yyyy/ddd
STATION ID:	xxx
CONTACT PERSON:	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
CONTACT TITLE:	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
MAILING ADDRESS 1:	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
MAILING ADDRESS 2:	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
MAILING ADDRESS 3:	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
MAILING ADDRESS 4:	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
VOICE PHONE NO:	xxx yyy zzzzzzzz
FAX PHONE NO:	xxx yyy zzzzzzzz
IGS E-MAIL ADDRESS TO BE USED BY THE MOC/MMO:	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
IGS E-MAIL ADDRESS TO BE USED BY THE DAAC:	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
ORBITAL ELEMENTS TYPE:	xxx
ANTENNA LATITUDE:	x dd mm ss
ANTENNA LONGITUDE:	x ddd mm ss
ANTENNA ALTITUDE:	xxxx
X-BAND FREQ. HIGH:	xxx
X-BAND FREQ. MID:	xxx
X-BAND FREQ. LOW:	xxx
NEED S-BAND BEACON:	xxx
TEXTEND:	

Figure B-5 Station Description Message Format (1 of 3)

KEYWORD	VALUE	DESCRIPTION
TYPE:	DES	Identifies this as a Station Description message
DTG:	yyyy/ddd:hh:mm:ss where yyyy = 1997 - 2100 (year) ddd = 001 - 366 (day of year) hh = 00 - 23 (hours) mm = 00 - 59 (minutes) ss = 00 - 59 (seconds)	Identifies the date and time of creation of the message
EFFECTIVITY:	yyyy/ddd (same as above)	Identifies the first date on which the following information comes into effect
STATION ID:	xxx as defined in Table 3-2	Identifies the station to which the following information applies
CONTACT PERSON:	free-form text	Name of a person who can be contacted if required for operational purposes
CONTACT TITLE:	free-form text	Title of the contact person
MAILING ADDRESS 1:	free-form text	First line of the mailing address for the station
MAILING ADDRESS 2:	free-form text	Second line of the mailing address for the station
MAILING ADDRESS 3:	free-form text	Third line of the mailing address for the station
MAILING ADDRESS 4:	free-form text	Fourth line of the mailing address for the station
VOICE PHONE NO:	xxx yyy zzzzzzzz 3 fields separated by blanks, where xxx = 1-3 character country code yyy = 1-3 character city or area code zzzzzzzz = 4-8 character local number	Phone number for the contact person
FAX PHONE NO:	xxx yyy zzzzzzzz (same as above)	Facsimile phone number for the station
IGS E-MAIL ADDRESS TO BE USED BY THE MOC/MMO:	free-form text	Electronic mail address for messages from the MOC and MMO
IGS E-MAIL ADDRESS TO BE USED BY THE DAAC:	free-form text	Electronic mail address for messages from the DAAC
ORBITAL ELEMENTS TYPE:	xxx where BME = Brouwer Mean Elements IRV = Improved Inter-Range Vectors NOR = NORAD 2-line Elements	The type of satellite orbit definition message desired by the station for use in ground antenna pointing during Landsat 7 acquisition.

Figure B-5 Station Description Message Format (2 of 3)

KEYWORD	VALUE	DESCRIPTION
ANTENNA LATITUDE:	x dd mm ss where x = N for North or S for South dd = 00 - 90 degrees mm = 00 - 59 minutes ss = 00 - 59 seconds	The latitude of the station antenna.
ANTENNA LONGITUDE:	x ddd mm ss where x = E for East or W for West ddd = 00 - 180 degrees mm = 00 - 59 minutes ss = 00 - 59 seconds	The longitude of the station antenna.
ANTENNA ALTITUDE:	xxxx (meters)	The altitude of the station antenna.
X-BAND FREQ. HIGH:	xxx where YES = station can receive High NO = station cannot receive High	Indicates whether the station can receive and process the high frequency X-band link which operates at 8342.5 MHz.
X-BAND FREQ. MID:	xxx where YES = station can receive Mid NO = station cannot receive Mid	Indicates whether the station can receive and process the mid frequency X-band link which operates at 8212.5 MHz.
X-BAND FREQ. LOW:	xxx where YES = station can receive Low NO = station cannot receive Low	Indicates whether the station can receive and process the low frequency X-band link which operates at 8082.5 MHz.
NEED S-BAND BEACON:	xxx where YES = need S-band to acquire NO = don’t need S-band	Indicates whether the station requires an S-band signal to aid in acquisition tracking of the satellite prior to X-band signal receipt
TEXTEND:		Indicates the end of the message

Figure B-5 Station Description Message Format (3 of 3)

B.6 RECEIVE ANTENNA HORIZON MASK MESSAGE

The Receive Antenna Horizon Mask (MSK) message contains forty (40) keywords. Figure B-6 shows the format of the Receive Antenna Horizon Mask message.

A Receive Antenna Horizon Mask message is required for each site that will receive X-band data. For example, Japan must submit two Receive Antenna Horizon Mask messages, one for the Hatoyama site and one for the Kumomoto site.

Antenna mask data is provided in one (1) degree increments of azimuth, from 000 through 359. If a station does not provide a horizon mask, a default mask of 5 degrees minimum elevation for every degree of azimuth will be used.

TYPE:	MSK
DTG:	yyyy/ddd:hh:mm:ss
EFFECTIVITY:	yyyy/ddd
000-009:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
010-019:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
020-029:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
030-039:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
040-049:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
050-059:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
060-069:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
070-079:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
080-089:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
090-099:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
100-109:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
110-119:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
120-129:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
130-139:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
140-149:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
150-159:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
160-169:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
170-179:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
180-189:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
190-199:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
200-209:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
210-219:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
220-229:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
230-239:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
240-249:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
250-259:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
260-269:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
270-279:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
280-289:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
290-299:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
300-309:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
310-319:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
320-329:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
330-339:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
340-349:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
350-359:	xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx
TEXTEND:	

Figure B-6 Receive Antenna Horizon Mask Message Format (1 of 2)

KEYWORD	VALUE	DESCRIPTION
TYPE:	MSK	Receive Antenna Horizon Mask message
DTG:	yyyy/ddd:hh:mm:ss where yyyy = 1997 - 2100 (year) ddd = 001 - 366 (day of year) hh = 00 - 23 (hours) mm = 00 - 59 (minutes) ss = 00 - 59 (seconds)	Identifies the date and time of creation of the message
EFFECTIVITY:	yyyy/ddd (same as above)	Identifies the first date on which the following information comes into effect
000-009:	10 fields, separated by ASCII space where xx.xxx = 00.000 - 90.000 degrees	Receive antenna elevation angle from the horizon, at each degree azimuth from 000 to 009
010-019:	same as for 000-009	for each degree azimuth from 010 to 019
020-029:	same as for 000-009	for each degree azimuth from 020 to 029
030-039:	same as for 000-009	for each degree azimuth from 030 to 039
040-049:	same as for 000-009	for each degree azimuth from 040 to 049
050-059:	same as for 000-009	for each degree azimuth from 050 to 059
060-069:	same as for 000-009	for each degree azimuth from 060 to 069
070-079:	same as for 000-009	for each degree azimuth from 070 to 079
080-089:	same as for 000-009	for each degree azimuth from 080 to 089
090-099:	same as for 000-009	for each degree azimuth from 090 to 099
100-109:	same as for 000-009	for each degree azimuth from 100 to 109
110-119:	same as for 000-009	for each degree azimuth from 110 to 119
120-129:	same as for 000-009	for each degree azimuth from 120 to 129
130-139:	same as for 000-009	for each degree azimuth from 130 to 139
140-149:	same as for 000-009	for each degree azimuth from 140 to 149
150-159:	same as for 000-009	for each degree azimuth from 150 to 159
160-169:	same as for 000-009	for each degree azimuth from 160 to 169
170-179:	same as for 000-009	for each degree azimuth from 170 to 179
180-189:	same as for 000-009	for each degree azimuth from 180 to 189
190-199:	same as for 000-009	for each degree azimuth from 190 to 199
200-209:	same as for 000-009	for each degree azimuth from 200 to 209
210-219:	same as for 000-009	for each degree azimuth from 210 to 219
220-229:	same as for 000-009	for each degree azimuth from 220 to 229
230-239:	same as for 000-009	for each degree azimuth from 230 to 239
240-249:	same as for 000-009	for each degree azimuth from 240 to 249
250-259:	same as for 000-009	for each degree azimuth from 250 to 259
260-269:	same as for 000-009	for each degree azimuth from 260 to 269
270-279:	same as for 000-009	for each degree azimuth from 270 to 279
280-289:	same as for 000-009	for each degree azimuth from 280 to 289
290-299:	same as for 000-009	for each degree azimuth from 290 to 299
300-309:	same as for 000-009	for each degree azimuth from 300 to 309
310-319:	same as for 000-009	for each degree azimuth from 310 to 319
320-329:	same as for 000-009	for each degree azimuth from 320 to 329
330-339:	same as for 000-009	for each degree azimuth from 330 to 339
340-349:	same as for 000-009	for each degree azimuth from 340 to 349
350-359:	same as for 000-009	for each degree azimuth from 350 to 359
TEXTEND:		Indicates the end of the message.

Figure B-6 Receive Antenna Horizon Mask Message Format (2 of 2)

B.7 BROUWER MEAN ELEMENT MESSAGE

The Brouwer Mean Element (BME) message is a standard message from Goddard Space Flight Center. The introductory paragraph of the message identifies the satellite, epoch and coordinate system. The elements and inertial coordinates are then listed. There is a text trailer. Figure B-7 shows the format and description of the Brouwer Mean Element message.

Each line in the BME is ended with a carriage return followed by a line feed. Each field within a line is separated from the next field by one (1) ASCII space unless otherwise specified.

```
THE FOLLOWING ARE THE BROUWER MEAN ORBITAL ELEMENTS FOR SATELLITE
1998 nna landsat7  COMPUTED AND ISSUED BY THE GODDARD
SPACE FLIGHT CENTER.  EPOCH yyyy Y mm M dd D hh H nn M ss.sss S
UT.
THE FOLLOWING ARE THE GEOCENTRIC TRUE OF DATE ELEMENTS


        SEMI-MAJOR AXIS                xxxxx.xxxx  KILOMETERS
        ECCENTRICITY                    .xxxxxxxx
        INCLINATION                       xx.xxxx  DEGREES
        MEAN ANOMALY                     xxx.xxxx  DEGREES
        ARG. OF PERIFOCUS                xxx.xxxx  DEGREES
          MOTION        PLUS               x.xxxx  DEG. PER DAY
        R.A. OF ASCEND. NODE             xxx.xxxx  DEGREES
          MOTION       MINUS               x.xxxx  DEG. PER DAY
        ANOMALISTIC PERIOD             xxxx.xxxxx  MINUTES
        PERIOD DOT      PLUS               x.xxxx  MIN. PER DAY
        HT. OF PERIFOCUS                xxxxx.xxx  KILOMETERS
        HT. OF APOFOCUS                 xxxxx.xxx  KILOMETERS
        VEL. AT PERIFOCUS                  xxxxx.  KM. PER HR.
        VEL. AT APOFOCUS                   xxxxx.  KM. PER HR.
        GEOC. LAT. OF PERIFOCUS            xx.xxx  DEGREES
        PLUS


        INERTIAL COORDINATES REFERENCE TRUE OF DATE

        X                             sxxxxx.xxxx  KILOMETERS
        Y                             sxxxxx.xxxx  KILOMETERS
        Z                             sxxxxx.xxxx  KILOMETERS
        X DOT                          sx.xxxxxxx  KM. PER SEC.
        Y DOT                          sx.xxxxxxx  KM. PER SEC.
        Z DOT                          sx.xxxxxxx  KM. PER SEC.
** THE END NO MORE INPUT****
```

Figure B-7 Brouwer Mean Element Message Format (1 of 6)

LINE NO.	NO. OF BYTES	FORMAT	DESCRIPTION
1	65	"THE FOLLOWING ARE THE BROUWER MEAN ORBITAL ELEMENTS FOR SATELLITE"	Text field - identifies the type of message
2		4 fields as defined below, separated by an ASCII space	
	4	yyyy = 1998	Year of satellite launch
	3	nna where nn = launch number of year (**TBD** - value not available until launch) a = piece of launch (**TBD** - value not available until launch)	Launch identification
	8	landsat7	Satellite name
	34	"COMPUTED AND ISSUED BY THE GODDARD"	Text field
3		13 fields as defined below, separated by an ASCII space	
	27	"SPACE FLIGHT CENTER. EPOCH"	Text field
	4	yyyy = 1997 - 2100	Year of epoch
	1	"Y"	Indicates preceding field is year
	2	mm = 01 - 12	Month of epoch
	1	"M"	Indicates preceding field is month
	2	dd = 01 - 31	Day of epoch
	1	"D"	Indicates preceding field is day
	2	hh = 00 - 23	Hour of epoch
	1	"H"	Indicates preceding field is hours
	2	nn = 00 - 59	Minutes of epoch
	1	"M"	Indicates preceding field is minutes
	6	ss.sss = 00.000 - 59.999	Seconds of epoch, specified to the millisecond
	5	"S UT."	Indicates preceding field is seconds and epoch is specified in Universal Time.
4	54	"THE FOLLOWING ARE THE GEOCENTRIC TRUE OF DATE ELEMENTS"	Text field - identifies coordinate system of elements
5	0	blank line	
6	0	blank line	
7		3 fields as defined below, the first preceded by 9 ASCII spaces	Semi-major axis in kilometers
	15	"SEMI-MAJOR AXIS" followed by 14 ASCII spaces instead of 1	Element name
	10	xxxxx.xxxx	Value
	10	"KILOMETERS"	Unit
8		2 fields as defined below, the first preceded by 9 ASCII spaces	Eccentricity
	12	"ECCENTRICITY" followed by 15 ASCII spaces instead of 1	Element name
	9	.xxxxxxxx	Value

Figure B-7 Brouwer Mean Element Message Format (2 of 6)

LINE NO.	NO. OF BYTES	FORMAT	DESCRIPTION
9		3 fields as defined below, the first preceded by 9 ASCII spaces	Inclination
	11	"INCLINATION" followed by 21 ASCII spaces instead of 1	Element name
	7	xx.xxxx	Value
	7	"DEGREES"	Unit
10		3 fields as defined below, the first preceded by 9 ASCII spaces	Mean Anomaly
	12	"MEAN ANOMALY" followed by 19 ASCII spaces instead of 1	Element name
	8	xxx.xxxx	Value
	7	"DEGREES"	Unit
11		3 fields as defined below, the first preceded by 9 ASCII spaces	Argument of perifocus
	17	"ARG. OF PERIFOCUS" followed by 14 ASCII spaces instead of 1	Element name
	8	xxx.xxxx	Value
	7	"DEGREES"	Unit
12		4 fields as defined below, the first preceded by 14 ASCII spaces	First derivative of argument of perifocus
	6	"MOTION" followed by 8 ASCII spaces instead of 1	Element name
	5	" PLUS" or "MINUS", followed by 9 ASCII spaces instead of 1	Sign
	6	x.xxxx	Value
	12	"DEG. PER DAY"	Unit
13		3 fields as defined below, the first preceded by 9 ASCII spaces	Right ascension of ascending node
	20	"R.A. OF ASCEND. NODE" followed by 11 ASCII spaces instead of 1	Element name
	8	xxx.xxxx	Value
	7	"DEGREES"	Unit
14		4 fields as defined below, the first preceded by 14 ASCII spaces	First derivative of right ascension of ascending node
	6	"MOTION" followed by 8 ASCII spaces instead of 1	Element name
	5	" PLUS" or "MINUS", followed by 9 ASCII spaces instead of 1	Sign
	6	x.xxxx	Value
	12	"DEG. PER DAY"	Unit
15		3 fields as defined below, the first preceded by 9 ASCII spaces	Anomalistic period
	18	"ANOMALISTIC PERIOD" followed by 11 ASCII spaces instead of 1	Element name
	10	xxxx.xxxxx	Value
	7	"MINUTES"	Unit

Figure B-7 Brouwer Mean Element Message Format (3 of 6)

LINE NO.	NO. OF BYTES	FORMAT	DESCRIPTION
16		4 fields as defined below, the first preceded by 9 ASCII spaces	Period dot
	10	"PERIOD DOT" followed by 9 ASCII spaces instead of 1	Element name
	5	" PLUS" or "MINUS", followed by 9 ASCII spaces instead of 1	Sign
	6	x.xxxx	Value
	12	"MIN. PER DAY"	Unit
17		3 fields as defined below, the first preceded by 9 ASCII spaces	Height of perifocus
	16	"HT. OF PERIFOCUS" followed by 14 ASCII spaces instead of 1	Element name
	9	xxxxx.xxx	Value
	10	"KILOMETERS"	Unit
18		3 fields as defined below, the first preceded by 9 ASCII spaces	Height of apofocus
	15	"HT. OF APOFOCUS" followed by 15 ASCII spaces instead of 1	Element name
	9	xxxxx.xxx	Value
	10	"KILOMETERS"	Unit
19		3 fields as defined below, the first preceded by 9 ASCII spaces	Velocity at perifocus
	17	"VEL. AT PERIFOCUS" followed by 16 ASCII spaces instead of 1	Element name
	6	xxxxx.	Value
	11	"KM. PER HR."	Unit
20		3 fields as defined below, the first preceded by 9 ASCII spaces	Velocity at apofocus
	16	"VEL. AT APOFOCUS" followed by 17 ASCII spaces instead of 1	Element name
	6	xxxxx.	Value
	11	"KM. PER HR."	Unit
21		4 fields as defined below, the first preceded by 9 ASCII spaces	Geocentric latitude of perifocus
	23	"GEOC. LAT. OF PERIFOCUS"	Element name
	5	" PLUS" or "MINUS" followed by 6 ASCII spaces instead of 1	Sign
	6	xx.xxx	Value
	7	"DEGREES"	Unit
22	0	blank line	
23	0	blank line	
24	43	"INERTIAL COORDINATES REFERENCE TRUE OF DATE" preceded by 9 ASCII spaces	Header line
25	0	blank line	

Figure B-7 Brouwer Mean Element Message Format (4 of 6)

LINE NO.	NO. OF BYTES	FORMAT	DESCRIPTION
26		3 fields as defined below, the first preceded by 9 ASCII spaces	X component of position vector
	1	"X" followed by 27 ASCII spaces instead of 1	Element name
	11	sxxxxx.xxxx where s = blank for positive sign or "-" for negative sign	Value
	10	"KILOMETERS"	Unit
27		3 fields as defined below, the first preceded by 9 ASCII spaces	Y component of position vector
	1	"Y" followed by 27 ASCII spaces instead of 1	Element name
	11	sxxxxx.xxxx where s = blank for positive sign or "-" for negative sign	Value
	10	"KILOMETERS"	Unit
28		3 fields as defined below, the first preceded by 9 ASCII spaces	Z component of position vector
	1	"Z" followed by 27 ASCII spaces instead of 1	Element name
	11	sxxxxx.xxxx where s = blank for positive sign or "-" for negative sign	Value
	10	"KILOMETERS"	Unit
29		3 fields as defined below, the first preceded by 9 ASCII spaces	X component of velocity vector
	5	"X DOT" followed by 24 ASCII spaces instead of 1	Element name
	10	sx.xxxxxxx where s = blank for positive sign or "-" for negative sign	Value
	12	"KM. PER SEC."	Unit
30		3 fields as defined below, the first preceded by 9 ASCII spaces	Y component of velocity vector
	5	"Y DOT" followed by 24 ASCII spaces instead of 1	Element name
	10	sx.xxxxxxx where s = blank for positive sign or "-" for negative sign	Value
	12	"KM. PER SEC."	Unit

Figure B-7 Brouwer Mean Element Message Format (5 of 6)

LINE NO.	NO. OF BYTES	FORMAT	DESCRIPTION
31		3 fields as defined below, the first preceded by 9 ASCII spaces	Z component of velocity vector
	5	"Z DOT" followed by 24 ASCII spaces instead of 1	Element name
	10	sx.xxxxxxx where s = blank for positive sign or "-" for negative sign	Value
	12	"KM. PER SEC."	Unit
32	28	"** THE END NO MORE INPUT****"	Indicates the end of the message

Figure B-7 Brouwer Mean Element Message Format (6 of 6)

B.8 IMPROVED INTER-RANGE VECTOR MESSAGE

The Improved Inter-Range Vector (IRV) message is a standard message from Goddard Space Flight Center (GSFC). The message contains six (6) lines. Figure B-8 shows the format and description of the Improved Inter-Range Vector message.

Each of the six lines in the message is terminated by two (2) carriage returns followed by two (2) line feeds. There are no spaces between fields on a line.

If there are multiple vectors being sent in the same message, the following will be repeated for each subsequent vector:

- the last three fields of line 1 (starting with "GIIRV")
- lines 2 through 6 in their entirety

```
03uuuuuuu010GIIRV MANY
1111736801nnndddhhmmsssssccc
sxxxxxxxxxxxxsyyyyyyyyyyyyszzzzzzzzzzzzzccc
sxxxxxxxxxxxxsyyyyyyyyyyyyszzzzzzzzzzzzzccc
mmmmmmmmaaaaakkkksrrrrrrrccc
ITERM GAQD
```

LINE NO.	NO. OF BYTES	FORMAT	DESCRIPTION
1		7 fields as defined below	
	2	03	Message Type (Operations Data Message)
	7	uuuuuuu = 0000100 - 9999900 (updated in increments of 100)	Message ID
	1	0	Message source (Flight Dynamics Facility)
	2	10	Message class (nominal)
	5	"GIIRV"	Message start
	1	ASCII space	Originator of message (GSFC)
	4	"MANY"	Routing indicator (multiple destinations)
2		10 fields as defined below	
	1	1	Vector type (free flight, routine on-orbit)
	1	1	Data source (nominal/planning)
	1	1	Transfer type (Interrange)
	1	1	Coordinate system (Geocentric true-of-date rotation)
	4	7368	Support Identification Code
	2	01	Vehicle Identification Code

Figure B-8 Improved Inter-Range Vector Message Format (1 of 3)

LINE NO.	NO. OF BYTES	FORMAT	DESCRIPTION
	3	nnn = 000 - 999	Sequence number incremented for each vector in a set of vector data
	3	ddd = 001 - 366	Day of year
	9	hhmmsssss where hh = 00 - 23 (hours) mm = 00 - 59 (minutes) sssss = 00000 - 59999 (milliseconds - implied decimal is three places from the right)	Vector epoch in UTC
	3	ccc	Checksum for line 2; calculated by summing the decimal equivalent of the preceding characters in the line, counting spaces as 0 and negative signs as 1
3		4 fields as defined below	
	13	sxxxxxxxxxxxx where s = "-" for negative sign or ASCII space for positive sign	X component of the position vector in meters
	13	syyyyyyyyyyyy where s = "-" for negative sign or ASCII space for positive sign	Y component of the position vector in meters
	13	szzzzzzzzzzzz where s = "-" for negative sign or ASCII space for positive sign	Z component of the position vector in meters
	3	ccc	Checksum for line 3
4		4 fields as defined below	
	13	sxxxxxxxxxxxx where s = "-" for negative sign or ASCII space for positive sign	X component of the velocity vector in meters per second, with a resolution to the nearest millimeter per second; assumed decimal point is three places from the right.
	13	syyyyyyyyyyyy where s = "-" for negative sign or ASCII space for positive sign	Y component of the velocity vector in meters per second, with a resolution to the nearest millimeter per second; assumed decimal point is three places from the right.
	13	szzzzzzzzzzzz where s = "-" for negative sign or ASCII space for positive sign	Z component of the velocity vector in meters per second, with a resolution to the nearest millimeter per second; assumed decimal point is three places from the right.
	3	ccc	Checksum for line 4

Figure B-8 Improved Inter-Range Vector Message Format (2 of 3)

LINE NO.	NO. OF BYTES	FORMAT	DESCRIPTION
5		5 fields as defined below	
	8	mmmmmmmm Must contain all zeros if not used	Mass of the satellite in kilograms with a resolution to the nearest tenth of a kilogram; assumed decimal point is one place from the right.
	5	aaaaa Must contain all zeros if not used	Average satellite cross-sectional area in square meters with a resolution to the nearest hundredth of a square meter; assumed decimal point is two places from the right.
	4	kkkk Must contain all zeros if not used	Dimensionless drag coefficient; assumed decimal point is two places from the right.
	8	srrrrrrr where s = "-" for negative sign or ASCII space for positive sign Must contain all zeros if not used	Dimensionless solar reflectivity coefficient; assumed decimal point is six places from the right.
	3	ccc	Checksum for line 5
6		3 fields as defined below	
	5	"ITERM"	Indicates end of message
	1	ASCII blank	
	4	"GAQD"	Originator routing
7	10	"GIIRV MANY"	Identifies message start, originator and routing indicator for second vector set
8-12		same as lines 2-6 for a second vector set	Second vector set
		repeat lines 7-12 for each subsequent vector set	Additional vector sets

Figure B-8 Improved Inter-Range Vector Message Format (3 of 3)

B.9 NORAD TWO LINE ELEMENT MESSAGE

The NORAD Two Line Element (NOR) message being distributed by the MOC is generated by NORAD and posted on an online data base from which the MOC retrieves it on a daily basis. The update rate for the NORAD message is determined by NORAD; it is possible that the message retrieved on one day is the same as the message that was retrieved on the previous day.

