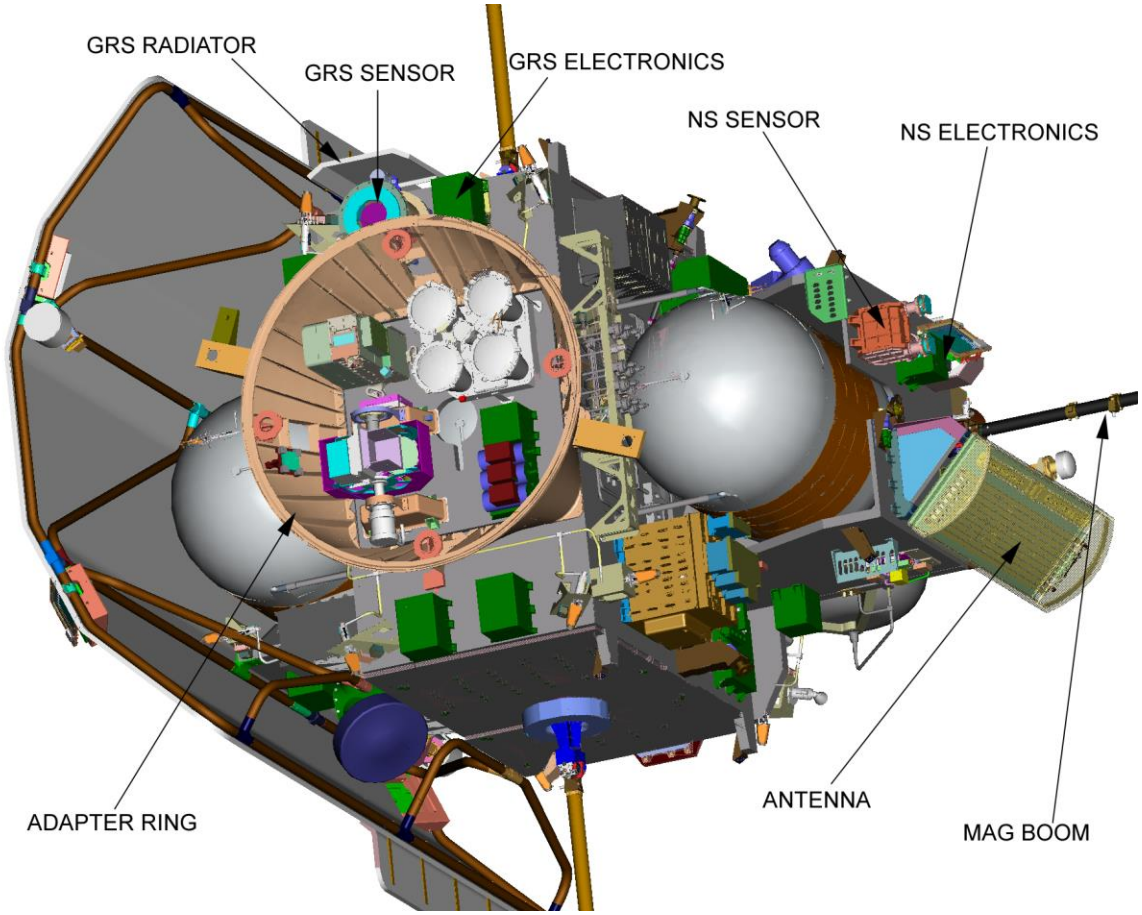
MESSENGER Software Interface Specification for the Neutron Spectrometer Experiment Data Records

Version 4.4



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Document Review

This document and the archive it describes have been through PDS Peer Review and have been accepted into the PDS archive.

David Lawrence, MESSENGER NS Instrument Scientist, has reviewed and approved this document.

Susan Slavney, PDS Geosciences Node Representative, has reviewed and approved this document.

Susan Ensor, MESSENGER Science Operations Center Lead, has reviewed and approved this document.