The message contains two (2) lines. Figure B-9 shows the format and description of the NORAD Two Line Element message. There is an ASCII space between each field on each line. The first line is terminated with a carriage return and a line feed.

```
1 sssssU 98lllvvv yyddd.dddddddd s.mmmmmmmm smmmmm-m sddddd-d 0 nnnnc
2 sssss iii.iiii rrr.rrrr eeeeeee ppp.pppp aaa.aaaa rr.rrrrrrrreeeeec
```

LINE NO.	NO. OF BYTES	FORMAT	DESCRIPTION
1		9 fields as described below	
	1	1	Line number
	6	sssssU where sssss = **TBD** (satellite number - not available until launch)	Satellite number and classification (Unclassified)
	8	98lllvvv where lll = **TBD** (launch number of year - not available until launch) vvv = **TBD** (vehicle identifier - not available until launch)	International designator for Landsat 7
	14	yyddd.dddddddd where yy = 00 - 99 (last two digits of year) ddd.dddddddd = 000.00000000 - 365.99999999 (day and fraction of day)	Epoch year and day
	10	s.mmmmmmmm where s = blank for positive value or s = "-" for negative value	First time derivative of Mean Motion, in revolutions per day^2
	8	smmmmm-m where s = blank for positive value or s = "-" for negative value	Second time derivative of Mean Motion, in revolutions per day^3 Decimal point is assumed. Field is usually zero-filled.
	8	sddddd-d where s = blank for positive value or s = "-" for negative value	BSTAR drag term if GP4 general perturbations theory was used; otherwise, is radiation pressure coefficient Decimal point is assumed.

Figure B-9 NORAD Two Line Element Message Format (1 of 2)

LINE NO.	NO. OF BYTES	FORMAT	DESCRIPTION
	1	0	Ephemeris type (mean inertial)
	5	nnnnc where nnnn = 0000 - 9999 (element number) c = 0 - 9 (line checksum, modulo 10)	Element number and line checksum
2		8 fields as described below	
	1	2	Line number
	5	sssss = **TBD** (satellite number - not available until launch)	Satellite number
	8	iii.iiii = 098.0000 - 098.5000 (degrees)	Inclination
	8	rrr.rrrr = 000.0000 - 360.0000 (degrees)	Right ascension of ascending node
	7	eeeeeee	Eccentricity; decimal point is assumed at beginning of the field
	8	ppp.pppp = 075.0000 - 100.0000 (degrees)	Argument of perigee
	8	aaa.aaaa = 000.0000 - 360.0000 (degrees)	Mean anomaly
	17	rr.rrrrrrrreeeeec where rr.rrrrrrrr = 00.00000000 - 99.99999999 (mean motion in revolutions per day) eeeee = 00000 - 99999 (revolution number at epoch) c = 0 - 9 (line checksum, modulo 10)	Mean motion, epoch revolution and line checksum

Figure B-9 NORAD Two Line Element Message Format (2 of 2)

APPENDIX C
X-BAND COMMUNICATIONS LINK INTERFACE CHARACTERISTICS

C.1 LINK FUNCTIONAL DESIGN

During the period that Radio Frequency (RF) line-of-sight conditions exist between the Landsat 7 satellite and the IGS, wideband science data is downlinked to the IGS through the use of the gimballed X-band antennas (GXAs) as scheduled by the MOC. Link operation is dependent upon RF line-of-sight conditions between the satellite and the IGS, and the IGS antenna local elevation angle being greater than 5 degrees and above the local mask. Accessibility for signal acquisition purposes is not precluded by the satellite for IGS antenna local elevation angles greater than 1 degree. The maximum expected Doppler is less than 190 kHz.

The interface links between the IGS and the satellite are:

- 8082.5 MHz (Low Frequency)
- 8212.5 MHz (Mid Frequency)
- 8342.5 MHz (High Frequency)

Transmission from the satellite to IGS of real-time science data from the ETM+ payload is at a data rate of 150 Mbps. The ETM+ payload data consists of ETM+ payload imagery, calibration data, and payload correction data (PCD). Each 150 Mbps link consists of two 75 Mbps data streams which are modulated on the In-phase (I) and Quadrature (Q) channels.

The functional interface of this link is shown in Figure C-1. Real-time ETM+ payload data is provided by the baseband switching unit (BSU) for routing to the appropriate X-band transmitters. The 75 Mbps (74.914 Mbps ± 0.00075 Mbps) I and Q channel data streams from the BSU are input to the appropriate X-band transmitter. Within the X-band transmitter, data from the BSU is input to the baseband driver which reclocks the incoming Non Return to Zero Level (NRZ-L) data and drives the Quadrature Phase Shift Keying (QPSK) modulator. I and Q channel data from the baseband driver is QPSK modulated onto the X-band carrier with an I/Q channel power ratio of 1:1, as shown in Figure C-2. No attempt is made onboard the satellite to synchronize the bit transitions on the I and Q channels, and they must therefore be treated as Asynchronous QPSK (AQPSK). The transmit carrier is derived from a Phase Locked Dielectric Resonator Oscillator (PL-DRO). The output of the QPSK modulator is input to a solid state power amplifier (SSPA) within the X-band transmitter which amplifies the AQPSK modulated signal to provide the necessary output power. The amplified AQPSK modulated signal is transmitted at the appropriate carrier frequency and sent through a triplexer which bandwidth limits the signal to a 112.5 MHz (3 dB) bandwidth. The signal is routed to the IGS via a right-hand circular (RHC) GXA.

Within the IGS, the input signal from the receive antenna is downconverted before being input to the QPSK receiver/demodulator. The QPSK receiver/demodulator demodulates the downconverted AQPSK signal into separate I and Q channel data streams with NRZ-L format. Following QPSK demodulation, the bit synchronizer provides I and Q channel data clock recovery. Separate clock recovery circuits must be provided for the I and Q channels, either by using two independent bit synchronizers or one bit synchronizer which internally generates two independent clocks. The outputs (data and clock) from the bit synchronizer(s) are provided for data storage.

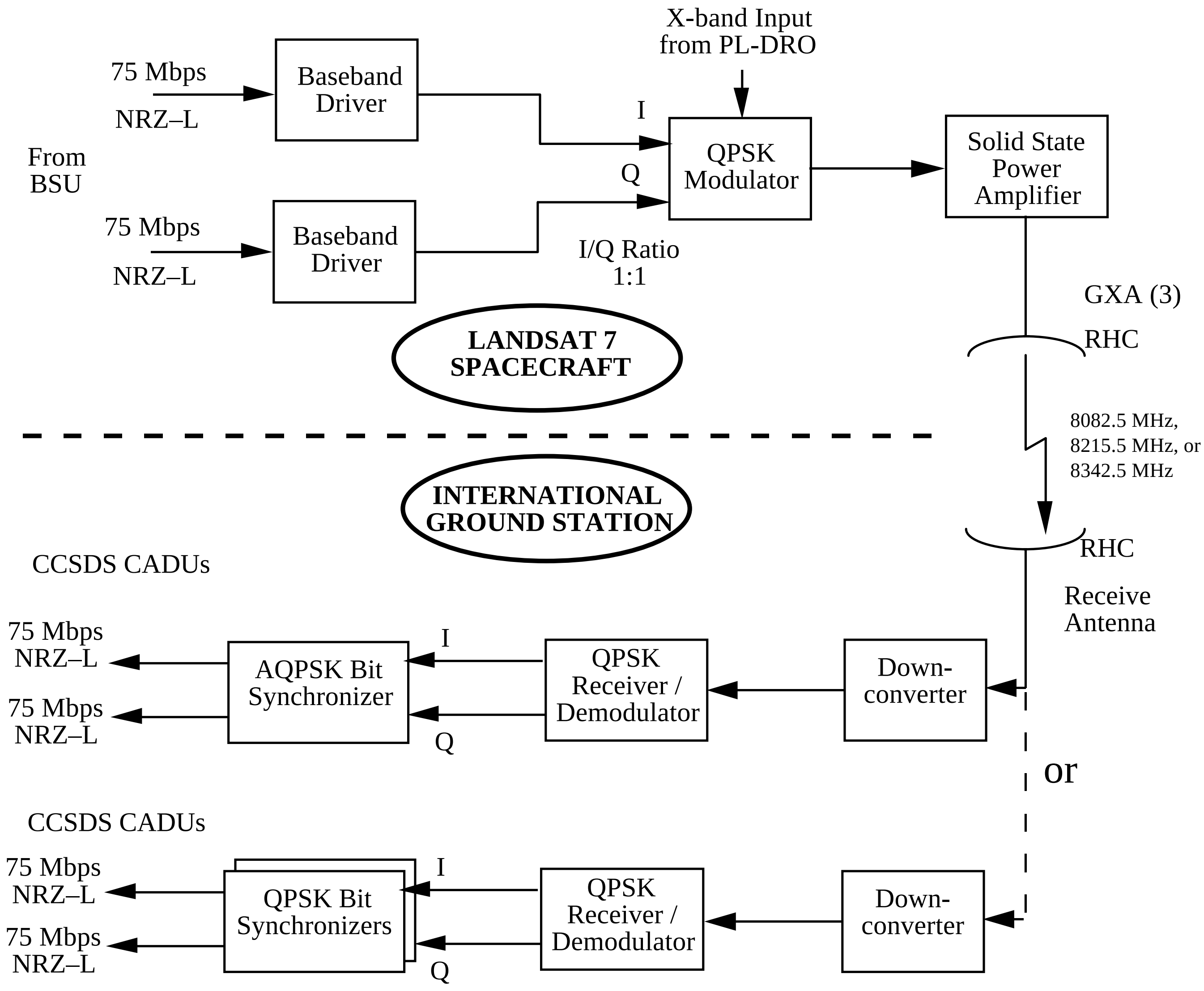


Figure C-1 Landsat 7 to IGS X-Band Downlink Configuration

C.2 BASEBAND SIGNAL CHARACTERISTICS

The science data baseband signal in the satellite is an NRZ-L waveform. All Landsat 7 science data is formatted for transmission at 150 Mbps over the X-band link. With the exception of pseudorandom noise (PN) fill data, the delivery service is equivalent to the Grade 3 service defined in Consultative Committee for Space Data Systems (CCSDS) 701.0-B-1, Advanced Orbiting Systems, Networks and Data Links: Architectural Specification. The downlink transfer frame format is depicted in Figure C-3. PN fill data will not be structured in CCSDS Channel Access Data Units (CADUs).

Data is formatted by the ETM+ payload into separate mission data streams which are provided as a single bit stream for Bose–Chaudhuri–Hocquenghem (BCH) encoding. Data streams consist of 992 bit data blocks of payload data. Data blocks are segmented into a BCH data unit which contains a predefined data zone of 7936 bits, a BCH error detection and correction (EDAC), data pointer, and data pointer error control field. Each BCH data unit is encapsulated in a Virtual Channel Data Unit (VCDU) which contains a VCDU header, data zone, and VCDU error control field. Data is transmitted serially in CCSDS Channel Access Data Units (CADUs) which encapsulate the VCDUs.

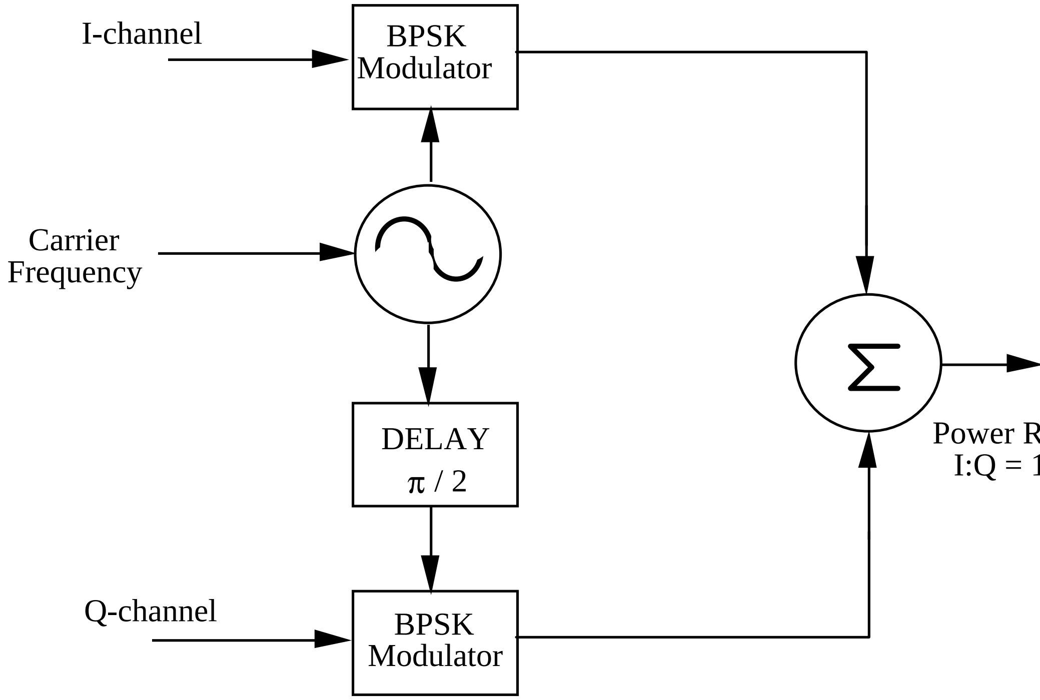


Figure C-2 X-Band Downlink Modulation Functional Configuration

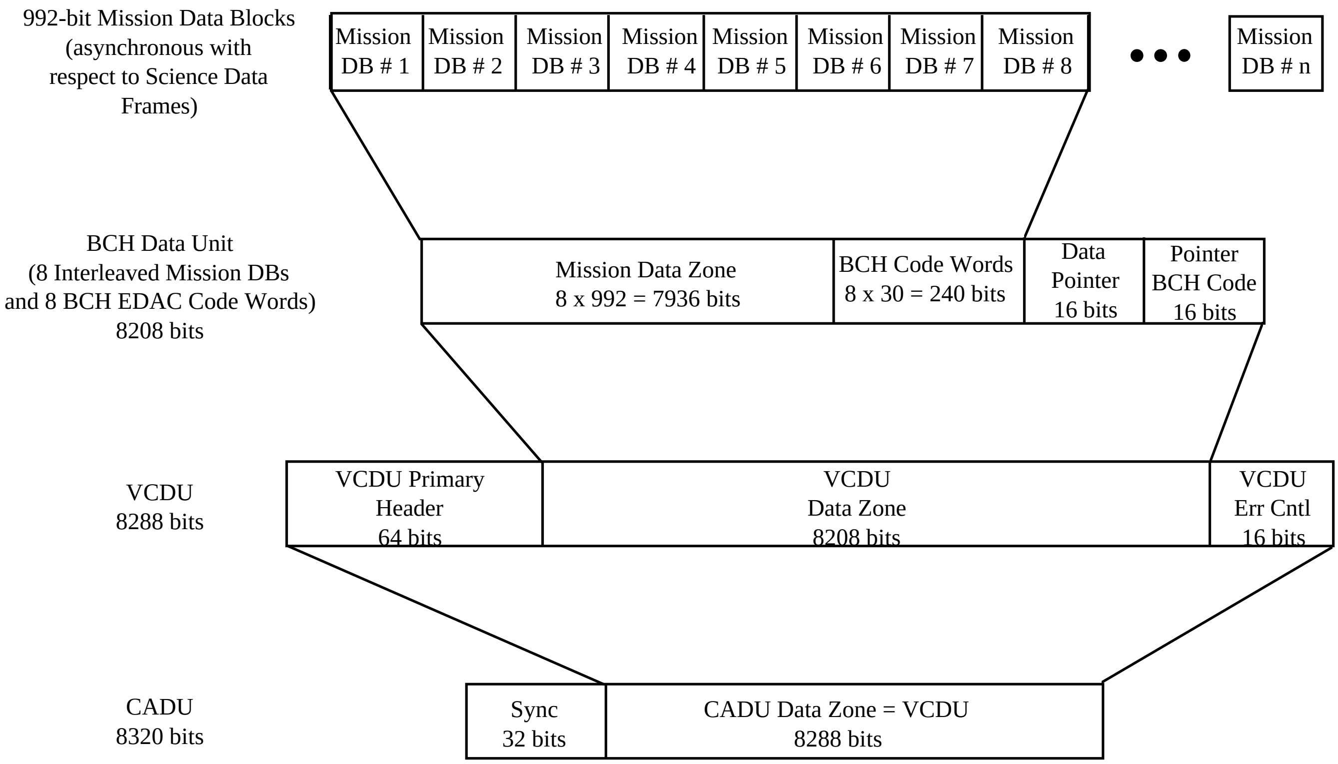


Figure C-3 X-Band Channel Access Data Unit (Sync + Virtual Channel Data Unit)

The X-band direct downlink data has a (1023,993,3) BCH code with interleave depth I=8. The BCH encoder output is 1023 bits (for each input data block of 993 bits). The input consists of 992 bits of science data and one fill bit. Only the 992 bits of science data are transmitted to the ground. The fill bit ("0") is added, on the ground, prior to decoding. The error correction code word corresponding to each input data block has a length of 30 bits. The code corrects up to three bit errors per block. The (1023,993,3) BCH encoder is shown in Figure C-4. Figure C-3 shows the organization of BCH data blocks and code words within each BCH data unit. Through the application of a BCH error correction code to the science data, the real-time ETM+ payload science data has a bit error rate (BER) of $< 10^{-6}$. If the IGS does not provide BCH decoding, the data will have a BER of 10^{-5} at the ground station interface.

C.3 RF SIGNAL CHARACTERISTICS

Balanced QPSK modulation (channel power ratio of 1:1 ± 0.8 dB) is used, as shown in Figure C-2. The X-band carrier is modulated by the I and Q baseband signals.

The X-band transmitter uses a single fixed frequency reference. The frequency reference source is a Phased Locked Dielectric Resonator Oscillator (PL–DRO).

The satellite is required to close the link for an IGS receive system performance (G/T) greater than or equal to 30.4 dB/K during a rain rate of 4 mm/hr at a 5 degree local elevation angle. The satellite is required to provide the capability to transmit each 150 Mbps X-band downlink with a minimum 24.2 dBW effective isotropic radiated power (EIRP) in the direction of the IGS.

C.4 LINK BUDGETS

Tables C-1 through C-3 show the link budgets for the Landsat 7 to IGS downlinks at each of the three available frequencies.

C.5 ANTENNA CHARACTERISTICS

The actual radiation pattern of one of the three X-band flight antennas, at each of the three frequencies, is given in Figures C-5 through C-7. These patterns were used to verify that the beamwidth, gain, and sidelobes of the antennas met the specified system requirements.

Generator polynomial $g(x) = x^{30} + x^{28} + x^{23} + x^{21} + x^{19} + x^{16} + x^{12} + x^{8} + x^{4} + x + 1$

Number of error control bits = 30

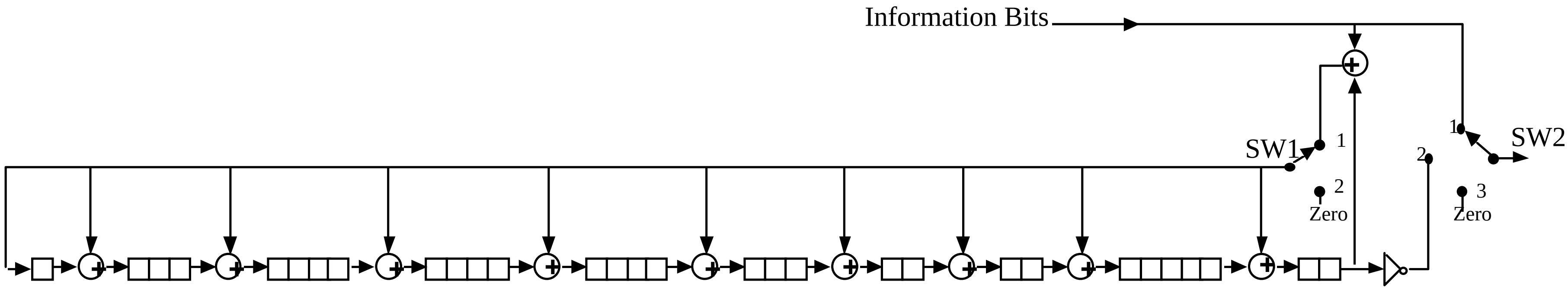


Figure C-4 (1023,993,3) BCH Code Generator – X-Band Science Data

430-11-06-009-B

Carrier Frequency (MHz) 8342.5 (150 Mbps)

PARAMETER	VALUE	COMMENTS
EIRP (dBW)	24.20	Landsat 7 System requirement
Transmit Power (dBW)	5.40	
Passive Loss (dB)	–6.90	
Antenna Gain (dBi)	26.20	
Pointing Loss (dB)	–0.50	
Modulation Loss (dB)	–0.40	1:1 I/Q ratio with ± 0.8 dB
Space Loss (dB)	–179.08	range = 2575 km, 5 degrees elevation
Polarization Loss (dB)	–0.35	AR (LS7) = 3.5, AR (IGS) = 1.5
Scintillation Loss	–1.00	Estimate based on Sioux Falls antenna
Propagation Loss (dB)	–1.82	
Rain Attenuation (dB)	–1.13	4 mm/hr, 5 degrees elevation, Sioux Falls
Atmospheric Loss (dB)	–0.69	28°C, 70% relative humidity
Receive G/T (dB/K)	30.40	Landsat 7 System requirement
Clear Sky G/T (dB/K)	32.30	Based on 9–meter antenna with 185 K
T Increase due to Rain	–1.90	Increase of 101 K
Pointing Loss - IGS (dB)	–0.50	Estimate based on Sioux Falls antenna
Boltzmann Constant (dBW/Hz-K)	–228.60	
Received C/N_0 (dB-Hz)	100.05	
Noise Bandwidth (dB-Hz)	81.76	150 Mbps
Link E_b/N_0 (dB)	18.29	
Implementation Loss (dB)	–5.50	Estimate based on simulation
Required E_b/N_0 (dB)	9.60	BER 1e-5, theory (NRZ-L)
Available Signal Margin (dB)	3.19	
Required Signal Margin (dB)	3.00	Landsat 7 System requirement
Excess Signal Margin (dB)	0.19	

Table C-1 Link Budget for X-Band High Frequency

Carrier Frequency (MHz) 8212.5 (150 Mbps)

PARAMETER	VALUE	COMMENTS
EIRP (dBW)	24.20	Landsat 7 System requirement
Transmit Power (dBW)	5.40	
Passive Loss (dB)	–6.90	
Antenna Gain (dBi)	26.20	
Pointing Loss (dB)	–0.50	
Modulation Loss (dB)	–0.40	1:1 I/Q ratio with ± 0.8 dB
Space Loss (dB)	–178.95	range = 2575 km, 5 degrees elevation
Polarization Loss (dB)	–0.35	AR (LS7) = 3.5, AR (IGS) = 1.5
Scintillation Loss	–1.00	Estimate based on Sioux Falls antenna
Propagation Loss (dB)	–1.82	
Rain Attenuation (dB)	–1.13	4 mm/hr, 5 degrees elevation, Sioux Falls SD
Atmospheric Loss (dB)	–0.69	28°C, 70% relative humidity
Receive G/T (dB/K)	30.40	Landsat 7 System requirement
Clear Sky G/T (dB/K)	32.30	Based on 9 m antenna with 185 K
T Increase due to Rain	–1.90	Increase of 101 K
Pointing Loss - IGS (dB)	–0.50	Estimate based on Sioux Falls antenna
Boltzmann Constant (dBW/Hz-K)	–228.60	
Received C/N_0 (dB-Hz)	100.18	
Noise Bandwidth (dB-Hz)	81.76	150 Mbps
Link E_b/N_0 (dB)	18.43	
Implementation Loss (dB)	–5.50	Estimate based on simulation
Required E_b/N_0 (dB)	9.60	BER 1e-5, theory (NRZ-L)
Available Signal Margin (dB)	3.33	
Required Signal Margin (dB)	3.00	Landsat 7 System requirement
Excess Signal Margin (dB)	0.33	

Table C-2 Link Budget for X-Band Mid Frequency

Carrier Frequency (MHz) 8082.5 (150 Mbps)

PARAMETER	VALUE	COMMENTS
EIRP (dBW)	24.20	Landsat 7 System requirement
Transmit Power (dBW)	5.40	
Passive Loss (dB)	–6.90	
Antenna Gain (dBi)	26.20	
Pointing Loss (dB)	–0.50	
Modulation Loss (dB)	–0.40	1:1 I/Q ratio with ± 0.8 dB
Space Loss (dB)	–178.81	range = 2575 km, 5 degrees elevation
Polarization Loss (dB)	–0.35	AR (LS7) = 3.5, AR (IGS) = 1.5
Scintillation Loss	–1.00	Estimate based on Sioux Falls antenna
Propagation Loss (dB)	–1.82	
Rain Attenuation (dB)	–1.13	4 mm/hr, 5 degrees elevation, Sioux Falls SD
Atmospheric Loss (dB)	–0.69	28°C, 70% relative humidity
Receive G/T (dB/K)	30.40	Landsat 7 System requirement
Clear Sky G/T (dB/K)	32.30	Based on 9 m antenna with 185 K
T Increase due to Rain	–1.90	Increase of 101 K
Pointing Loss - IGS (dB)	–0.50	Estimate based on Sioux Falls antenna
Boltzmann Constant (dBW/Hz-K)	–228.60	
Received C/N_0 (dB-Hz)	100.32	
Noise Bandwidth (dB-Hz)	81.76	150 Mbps
Link E_b/N_0 (dB)	18.57	
Implementation Loss (dB)	–5.50	Estimate based on simulation
Required E_b/N_0 (dB)	9.60	BER 1e-5, theory (NRZ-L)
Available Signal Margin (dB)	3.47	
Required Signal Margin (dB)	3.00	Landsat 7 System requirement
Excess Signal Margin (dB)	0.47	

Table C-3 Link Budget for X-Band Low Frequency

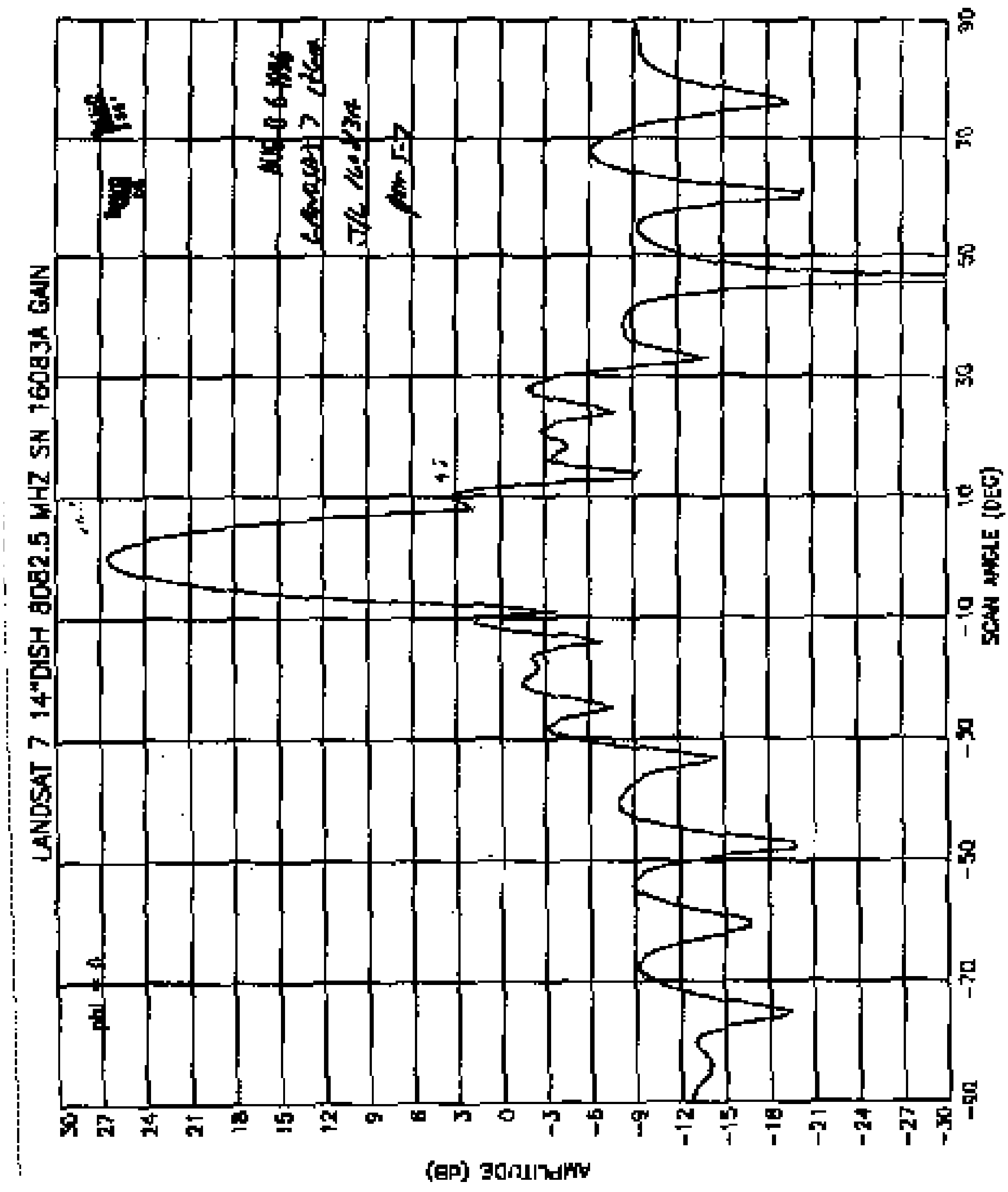


Figure C-5 Actual Radiation Pattern for Gimballed X-band Antenna at Low Frequency

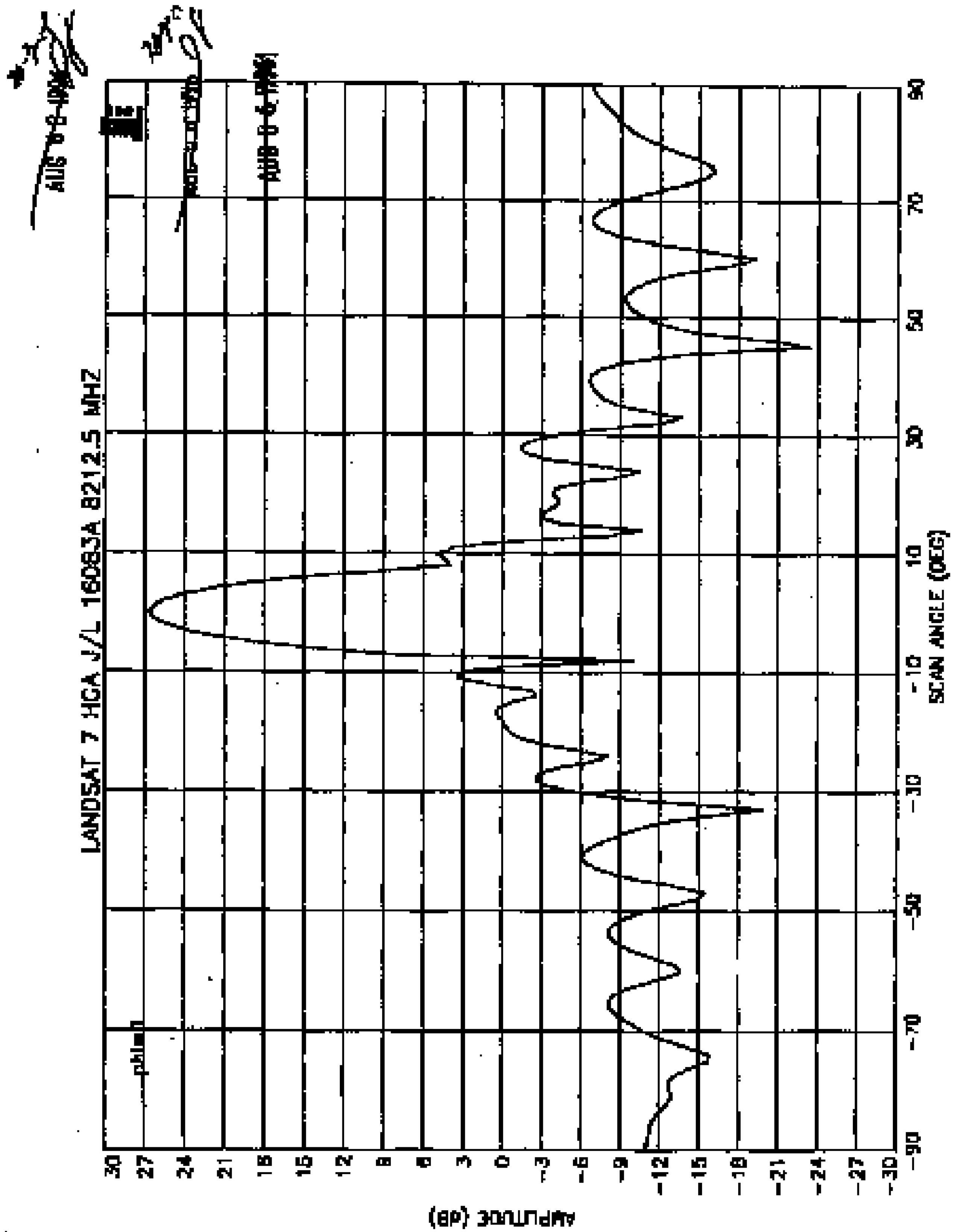


Figure C-6 Actual Radiation Pattern for Gimballed X-band Antenna at Mid Frequency

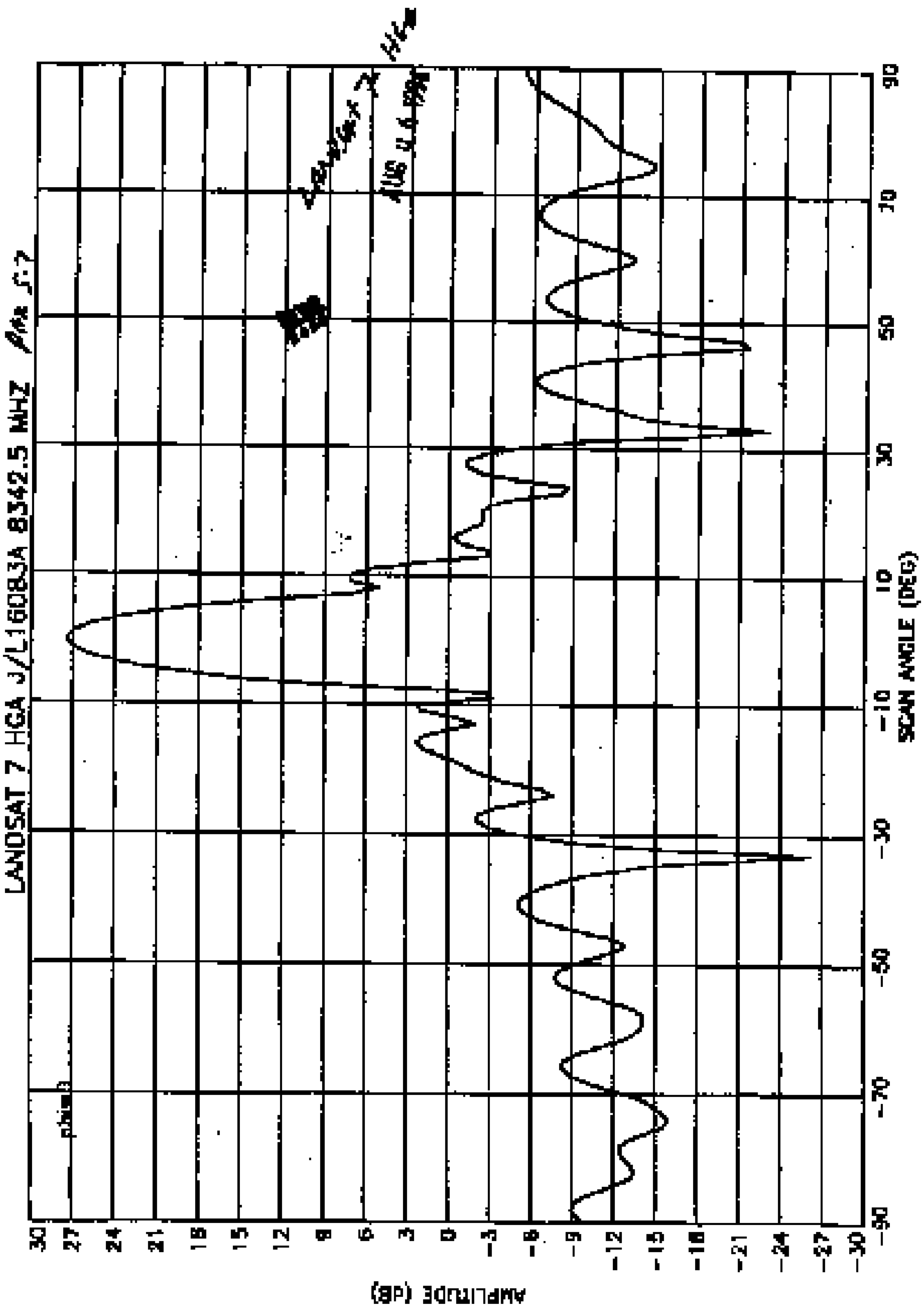


Figure C-7 Actual Radiation Pattern for Gimballed X-band Antenna at High Frequency

APPENDIX D
METADATA FORMAT

The metadata file is written in Object Description Language (ODL), which is a text-based language. The ODL conventions are discussed in D.1. The format of the metadata is specified in D.2, along with an example of the metadata file. The algorithm used to calculate the scene quality parameter in the metadata is presented in D.3. The transfer of metadata from the IGS to the DAAC is described in Appendix F.

D.1 OBJECT DESCRIPTION LANGUAGE (ODL)

The metadata file format conforms to the Object Description Language (ODL) standard. Details on the ODL standard are provided in the Planetary Data System Standards Reference document (Reference Document 5). In accordance with the ODL standard, all parameters and values are presented using ASCII standard characters.

The following notes apply to the construction of metadata statements:

1. Metadata definition is in the form of Parameter = Value.
2. There is one Parameter definition per line.
3. Blank spaces and lines are ignored.
4. Each line of comments must begin with the characters /* and end with the characters */, including comments embedded on the same line as a Parameter definition.
5. Leading zeros are recommended throughout for consistency, but not required except as follows:
   - parameters associated with WRS path and row (e.g., WRS_PATH and WRS_ROW)
   - in the metadata GROUP and END_GROUP statements that include a multiple digit field (e.g., METADATA_SCENE_nn)
   - in the SCENE_QUALITY parameter, for positive values only
6. All absolute character strings, including single character strings such as "+", "-", "Y", and "N" characters, are enclosed with quotes (" "). The exceptions to this rule are the GROUP and END_GROUP Values, which do not use quotation marks.
7. All values equal to or greater than zero (0) are considered positive. All values less than zero (0) are considered negative.
8. Case is not significant, but upper case is recommended for Parameters for readability.
9. Indentation is not significant, but is recommended for readability.
10. Bolding and capitalization of group names is used purely for readability.
11. Only the basic ASCII character set may be used.

D.2 METADATA FORMAT

Figure D-1 describes the structure of the metadata file. (The dots in Figure D-1 are for illustrative purposes only – to highlight the file hierarchy – and are not a part of the format.) Within each file, there are five different ODL groups defined:

1. METADATA_FILE — this group encompasses the entire file and identifies it as a metadata file; it is a shell and is immediately followed by the METADATA_FILE_INFO header; there is one of this group per file
2. METADATA_FILE_INFO — this group is the file header and identifies the file name, creation date, version, and station; there is one of this group per file
3. SUBINTERVAL_METADATA_FMT_n — this group defines the subinterval in terms of satellite, sensor, path/row, latitude/longitude, and band state; it brackets the scene metadata groups for the specified format; there is one of this group for each format in the file

4. METADATA_SCENE_nn — this group is a shell for the scene-level metadata (the Landsat Processing System (LPS) inserts Parameters in this group, but none are required in IGS files) and is followed immediately by the WRS_SCENE_nn group header; there is one of this group for each scene (including partial scenes) in the subinterval
5. WRS_SCENE_nn -- this group defines each scene (including partial scenes) in the subinterval, including path/row, scene center time, latitude/longitude, quality, gain settings and associated browse file name; there is one of this group for each scene (including partial scenes) in the subinterval

Typically, a single metadata file describes a single subinterval, both Format 1 and Format 2. The Format 1 metadata group (SUBINTERVAL_METADATA_FMT_1) contains subinterval level and WRS scene level metadata for Bands 1–6. The Format 2 metadata group (SUBINTERVAL_ METADATA_FMT_2) contains subinterval level and WRS scene level metadata for Bands 6–8. The multiband-scene browse file names and the Automated Cloud Cover Assessment (ACCA) results are provided in the Format 1 (Bands 1–6) subinterval metadata only. They must be present in the Format 1 metadata but may be repeated in the Format 2 metadata if desired by the IGS.

It is permissible to write the two formats of a subinterval to separate metadata files. If, for example, a metadata file included only Format 1 data, then the SUBINTERVAL_METADATA_FMT_2 group and its associated scene metadata groups would not be included in the file.

Table D-1 provides details for constructing the metadata file. It specifies the following for each field in the metadata format: Parameter name, size (in ASCII bytes), value, format, range and units, and parameter description/remarks. All parameters are required fields, unless the word "OPTIONAL" appears in the parameter description/remarks column of Table D-1. Any references in the Remarks or Value columns about how the LPS derives the data are for information purposes only and not intended to direct IGS implementation.

Figure D-2 is an example of a metadata file. The use of group definitions, syntax, comments, quotation marks, indentation and case is consistent with the guidelines listed above. Sample values are given to illustrate the formatting of the Value field. The comments enclosed in "/*...*/" are not explicitly required in the implemented metadata file format; they are shown to clarify the metadata format construction. GROUP statements are presented in bold in this ICD only for readability. (Bolding these statements is not required in the metadata implementation.)

```
/*  FORMAT STRUCTURE FOR IGS-PROVIDED LANDSAT 7 METADATA */

GROUP = METADATA_FILE        /*  first declaration of every metadata file  */
.
.   GROUP = METADATA_FILE_INFO /*  second declaration of every metadata file  */
.   .          file name, creation date, version, and station id go here
.   END_GROUP = METADATA_FILE_INFO                 /*  closes the file header group  */
.
.   GROUP = SUBINTERVAL_METADATA_FMT_1      /* descr. of fmt 1 subinterval */
.   .          Satellite, sensor, path/rows, subinterval corner latitude and longitudes go here
.   .
.   .   GROUP = METADATA_SCENE_01                  /*  starts description of first scene  */
.   .   .   GROUP = WRS_SCENE_01
.   .   .   .          Metadata for scene 1 of Format 1's subinterval
.   .   .   END_GROUP = WRS_SCENE_01
.   .   END_GROUP = METADATA_SCENE_01              /*  closes the first scene group  */
.   .          •                    •
.   .          •                    •
.   .          •                    •
.   .   GROUP = METADATA_SCENE_nn                  /*  description of format 1 last scene  */
.   .   .   GROUP = WRS_SCENE_nn
.   .   .   .          Metadata for last scene of Format 1's subinterval
.   .   .   .          nn = sequence number of last scene in Format 1 subinterval
.   .   .   END_GROUP = WRS_SCENE_nn
.   .   END_GROUP = METADATA_SCENE_nn              /*  closes the last scene group  */
.   .
.   END_GROUP = SUBINTERVAL_METADATA_FMT_1  /*closes format 1 subinterval descr.*/
.
.   GROUP = SUBINTERVAL_METADATA_FMT_2      /* descr. of fmt 2 subinterval */
.   .          Satellite, sensor, path/rows, subinterval corner latitude and longitudes go here
.   .
.   .   GROUP = METADATA_SCENE_01                  /*  starts description of first scene  */
.   .   .   GROUP = WRS_SCENE_01
.   .   .   .          Metadata for scene 1 of Format 2's subinterval
.   .   .   END_GROUP = WRS_SCENE_01
.   .   END_GROUP = METADATA_SCENE_01              /*  closes the first scene group  */
.   .          •                    •
.   .          •                    •
.   .          •                    •
.   .   GROUP = METADATA_SCENE_nn                  /*  description of format 2 last scene  */
.   .   .   GROUP = WRS_SCENE_nn
.   .   .   .          Metadata for last scene of Format 2's subinterval
.   .   .   .          nn = sequence number of last scene in Format 2 subinterval
.   .   .   END_GROUP = WRS_SCENE_nn
.   .   END_GROUP = METADATA_SCENE_nn              /*  closes the last scene group  */
.   .
.   END_GROUP = SUBINTERVAL_METADATA_FMT_2  /*closes format 2 subinterval descr.*/
.   .
END_GROUP = METADATA_FILE
END                                        /*  last declaration of every metadata file  */
```

Figure D-1 IGS Metadata Format Structure

GROUP	13	= METADATA_FILE	First declaration of every metadata file. It identifies the file as a metadata file.
GROUP	18	= METADATA_FILE_INFO	Indicates the start of the metadata file information group records.
FILE_NAME	24	= "L7xxxppprrryyyymmddf.MTA" where: "L7" = constant (Landsat 7) xxx= station id code (ref. Table 3-2) ppp = WRS Path of first scene rrr = WRS Row of first scene yyyy = 4-digit Year of acquisition mm = Month (01-12) dd = Day (01-31) f = format in file (0 (both), 1, or 2) ".MTA" = constant (metadata file)	This field is a file name for all the metadata records for a particular subinterval. This convention creates a unique file name for each subinterval metadata file.
FILE_CREATION_DATE_TIME	20	= yyyy-mm-ddThh:mm:ssZ where: yyyy = 4-digit Year of creation (e.g., 1998 or 2001) "-" = date field separator mm = Month (01-12 for January to December) "-" = date field separator dd = Day (01-31) "T" = constant (start of time information in ODL ASCII time code format) hh = Hour (00 - 23) ":" = time field separator mm = Minutes (00-59) ":" = time field separator ss = Seconds (00 - 59) "Z" = constant (Zulu time - same as GMT)	This field specifies the date and time the metadata file was created. For ease of human readability, this date and time information is presented in the ODL ASCII format. The time is expressed as Coordinated Universal Time (UTC) - also known as Greenwich Mean Time (GMT) or Zulu time. Insertion of characters "T" and "Z" is required to meet the ODL ASCII time format.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (1 of 37)