Revision History

Version Number	Date	Section	Changes
4	12/22/2008	N/A	• Start of revision history: version included in MESSENGER PDS Release 4.
4.1	11/9/2009	5.3.4.9	• Changed ROW_BYTES from 79 to 80 for NS Calibration/Diagnostic EDR. The extra byte comes from the line-feed character that was missing previously.
4.2	6/15/11	Document Review, Revision History, 8	• Replaced signature page with document review information • Changed "periherm" to "apoherm" in description of orbit start times for orbit numbering. • Add section column to revision history table.
4.3	5/25/12	2, 7	• Change document name *Data Management and Science Analysis Plan* to *Data Management and Archiving Plan*. Update references. • Reference *MESSENGER Data Management and Archiving Plan* for release schedule and remove delivery schedule table from this document.
4.4	7/7/15	Title and various sections, 5.4.3	• Change "Experimental Data Record" to "Experiment Data Record" in document name and text. • Note use of clock partitions in time tags in product labels following January 8, 2013 S/C clock reset.

Table of Contents

1. Purpose and Scope of Document

1.1. Purpose

This document will serve to provide users of the MESSENGER Neutron Spectrometer (NS) data products with a basic description of the Neutron Spectrometer instrument and Experiment Data Records (EDRs). The NS EDR data products are deliverables to the Planetary Data System (PDS) and the scientific community that it supports. Note that the Gamma Ray Spectrometer (GRS) and Neutron Spectrometer instruments are generally referred to together as the Gamma-Ray and Neutron Spectrometer (GRNS) instrument. However they are two separate instruments, each with its own Event Processing Unit (EPU) and the data products are described within the specific SIS of each instrument. This document is both an EDR data product SIS and an EDR archive volume SIS.

1.2. Scope

This Software Interface Specification (SIS) document is of a very limited scope due to the EDRs being of a very low-level. It does not provide a description or understanding of the NS instrument or its EDRs at a detailed level. It is not intended for general use by data analysts outside of the MESSENGER project and it is not intended for the typical science user to access the EDRs routinely. Rather, the EDRs are mainly useful as an input to producing the Calibrated Data Record (CDR) and Reduced Data Record (RDR) products. There will be a separate PDS data archive for the CDR and RDR products and these products will be described by a separate RDR SIS.

Data are converted to engineering and science units from raw EDR units (such as conversion of bins to energies and binary numbers to temperatures) in the CDRs, which will be accompanied by calibration reports describing the calibration process. CDR and RDR products planned to be produced are identified in the MESSENGER Data Management and Archiving Plan which also contains the schedule for their delivery to PDS.

2. Applicable Documents

The MESSENGER NS SIS is responsive to the following Documents:

- Planetary Data System (PDS) Standards Reference, Aug 1, 2003, Version 3.6. JPL D-7669, Part-2.
- Neutron Spectrometer Flight Software Specification 7386-9042, June 2, 2003; Revision Memo SIE-04-008, January 13, 2004.
- MESSENGER Data Management and Archiving Plan, The Johns Hopkins University, APL. Document ID number 7384-9019

- MESSENGER Mercury: Surface, Space Environment, Geochemistry, Ranging; A mission to Orbit and Explore the Planet Mercury, Concept Study, March 1999. Document ID number FG632/99-0479
- Appendix 7 to the discovery program Plan; Program Level Requirement for the MESSENGER Discovery project; June 20, 2001.
- The MESSENGER Gamma-ray and Neutron Spectrometer, Space Science Reviews 131, 339-391, 2007.

3. Relationships with other Interfaces

The NS data products are stored on Hard Disk and in an SQL (Structured Query Language) relational database for rapid mission access during mission operations. The data products will be electronically transferred to the PDS Geosciences Node according to the delivery schedule in the MESSENGER Data Management and Archiving Plan. The data in the EDR files themselves will be stored in a PDS binary table object with the exception of the NS Status and NS Calibration/Diagnostic EDRs. These two EDRs will consist of data stored in PDS ASCII table objects.

4. Roles and Responsibilities

The roles and responsibilities of the instrument teams, Applied Physics Lab (APL), Applied Coherent Technology (ACT), and the Planetary Data System (PDS) are defined in the MESSENGER Data Management and Archiving Plan.