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
FILE_VERSION_NO	1	= 0-9 where: 0 = new file, 1-9 = the file replacement count	Field to distinguish a later file from an earlier file for the same subinterval previously sent to the EDC DAAC.
STATION_ID	3	= "sss" sss = 3-letter station id; see Table 3-2 for valid values	ID of Landsat ground station that produced the metadata
END_GROUP	18	= METADATA_FILE_INFO	Indicates the end of the metadata file information group records
Start of Subinterval Level Metadata			
GROUP	26	= SUBINTERVAL_METADATA_FMT_1	Indicates the start of the Format 1 subinterval level metadata group records
SPACECRAFT_ID	8	= "Landsat7"	Name of satellite
SENSOR_ID	4	= "ETM+"	Sensor that acquired the data
STARTING_PATH	3	= 001 - 233 (Leading zeros are required)	The WRS path number for the scenes included in this subinterval.
STARTING_ROW	3	= 001 - 248 (Leading zeros are required)	The starting WRS row number for the scene data included in this subinterval.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (2 of 37)

ENDING_ROW	3	= 001 - 248 (Leading zeros are required)	The ending WRS row number for the scene data included in this subinterval.
TOTAL_WRS_SCENES	1-2	= 1 - 99	The total number of scenes (including partial scenes) that are in this subinterval. The LPS produces this count from the total number of WRS scenes identified in a subinterval. The LPS does not use the absolute difference between STARTING_ROW and ENDING_ROW + 1 to compute this count.
SUBINTERVAL_START_TIME	18	= yyyy-dddThh:mm:ssZ where: yyyy = 4-digit year "-" = date field separator ddd = Day of year (001 - 366) "T" = constant hh = Hours (00 - 23) ":" = time field separator mm = Minutes (00 - 59) ":" = time field separator ss = Seconds (00 - 59) "Z" = constant	The time associated with the start of the first scene of the subinterval. The LPS extracts the spacecraft time from the timecode minor frames of the first ETM+ major frame of the subinterval reported in this file. A computed start time is provided if the timecode in the first ETM+ major frame is in error. The year information is appended by LPS to the spacecraft timecode.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (3 of 37)

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SUBINTERVAL_STOP_TIME	18	= yyyy-dddThh:mm:ssZ where: yyyy = 4-digit year "-" = date field separator ddd = Day of year (001 - 366) "T" = constant hh = Hours (00 - 23) ":" = time field separator mm = Minutes (00 - 59) ":" = time field separator ss = Seconds (00 - 59) "Z" = constant	The time associated with the end of the last scene of the subinterval. The LPS extracts the spacecraft time from the timecode minor frames of the last ETM+ major frame of the subinterval reported in this file. A computed end time is provided if the timecode in the last ETM+ major frame is in error. The year information is appended by LPS to the spacecraft timecode.
SUBINTERVAL_UL_CORNER_LAT	6-8	= -90.0000 through 90.0000 units are degrees (with a 4-digit precision) A positive value (no sign) indicates North latitude. A negative value (-) indicates South latitude.	Calculated "actual" latitude of the subinterval's upper left corner. See A.1 for corner definitions. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_UL_CORNER_LON	6-9	= -180.0000 through 180.0000 units are degrees (with a 4-digit precision) A positive value (no sign) indicates East longitude. A negative value (-) indicates West longitude.	Calculated "actual" longitude of the subinterval's upper left corner. See A.1 for corner definitions. A subinterval may start at the first actual scan (not filled) in a partial scene.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (4 of 37)

SUBINTERVAL_UR_CORNER_LAT	6-8	(Same as SUBINTERVAL_UL_CORNER_LAT)	Calculated "actual" latitude of the subinterval's upper right corner. See A.1 for corner definitions. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_UR_CORNER_LON	6-9	(Same as SUBINTERVAL_UL_CORNER_LON)	Calculated "actual" longitude of the subinterval's upper right corner. See A.1 for corner definitions. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_LL_CORNER_LAT	6-8	(Same as SUBINTERVAL_UL_CORNER_LAT)	Calculated "actual" latitude of the subinterval's lower left corner. See A.1 for corner definitions. A subinterval may end at the last actual scan (not filled) in a partial scene.
SUBINTERVAL_LL_CORNER_LON	6-9	(Same as SUBINTERVAL_UL_CORNER_LON)	Calculated "actual" longitude of the subinterval's lower left corner. See A.1 for corner definitions. A subinterval may end at the last actual scan (not filled) in a partial scene.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SUBINTERVAL_LR_CORNER_LAT	6-8	(Same as SUBINTERVAL_ UL_CORNER_LAT)	Calculated "actual" latitude of the subinterval's lower right corner. See A.1 for corner definitions. A subinterval may end at the last actual scan (not filled) in a partial scene.
SUBINTERVAL_LR_CORNER_LON	6-9	(Same as SUBINTERVAL_ UL_CORNER_LON)	Calculated "actual" longitude of the subinterval's lower right corner. See A.1 for corner definitions. A subinterval may end at the last actual scan (not filled) in a partial scene.
BAND1_PRESENT	1	= "Y" or "N" where: "Y" indicates that Band 1 is present "N" indicates that Band 1 is not present	This is the "Band 1 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 0, where a bit set condition (=1) indicates "Band 1 ON state". In the LPS, the first error-free PCD major frame (2) is used to derive this value.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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BAND2_PRESENT	1	= "Y" or "N" where: "Y" indicates that Band 2 is present "N" indicates that Band 2 is not present	This is the "Band 2 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 1, where a bit set condition (=1) indicates "Band 2 ON state".
BAND3_PRESENT	1	= "Y" or "N" where: "Y" indicates that Band 3 is present "N" indicates that Band 3 is not present	This is the "Band 3 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 2, where a bit set condition (=1) indicates "Band 3 ON state".
BAND4_PRESENT	1	= "Y" or "N" where: "Y" indicates that Band 4 is present "N" indicates that Band 4 is not present	This is the "Band 4 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 3, where a bit set condition (=1) indicates "Band 4 ON state".
BAND5_PRESENT	1	= "Y" or "N" where: "Y" indicates that Band 5 is present "N" indicates that Band 5 is not present	This is the "Band 5 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 4, where a bit set condition (=1) indicates "Band 5 ON state".

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
BAND6_PRESENT	1	= "Y" or "N" where: "Y" indicates that Band 6 is present "N" indicates that Band 6 is not present	This is the "Band 6 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 5, where a bit set condition (=1) indicates "Band 6 ON state".
Start of Scene Level Metadata for scenes within Format 1			**The following parameter values are repeated for each ETM+ scene included in the subinterval.**
GROUP	17	= METADATA_SCENE_nn where nn = 01-99 (Up to 35 full scenes are expected in a 14-minute subinterval)	Indicates the beginning of the ETM+ Format 1 metadata Scene nn group records. This group is carried for LPS compatibility.
GROUP	12	= WRS_SCENE_nn where nn = 01-99	Indicates the beginning of the ETM+ Format 1 WRS Scene nn group records.
WRS_SCENE_NO	1-2	= 1 to 99	This is the incremental scene counter for scenes within this subinterval.
WRS_PATH	3	= 001 - 233 (Leading zeros are required.)	The WRS Path number associated with the scene.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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WRS_ROW	3	= 001 - 248 (Leading zeros are required.)	The WRS Row number associated with the scene.
FULL_OR_PARTIAL_SCENE	1	= "F" or "P" where: "F" = Full WRS scene "P" = Partial WRS scene at the start or end of a subinterval	This field designates whether the scene is full or partial. Partial scenes may be received at the start and/or end of a subinterval.
SCENE_CENTER_SCAN_TIME	26	= yyyy-dddThh:mm:ss.tttttttZ where: yyyy = 4-digit year "-" = date field separator ddd = Day of year (001 - 366) "T" = constant hh = Hours (00 - 23) ":" = time field separator mm = Minutes (00 - 59) ":" = time field separator ss = Seconds (00 - 59) "." = decimal point ttttttt = Fractional seconds (0000000 - 9999375) "Z" = constant	The spacecraft time associated with a WRS scene center scan number. Clock's cycle is 1/16 millisecond = .0000625; tttttt takes on a fractional second value from 0 - .9999375 which equates to 0 - 15,999 1/16th milliseconds (15999 * .0000625 = .9999375).

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SCENE_BAND1_PRESENT	1	= "x" where: "Y" = Yes, band 1 is present "N" = No, band 1 is missing "U" = Unknown if band 1 is present	This field indicates whether band 1 is present or missing for this scene. In the LPS, this is the "Band 1 ON" state information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 0, where a bit set condition (=1) indicates "Band 1 ON state". The first error-free PCD major frame (2) associated with the scene is used to derive this value. If no valid PCD major frame falls within the scene's time boundary, then the value for the previous scene will be used. If the previous scene has no valid major frame (e.g., the first partial scene in a subinterval), then the value "U" for unknown will be used.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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SCENE_BAND2_PRESENT	1	= "x" where: "Y" = Yes, band 2 is present "N" = No, band 2 is missing "U" = Unknown if band 2 is present	This field indicates whether band 2 is present or missing for this scene. Same as above with this exception: This is the "Band 2 ON" state information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 1, where a bit set condition (=1) indicates "Band 2 ON state".
SCENE_BAND3_PRESENT	1	= "x" where: "Y" = Yes, band 3 is present "N" = No, band 3 is missing "U" = Unknown if band 3 is present	This field indicates whether band 3 is present or missing for this scene. Same as above with this exception: This is the "Band 3 ON" state information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 2, where a bit set condition (=1) indicates "Band 3 ON state".
SCENE_BAND4_PRESENT	1	= "x" where: "Y" = Yes, band 4 is present "N" = No, band 4 is missing "U" = Unknown if band 4 is present	This field indicates whether band 4 is present or missing for this scene. Same as above with this exception: This is the "Band 4 ON" state information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 3, where a bit set condition (=1) indicates "Band 4 ON state".

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SCENE_BAND5_PRESENT	1	= "x" where: "Y" = Yes, band 5 is present "N" = No, band 5 is missing "U" = Unknown if band 5 is present	This field indicates whether band 5 is present or missing for this scene. Same as above with this exception: This is the "Band 5 ON" state information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 4, where a bit set condition (=1) indicates "Band 5 ON state".
SCENE_BAND6_PRESENT	1	= "x" where: "Y" = Yes, band 6 is present "N" = No, band 6 is missing "U" = Unknown if band 6 is present	This field indicates whether band 6 is present or missing for this scene. Same as above with this exception: This is the "Band 6 ON" state information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 5, where a bit set condition (=1) indicates "Band 6 ON state".

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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SCENE_CENTER_LAT	6-8	= -90.0000 through 90.0000 units are degrees (with a 4-digit precision) A positive (no sign) value indicates North latitude. A negative (-) value indicates South latitude.	WRS scene center latitude. This field is the calculated "actual" coordinate value. The computed "actual" scene centers for full and greater than half-scene length partial scenes are expected to be in the proximity of the nominal WRS scene centers. They are always indexed to actual data in the LPS band file. The computed "actual" scene centers for smaller than half-scene length partial scenes are also expected to be in the proximity of the nominal WRS scene centers, but outside the actual subinterval band data range. They are indexed to a non-existent scan 0 in the LPS band file.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SCENE_CENTER_LON	6-9	= -180.0000 through 180.0000 units are degrees (with a 4-digit precision) A positive value (no sign) indicates East longitude. A negative value (-) indicates West longitude.	WRS scene center longitude. This field is the calculated "actual" coordinate value. The computed "actual" scene centers for full and greater than half a scene length partial scenes are expected to be in the proximity of the nominal WRS scene centers. They are always indexed to actual data in the LPS band file. The computed "actual" scene centers for smaller than half a scene length partial scenes are also expected to be in the proximity of the nominal WRS scene centers, but outside the actual subinterval band data range. They are indexed to a non-existent scan 0 in the LPS band file.
SCENE_UL_CORNER_LAT	6-8	= -90.0000 through 90.0000 units are degrees (with a 4-digit precision) A positive value (no sign) indicates North latitude. A negative value (-) indicates South latitude.	This field defines the calculated "actual" latitude for the upper left corner of the scene. See A.1 for corner definitions.
SCENE_UL_CORNER_LON	6-9	= -180.0000 through 180.0000 units are degrees (with a 4-digit precision) A positive value (no sign) indicates East longitude. A negative value (-) indicates West longitude.	This field defines the calculated "actual" longitude for the upper left corner of the scene. See A.1 for corner definitions.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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SCENE_UR_CORNER_LAT	6-8	(Same as SCENE_UL_CORNER_LAT)	This field defines the calculated "actual" latitude for the upper right corner of the scene. See A.1 for corner definitions.
SCENE_UR_CORNER_LON	6-9	(Same as SCENE_UL_CORNER_LON)	This field defines the calculated "actual" longitude for the upper right corner of the scene. See A.1 for corner definitions.
SCENE_LL_CORNER_LAT	6-8	(Same as SCENE_UL_CORNER_LAT)	This field defines the calculated "actual" latitude for the lower left corner of the scene. See A.1 for corner definitions.
SCENE_LL_CORNER_LON	6-9	(Same as SCENE_UL_CORNER_LON)	This field defines the calculated "actual" longitude for the lower left corner of the scene. See A.1 for corner definitions.
SCENE_LR_CORNER_LAT	6-8	(Same as SCENE_UL_CORNER_LAT)	This field defines the calculated "actual" latitude for the lower right corner of the scene. See A.1 for corner definitions.
SCENE_LR_CORNER_LON	6-9	(Same as SCENE_UL_CORNER_LON)	This field defines the calculated "actual" longitude for the lower right corner of the scene. See A.1 for corner definitions.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
HORIZONTAL_DISPLAY_SHIFT	1-5	= -9999 through 9999 units are meters A negative value (-) defines a shift of the calculated "true" WRS scene center to the West of the nominal WRS scene center. A positive value (no sign) defines a shift of the calculated "true" WRS scene center to the East of the nominal WRS scene center.	OPTIONAL field. This field defines the horizontal distance between the perpendiculars through the calculated "true" WRS scene center and the nominal (known) WRS scene center on the ground. The LPS will maintain a lookup table of nominal WRS scene centers for computing HORIZONTAL_DISPLAY_SHIFT values.
SCENE_CCA	1-3	= 0 to 100 percentage (This field is required only in Format 1 metadata.)	Percent cloud cover assessment (CCA) for the entire scene. This CCA is an average of the CCAs for all quadrants of the WRS scene.
UL_QUAD_CCA	1-3	= 0 to 100 (If provided, this field is required only in Format 1 metadata.)	OPTIONAL field. Percent cloud cover in the upper left quadrant of the scene. If quadrant scores are reported, all four must be present.
UR_QUAD_CCA	1-3	= 0 to 100 (If provided, this field is required only in Format 1 metadata.)	OPTIONAL field. Percent cloud cover in the upper right quadrant of the scene. If quadrant scores are reported, all four must be present.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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LL_QUAD_CCA	1-3	= 0 to 100 (If provided, this field is required only in Format 1 metadata.)	OPTIONAL field. Percent cloud cover in the lower left quadrant of the scene. If quadrant scores are reported, all four must be present.
LR_QUAD_CCA	1-3	= 0 to 100 (If provided, this field is required only in Format 1 metadata.)	OPTIONAL field. Percent cloud cover in the lower right quadrant of the scene. If quadrant scores are reported, all four must be present.
SUN_AZIMUTH_ANGLE	3-6	= -180.0 to 180.0 units are degrees (with 1-digit precision) A positive value (no sign) indicates angles to the East or clockwise from North. A negative value (-) indicates angles to the West or counterclockwise from North.	The Sun azimuth angle at the "true" WRS scene center. (calculated by LPS from PCD processing)
SUN_ELEVATION_ANGLE	3-5	= -90.0 through 90.0 units are degrees (with 1-digit precision) A positive value (no sign) indicates a daytime scene. A negative value (-) indicates a nighttime scene.	The Sun elevation angle at the "true" WRS scene center. (calculated by LPS from PCD processing)

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
BAND1_GAIN	1	= "x" where: "L" = Low gain condition "H" = High gain condition	This field describes the band gain condition at the start of a WRS scene. This information is obtained from Words 7 and 8 of the PCD/Status Data field of the first error-free VCDU in a WRS scene. If there is a band gain change within the scene it will be indicated in the next two fields.
BAND2_GAIN	1	= "x" where: "L" = Low gain condition "H" = High gain condition	(See parameter description for BAND1_GAIN.)
BAND3_GAIN	1	= "x" where: "L" = Low gain condition "H" = High gain condition	(See parameter description for BAND1_GAIN.)
BAND4_GAIN	1	= "x" where: "L" = Low gain condition "H" = High gain condition	(See parameter description for BAND1_GAIN.)
BAND5_GAIN	1	= "x" where: "L" = Low gain condition "H" = High gain condition	(See parameter description for BAND1_GAIN.)
BAND6_GAIN	1	= "x" where: "L" = Low gain condition "H" = High gain condition	(See parameter description for BAND1_GAIN.)

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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BAND1_GAIN_CHANGE	1	= "x" where: "0" = no band gain change within the scene "+" = gain change from low to high within the scene "-" = gain change from high to low within the scene	This field indicates if there has been a band gain change within a scene and which direction the band gain condition changed; e.g. from high to low or low to high. The LPS generates this by evaluating corresponding band gain states in adjacent ETM+ scans (major frames).
BAND2_GAIN_CHANGE	1	(Same as BAND1_GAIN_CHANGE)	(See parameter description for BAND1_GAIN_ CHANGE parameter)
BAND3_GAIN_CHANGE	1	(Same as BAND1_GAIN_CHANGE)	(See parameter description for BAND1_GAIN_ CHANGE parameter)
BAND4_GAIN_CHANGE	1	(Same as BAND1_GAIN_CHANGE)	(See parameter description for BAND1_GAIN_ CHANGE parameter)
BAND5_GAIN_CHANGE	1	(Same as BAND1_GAIN_CHANGE)	(See parameter description for BAND1_GAIN_ CHANGE parameter)
BAND6_GAIN_CHANGE	1	(Same as BAND1_GAIN_CHANGE)	(See parameter description for BAND1_GAIN_ CHANGE parameter)

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
BAND1_SL_GAIN_CHANGE	1-5	= nnnnn where: 0 = no gain change 1- 12000 = first scan line number at new band gain setting	This field indicates the scan line (SL) number within this band in the WRS scene for the first change detected in the band gain condition.
BAND2_SL_GAIN_CHANGE	1-5	(Same as BAND1_SL_GAIN_CHANGE)	(See parameter description for BAND1_SL_GAIN_ CHANGE parameter.)
BAND3_SL_GAIN_CHANGE	1-5	(Same as BAND1_SL_GAIN_CHANGE)	(See parameter description for BAND1_SL_GAIN_ CHANGE parameter.)
BAND4_SL_GAIN_CHANGE	1-5	(Same as BAND1_SL_GAIN_CHANGE)	(See parameter description for BAND1_SL_GAIN_ CHANGE parameter.)
BAND5_SL_GAIN_CHANGE	1-5	(Same as BAND1_SL_GAIN_CHANGE)	(See parameter description for BAND1_SL_GAIN_ CHANGE parameter.)
BAND6_SL_GAIN_CHANGE	1-5	(Same as BAND1_SL_GAIN_CHANGE)	(See parameter description for BAND1_SL_GAIN_ CHANGE parameter.)

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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BROWSE_FILE_NAME	23	="L7xxxppprrryyyymmdd.Rnn" where: "L7" = constant (Landsat 7) xxx = station id (ref. Table 3-2) ppp = WRS Path rrr = WRS Row yyyy = 4-digit Year of acquisition mm = Month (01-12) dd = Day (01-31) ".R" = constant (browse file) nn = sequence number of this scene in the subinterval - same as WRS_SCENE_NO) (If provided, this field is required only in Format 1 metadata.)	OPTIONAL field if browse file will not be sent to the EDC DAAC. REQUIRED field if the browse file is to be sent to the EDC DAAC.
BROWSE_AVAILABLE_AT_STATION	1	= "x" where: "Y" = Yes "N" = No (This field is required only in Format 1 metadata.)	This field indicates if scene browse imagery is available for viewing at or distribution from the IGS.
DAY_NIGHT_FLAG	1	= "x" where: "D" = Daytime scene "N" = Nighttime scene	This field indicates the day or night condition for the scene. LPS determines the day/night condition of a scene by comparing the Sun elevation values against an angle value of 0 degrees. A scene is declared a day scene if the Sun elevation angle is greater than 0 degrees; otherwise it is declared a night scene.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SCENE_QUALITY	2	= nn where: nn = 00 - 99 or nn = -1 A value of -1 means no quality assessment was made. A value of 00 means very poor quality and a value of 99 means very good quality. Leading zeros are required for positive values.	This field may integrate several measures of image quality to arrive at an integrated quality rating on a scene basis. The algorithm for the calculation of scene quality is described in D.3.
END_GROUP	12	= WRS_SCENE_nn where nn = 01-99	Indicates the end of the ETM+ WRS scene group records.
END_GROUP	17	= METADATA_SCENE_nn where nn = 01-99	Indicates the end of the metadata scene nn level group records.
End of Scene Level Metadata for Format 1			
END_GROUP	26	= SUBINTERVAL_METADATA_FMT_1	Indicates the end of the Format 1 subinterval level metadata group records
End of Format 1 Metadata and Start of Format 2 Metadata			
GROUP	26	=SUBINTERVAL_METADATA_FMT_2	Indicates the start of the Format 2 subinterval level metadata group records.
SPACECRAFT_ID	8	= "Landsat7"	Name of satellite

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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SENSOR_ID	4	= "ETM+"	Sensor that acquired the data
STARTING_PATH	3	= 001 - 233 (Leading zeros are required)	The WRS path number for the scenes included in this subinterval.
STARTING_ROW	3	= 001 - 248 (Leading zeros are required)	The starting WRS row number for the scene data included in this subinterval.
ENDING_ROW	3	= 001 - 248 (Leading zeros are required)	The ending WRS row number for the scene data included in this subinterval.
TOTAL_WRS_SCENES	1-2	= 1 - 99	The total number of scenes (including partial scenes) that are in this subinterval. The LPS produces this count from the total number of WRS scenes identified in a subinterval. The LPS does not use the absolute difference between STARTING_ROW and ENDING_ROW +1 to compute this count.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SUBINTERVAL_START_TIME	18	= yyyy-dddThh:mm:ssZ where: yyyy = 4-digit year "-" = date field separator ddd = Day of year (001 - 366) "T" = constant hh = Hours (00 - 23) ":" = time field separator mm = Minutes (00 - 59) ":" = time field separator ss = Seconds (00 - 59) "Z" = constant	The time associated with the start of the first scene of the subinterval. The LPS extracts the spacecraft time from the timecode minor frames of the first ETM+ major frame of the subinterval reported in this file. A computed start time is provided if the timecode in the first ETM+ major frame is in error. The year information is appended by LPS to the spacecraft timecode.
SUBINTERVAL_STOP_TIME	18	= yyyy-dddThh:mm:ssZ where: yyyy = 4-digit year "-" = date field separator ddd = Day of year (001 - 366) "T" = constant hh = Hours (00 - 23) ":" = time field separator mm = Minutes (00 - 59) ":" = time field separator ss = Seconds (00 - 59) "Z" = constant	The time associated with the end of the last scene of the subinterval. The LPS extracts the spacecraft time from the timecode minor frames of the last ETM+ major frame of the subinterval reported in this file. A computed end time is provided if the timecode in the last ETM+ major frame is in error. The year information is appended by LPS to the spacecraft timecode.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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SUBINTERVAL_UL_CORNER_LAT	6-8	= -90.0000 through 90.0000 units are degrees (with a 4-digit precision) A positive value (no sign) indicates North latitude. A negative value (-) indicates South latitude.	Calculated "actual" latitude of the subinterval's upper left corner. See A.1 for corner definitions. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_UL_CORNER_LON	6-9	= -180.0000 through 180.0000 units are degrees (with a 4-digit precision) A positive value (no sign) indicates East longitude. A negative value (-) indicates West longitude.	Calculated "actual" longitude of the subinterval's upper left corner. See A.1 for corner definitions. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_UR_CORNER_LAT	6-8	(Same as SUBINTERVAL_UL_CORNER_LAT)	Calculated "actual" latitude of the subinterval's upper right corner. See A.1 for corner definitions. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_UR_CORNER_LON	6-9	(Same as SUBINTERVAL_UL_CORNER_LON)	Calculated "actual" longitude of the subinterval's upper right corner. See A.1 for corner definitions. A subinterval may start at the first actual scan (not filled) in a partial scene.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

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Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SUBINTERVAL_LL_CORNER_LAT	6-8	(Same as SUBINTERVAL_UL_CORNER_LAT)	Calculated "actual" latitude of the subinterval's lower left corner. See A.1 for corner definitions. A subinterval may end at the last actual scan (not filled) in a partial scene.
SUBINTERVAL_LL_CORNER_LON	6-9	(Same as SUBINTERVAL_UL_CORNER_LON)	Calculated "actual" longitude of the subinterval's lower left corner. See A.1 for corner definitions. A subinterval may end at the last actual scan (not filled) in a partial scene.
SUBINTERVAL_LR_CORNER_LAT	6-8	(Same as SUBINTERVAL_UL_CORNER_LAT)	Calculated "actual" latitude of the subinterval's lower right corner. See A.1 for corner definitions. A subinterval may end at the last actual scan (not filled) in a partial scene.
SUBINTERVAL_LR_CORNER_LON	6-9	(Same as SUBINTERVAL_UL_CORNER_LON)	Calculated "actual" longitude of the subinterval's lower right corner. See A.1 for corner definitions. A subinterval may end at the last actual scan (not filled) in a partial scene.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (26 of 37)

BAND6_PRESENT	1	= "Y" or "N" where: "Y" indicates that Band 6 is present "N" indicates that Band 6 is not present	This is the "Band 6 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 5, where a bit set condition (=1) indicates "Band 6 ON state". In the LPS, the first error-free PCD major frame (2) is used to derive this value.
BAND7_PRESENT	1	= "Y" or "N" where: "Y" indicates that Band 7 is present "N" indicates that Band 7 is not present	This is the "Band 7 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 6, where a bit set condition (=1) indicates "Band 7 ON state".
BAND8_PRESENT	1	= "Y" or "N" where: "Y" indicates that Band 8 is present "N" indicates that Band 8 is not present	This is the "Band 8 ON" status information obtained from PCD Serial Word "E" (major frame (2), minor frame 35, word 72), bit 0, where a bit set condition (=1) indicates "Band 8 ON state".

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (27 of 37)

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
Start of Scene Level Metadata for scenes within Format 2			**The following parameter values are repeated for each ETM+ scene included in the subinterval.**
GROUP	17	= METADATA_SCENE_nn where nn = 01-99 (Up to 35 full scenes are expected in a 14-minute subinterval.)	Indicates the beginning of the ETM+ Format 2 metadata Scene nn group records. This group is carried for LPS compatibility.
GROUP	12	= WRS_SCENE_nn where nn = 01-99	Indicates the beginning of the ETM+ Format 2 WRS Scene nn group records.
WRS_SCENE_NO	1-2	= 1 to 99	This is the incremental scene counter for scenes within this subinterval.
WRS_PATH	3	= 001 - 233 (Leading zeros are required.)	The WRS Path number associated with the scene.
WRS_ROW	3	= 001 - 248 (Leading zeros are required.)	The WRS Row number associated with the scene.
FULL_OR_PARTIAL_SCENE	1	= "F" or "P" where: "F" = Full WRS scene "P" = Partial WRS scene at the start or end of a subinterval	This field designates whether the scene is full or partial. Partial scenes may be received at the start and/or end of a subinterval.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (28 of 37)

SCENE_CENTER_SCAN_TIME	26	= yyyy-dddThh:mm:ss.tttttttZ where: yyyy = 4-digit year "-" = date field separator ddd = Day of year (001 - 366) "T" = constant hh = Hours (00 - 23) ":" = time field separator mm = Minutes (00 - 59) ":" = time field separator ss = Seconds (00 - 59) "." = decimal point ttttttt = Fractional seconds (0000000 - 9999375) "Z" = constant	The spacecraft time associated with a WRS scene center scan number. Clock's cycle is 1/16 millisecond = .0000625; ttttttt takes on a fractional second value from 0 - .9999375 which equates to 0 - 15,999 1/16th milliseconds (15999 * .0000625 = .9999375).
SCENE_BAND6_PRESENT	1	= "x" where: "Y" = Yes, band 6 is present "N" = No, band 6 is missing "U" = Unknown if band 6 is present	This field indicates whether band 6 is present or missing for this scene. In the LPS, this is the "Band 6 ON" state information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 5, where a bit set condition (=1) indicates "Band 6 ON state". The first error-free PCD major frame (2) associated with the scene is used to derive this value. If no valid PCD major frame falls within the scene's time boundary, then the value for the previous scene will be used. If the previous scene has no valid major frame (i.e., the first partial scene in a subinterval), then the value "U" for unknown will be used.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (29 of 37)

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SCENE_BAND7_PRESENT	1	= "x" where: "Y" = Yes, band 7 is present "N" = No, band 7 is missing "U" = Unknown if band 7 is present	This field indicates whether band 7 is present or missing for this scene. Same as above with this exception: This is the "Band 7 ON" state information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 6, where a bit set condition (=1) indicates "Band 7 ON state".
SCENE_BAND8_PRESENT	1	= "x" where: "Y" = Yes, band 8 is present "N" = No, band 8 is missing "U" = Unknown if band 8 is present	This field indicates whether band 8 is present or missing for this scene. Same as above with this exception: This is the "Band 8 ON" state information obtained from PCD Serial Word "E" (major frame (2), minor frame 35, word 72), bit 0, where a bit set condition (=1) indicates "Band 8 ON state".

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (30 of 37)

SCENE_CENTER_LAT	6-8	= -90.0000 through 90.0000 units are degrees (with a 4-digit precision) A positive value (no sign) indicates North latitude. A negative value (-) indicates South latitude.	WRS scene center latitude This field is the calculated "actual" coordinate value. The computed "actual" scene centers for full and greater than half a scene length partial scenes are expected to be in the proximity of the nominal WRS scene centers. They are always indexed to actual data in the LPS band file. The computed "actual" scene centers for smaller than half a scene length partial scenes are also expected to be in the proximity of the nominal WRS scene centers, but outside the actual subinterval band data range. They are indexed to a non-existent scan 0 in the LPS band file.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (31 of 37)

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SCENE_CENTER_LON	6-9	= -180.0000 through 180.0000 units are degrees (with a 4-digit precision) A positive value (no sign) indicates East longitude. A negative value (-) indicates West longitude.	WRS scene center longitude. This field is the calculated "actual" coordinate value. The computed "actual" scene centers for full and greater than half a scene length partial scenes are expected to be in the proximity of the nominal WRS scene centers. They are always indexed to actual data in the LPS band file. The computed "actual" scene centers for smaller than half a scene length partial scenes are also expected to be in the proximity of the nominal WRS scene centers, but outside the actual subinterval band data range. They are indexed to a non-existent scan 0 in the LPS band file.
SCENE_UL_CORNER_LAT	6-8	= -90.0000 through 90.0000 units are degrees (with a 4-digit precision) A positive value (no sign) indicates North latitude. A negative value (-) indicates South latitude.	This field defines the calculated "actual" latitude for the upper left corner of the scene. See A.1 for corner definitions.
SCENE_UL_CORNER_LON	6-9	= -180.0000 through 180.0000 units are degrees (with a 4-digit precision) A positive value (no sign) indicates East longitude. A negative value (-) indicates West longitude.	This field defines the calculated "actual" longitude for the upper left corner of the scene. See A.1 for corner definitions.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (32 of 37)

SCENE_UR_CORNER_LAT	6-8	(Same as SCENE_UL_CORNER_LAT)	This field defines the calculated "actual" latitude for the upper right corner of the scene. See A.1 for corner definitions.
SCENE_UR_CORNER_LON	6-9	(Same as SCENE_UL_CORNER_LON)	This field defines the calculated "actual" longitude for the upper right corner of the scene. See A.1 for corner definitions.
SCENE_LL_CORNER_LAT	6-8	(Same as SCENE_UL_CORNER_LAT)	This field defines the calculated "actual" latitude for the lower left corner of the scene. See A.1 for corner definitions.
SCENE_LL_CORNER_LON	6-9	(Same as SCENE_UL_CORNER_LON)	This field defines the calculated "actual" longitude for the lower left corner of the scene. See A.1 for corner definitions.
SCENE_LR_CORNER_LAT	6-8	(Same as SCENE_UL_CORNER_LAT)	This field defines the calculated "actual" latitude for the lower right corner of the scene. See A.1 for corner definitions.
SCENE_LR_CORNER_LON	6-9	(Same as SCENE_UL_CORNER_LON)	This field defines the calculated "actual" longitude for the lower right corner of the scene. See A.1 for corner definitions.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (33 of 37)

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
HORIZONTAL_DISPLAY_SHIFT	1-5	= -9999 through 9999 units are meters A negative value (-) defines a shift of the calculated "true" WRS scene center to the West of the nominal WRS scene center. A positive value (no sign) defines a shift of the calculated "true" WRS scene center to the East of the nominal WRS scene center.	OPTIONAL field. This field defines the horizontal distance between the perpendiculars through the calculated "true" WRS scene center and the nominal (known) WRS scene center on the ground. The LPS will maintain a lookup table of nominal WRS scene centers for computing HORIZONTAL_DISPLAY_SHIFT values for WRS scenes.
SUN_AZIMUTH_ANGLE	3-6	= -180.0 to 180.0 units are degrees (with 1-digit precision) A positive value (no sign) indicates angles to the East or clockwise from North. A negative value (-) indicates angles to the West or counterclockwise from North.	The Sun azimuth angle at the "true" WRS scene center (calculated by LPS from PCD processing)
SUN_ELEVATION_ANGLE	3-5	= -90.0 through 90.0 units are degrees (with 1-digit precision) A positive value (no sign) indicates a daytime scene. A negative value (-) indicates a nighttime scene.	The Sun elevation angle at the "true" WRS scene center (calculated by LPS from PCD processing)

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (34 of 37)

BAND6_GAIN	1	= "x" where: "L" = Low gain condition "H" = High gain condition	This field describes the band gain condition at the start of a WRS scene. This information is obtained from Words 7 and 8 of the PCD/Status Data field of the first error-free VCDU in a WRS scene. If there is a band gain change within the scene it will be indicated in the next two fields.
BAND7_GAIN	1	= "x" where: "L" = Low gain condition "H" = High gain condition	(See parameter description for BAND6_GAIN.)
BAND8_GAIN	1	= "x" where: "L" = Low gain condition "H" = High gain condition	(See parameter description for BAND6_GAIN.)
BAND6_GAIN_CHANGE	1	= "x" where: "0" = no band gain change within the scene "+" = gain change from low to high within the scene "-" = gain change from high to low within the scene	This field indicates if there has been a band gain change within a scene and which direction the band gain condition changed; e.g. from high to low or low to high. The LPS generates this by evaluating corresponding band gain states in adjacent ETM+ scans (major frames).

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
BAND7_GAIN_CHANGE	1	(Same as BAND6_GAIN_CHANGE)	(See parameter description for BAND6_GAIN_ CHANGE parameter)
BAND8_GAIN_CHANGE	1	(Same as BAND6_GAIN_CHANGE)	(See parameter description for BAND6_GAIN_ CHANGE parameter)
BAND6_SL_GAIN_CHANGE	1-5	= nnnnn where: 0 = no gain change 1- 12000 = first scan line number at new band gain setting	This field indicates the scan line (SL) number within this band in the WRS scene for the first change detected in the band gain condition.
BAND7_SL_GAIN_CHANGE	1-5	(Same as BAND6_SL_GAIN_CHANGE)	(See parameter description for BAND6_SL_GAIN_ CHANGE parameter.)
BAND8_SL_GAIN_CHANGE	1-5	(Same as BAND6_SL_GAIN_CHANGE)	(See parameter description for BAND6_SL_GAIN_ CHANGE parameter.)
DAY_NIGHT_FLAG	1	= "x" where: "D" = Daytime scene "N" = Nighttime scene	This field indicates the day or night condition for the scene. LPS determines the day/night condition of a scene by comparing the Sun elevation values against an angle value of 0 degrees. A scene is declared a day scene if the Sun elevation angle is greater than 0 degrees; otherwise it is declared a night scene.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (36 of 37)

SCENE_QUALITY	2-3	= nn where: nn = 00 - 99 or nn = -1 A value of -1 means no quality assessment was made. A value of 00 means very poor quality and a value of 99 means very good quality. Leading zeros are required for positive values.	This field may integrate several measures of image quality to arrive at an integrated quality rating on a scene basis. The algorithm for the calculation of scene quality is described in D.3.
END_GROUP	12	= WRS_SCENE_nn where nn = 01-99	Indicates the end of the ETM+ WRS scene nn group records.
END_GROUP	17	= METADATA_SCENE_nn where nn = 01-99	Indicates the end of the metadata scene nn level metadata group records.
End of Scene Level Metadata for Format 2			
END_GROUP	26	=SUBINTERVAL_METADATA_FMT_2	Indicates the end of the Format 2 subinterval level metadata group records.
END_GROUP	13	= METADATA_FILE	Indicates the end of the Metadata file records for an ETM+ subinterval.
END	0		Indicates the end of the file.

(Note: In this table, quotation marks are used in the Value definitions to signify literal characters or strings that are constants in the Value field.)

Table D-1 IGS Metadata Format Specification (37 of 37)

```
                    /*   IGS-PROVIDED LANDSAT-7 METADATA FORMAT   */

                              /* ------------------------------ */
                              /*   Metadata File Header   */
                              /* ------------------------------ */
GROUP = METADATA_FILE
    GROUP = METADATA_FILE_INFO
        FILE_NAME = "L7EDC032036199806040.MTA"
        FILE_CREATION_DATE_TIME = 1998-06-04T11:36:48Z
        FILE_VERSION_NO =  0
        STATION_ID = "EDC"
    END_GROUP = METADATA_FILE_INFO

                              /* --------------------------------------------- */
                              /*   Sub-Interval Metadata - Format 1    */
                              /* --------------------------------------------- */
    GROUP = SUBINTERVAL_METADATA_FMT_1
        SPACECRAFT_ID = "Landsat7"
        SENSOR_ID = "ETM+"
        STARTING_PATH = 032
        STARTING_ROW = 036
        ENDING_ROW = 061
        TOTAL_WRS_SCENES = 26


        /*  Start and stop time of the subinterval  */
        SUBINTERVAL_START_TIME     = 1998-155T04:01:49Z
        SUBINTERVAL_STOP_TIME      = 1998-155T04:13:11Z


        /*   Calculated latitude, longitude of subinterval's four corners        */
        SUBINTERVAL_UL_CORNER_LAT       = 35.5833        /*   35 deg 35 min North latitude
*/
        SUBINTERVAL_UL_CORNER_LON       = –105.1333    /* 105 deg 8 min West longitude
*/
        SUBINTERVAL_UR_CORNER_LAT       =  35.1333
        SUBINTERVAL_UR_CORNER_LON       =  –103.1667
        SUBINTERVAL_LL_CORNER_LAT       =  –1.9000       /*     1 deg 54 min South latitude
*/
        SUBINTERVAL_LL_CORNER_LON       =  –109.8833
        SUBINTERVAL_LR_CORNER_LAT       =  –2.3833
        SUBINTERVAL_LR_CORNER_LON       = –108.3333
```

Figure D-2   Example of IGS Metadata Format (1 of 7)

```
        /*   BAND#_PRESENT is derived from PCD   */
        BAND1_PRESENT = "Y"
        BAND2_PRESENT = "Y"
        BAND3_PRESENT = "Y"
        BAND4_PRESENT = "Y"
        BAND5_PRESENT = "Y"
        BAND6_PRESENT = "Y"

                        /* -------------------------------------------- */
                        /*   Scene Metadata Groups - Format 1   */
                        /* -------------------------------------------- */

    GROUP = METADATA_SCENE_01
        GROUP = WRS_SCENE_01

            WRS_SCENE_NO                  = 1
            WRS_PATH                      = 032
            WRS_ROW                       = 036
            FULL_OR_PARTIAL_SCENE         = "F"
            SCENE_CENTER_SCAN_TIME        = 1998-155T04:02:01.1234567Z


            SCENE_BAND1_PRESENT           =  "Y"
            SCENE_BAND2_PRESENT           =  "Y"
            SCENE_BAND3_PRESENT           =  "Y"
            SCENE_BAND4_PRESENT           =  "Y"
            SCENE_BAND5_PRESENT           =  "Y"
            SCENE_BAND6_PRESENT           =  "Y"

            /*   Calculated latitude, longitude of this scene's center and four corners,     */
            /*   using PCD position and attitude information                                  */

            SCENE_CENTER_LAT              = 34.6333      /*  34 deg 38 min North latitude
*/
            SCENE_CENTER_LON              = –104.4500   /*  104 deg 27 min West longitude
*/
            SCENE_UL_CORNER_LAT           = 35.5833
            SCENE_UL_CORNER_LON           = –105.1333
            SCENE_UR_CORNER_LAT           = 35.1333
            SCENE_UR_CORNER_LON           = –103.1667
            SCENE_LL_CORNER_LAT           = 34.0000
            SCENE_LL_CORNER_LON           = –105.6000
            SCENE_LR_CORNER_LAT           = 33.6500
            SCENE_LR_CORNER_LON           = –103.7500
            HORIZONTAL_DISPLAY_SHIFT  = –34
```

Figure D-2   Example of IGS Metadata Format (2 of 7)

```
/*   Cloud Cover Assessment Score          */

SCENE_CCA              = 40        /*   40% cloud cover   */
UL_QUAD_CCA            = 35
UR_QUAD_CCA            = 20
LL_QUAD_CCA            = 70
LR_QUAD_CCA            = 35

SUN_AZIMUTH_ANGLE    = 35.0
SUN_ELEVATION_ANGLE = 56.3

/*   Indication of Band gain setting at start of this scene   */
BAND1_GAIN      = "H"
BAND2_GAIN      = "H"
BAND3_GAIN      = "H"
BAND4_GAIN      = "H"
BAND5_GAIN      = "H"
BAND6_GAIN      = "L"              /*  L is default gain for Band 6 Format 1   */

/*   Indication of a Band gain setting change within this scene            */
BAND1_GAIN_CHANGE         = "0"
BAND2_GAIN_CHANGE         = "0"
BAND3_GAIN_CHANGE         = "0"
BAND4_GAIN_CHANGE         = "0"
BAND5_GAIN_CHANGE         = "0"
BAND6_GAIN_CHANGE         = "0"

/*   Scan line at which a Band gain change occurred in this scene              */
BAND1_SL_GAIN_CHANGE    = 0
BAND2_SL_GAIN_CHANGE    = 0
BAND3_SL_GAIN_CHANGE    = 0
BAND4_SL_GAIN_CHANGE    = 0
BAND5_SL_GAIN_CHANGE    = 0
BAND6_SL_GAIN_CHANGE    = 0
BROWSE_FILE_NAME = "L7EDC03203619980604.R01"
BROWSE_AVAILABLE_AT_STATION    = "Y"

DAY_NIGHT_FLAG           = "D"
```

Figure D-2   Example of IGS Metadata Format (3 of 7)

```
        SCENE_QUALITY           = 97


    END_GROUP = WRS_SCENE_01
  END_GROUP = METADATA_SCENE_01                    /*   End of scene 1 metadata   */


  GROUP = METADATA_SCENE_02
    GROUP = WRS_SCENE_02

                 /*   Metadata for scene 2 of Format 1's subinterval   */

    END_GROUP = WRS_SCENE_02
  END_GROUP = METADATA_SCENE_02


  GROUP = METADATA_SCENE_nn
    GROUP = WRS_SCENE_nn

                 /*    nn = sequence number of last scene   */

    END_GROUP = WRS_SCENE_NN
  END_GROUP = METADATA_SCENE_NN

END_GROUP = SUBINTERVAL_METADATA_FMT_1

                  /* ------------------------------------------ */
                  /*   Sub-Interval Metadata - Format 2    */
                  /* ------------------------------------------ */

GROUP = SUBINTERVAL_METADATA_FMT_2
  SPACECRAFT_ID = "Landsat7"
  SENSOR_ID= "ETM+"
  STARTING_PATH = 032
  STARTING_ROW = 036
  ENDING_ROW = 061
  TOTAL_WRS_SCENES = 26
```

Figure D-2 Example of IGS Metadata Format (4 of 7)

```
        /*  Start and stop time of the subinterval  */
        SUBINTERVAL_START_TIME     = 1998-155T04:01:49Z
        SUBINTERVAL_STOP_TIME      = 1998-155T04:13:11Z


        /*   Calculated latitude, longitude of subinterval's four corners
*/
        SUBINTERVAL_UL_CORNER_LAT       = 35.5833       /*   35 deg 35 min North latitude
*/
        SUBINTERVAL_UL_CORNER_LON       = –105.1333    /*  105 deg 8 min West longitude
*/
        SUBINTERVAL_UR_CORNER_LAT       = 35.1333
        SUBINTERVAL_UR_CORNER_LON       = –103.1667
        SUBINTERVAL_LL_CORNER_LAT       = –1.9000      /*   1 deg 54 min South latitude      */
        SUBINTERVAL_LL_CORNER_LON       = –109.8833
        SUBINTERVAL_LR_CORNER_LAT       = –2.3833
        SUBINTERVAL_LR_CORNER_LON       = –108.3333

        /*   BAND#_PRESENT is derived from PCD   */
        BAND6_PRESENT = "Y"
        BAND7_PRESENT = "Y"
        BAND8_PRESENT = "Y"

                        /* -------------------------------------------- */
                        /*   Scene Metadata Groups - Format 2   */
                        /* -------------------------------------------- */

    GROUP = METADATA_SCENE_01
        GROUP = WRS_SCENE_01

            WRS_SCENE_NO                = 1
            WRS_PATH                    = 032
            WRS_ROW                     = 036
            FULL_OR_PARTIAL_SCENE       = "F"
            SCENE_CENTER_SCAN_TIME      = 1998-155T04:02:01.1234567Z

            SCENE_BAND6_PRESENT         =  "Y"
            SCENE_BAND7_PRESENT         =  "Y"
            SCENE_BAND8_PRESENT         =  "Y"

            /*   Calculated latitude, longitude of this scene's center and four corners,       */
            /*   using PCD position and attitude information                                    */

            SCENE_CENTER_LAT            = 34.6333     /*  34 deg 38 min North latitude     */
            SCENE_CENTER_LON            = –104.4500  /* 104 deg 27 min West longitude  */
```

Figure D-2 Example of IGS Metadata Format (5 of 7)

```
        SCENE_UL_CORNER_LAT          =  35.5833
        SCENE_UL_CORNER_LON          =  –105.1333
        SCENE_UR_CORNER_LAT          =  35.1333
        SCENE_UR_CORNER_LON          =  –103.1667
        SCENE_LL_CORNER_LAT          =  34.0000
        SCENE_LL_CORNER_LON          =  –105.6000
        SCENE_LR_CORNER_LAT          =  33.6500
        SCENE_LR_CORNER_LON          =  –103.7500
        HORIZONTAL_DISPLAY_SHIFT  =  –34

        SUN_AZIMUTH_ANGLE     = 35.0
        SUN_ELEVATION_ANGLE = 56.3

        /*   Indication of Band gain setting at start of this scene   */
        BAND6_GAIN       = "H"                  /*  H is default gain for Band 6 Format 2   */
        BAND7_GAIN       = "H"
        BAND8_GAIN       = "H"

        /*   Indication of a Band gain setting change within this scene             */
        BAND6_GAIN_CHANGE          = "0"
        BAND7_GAIN_CHANGE          = "–"
        BAND8_GAIN_CHANGE          = "0"

        /*   Scan line at which a Band gain change occurred in this scene   */
        BAND6_SL_GAIN_CHANGE    = 0
        BAND7_SL_GAIN_CHANGE    = 1564
        BAND8_SL_GAIN_CHANGE    = 0

        DAY_NIGHT_FLAG                          = "D"

        SCENE_QUALITY               = –1

    END_GROUP = WRS_SCENE_01
  END_GROUP = METADATA_SCENE_01                      /*   End of scene 1 metadata   */
```

Figure D-2   Example of IGS Metadata Format (6 of 7)

```
        GROUP = METADATA_SCENE_02
            GROUP = WRS_SCENE_02

                        /*   Metadata for scene 2 of Format 2's subinterval   */

            END_GROUP = WRS_SCENE_02
        END_GROUP = METADATA_SCENE_02


        GROUP = METADATA_SCENE_NN
            GROUP = WRS_SCENE_NN

                        /*    nn = sequence number of last scene   */

            END_GROUP = WRS_SCENE_NN
        END_GROUP = METADATA_SCENE_NN

    END_GROUP = SUBINTERVAL_METADATA_FMT_2

END_GROUP = METADATA_FILE

END                                              /*   End of this metadata file   */
```

Figure D-2 Example of IGS Metadata Format (7 of 7)

D.3 ALGORITHM FOR CALCULATION OF SCENE QUALITY

A two digit number that separates image and PCD data quality is proposed for Landsat 7. The first digit represents image data quality and can range in value from 0 to 9. The second digit represents PCD quality and can range in value from 0 to 9. The formula for the combined score is:

image score * 10 + PCD score

The following paragraphs describe how the image quality and PCD quality scores are assigned.