5. Data Product Characteristics and Environment

5.1. Instrument Overview

The Mercury Surface, Space Environment, Geochemistry and Ranging (MESSENGER) mission is designed to orbit Mercury following two flybys each of Venus and Mercury. It launched in August 2004 and will use several flybys of Venus and Mercury to achieve an orbit insertion around Mercury on March 2011. Initial data collection will begin during the first two flybys of Mercury, and will primarily consist of global mapping and measurements of the surface, atmosphere and magnetosphere composition. MESSENGER will then remain in orbit for the rest of the nominal mission, which is scheduled to end in March 2012 [see MESSENGER Data Management and Archiving Plan for extended mission updates]. Once in orbit around Mercury it will begin a series of observations using multiple instruments. These observations will provide data to answer questions about the nature and composition of Mercury's crust, tectonic history, the structure of the atmosphere and magnetosphere, and the nature of the polar caps.

The Neutron Spectrometer (NS) is one of the instruments onboard the MESSENGER spacecraft. It is designed to observe the neutrons emitted from Mercury's surface in the thermal, epithermal, and fast energy ranges, from ~ 0. 01 eV to 7 MeV, that are produced by nuclear reactions by the cosmic ray background (CRB). Elements that can be most readily identified by the NS include those that strongly moderate and absorb neutrons (hydrogen and rare earths). The approximate average element atomic mass can also be

estimated. It may be feasible for the NS to measure the water content at Mercury's north pole.

The MESSENGER NS consists of a sandwich of three scintillators that are optically decoupled from each other. The first and third scintillators are lithium (^{6}Li)-glass scintillators (LiG) which respond to a combination of thermal and epithermal neutrons that span the range between 0 eV and about 1 keV. (Thermal neutrons correspond to 0 to ~ 0.025 eV and epithermal neutrons correspond to ~ 0.025 eV up to ~ several keV.) The middle scintillator is a borated plastic (BP) scintillator that responds only to epithermal and fast neutrons, since it is surrounded by thermal neutron absorbers (LiG on each end and wrapped with a sheet of gadolinium). Each of these scintillators generates a neutron spectrum (or histogram) When a neutron interacts with one of these scintillators, a charge is generated in its electronics. The charge is converted into one of 64 LiG channels (32 for the old NS spectra in Sec. 5.2) or 64 (BP) channels, which are correlated to the energy deposited in the scintillators. Over a commanded integration time period the distribution of events (neutron interactions) as a function of equivalent-electron energy (channel number) is recorded. The result is a histogram of the number of events in each channel accumulated over the integration period, which is designated as a singles prompt neutron spectrum. Three such spectra are produced, one by each lithium-glass (LiG) scintillator and one by the borated plastic (BP) scintillator. (Some of the neutrons detected in the BP scintillator will be downscattered to thermal energies and be detected in the LiG scintillators.)

Time-correlated events in the BP scintillator provide a measure of the neutron energies of the flux of fast neutrons 0.7 MeV < E < 7 MeV). These events are defined by a time-correlated pair of interactions in the BP scintillator. The first pulse corresponds to a neutron that loses all of its energy (above detection threshold and thermal neutron energies) in the BP scintillator, since the second pulse corresponds to the energy released by the $^{10}B(n,\alpha)^7Li$ reaction after the neutron has slowed down to thermal energies and has been absorbed in the scintillator. The signature of the time-correlated events includes the pulse height (measure of energy) of the first event (called the prompt energy, E_p), the pulse height of the second event that corresponds to the Q-value of the $^{10}B(n,\alpha)^7Li$ reaction (called the capture energy, E_c), and the time between first and second events (or Time To Second Pulse, TTSP). When a fast neutron interacts with the BP scintillator, a charge is generated corresponding to E_p. The charge is converted into channels, which are correlated to neutron energy. Over a commanded integration time period the distribution of E_p events as a function of energy (channel number) is recorded. The result is a histogram of the number of E_p events in each channel accumulated over the integration period for TTSP values between 0.3 and 5.4 μs, which is designated as the time-correlated early spectrum corresponding to E_c. A time-correlated late spectrum histogram is also accumulated, for events whose second pulse occurs substantially later than expected, for TTSP values between 20 and 25 μs, as a measure of spectrum background. The two TTSP spectra each have 256 channels (8 quasilog channels for the old NS spectra in Sec. 5.2).