D.3.1 Image Quality Component

The image quality digit is based on the number and distribution of bad scans or equivalent bad scans in a scene. It is computed by dividing the total number of filled minor frames for a scene by 6313 (the nominal number of image data minor frames in a scan for 30 meter bands). This will give a number of equivalent bad scans.

The distribution of filled minor frames is characterized as being either clustered or scattered. A cluster of 128 bad scans will still yield a scene with a cluster 246 good scans which is almost 2/3 of a scene. A scattering of 128 band scans may make the entire image worthless.

What defines clustering versus scattering? It is proposed that bad scan lines are clustered if they occur within a grouping of 128 contiguous scans (approximately 1/3 of a scene). Errors are characterized as scattered if they occur outside the bounds of 128 contiguous scans. The image score is assigned according to the rules in Table D-2.

SCORE	IMAGE QUALITY
9	no errors detected, a perfect scene
8	² 4 but > 0 equivalent bad scans, clustered
7	² 4 but > 0 equivalent bad scans, scattered
6	² 16 but > 4 equivalent bad scans, clustered
5	² 16 but > 4 equivalent bad scans, scattered
4	² 64 but > 16 equivalent bad scans, clustered
3	² 64 but > 16 equivalent bad scans, scattered
2	² 128 but > 64 equivalent bad scans, clustered
1	² 128 but > 64 equivalent bad scans, scattered
0	> 128 equivalent bad scans, scattered (> 33% of the scene is bad)

Table D-2 Image Quality Scoring Rules

D.3.2 PCD Quality Component

The PCD quality digit is based on the number and distribution of filled PCD minor frames. There are approximately 7 PCD major frames for a standard WRS scene comprised of 375 scans. Each PCD major frame consists of 128 minor frames or 16,384 bytes. Clustering of filled PCD minor frames indicates that errors are localized whereas scattering indicates that numerous or all major frames may be affected.

What defines clustering versus scattering? Each PCD minor frame has 16 jitter measurements and corresponds to 30 milliseconds or approximately 1/2 of a scan. Two minor frames correspond to a single scan while 256 minor frames (i.e., 2 PCD major frames) correspond to 128 scans or approximately 1/3 of a scene.

Like the image data, it is proposed that bad PCD minor frames are clustered if they occur within a grouping of 2 contiguous PCD major frames (1/3 of a scene). Errors are characterized as scattered if they occur outside the bounds of contiguous PCD major frames. The PCD score is assigned according to the rules in Table D-3.

SCORE	PCD QUALITY
9	no PCD errors detected
8	² 8 but > 0 bad minor frames, clustered
7	² 8 but > 0 bad minor frames, scattered
6	² 32 but > 8 bad minor frames, clustered
5	² 32 but > 8 bad minor frames, scattered
4	² 128 but > 32 bad minor frames, clustered
3	² 128 but > 32 bad minor frames, scattered
2	² 256 but > 128 bad minor frames, clustered
1	² 256 but > 128 bad minor frames, scattered
0	> 256 bad minor frames, scattered (>33% of the scene is bad)

Table D-3 PCD Quality Scoring Rules

D.3.3 Scene Quality

The score calculated using the methods described above are recorded in the scene level metadata under the keyword SCENE_QUALITY. Using this scoring system the highest possible rating for an image would be 99, the lowest 00. A "-1" signals that scene quality analysis was not performed. The score treats missing image data more critically than missing or filled PCD data. For example, an image with 16 filled scans that are scattered and with errorless PCD would have a 59 score whereas an image with intact image data and 32 filled PCD minor frames that are scattered would receive a score of 95. The rationale is that PCD is less important because missing values can always be extrapolated or interpolated to enable level 1 processing. Missing image data cannot be retrieved and thus impacts the user more severely than missing PCD. The score construct unambiguously alerts the user to image data deterioration.

APPENDIX E
BROWSE DATA FORMAT

Transfer of browse imagery from the IGS to the DAAC is not required, but it is encouraged if a station does not plan to provide online access to its browse products. The characteristics of the browse image are described in E.1. The browse product format is described in E.2. For information purposes only, the LPS browse generation process is described in E.3. The mechanism for transfer of browse data from the IGS to the DAAC is specified in Appendix F.

Several of the reference documents in 2.0 apply to browse data:

- the Hierarchical Data Format (HDF) used to package the browse data (Reference Document 8)
- LPS browse generation algorithms (Reference Documents 9 and 10)

E.1 BROWSE IMAGE CHARACTERISTICS

The characteristics of the Landsat 7 browse image and the permissible values of each characteristic are specified in Table E-1. Browse data generated by the IGSs, whether sent to the DAAC or not, must be generated within the ranges specified in the table. For most of the characteristics listed, the value used in generating the browse image is left to the IGS to choose. For information purposes, the values of each characteristic for the LPS browse product are also given in Table E-1.

It is highly recommended that contrast stretch be applied to the browse product to not only remove the possible effects of low solar illumination angles and inappropriate gain settings but also to exploit the full 8-bit dynamic range for improved viewing.

BROWSE PRODUCT CHARACTERISTIC	ALLOWABLE IGS VALUE RANGE	VALUE USED BY THE LPS
Subsampling	IGS choice	None
Wavelet passes	IGS choice	3 (64:1)
Contrast stretch	IGS choice	Applied prior to compression
Browse image size	IGS choice	825 samples (width) x 750 lines (height)
Number of bands	3	3
Selected bands	IGS choice	Operator selectable - default: 5/4/2 (RGB)
Radiometric correction	IGS choice	Yes, using nominal gains and offsets
Browse framing	Scene based	Scene based
Interlace format	Pixel interlace	Pixel interlace
Browse file size	IGS choice	1.85 MB
Compression / Type	Yes / JPEG	Yes / JPEG
Compression quality factor	IGS choice	90
Compression browse file size	^{2} 100 KB	100 - 185 KB
Browse file format	HDF (Note 1)	HDF

Note 1: Unix-based tools for converting JFIF to HDF and JPEG to HDF will be made available to the IGSs.

Table E-1 Browse Image Characteristics

E.2 BROWSE PRODUCT FORMAT

The three-banded, JPEG compressed, and pixel interlaced browse image submitted to the DAAC by the IGSs must be in HDF. The HDF data model employed for the browse product is the 24-bit raster image or RIS24. An HDF application programming interface (API) for the RIS24 data model is freely available on the NCSA FTP server. This interface includes a set of routines designed to simplify the process of storing and retrieving an RIS24 image. Although programming is required, all the low level details can be ignored. All HDF API routines are available in both Fortran-77 and C.

An IGS browse image stored in HDF is composed of: the two-dimensional 24-bit raster image, its dimensions, and its attibutes. Band selection and image dimensioning are IGS choices as long as the physical file size of 100 KB is not exceeded. The EDC DAAC client software will have a scrollable image area of approximately 620 by 620 pixels. These dimensions should serve as a guideline, not a restriction. Larger images are acceptable, but users may need to use the viewer's scrolling features to see the entire image.

JPEG compression is required and is conveniently performed using the RIS24 API. The 100 KB restriction is a post compression limit. The required interlace mode is pixel interlaced as opposed to scan line or band interlacing. The interlace format describes the physical format of an image as it is stored both in memory and in the file. After an image is reduced to the desired browse size it must be pixel interlaced in memory. The RIS24 routines will automatically store the browse image on disk in the same format.

The C program in Figure E-1 illustrates the straightforward programming steps necessary to create a browse image in HDF. The names of all C routines in the RIS24 interface are prefaced by "DF24". The code does not illustrate populating the browse_image array with actual data. The default interlace setting is pixel interlaced, therefore, it is not explicitly set.

E.3 LPS BROWSE GENERATION PROCESS

This section describes the process used by the Landsat 7 Processing System at EDC to generate the browse data for US acquisitions. It is presented as an example only; there is no requirement for the IGSs to process their browse data in this manner.

Landsat 7 browse is generated during LPS processing using bands 5, 4, and 2 from Format 1 Level 0R data. The browse is framed according to standard WRS scene dimensions although partial scene browse can occur at the beginning or end of a subinterval.

The three Level 0R bands used for the browse first undergo radiometric correction using nominal gains and offsets from the Calibration Parameter File. Afterwards, the bands are reduced by a factor of 64 to produce a 3-banded browse image that is 825 columns by 750 lines in size. A wavelet algorithm, described in Reference Documents 9 and 10, is used for image reduction. Its primary benefit – the preservation of high frequency information – makes this approach superior to subsampling. The encoded algorithm, written in the C programming language, is available from the NOAA/NESDIS Landsat 7 Office upon request.

After wavelet reduction, each band is automatically enhanced using a saturating linear stretch that maps a minimum and maximum value to 0 and 255 respectively. Minimum and maximum cutoffs are determined by histogramming the image values from each band, clipping 2.5% from the top end of the histogram, and clipping 4.1% (includes additional 1.6% from fill) from the bottom end of the histogram. All intervening input values are scaled proportionately .

The LPS browse product comprises the 24-bit image described above and text attributes containing descriptive auxillary information or metadata.

```
#include "hdf.h"
#include "stdio.h"
#include "hcomp.h"
#define WIDTH 825
#define HEIGHT 750
#define PIXEL_DEPTH 3
#define NUM_BROWSE_BANDS 3

main()
{
static uint8 browse_image[HEIGHT] [WIDTH] [PIXEL_DEPTH];
static int bandIDs[NUM_BROWSE_BANDS] = {5, 4, 2}, wavelet_runs = 3,  pixel_interlacing = 0;
static char browse_file_name[] = {"L7EDC03203619980604.R01"};
static char ref_metadata_file_name[] = {"L7EDC032036199806040.MTA"};
static float UpperClipPercent = 2.5, LowerClipPercent = 4.1;

/* the comp_info structure contains the quality and baseline variables. Compress_info points to this
structure */

static  comp_info compress_info;

/* open the SDS interface and set the attribute values */

browse_SDid = SDstart ("browse_example.hdf", DFACC_CREATE);

SDsetattr (browse_SDid, "multiband_browse_file_label",  DFNT_CHAR8, sizeof (browse_file_name),
        (char *) browse_file_name);
SDsetattr (browse_SDid, "ref_metadata_file_name", DFNT_CHAR8, sizeof (ref_metadata_file_name),
        (char *) ref_metadata_file_name);
SDsetattr (browse_SDid, "band_IDs", DFNT_INT32, NUM_BROWSE_BANDS, (VOIDP) bandIDs);
SDsetattr (browse_SDid, "wavelet_runs", DFNT_INT32, 1, (VOIDP) &wavelet_runs);
SDsetattr (browse_SDid, "stretch_clip%_high", DFNT_FLOAT32, 1, (VOIDP) &UpperClipPercent);
SDsetattr (browse_SDid, "stretch_clip%_low", DFNT_FLOAT32, 1, (VOIDP) &LowerClipPercent);

/* close the SDS interface which writes the attribute values to the file*/

SDend (browse_SDid);

/*  Set interlace scheme to pixel interlacing and initialize the JPEG compression structure. The JPEG
quality factor is set to 90. The baseline factor is set to 1 which forces the quantization tables into the full
0-255 range */

DF24setil (pixel_interlacing);
compress_info.jpeg.quality = 90;
compress_info.jpeg.force_baseline = 1;

/* set JPEG compression for storing the image */

DF24setcompress(COM_JPEG, &compress_info);

/* write the 24 bit browse image to a file */

DF24addimage("Browse_example.hdf", (VOIDP) browse_image, WIDTH, HEIGHT);
}
```

Figure E-1   Example – Writing a Browse Image Using C

Once the browse image is wavelet reduced and stretched, it is converted into the HDF 24-bit raster image, or RIS24, data model. The RIS24 data structure includes: the actual RGB image, its dimensions (length, width, depth), and its attributes. The image and the dimensions are defined by the following parameters which are input by the operator or hardcoded into the software:

- image_file_name
- image_interlace_il
- image_compression
- compression_quality_factor

The following attributes serve as metadata for the LPS browse image:

- browse_file_name
- ref_metadata_file_name
- band_IDs
- wavelet_runs
- stretch_clip%_high
- stretch_clip%_low

When the data is written to the HDF file, it is structured as shown in Table E-2.

HDF TAG	DD BLOCK
IMAGE_DIMENSION_WIDTH, IMAGE_DIMENSION_LENGTH, IMAGE_DIMENSION_DEPTH	
IMAGE DATA	
IMAGE DATA	
• • •	
IMAGE DATA	
ATTRIBUTES	

Table E-2 LPS Browse Image HDF File Structure

The DD BLOCK, where DD stands for Data Descriptor, contains a JPEG flag (indicating the data is JPEG compressed), and specifies the name and byte offset for the dimension parameters, the image data itself, and the attributes.

The programming model for writing a RIS24 image consists of specifying the data layout or interlace structure, setting the compression method, and writing the image to a file. The browse image for Landsat 7 employs pixel interlacing (i.e., band interleaved by pixel) and the JPEG compression algorithm which reduces the image from 1.86 MB to approximately 150 KB in size.

The attributes are created and affixed to the RIS24 browse image using the HDF Scientific Data Set (SDS) software interface.

A C-encoded example for creating a browse image using the RIS24 and SDS interfaces is presented in Figure E-1. Generalized Fortran and C examples for creating a RIS24 image, defining and writing attributes, and further model details are provided in the HDF Users Guide (Ref. Doc. 8).

APPENDIX F
TRANSFER OF DATA FROM IGS TO DAAC

Transfers of data from the IGSs to the DAAC are made using electronic transfer or physical media. Electronic transfer applies only to metadata. Physical media transfer applies to both metadata and browse data. All deliveries of browse data must be accompanied by the corresponding metadata file(s), even if the metadata was previously delivered to the DAAC by electronic transfer.

F.1 ELECTRONIC TRANSFER

The electronic transfer mechanism is summarized in Figure F-1. The transfer process is described below. The next three sections describe the files that facilitate the transfer, and the last section discusses error handling and backup methods.

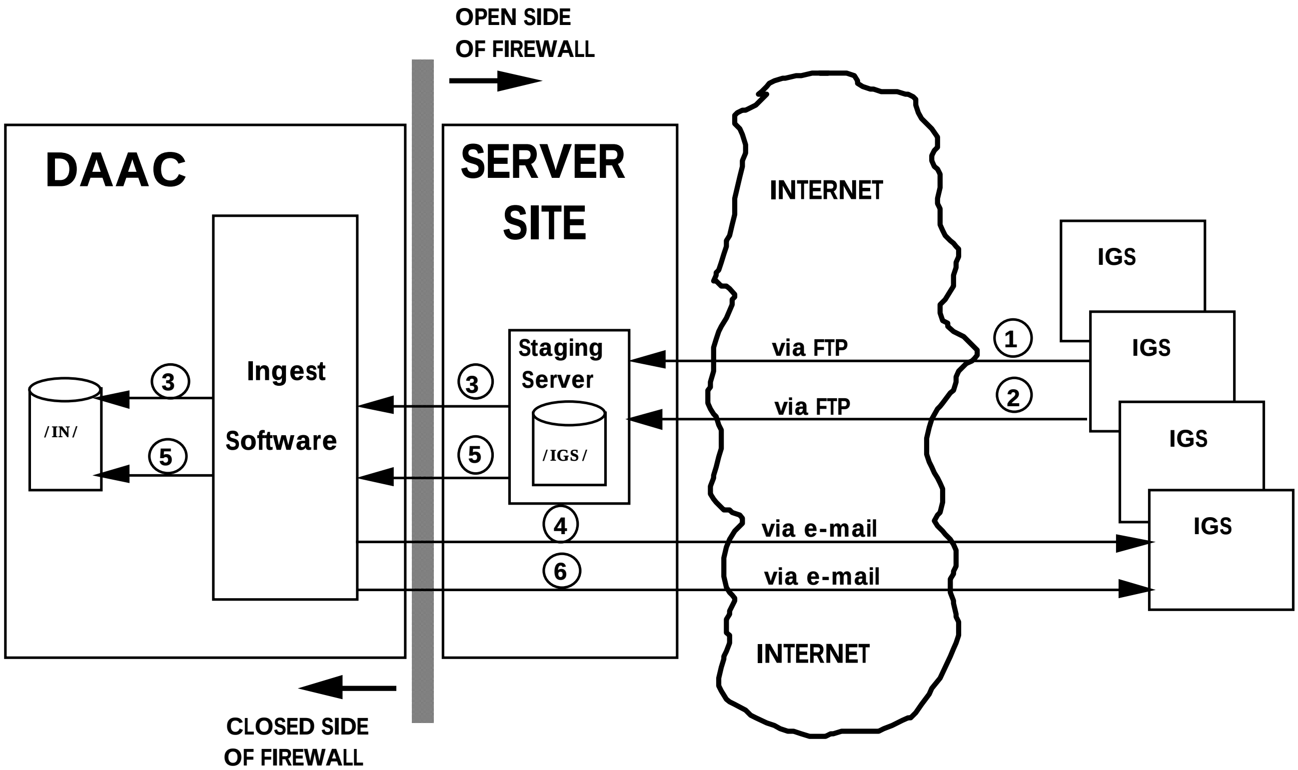
For each subinterval, the IGS generates either one metadata file (containing both Format 1 and Format 2 data) or two metadata files (one file each for Format 1 and Format 2 data). The IGS sends the metadata file(s) via FTP to a specified location on the staging server (see the directory structure in Figure F-2). The IGS then generates a Product Delivery Record (PDR) for the metadata file(s) being submitted. The PDR file is then placed in a known directory on the staging server using FTP. There is one PDR file for each subinterval of metadata.

The EDC DAAC polls the staging server PDR directory on a routine basis. When a PDR is found on the staging server, it is transferred to a closed server and validated for proper content and format. If an error is found in the PDR, processing is terminated and none of its files are transferred to a closed server for processing until a corrected PDR is received and successfully processed. When a problem in the PDR is found, either a short or long Product Delivery Record Discrepancy file is generated by the DAAC and sent to the originating IGS via e-mail. In either case, the associated metadata file(s) is deleted from the staging server. The IGS corrects the problem described in the PDR Discrepancy file and submits the corrected PDR to the PDR directory on the staging server via FTP, along with the associated metadata file(s). When the PDR is successfully retrieved and validated, the DAAC does not send anything to the IGS but continues on to the next step of transferring the associated metadata file(s) onto a closed server for ingest and archiving.

The metadata file(s) is checked for conformance with the ODL standards. If no problems are found, the metadata is ingested into the archive and a short Production Acceptance Notification (PAN) file indicating success is generated and sent via e-mail to the IGS.

If a problem is found during transfer, ingest, or archival of the metadata file(s),either a short or long Production Acceptance Notification file is generated containing a description of the problem and is sent via e-mail to the IGS. Resubmission of the metadata file(s) is done as if it were the original submission – i.e., a PDR file and the metadata file(s), including corrections, are sent to the staging server. All of the original files (PDR and metadata files) are deleted.

There is a one-to-one correspondence among the PDR, the PDR Discrepancy (if required to be generated), and the PAN files.



1. Metadata file(s) are sent to the staging server from the IGS via FTP and "put" in the /DATA directory.

2. The associated Product Delivery Record file is then sent to the staging server from the IGS via FTP, and "put" in the /PDR directory.

3. The Product Delivery Record is processed first.

4. If errors are found in the Product Delivery Record, they are reported in the Product Delivery Record Discrepancy file which is sent via e-mail to the IGS.

5. After no errors are found in the Product Delivery Record, metadata is ingested and processed.

6. Results of metadata processing are reported in the Production Acceptance Notification file which is sent to the IGS via e-mail.

Figure F-1 DAAC Communications Architecture and Data Flow for Electronic Transfer

```
The directory structure on the staging server for metadata files is:
     /IGS/META/xxx/DATA

The directory structure on the staging server for PDR files is:
     /IGS/META/xxx/PDR

where:    xxx = 3-letter station ID from Table 3-2
     examples: /IGS/META/CUB/DATA
               /IGS/META/RSA/PDR
```

Figure F-2 Directory Structure on the DAAC Staging Server

F.1.1 Product Delivery Record File

The purpose of the IGS Product Delivery Record (PDR) is to announce the availability of metadata for transfer, including file names, file size, location, etc. The PDR file format is given in Table F-1. An example of a PDR is shown in Figure F-3. Indentation in the example is for readability only; it is not required formatting.

The IGS PDR file naming convention is:

ORIGINATING_SYSTEM.yyyymmddhhmmss.PDR

where:

ORIGINATING_SYSTEM.	= value of originating system provided in PDR (IGSxxx where xxx is a 3-letter station id, as defined in Table 3-2)
yyyymmdd	= date of PDR file creation
hhmmss	= time of PDR file creation
.PDR	= constant, file extension which identifies this as a PDR file

for example: IGSKUJ.19991127221345.PDR

Each IGS PDR corresponds to a single subinterval and contains a single file group (identified by the parameter OBJECT = FILE_GROUP). The file group in an IGS PDR contains either one or two files, depending on whether Formats 1 and 2 are packaged within a single file, or kept as separate files.

IGS PDRs are validated to check that all required fields contain valid values and that the format is correct and consistent with the standards. IGS PDRs that adhere to the defined message standards shown in Table F-1 are accepted and processed.