In addition to the five spectra described above, the NS EDRs include a precommanded set of up to the first 256 events of BP event-mode data at higher precision E_p, E_c, and TTSP values (16 bits, 16 bits, and 8 bits respectively). (E_p has a precision of only 8 bits for the old NS events in Sec. 5.2.) The event-mode data (E_p, E_c, and TTSP) are event-by-event time-series data of fast-neutron events, rather than energy histograms. Over the integration time period, a set of event classification flags is polled to determine whether valid BP sensor events have occurred. An additional event mode produces the Calibration/Diagnostics data in higher precision along with data quality and event classification flags, up to the first 96 events, as generated in any of the LG or BP sensors. (Normally only the instrument engineer would activate the Calibration/Diagnostics mode and examine the subsequent data.)

Neutron and gamma-ray burst modes are also available. The gamma-ray and neutron burst data packets are of astrophysical interest and are present when the corresponding mode is activated. Gamma-rays are detected by the NS sensors, as well as neutrons, and the BP sensor detects gamma-rays of the widest energy range with the highest efficiency, of the three sensors. Gamma-ray bursts are detected as BP counts that exceed a settable threshold over background as determined by a running average of a counter. The gamma-ray burst packet contains a time series of 1-s counts starting and ending at settable pre- and post-trigger times, along with the trigger time and other parameters. Neutron burst packets are not really detected bursts against some threshold but rather a subset of the normal neutron science packets called Short Science packets (fast neutrons only) that allows determination of neutron bursts as a reduced data set, enabling neutron burst mode to operate on much shorter time scales with little increase in data rate. These modes are useful for examining solar events, particularly solar neutrons.

Another data mode, available only after the software upload decribed in Sec. 5.2, is the GCR (Galactic Cosmic Ray) mode, in which GCRs are identified by coincidence between each LiG sensor and the BP sensor (double coincidences) and/or by coincidences between all three sensors (triple coincidences). The two 64-channel spectra from the LiG sensors associated with these coincidences have a broad central peak that facilitates setting gains and discriminators for these sensors. The non-coincident LiG sensor spectra have no identifiable peak, making such settings difficult.

The NS data rate is driven by the integration time for the spectra, since these EDRs constitute the largest amount of data. Since the orbital neutron flux is significantly higher than the gamma-ray flux, the NS integration times can be smaller than those for the GRS while still retaining statistical significance. Assumption of a reasonable 20-second integration time at low and moderate altitudes and correspondingly larger integration times at higher altitudes yields an estimated data rate of 4 Mbits per earth day. Further information on the NS instrument can be found in the MESSENGER instrument paper (not yet published).

5.2. Data Product Overview

There are ten different types of NS data products. The data products are identified via the value for the STANDARD_DATA_PRODUCT_ID within each PDS label. The data

products were modified by a software upload that occurred on 6/1/2006 (DOY 152). The upload occurred just after the NS was booted up on this date, so this upload applies to all data products generated on or after 6/1/2006. The NS Spectra was replaced by the NS Full Science Spectra in this upload, the NS GCR Spectra was created, and minor updates were made to some other data products. The NS Full Science Spectra and GCR Spectra have new ApIDs. The EDR format is designed to accommodate all data products before and after the software upload transparently. The data products are described as follows:

Data Product	**Product Description**
NS Full Science Spectra	• Detached PDS label file • Data file – contains 5 spectra histogram arrays, status and software countersfrom all three sensors in a binary table • Created as a result of 6/1/2006 flight software update.. Replaces NS Spectra EDRs till end of mission
NS Spectra	• Detached PDS label file • Data file - Contains 5 spectra histogram arrays, status, and software counters from all three sensors in a binary table • Replaced by NS Full Science spectra as a result of 6/1/2006 flight software update
NS Events	• Detached PDS label file • Data file - contains BP events time series in a binary table
NS Galactic Cosmic Ray (GCR)	• Detached PDS label file • Data file – Galactic Cosmic Ray spectra and counters from LiG sensors in a binary table • Created by 6/1/2006 flight software update
NS Gamma Burst	• Detached PDS label file • Data file - Gamma Burst BP time series in a binary table
NS Short Science	• Detached PDS label file • Data file – Contains 3 BP spectra histogram arrays in a binary table (“neutron burst mode”)
NS TC Counts	• Detached PDS label file • Data file – Time-correlated “neutron burst mode” counts in binary table
NS Status	• Detached PDS label file • Data file – critical state information in an ASCII table
NS Calibration / Diagnostic	• Detached PDS label file. • Data file – events time series for all three sensors in an ASCII table
Command Echo	• Detached PDS label file. • Data file – command echo information stored in an ASCII table.