PARAMETER NAME	SIZE (ASCII BYTES)	VALUE, FORMAT, RANGE, AND UNITS	PARAMETER DESCRIPTION / REMARKS
ORIGINATING_SYSTEM	6	=IGSxxx; where xxx = 3-letter station identifier as listed in Table 3-2	Identifies originating station
TOTAL_FILE_COUNT	1	=1; or =2;	Total number of metadata files referenced by PDR
OBJECT	10	=FILE_GROUP;	Start of file group parameters
DATA_TYPE	8	=L7IGS;	Identifies this as Landsat 7 IGS metadata
NODE_NAME	7	=M0Cxxxx; where xxxx is identified in the Operations Agreement (Reference Document 7)	Identifies server where metadata file resides
OBJECT	9	=FILE_SPEC;	Start of file specific parameters
DIRECTORY_ID	18	=/IGS/META/xxx/DATA; where: xxx = 3-letter station identifier as listed in Table 3-2	Identifies directory in which metadata file resides
FILE_ID	24	=L7xxxppprrryyyymmddf.MTA; where: "L7" = constant (Landsat 7) xxx = station id code (ref. Table 3-2) ppp = WRS Path of first scene rrr = WRS Row of first scene yyyy = 4-digit Year of acquisition mm = Month (01-12) dd = Day (01-31) f = format in file (= 0 (both), 1, or 2) ".MTA" = constant (metadata file)	File name - should match the file name in the metadata
FILE_TYPE	8	=METADATA0; or =METADATA1; or =METADATA2;	Identifies the data type in the file and whether both formats (0) are represented or just one of the formats
FILE_SIZE	10	= 0 - 9999999999; (formatted as unsigned 32-bit integer)	Number of bytes in this file; must be <2 GB
END_OBJECT	9	=FILE_SPEC;	End of file parameters
The previous six parameters (OBJECT=FILE_SPEC, DIRECTORY_ID, FILE_ID, FILE_TYPE, FILE_SIZE, and END_OBJECT=FILE_SPEC) are repeated for the second metadata file if TOTAL_FILE_COUNT=2.			
END_OBJECT	10	=FILE_GROUP;	End of file group

Table F-1 Product Delivery Record (PDR) File Format

```
ORIGINATING_SYSTEM = IGSKUJ;
TOTAL_FILE_COUNT = 2;
OBJECT = FILE_GROUP;
        DATA_TYPE = L7IGS;
        NODE_NAME = M0C2204;
        OBJECT = FILE_SPEC;
                DIRECTORY_ID = /IGS/META/KUJ/DATA;
                FILE_ID = L7KUJ110035199911271.MTA;
                FILE_TYPE = METADATA1;
                FILE_SIZE = 11000;
        END_OBJECT = FILE_SPEC;
        OBJECT = FILE_SPEC;
                DIRECTORY_ID = /IGS/META/KUJ/DATA;
                FILE_ID = L7KUJ110035199911272.MTA;
                FILE_TYPE = METADATA2;
                FILE_SIZE = 11000;
        END_OBJECT = FILE_SPEC;
END_OBJECT = FILE_GROUP;
```

Figure F-3 Example of Product Delivery Record (PDR) File

F.1.2 Product Delivery Record Discrepancy File

The Product Delivery Record Discrepancy file is sent by the DAAC to the IGS only in the event that the PDR cannot be validated. An IGS PDR specifies only one file group, which may contain one or two file specs. Processing of the file group in an IGS PDR ceases when the first error in that file group is found. There may be further errors in the file group, but only this first error is reported. The PDR Discrepancy file identifies the error or problem that was found, but not the file spec in which it was found.

There are two forms of PDR Discrepancy files: a short form and a long form. The short form is used for PDRs with errors that are not attributable to specific file groups, such as transfer errors. The long form is used when the file group in the PDR has invalid parameters. The short form is specified in Table F-2; the long form is specified in Table F-3. An example of each is shown in Figure F-4.

The IGS PDR Discrepancy file naming convention is:

ORIGINATING_SYSTEM.yyyymmddhhmmss.PDRD

where: ORIGINATING_SYSTEM. = value of originating system provided in PDR (IGSxxx where xxx is a 3-letter station id, as defined in Table 3-2)
- yyyymmdd = date of creation of associated PDR file
- hhmmss = time of creation of associated PDR file
- .PDRD = constant, file extension which identifies this as a PDR Discrepancy file (DAAC nomenclature)

for example: IGSKUJ.19991127221345.PDRD

The file name of the PDR Discrepancy file is placed in the subject line of the e-mail message. The body of the e-mail message contains the parameters and values in Tables F-2 or F-3.

The Operations Agreement (Reference Document 7) explains the actions to be taken by the IGS in response to each disposition reported in the PDR Discrepancy file.

PARAMETER NAME	SIZE (ASCII BYTES)	VALUE, FORMAT, RANGE, AND UNITS	PARAMETER DESCRIPTION / REMARKS
MESSAGE_TYPE	9	= SHORTPDRD;	Identifies this as a Short PDR Discrepancy file
DISPOSITION	up to 64	= one of the following: "INVALID FILE COUNT"; "ECS INTERNAL ERROR"; "DATABASE FAILURES"; "INVALID PVL STATEMENT"; (note 1) "MISSING OR INVALID ORIGINATING_SYSTEM PARAMETER"; "DATA PROVIDER REQUEST THRESHOLD EXCEEDED"; "DATA PROVIDER VOLUME THRESHOLD EXCEEDED"; "SYSTEM REQUEST THRESHOLD EXCEEDED"; "SYSTEM VOLUME THRESHOLD EXCEEDED";	The discrepancy that was found in the PDR file. Only the first error encountered is given.

note 1: Should be interpreted as invalid statement format

Table F-2 Short Product Delivery Record Discrepancy File Format

PARAMETER NAME	SIZE (ASCII BYTES)	VALUE, FORMAT, RANGE, AND UNITS	PARAMETER DESCRIPTION / REMARKS
MESSAGE_TYPE	8	= LONGPDRD;	Identifies this as a Long PDR Discrepancy file
NO_FILE_GRPS	1	= 1;	Number of file groups to follow
DATA_TYPE	8	= L7IGS;	Data type from PDR.
DISPOSITION	up to 64	= one of the following: "INVALID DATA TYPE"; "INVALID DIRECTORY"; "INVALID FILE SIZE"; "INVALID FILE ID"; "INVALID NODE NAME"; "INVALID FILE TYPE";	The discrepancy that was found in the PDR file. Only the first error encountered is given. All checks except file size are for null strings. File size is checked for null string, <0, =0, and ^{3}2GB.

Table F-3 Long Product Delivery Record Discrepancy File Format

```
MESSAGE_TYPE = SHORTPDRD;
DISPOSITION = "INVALID PVL STATEMENT";
```

```
MESSAGE_TYPE = LONGPDRD;
NO_FILE_GRPS = 1;
DATA_TYPE  = L7IGS;
DISPOSITION = "INVALID FILE SIZE";
```

Figure F-4 Example of Short and Long Product Delivery Record (PDR) Discrepancy Files

F.1.3 Production Acceptance Notification File

The Production Acceptance Notification (PAN) file announces the completion of data transfer and archival of the metadata file(s), and identifies any errors or problems that were encountered. The IGS PDR specifies a single file group; there may be one or two files being processed within the file group. All files are checked and reported on, regardless of the number of files found with errors or the number of errors found in each file. However, only the first error in each file is reported.

There are two forms of PAN files: a short form and a long form. The short form is sent to acknowledge that all files have been successfully transferred, or to report errors which are not specific to individual files but which have precluded processing of any and all files. If an error was found in a specific file, a long form PAN is sent. The last four fields of the long form are repeated for each file. The short form is specified in Table F-4; the long form is specified in Table F-5. An example of each is shown in Figure F-5.

The IGS PAN file naming convention is:

ORIGINATING_SYSTEM.yyyymmddhhmmss.PAN

where:
- ORIGINATING_SYSTEM. = value of originating system provided in PDR (IGSxxx where xxx is a 3-letter station id, as defined in Table 3-2)
- yyyymmdd = date of creation of associated PDR file
- hhmmss = time of creation of associated PDR file
- .PAN = constant, file extension which identifies this as a PAN file

for example: IGSKUJ.19991127221345.PAN

The file name of the PAN file is placed in the subject line of the e-mail message. The body of the e-mail message contains the parameters and values in Table F-4 or F-5.

The Operations Agreement (Reference Document 7) explains the actions to be taken by the IGS in response to each reported disposition in the PAN file.

PARAMETER NAME	SIZE (ASCII BYTES)	VALUE, FORMAT, RANGE, AND UNITS	PARAMETER DESCRIPTION / REMARKS
MESSAGE_TYPE	8	= SHORTPAN;	Identifies this as a Short PAN file
DISPOSITION	up to 64	= one of the following: "SUCCESSFUL"; "NETWORK FAILURE"; "UNABLE TO ESTABLISH FTP/KFTP CONNECTION"; "ALL FILE GROUPS/FILES NOT FOUND"; "FTP/KFTP FAILURE"; "POST-TRANSFER FILE SIZE CHECK FAILURE"; "FTP/KFTP COMMAND FAILURE"; "DUPLICATE FILE NAME IN GRANULE"; "METADATA PREPROCESSING ERROR"; "RESOURCE ALLOCATION FAILURE"; "ECS INTERNAL ERROR"; "DATA BASE ACCESS ERROR"; "INCORRECT NUMBER OF METADATA FILES"; "INCORRECT NUMBER OF SCIENCE FILES"; "INCORRECT NUMBER OF FILES"; "DATA CONVERSION FAILURE"; "REQUEST CANCELLED"; "UNKNOWN DATA TYPE"; "INVALID OR MISSING FILE TYPE"; "FILE I/O ERROR"; "DATA ARCHIVE ERROR";	The disposition of processing the metadata file(s). Only the first error encountered is given.
TIME_STAMP	20	= yyyy-mm-ddThh:mm:ssZ; where: yyyy-mm-dd = date "T" = literal indicating start of time field hh:mm:ss = time "Z" = literal indicating Zulu time	GMT (Zulu) time when DAAC system transferred the last part of data

Table F-4 Short Production Acceptance Notification (PAN) File Format

PARAMETER NAME	SIZE (ASCII BYTES)	VALUE, FORMAT, RANGE, AND UNITS	PARAMETER DESCRIPTION / REMARKS
MESSAGE_TYPE	7	= LONGPAN;	Identifies this as a Long PAN file
NO_OF_FILES	1	= 1; or = 2;	Number of files in the PDR
FILE_DIRECTORY	18	= /IGS/META/xxx/DATA; where xxx is the 3-letter station ID as specified in Table 3-2	DIRECTORY_ID parameter from the PDR
FILE_NAME	24	=L7xxxppprrryyyymmddf.MTA; where: "L7" = constant (Landsat 7) xxx = station id code (ref. Table 3-2) ppp = WRS Path of first scene rrr = WRS Row of first scene yyyy = 4-digit Year of acquisition mm = Month (01-12) dd = Day (01-31) f = format in file (= 0 (both), 1, or 2) ".MTA" = constant (metadata file)	FILE_ID parameter from the PDR
DISPOSITION	up to 64	= one of the following: "SUCCESSFUL"; "NETWORK FAILURE"; "UNABLE TO ESTABLISH FTP/KFTP CONNECTION"; "ALL FILE GROUPS/FILES NOT FOUND"; "FTP/KFTP FAILURE"; "POST-TRANSFER FILE SIZE CHECK FAILURE"; "FTP/KFTP COMMAND FAILURE"; "DUPLICATE FILE NAME IN GRANULE"; "METADATA PREPROCESSING ERROR"; "RESOURCE ALLOCATION FAILURE"; "ECS INTERNAL ERROR"; "DATA BASE ACCESS ERROR"; "INCORRECT NUMBER OF METADATA FILES"; "INCORRECT NUMBER OF SCIENCE FILES"; "INCORRECT NUMBER OF FILES"; "DATA CONVERSION FAILURE"; "REQUEST CANCELLED"; "UNKNOWN DATA TYPE"; "INVALID OR MISSING FILE TYPE"; "FILE I/O ERROR"; "DATA ARCHIVE ERROR";	The disposition of processing the metadata file(s). Only the first error encountered is given.
TIME_STAMP	20	= yyyy-mm-ddThh:mm:ssZ; where: yyyy-mm-dd = date "T" = literal indicating start of time field hh:mm:ss = time "Z" = literal indicating Zulu time	GMT (Zulu) time when DAAC system transferred the last part of data
The last four parameters (FILE_DIRECTORY, FILE_NAME, DISPOSITION, and TIME_STAMP) are repeated for each file in the PDR.			

Table F-5 Long Production Acceptance Notification (PAN) File Format

```
MESSAGE_TYPE = SHORTPAN;
DISPOSITION = "INCORRECT NUMBER OF METADATA FILES";
TIME_STAMP = 1999-06-23T09:46:35Z;
```

```
MESSAGE_TYPE = LONGPAN;
NO_OF_FILES = 2;
FILE_DIRECTORY = /IGS/META/KUJ/DATA;
FILE_NAME = L7KUJ110035199911271.MTA;
DISPOSITION = "INVALID OR MISSING FILE TYPE";
TIME_STAMP = 1999-06-23T09:46:35Z;
FILE_DIRECTORY = /IGS/META/KUJ/DATA;
FILE_NAME = L7KUJ110035199911272.MTA;
DISPOSITION = "SUCCESSFUL"
TIME_STAMP = 1999-06-23T09:46:36Z;
```

Figure F-5 Example of Short and Long Production Acceptance Notification (PAN) Files

F.1.4 Electronic Transfer Error Handling and Backup Methods

During the course of data exchange via FTP, the following error conditions may arise:

- Failure to establish TCP/IP connection
- Erroneous FTP command
- File not found (listed in the PDR but not found on the disk)
- File not readable due to permissions

Should a problem develop during an FTP file transfer due to any of these error conditions, a number of attempts are made to pull the data. The number of attempts is specified by an operations parameter at the DAAC. In the event that problems cannot be resolved in this number of attempts, the DAAC and the IGS operations personnel have the option to coordinate metadata delivery on physical media. While the use of tape media as a backup is not a requirement, it may be useful during emergencies and is fully supported by the DAAC. If it is used, the metadata is delivered uncompressed.

In the event that tape media are used during emergencies, a separate Physical Media PDR file must be supplied for each tape delivered to the DAAC. The Physical Media PDR must be contained as a file on the tape. In the event that a file check on the tape by the DAAC reveals that the Physical Media PDR is missing or unreadable, IGS operations personnel supply DAAC operations personnel with a copy of the Physical Media PDR via fax transmission. The format and information content for the Physical Media PDR is the same as that specified in Section F.2.1.

F.2 PHYSICAL MEDIA TRANSFER

Metadata files may also be delivered to the EDC DAAC on physical media, as an alternative to electronic transfer or as a backup in cases of transfer problems. Currently, the only delivery mechanism for browse data, from the IGSs to the DAAC, is physical media. The corresponding subinterval metadata file(s) must accompany each delivery of browse data.

Figure F-6 summarizes the physical media transfer process. The transfer process is described below. The next three sections describe the files that facilitate the transfer, and the last two sections discuss error handling, and type and structure of media. The options for media type are all tape.

The Physical Media PDR, when processed, serves as a data availability notice for ingesting the IGS data from the tape. There is one Physical Media PDR per tape. The Physical Media PDR is structured such that there is one file group for each subinterval recorded on the tape. Within each file group, there is a file spec for one or two metadata files (depending on whether Formats 1 and 2 are packaged within a single file, or kept as separate files) and, possibly, up to 37 browse files.

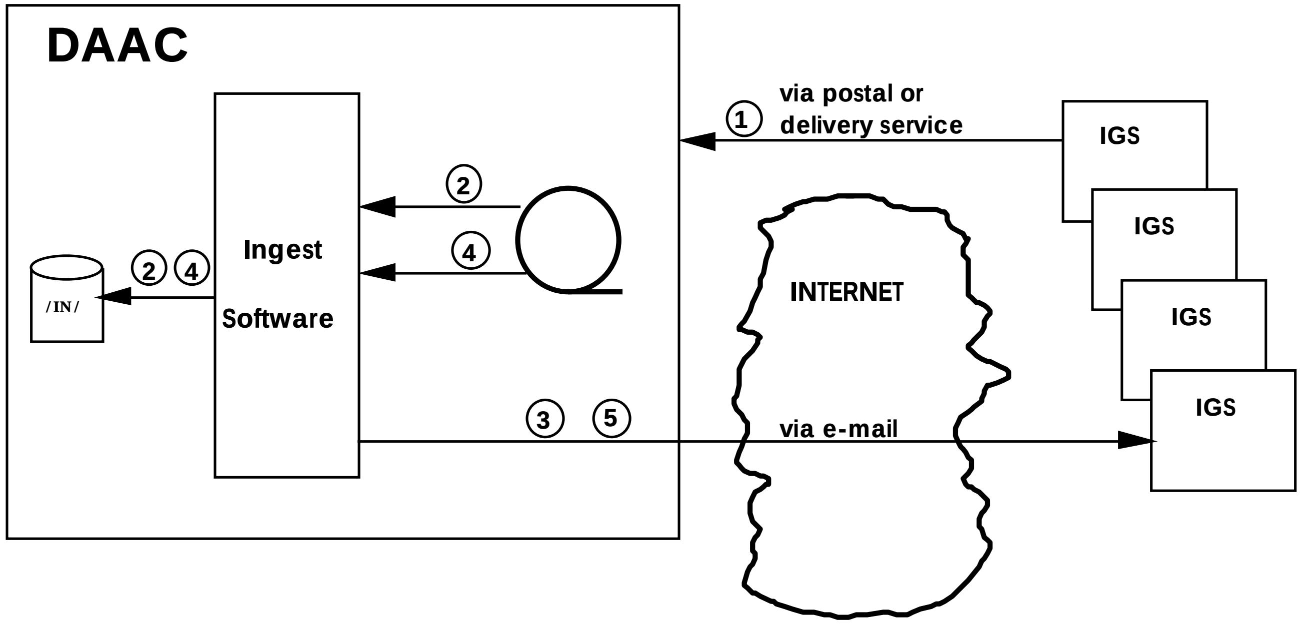
When a Physical Media PDR is ingested from tape, it is validated for proper content and format. If an error is found in the Physical Media PDR, processing is terminated, the associated metadata or browse files are not transferred, and either a short or long Physical Media PDR Discrepancy file is generated and sent to the originating IGS via e-mail. In either case, the original files are deleted from the DAAC system. The IGS corrects the problem reported in the Physical Media PDR Discrepancy file and resubmits the corrected Physical Media PDR and the associated metadata and browse files on physical media to the DAAC. When the Physical Media PDR is successfully transferred and validated, the DAAC does not send anything to the IGS but continues on to the next step of transferring the metadata and browse files for archiving.

The metadata and browse files are checked for conformance with the ODL standards. If no problems are found, the metadata and browse files are ingested into the archive and a short Physical Media PAN file, indicating the status of each file on the tape as successful, is generated and sent via e-mail to the IGS.

If a problem is found during transfer or ingest that affects all of the metadata and browse files on the tape, a short Physical Media PAN file is generated containing a description of the problem and is sent via e-mail to the IGS. Resubmission of the metadata and browse files is done as if it were the original submission – i.e., a Physical Media PDR file and the original set of metadata and browse files (with corrections as indicated by the short Physical Media PAN) are submitted via physical media to the DAAC. All of the previously submitted files (Physical Media PDR, metadata, and browse files) are deleted from the DAAC system.

If a problem is found during ingest or archival that affects some but not all of the metadata and browse files on the tape, a long Physical Media PAN file is generated containing a description of the problem and is sent via e-mail to the IGS. Every file group in which an error has been reported for at least one of its member files must be resubmitted in full, after correction of the reported error(s), as it was in the original submission – i.e., all of the metadata and browse files in each affected file group, and a new Physical Media PDR. All of the original files belonging to the file groups with reported errors are deleted from the DAAC server.

There is a one-to-one correspondence among the Physical Media PDR, the Physical Media PDR Discrepancy (if one is generated), and the Physical Media PAN files.



1. Metadata file(s), browse files, and associated Physical Media Product Delivery Record file are sent to the DAAC from the IGS on physical media via postal or delivery service.

2. The Physical Media Product Delivery Record is processed first.

3. If errors are found in the Physical Media Product Delivery Record, they are reported in the Physical Media PDR Discrepancy file which is sent via e-mail to the IGS.

4. After no errors are found in the Physical Media Product Delivery Record, metadata and browse data are ingested and processed.

5. Results of metadata and browse data processing are reported in the Physical Media Production Acceptance Notification file which is sent to the IGS via e-mail.

Figure F-6 DAAC Architecture and Data Flow for Physical Media Transfer

F.2.1 Physical Media PDR File

The Physical Media PDR contains information similar to that in the PDR used for electronic transfers. It is specified in Table F-6 and an example is given in Figure F-7. Indentation in the example is for readability only; it is not required formatting.

The IGS Physical Media PDR file naming convention is:

ORIGINATING_SYSTEM.yyyymmddhhmmss.PMPDR

where: ORIGINATING_SYSTEM. = value of originating system provided in Physical Media PDR (IGSxxx where xxx is a 3-letter station id, as defined in Table 3-2)
yyyymmdd = date of creation of associated Physical Media PDR file
hhmmss = time of creation of associated Physical Media PDR file
.PMPDR = constant, file extension which identifies this as a Physical Media PDR file

for example: IGSKUJ.19991127221345.PMPDR

The IGS Physical Media PDR contains a file group (identified by the parameter OBJECT = FILE_GROUP) for each subinterval on the tape. In the case of media transfers, there will probably be many subintervals on one tape and therefore many file groups per IGS Physical Media PDR. Within each file group (subinterval), there is a file spec (identified by the parameter OBJECT = FILE_SPEC) for each file. For metadata-only submissions, this may be one or two files, depending on whether Formats 1 and 2 are packaged within a single file, or kept as separate files. For browse submissions, this may be one or two metadata files per subinterval and up to 37 browse files per subinterval.

The Physical Media PDR is validated to check that all required fields contain valid values and that the format is correct and consistent with the standards. Physical Media PDRs that adhere to the defined message standards shown in Table F-6 are accepted and processed.

PARAMETER NAME	SIZE (ASCII BYTES)	VALUE, FORMAT, RANGE, AND UNITS	PARAMETER DESCRIPTION / REMARKS
ORIGINATING_SYSTEM	6	=IGSxxx; where: xxx = 3-letter station identifier as listed in Table 3-2	Identifies originating station
TOTAL_FILE_COUNT	1-4	= 1 - 9999;	Total number of files on the tape
OBJECT	10	=FILE_GROUP;	Start of file group parameters
DATA_TYPE	8	=L7IGS;	Identifies this file group as containing Landsat 7 IGS metadata and browse files for a subinterval
OBJECT	9	=FILE_SPEC;	Start of file specific parameters
FILE_ID	23-24	=L7xxxppprrryyyymmddf.MTA; or =L7xxxppprrryyyymmdd.Rnn; where: "L7" = constant (Landsat 7) xxx = station id code (ref. Table 3-2) ppp = WRS Path of first scene rrr = WRS Row of first scene yyyy = 4-digit Year of acquisition mm = Month (01-12) dd = Day (01-31) f = format in file (= 0 (both), 1, or 2) (applies to metadata filename only) ".MTA" = constant (metadata file) ".R" = constant (browse file) nn = sequence number of the scene in the subinterval for the browse file	File name - should match the file name specified in the metadata
FILE_TYPE	6-9	=METADATA0; or =METADATA1; or =METADATA2; or =BROWSE;	Identifies the data type in the file and whether both formats (0) are represented or just one of the formats; must be consistent with FILE_ID above
FILE_SIZE	10	= 0 - 9999999999; (formatted as unsigned 32-bit integer)	Number of bytes in this file; must be <2 GB
END_OBJECT	9	=FILE_SPEC;	End of file parameters
The previous five parameters (OBJECT=FILE_SPEC, FILE_ID, FILE_TYPE, FILE_SIZE, END_OBJECT=FILE_SPEC) are repeated for each file associated with the current subinterval (FILE_GROUP).			
END_OBJECT	10	=FILE_GROUP;	End of file group
The previous seven parameters (OBJECT=FILE_GROUP, the five parameters defining the file spec, and END_OBJECT=FILE_GROUP) are repeated for each subinterval on the tape.			

Table F-6 Physical Media Product Delivery Record File Format

```
ORIGINATING_SYSTEM = IGSKUJ;
TOTAL_FILE_COUNT = 7;
OBJECT = FILE_GROUP;
	DATA_TYPE = L7IGS;
		OBJECT = FILE_SPEC;
			FILE_ID = L7KUJ110035199911271.MTA;
			FILE_TYPE = METADATA1;
			FILE_SIZE = 11000;
		END_OBJECT = FILE_SPEC;
		OBJECT = FILE_SPEC;
			FILE_ID = L7KUJ110035199911272.MTA;
			FILE_TYPE = METADATA2;
			FILE_SIZE = 11000;
		END_OBJECT = FILE_SPEC;
		OBJECT = FILE_SPEC;
			FILE_ID = L7KUJ11003519991127.R01;
			FILE_TYPE = BROWSE;
			FILE_SIZE = 100000;
		END_OBJECT = FILE_SPEC;
END_OBJECT = FILE_GROUP;
OBJECT = FILE_GROUP;
	DATA_TYPE = L7IGS;
		OBJECT = FILE_SPEC;
			FILE_ID = L7KUJ112035199911301.MTA;
			FILE_TYPE = METADATA1;
			FILE_SIZE = 11000;
		END_OBJECT = FILE_SPEC;
		OBJECT = FILE_SPEC;
			FILE_ID = L7KUJ112035199911302.MTA;
			FILE_TYPE = METADATA2;
			FILE_SIZE = 11000;
		END_OBJECT = FILE_SPEC;
		OBJECT = FILE_SPEC;
			FILE_ID = L7KUJ11203519991130.R01;
			FILE_TYPE = BROWSE;
			FILE_SIZE = 100000;
		END_OBJECT = FILE_SPEC;
		OBJECT = FILE_SPEC;
			FILE_ID = L7KUJ11203519991130.R02;
			FILE_TYPE = BROWSE;
			FILE_SIZE = 100000;
		END_OBJECT = FILE_SPEC;
END_OBJECT = FILE_GROUP;
```

(This example illustrates one tape containing two subintervals, both of which have separate files for Format 1 and Format 2 metadata. The first subinterval has one scene, the second subinterval has 2 scenes.)

Figure F-7 Example of Physical Media Product Delivery Record (PDR) File

F.2.2 Physical Media PDR Discrepancy File

The Physical Media PDR Discrepancy file is sent by the DAAC to the IGS only in the event that the Physical Media PDR cannot be validated. The Physical Media PDR specifies multiple file groups, which may each contain multiple file specs. Processing of a file group in a Physical Media PDR ceases when the first error in that file group is found. There may be further errors in the same file group but only this first error is reported. The PDR Discrepancy file identifies the disposition of each file group - either successful or which errors or problems were found.

There are two forms of Physical Media PDR Discrepancy files: a short form and a long form. The short form is used for PDRs with errors that are not attributable to specific file groups, such as transfer errors. Otherwise, the long form is used. The short form is specified in Table F-7; the long form is specified in Table F-8. An example of each is shown in Figure F-8.

The IGS Physical Media PDR Discrepancy file naming convention is:

ORIGINATING_SYSTEM.yyyymmddhhmmss.PMPDRD

where: ORIGINATING_SYSTEM. = value of originating system provided in Physical Media PDR (IGSxxx where xxx is a 3-letter station id, as defined in Table 3-2)
yyyymmdd = date of creation of associated Physical Media PDR file
hhmmss = time of creation of associated Physical Media PDR file
.PMPDRD = constant, file extension which identifies this as a Physical Media PDR Discrepancy file (DAAC nomenclature)

for example: IGSKUJ.19991127221345.PMPDRD

The file name of the Physical Media PDR Discrepancy file is placed in the subject line of the e-mail message. The body of the e-mail message contains the parameters and values in Table F-7 or F-8.

The Operations Agreement (Reference Document 7) explains the actions to be taken by the IGS in response to each reported disposition in the Physical Media PDR Discrepancy file.

PARAMETER NAME	SIZE (ASCII BYTES)	VALUE, FORMAT, RANGE, AND UNITS	PARAMETER DESCRIPTION / REMARKS
MESSAGE_TYPE	11	= SHORTPMPDRD;	Identifies this as a Short Physical Media PDR Discrepancy file
DISPOSITION	up to 64	= one of the following: "INVALID FILE COUNT"; "ECS INTERNAL ERROR"; "DATABASE FAILURES"; "INVALID PVL STATEMENT"; (note 1) "MISSING OR INVALID ORIGINATING_SYSTEM PARAMETER"; "DATA PROVIDER REQUEST THRESHOLD EXCEEDED"; "DATA PROVIDER VOLUME THRESHOLD EXCEEDED"; "SYSTEM REQUEST THRESHOLD EXCEEDED"; "SYSTEM VOLUME THRESHOLD EXCEEDED";	The discrepancy that was found in the Physical Media PDR file. Only the first error encountered is given.

note 1: Should be interpreted as invalid statement format

Table F-7 Short Physical Media PDR Discrepancy File Format

PARAMETER NAME	SIZE (ASCII BYTES)	VALUE, FORMAT, RANGE, AND UNITS	PARAMETER DESCRIPTION / REMARKS
MESSAGE_TYPE	10	= LONGPMPDRD;	Identifies this as a Long Physical Media PDR Discrepancy file
NO_FILE_GRPS	1-4	= 1-9999	Number of file groups to follow
DATA_TYPE	8	= L7IGS;	Data type from Physical Media PDR.
DISPOSITION	up to 64	= one of the following: "SUCCESSFUL"; "INVALID DATA TYPE"; "INVALID DIRECTORY"; "INVALID FILE SIZE"; "INVALID FILE ID"; "INVALID NODE NAME"; "INVALID FILE TYPE";	The successful disposition or the discrepancy that was found in the Physical Media PDR file. Only the first error encountered is given. All checks except file size are for null strings. File size is checked for null string, <0, =0, and ^{3}2GB.
The last two parameters (DATA_TYPE and DISPOSITION) are repeated for each file group in the Physical Media PDR.			

Table F-8 Long Physical Media PDR Discrepancy File Format

MESSAGE_TYPE = SHORTPMPDRD;
DISPOSITION = "INVALID PVL STATEMENT";

MESSAGE_TYPE = LONGPMPDRD;
NO_FILE_GRPS = 2;
DATA_TYPE = L7IGS;
DISPOSITION = "INVALID FILE SIZE";
DATA_TYPE = L7IGS;
DISPOSITION = "SUCCESSFUL";

Figure F-8 Example of Short and Long Physical Media PDR Discrepancy Files

F.2.3 Physical Media PAN File

The Physical Media PAN file announces the completion of data ingest and archival of the metadata and browse files from tape, and identifies any errors or problems that were encountered. The Physical Media PDR specifies multiple file groups, which may contain multiple file specs. All files are checked and reported on, regardless of the number of files found with errors or the number of errors found in each file. However, only the first error in each file is reported.

There are two forms of the Physical Media PAN files: a short form and a long form. The short form is sent to acknowledge that all files have been successfully transferred, or to report errors which are not specific to individual files but which have precluded processing of any and all files. If errors were found in specific files, a long form Physical Media PAN is sent. The last three fields of the long form are repeated for each file group. The short form is specified in Table F-9; the long form is specified in Table F-10. An example of each is shown in Figure F-9.

The Physical Media PAN file naming convention is:

ORIGINATING_SYSTEM.yyyymmddhhmmss.PMPAN

where: ORIGINATING_SYSTEM. = value of originating system provided in Physical Media PDR (IGSxxx where xxx is a 3-letter station id, as defined in Table 3-2)
yyyymmdd = date of creation of associated Physical Media PDR file
hhmmss = time of creation of associated Physical Media PDR file
.PMPAN = constant, file extension which identifies this as a Physical Media PAN file

for example: IGSKUJ.19991127221345.PMPAN

The file name of the Physical Media PAN file is placed in the subject line of the e-mail message. The body of the e-mail message contains the parameters and values in Table F-9 or F-10.

The Operations Agreement (Reference Document 7) explains the actions to be taken by the IGS in response to each reported disposition in the Physical Media PAN file.

PARAMETER NAME	SIZE (ASCII BYTES)	VALUE, FORMAT, RANGE, AND UNITS	PARAMETER DESCRIPTION / REMARKS
MESSAGE_TYPE	10	= SHORTPMPAN;	Identifies this as a Short Physical Media PAN file
DISPOSITION	up to 64	= one of the following: "SUCCESSFUL"; "NETWORK FAILURE"; "UNABLE TO ESTABLISH FTP/KFTP CONNECTION"; "ALL FILE GROUPS/FILES NOT FOUND"; "FTP/KFTP FAILURE"; "POST-TRANSFER FILE SIZE CHECK FAILURE"; "FTP/KFTP COMMAND FAILURE"; "DUPLICATE FILE NAME IN GRANULE"; "METADATA PREPROCESSING ERROR"; "RESOURCE ALLOCATION FAILURE"; "ECS INTERNAL ERROR"; "DATA BASE ACCESS ERROR"; "INCORRECT NUMBER OF METADATA FILES"; "INCORRECT NUMBER OF SCIENCE FILES"; "INCORRECT NUMBER OF FILES"; "DATA CONVERSION FAILURE"; "REQUEST CANCELLED"; "UNKNOWN DATA TYPE"; "INVALID OR MISSING FILE TYPE"; "FILE I/O ERROR"; "DATA ARCHIVE ERROR";	The disposition of processing the metadata and browse files. Only the first error encountered is given.
TIME_STAMP	20	= yyyy-mm-ddThh:mm:ssZ; where: yyyy-mm-dd = date "T" = literal indicating start of time field hh:mm:ss = time "Z" = literal indicating Zulu time	GMT (Zulu) time when DAAC system transferred the last part of data

Table F-9 Short Physical Media PAN File Format

PARAMETER NAME	SIZE (ASCII BYTES)	VALUE, FORMAT, RANGE, AND UNITS	PARAMETER DESCRIPTION / REMARKS
MESSAGE_TYPE	9	= LONGPMPAN;	Identifies this as a Long Physical Media PAN file
NO_OF_FILES	1-4	= 1-9999;	Number of files in the Physical Media PDR
FILE_NAME	23-24	=L7xxxppprrryyyymmddf.MTA; or =L7xxxppprrryyyymmdd.Rnn; where: "L7" = constant (Landsat 7) xxx = station id code (ref. Table 3-2) ppp = WRS Path of first scene rrr = WRS Row of first scene yyyy = 4-digit Year of acquisition mm = Month (01-12) dd = Day (01-31) f = format in file (= 0 (both), 1, or 2) (applies to metadata file name only) ".MTA" = constant (metadata file) ".R" = constant (browse file) nn = sequence number for the scene in the subinterval for the browse file	FILE_ID parameter from the Physical Media PDR
DISPOSITION	up to 64	= one of the following: "SUCCESSFUL"; "NETWORK FAILURE"; "UNABLE TO ESTABLISH FTP/KFTP CONNECTION"; "ALL FILE GROUPS/FILES NOT FOUND"; "FTP/KFTP FAILURE"; "POST-TRANSFER FILE SIZE CHECK FAILURE"; "FTP/KFTP COMMAND FAILURE"; "DUPLICATE FILE NAME IN GRANULE"; "METADATA PREPROCESSING ERROR"; "RESOURCE ALLOCATION FAILURE"; "ECS INTERNAL ERROR"; "DATA BASE ACCESS ERROR"; "INCORRECT NUMBER OF METADATA FILES"; "INCORRECT NUMBER OF SCIENCE FILES"; "INCORRECT NUMBER OF FILES"; "DATA CONVERSION FAILURE"; "REQUEST CANCELLED"; "UNKNOWN DATA TYPE"; "INVALID OR MISSING FILE TYPE"; "FILE I/O ERROR"; "DATA ARCHIVE ERROR";	The disposition of processing the file. Only the first error encountered is given.
TIME_STAMP	20	= yyyy-mm-ddThh:mm:ssZ; where: yyyy-mm-dd = date "T" = literal indicating start of time field hh:mm:ss = time "Z" = literal indicating Zulu time	GMT (Zulu) time when DAAC system transferred the last part of data
The last three fields (FILE_NAME, DISPOSITION, TIME_STAMP) are repeated for each file on tape.			

Table F-10 Long Physical Media PAN File Format

```
MESSAGE_TYPE = SHORTPMPAN;
DISPOSITION = "INCORRECT NUMBER OF FILES";
TIME_STAMP = 1999-06-23T09:46:35Z;
```

```
MESSAGE_TYPE = LONGPMPAN;
NO_OF_FILES = 7;
FILE_NAME = L7KUJ110035199911271.MTA;
DISPOSITION = "DUPLICATE FILE NAME IN GRANULE";
TIME_STAMP = 1999-06-23T09:46:35Z;
FILE_NAME = L7KUJ110035199911272.MTA;
DISPOSITION = "SUCCESSFUL";
TIME_STAMP = 1999-06-23T09:46:36Z;
FILE_NAME = L7KUJ11003519991127.R01;
DISPOSITION = "SUCCESSFUL";
TIME_STAMP = 1999-06-23T09:46:37Z;
FILE_NAME = L7KUJ112035199911301.MTA;
DISPOSITION = "SUCCESSFUL";
TIME_STAMP = 1999-06-23T09:46:38Z;
FILE_NAME = L7KUJ112035199911302.MTA;
DISPOSITION = "SUCCESSFUL";
TIME_STAMP = 1999-06-23T09:46:39Z;
FILE_NAME = L7KUJ11203519991130.R01;
DISPOSITION = "SUCCESSFUL";
TIME_STAMP = 1999-06-23T09:46:40Z;
FILE_NAME = L7KUJ11203519991130.R02;
DISPOSITION = "INVALID OR MISSING FILE TYPE";
TIME_STAMP = 1999-06-23T09:46:41Z;
```

Figure F-9 Example of Short and Long Physical Media PAN Files

F.2.4 Physical Media Transfer Error Handling

In the event that a file check on the tape by the DAAC reveals that the Physical Media PDR is missing or unreadable, IGS operations personnel supply DAAC operations personnel with a hard copy of the Physical Media PDR via fax transmission.

If the tape cannot be read at all, the Mission Management Office will be notified. In this situation, the DAAC cannot generate a Physical Media PDR Discrepancy file as it needs to read the Physical Media PDR in order to generate the discrepancy file.

F.2.5 Type and Structure of Physical Media

The standard physical media type used for the transfer of data to and from the EDC DAAC is 8mm cartridge tape (112 meters, 5 GB standard capacity). The DAAC additionally supports 4mm digital audio tape (90 meters, 2 GB standard capacity).

The format of the 8 mm tape is a Unix Tar file, with a record blocking factor of 127. The Tar tape format is ported. The tape is labeled externally with a paper label listing the names of the files on the tape, in the order they were written to the tape.

The DAAC is compliant with the ANSI and ISO standards for physical and logical file formats for the appropriate physical media. The logical structure for 8 mm tape includes a volume description file containing a list of all files on the tape. This is the Physical Media PDR.

APPENDIX G
FILE EXCHANGE WITH THE MOC

G.1 SENDING FILES FROM MOC TO IGS

The communications architecture for electronic file transfer between the MOC and the IGSs is shown in Figure G-1. When the MOC generates files to be sent to the IGSs, these files are placed in an output directory on a server on the closed side of the firewall. In the MOC, the Flight Dynamics Facility Orbit and Mission Aids Transformation System (FORMATS) software manages file transfers across the firewall. The FORMATS software polls the output directory for files waiting to be sent. When an IGS file is sensed, FORMATS transfers the file to the appropriate IGS output directory on the open server. Figure G-2 shows the directory structure on the open server for messages to be sent to the IGSs. The IGSs poll their assigned output directories on the open server and retrieve new files using an FTP "get".

G.2 SENDING FILES FROM IGS TO MOC

When an IGS generates files to be sent to the MOC, these files are placed in the appropriate input directory on the MOC open server using an FTP "put". Figure G-3 shows the directory structure on the open server for messages received from the IGSs. The FORMATS software polls the input directories on the MOC open server to see if files have been received from an IGS. When a file from an IGS is sensed, FORMATS transfers the file to the appropriate MOC directory on a server on the closed side of the firewall.

G.3 ACKNOWLEDGING RECEIPT OF FILES FROM IGS

The FORMATS software generates a Product Report as an acknowledgment to the IGS that the file was received and successfully transferred into the MOC. For Service Request messages, the Product Report also indicates the results of validation. The Product Report is placed in the appropriate IGS output directory on the MOC open server, in accordance with Figure G-2, within 5 minutes of product receipt. Figure G-4 shows an example of a FORMATS Product Report reporting no errors and a FORMATS Product Report reporting one error. The FORMATS Product Report file name consists of the full file name of the input file from the IGS with the letters IRPT or ERPT appended to the extension. Field content validation is performed only on the Service Request message and includes:

- Effective date ² Expiration date
- Path = 001 - 233
- Start row = 001 - 248
- Stop row = 001 - 248
- Start Row ² Stop Row
- Acquisition Rate = 0 or 1

The file name convention for the FORMATS Product Report is:

[Original file name]xRPT

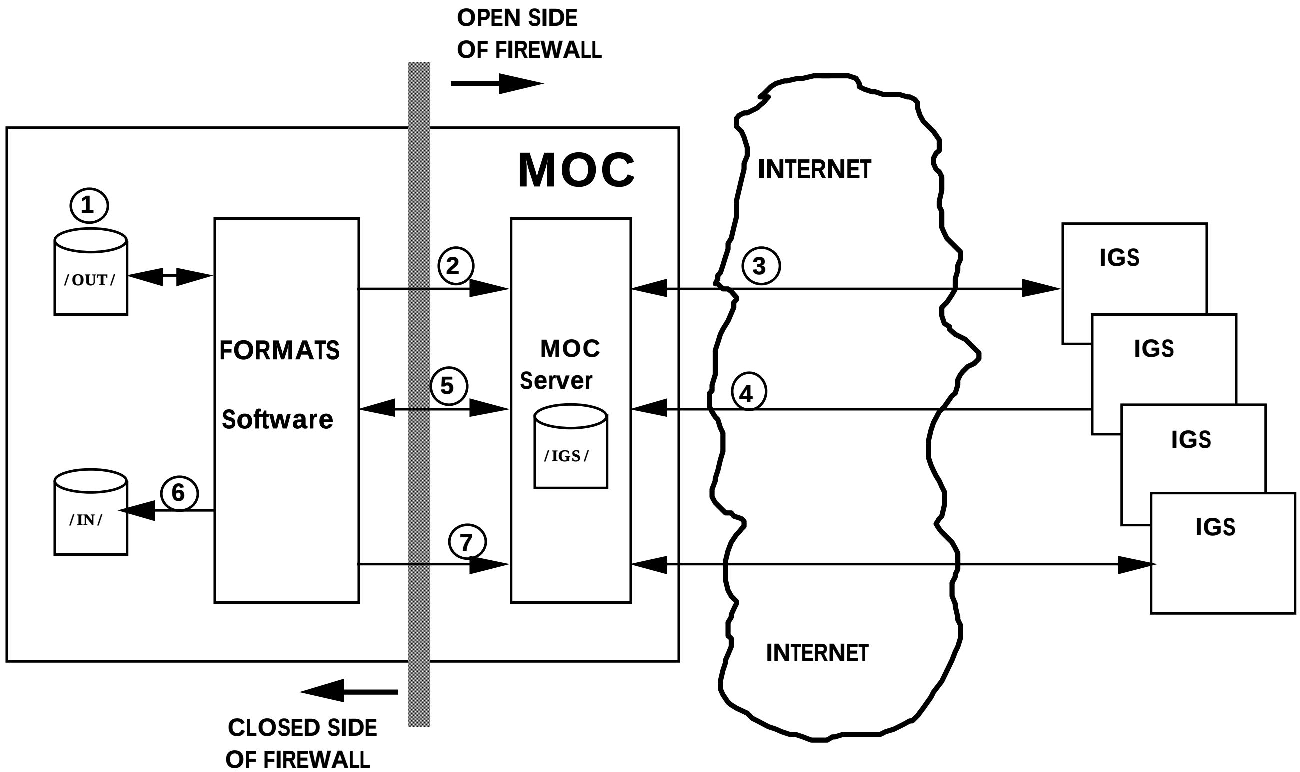
where: [Original file name] = the name of the file that was transferred into the MOC and is being acknowledged, including the file extension
x = severity of the message:
I = informational, no errors are being reported
E = error(s) is(are) being reported
RPT = constant, identifies this as a Report file

for example: L71997153DKIREQ.S00IRPT

G.4 DIRECTORY MAINTENANCE ON THE OPEN SERVER

Each IGS has both read and write privileges in their own directories. The IGSs are responsible for file maintenance and cleanup of the output directory (used by the MOC to send files to the IGSs). There is no need for the IGSs to maintain the input directory, because FORMATS removes the files from the input directory as soon as it processes them. The MOC periodically initiates a file purge on the output directories, to make sure that the directories are not in use as long term storage of files. This purge occurs at approximately 30-day intervals, under operator initiation and control. Advance warning of the purge is given to the IGSs via the ADM message.

Further details on all aspects of file exchange with the MOC are found in the Operations Agreement (Reference Document 7).



1. Files (messages) to be sent from the MOC to the IGSs are placed in MOC output directories for pickup by FORMATS.
2. FORMATS polls the MOC output directories for IGS files and places them on the open server in the appropriate IGS output directory.
3. The IGSs poll the open server and "get" files via FTP.
4. Files to be sent from the IGSs to the MOC are "put" on the open server in the appropriate IGS input directory.
5. FORMATS polls the open server and "get"s files via FTP.
6. Files are validated and transferred to the appropriate MOC server.
7. FORMATS generates Product Report as acknowledgment of files received from the IGS and transferred into the MOC, or to report errors found during validation of the Service Request message.

Figure G-1 MOC Communications Architecture and Message Flow

```
FOR ADM, PRB, REQ, DES, MSK MESSAGES

C:\LS7\ProductRepository\Inbound\Station\<country>\<sta id>\Products


where:
 <country> = country name from Table 3-2, with blanks and commas
removed
 <sta id>  = three-letter station id from Table 3-2

examples:
  C:\LS7\ProductRepository\Inbound\Station\Australia\ASA\Products
  C:\LS7\ProductRepository\Inbound\Station\Australia\HOA\Products
```

Figure G-2 Directory Structure on the MOC Open Server for Incoming Files

```
FOR ADM, SCH, BME, IRV, NOR MESSAGES, AND FOR CPF FILES

C:\LS7\ProductRepository\Outbound\Station\<country>\<sta id>\Products

FOR FORMATS PRODUCT REPORTS

C:\LS7\ProductRepository\Outbound\Station\<country>\<sta id>\Reports


where:
 <country> = country name from Table 3-2, with blanks and commas
removed
 <sta id>  = three-letter station id from Table 3-2

examples:
  C:\LS7\ProductRepository\Outbound\Station\SaudiArabia\RSA\Products
  C:\LS7\ProductRepository\Outbound\Station\TaipeiChina\CLT\Reports
```

Figure G-3 Directory Structure on the MOC Open Server for Outgoing Files

FORMATS Product Report

L71999176HOAREQ.S01xRPT
Date Generated: 1999:176:14:15:46

Product: 309_SVCREQ
Incoming File: L71999176HOAREQ.S01

Message Type	Message
INFO	L71999176HOAREQ.S01 received by Transform.
ERROR	in parsing template cannot open file /home/formats/mmitchel/develop/data/Support/ls7_igsSvcRqst_val.TPL: No such file or directory
ERROR	Unable to parse template /home/formats/mmitchel/develop/data/Support/ls7_igsSvcRqst_val.TPL. 0 syntax errors
ERROR	71999176HOAREQ.S01 data, template or I/O error while validating with ls7_igsSvcRqst_val.TPL
WARN	Could not send event to MOC event log

Error count = 3
Warning count = 1
Total Messages = 5

FORMATS Product Report

L71999176HOAREQ.S01xRPT
Date Generated: 1999:176:14:15:46

Product: 309_SVCREQ
Incoming File: L71999176HOAREQ.S01

Message Type	Message
INFO	L71999176HOAREQ.S01 received by Transform.
INFO	[numReq1] (template line 210 input file line 13 offset 392) : 1 request received
INFO	L71999176HOAREQ.S01 passed validation using ls7_igsSvcRqst_val.TPL.
INFO	L71999176HOAREQ.S01 reformatted OK to L71999176HOAREQ.S01.schRqst using ls7_igsSvcRqst_rfm.TPL
INFO	L71999176HOAREQ.S01 sent to Transmit.

Error count = 0
Warning count = 0
Total Messages = 5

Figure G-4 Sample of FORMATS Product Reports