NS Full Science Spectra EDR

The STANDARD_DATA_PRODUCT_ID is “NS_FULLSPECTRA”. Contains the five spectra histogram arrays, LiG1, LiG2, BPS, BPET, and BPLT (LiG sensors 1 and 2, BP

singles, BP early time correlated, and BP late time correlated, respectively), and associated counters,, data collected by the NS in "Full Science" mode. Data is stored in a PDS binary table. This EDR replaces the NS Spectra EDR as a result of a flight software update in which the previous "Science Mode" packet is retired and replaced by the "Full Science Mode" packet. The Full Science Spectra data will be organized such that one EDR file will contain all the data with timestamps that correspond to a given Earth day.

The LiG1, LiG2, and BPS spectra each have 64 bins, while the BPET and BPLT spectra each have 256 bins. Each spectrum has the following scaling capability: bin counts premultiplied by 2, and commandable divide by N (separate N for each spectrum). New BPET and BPLT software counters were added in the update, and the LG1/BPS and LG2/BPS software counters were removed; also sensor and LVPS temperatures were added.

NS Spectra EDR
The STANDARD_DATA_PRODUCT_ID is "NS_SPECTRA". Contains the five spectra histogram arrays, LiG1, LiG2, BPS, BPET, and BPLT, data collected by the NS in "Science Data" mode. Data is stored in a PDS binary table.This EDR is longer created past February 2006 as a result of a flight software update.
The NS Spectra data will be organized such that one EDR file will contain all the data with timestamps that correspond to a given Earth day.

The LiG1 and LiG2 spectra each have 32 bins, the BPS spectrum has 64 bins, and the BPET and BPLT spectra each have 8 quasi-log bins. Each spectrum has the following scaling capability: bin counts premultiplied by 2 and fixed power-of-2 divide.

NS Events EDR
The STANDARD_DATA_PRODUCT_ID is "NS_EVENTS". Contains event data time series collected by the NS in "Full Science" mode. Data is stored in a binary table. The data file is organized such that one EDR file will contain all the events data with timestamps that correspond to a given Earth day. . The events data are transmitted in the same science telemetry packet that contains the NS spectra data. An individual science telemetry packet will contain from 0-255 events. Events are not individually timetagged. Instead, the Mission Elapsed Time (MET) recorded by the science telemetry packet will be assigned to all N events. Thus 1-255 events will share the same MET time tag within a given EDR. The MET records the start of the reporting/accumulation period.

As stated above in Sec. 5.1, E_p, E_c, and TTSP values have precision 16 bits, 16 bits, and 8 bits respectively. (E_p has a precision of only 8 bits for the old NS events prior to the software update.)

NS Galactic Cosmic Ray EDR
The STANDARD_DATA_PRODUCT_ID is "NS_GALACTIC_COSMICRAY". Contains LiG1 and LiG2 Galactic Cosmic Ray spectra and associated counters. Data is stored in a binary table. Each Galactic Cosmic Ray EDR file will contain all the data with

timestamps that correspond to a given Earth day. This data product is not available before the software update.

The two GCR spectra each have 64 bins and have the same scaling capability as mentioned for the Full Science Spectra above. Double or triple coincidence mode is commandable.

NS Gamma burst EDR
The STANDARD_DATA_PRODUCT_ID is "NS_GAMMA_BURST". Contains Gamma Ray burst data time series collected by the NS in "Gamma Burst" mode. Data is stored in a binary table. Each Gamma Burst EDR file will contain all the Gamma Bursts data with timestamps that correspond to one Earth day.

NS Short Science EDR
The STANDARD_DATA_PRODUCT_ID is "NS_SHORTSCIENCE". Contains data collected by the NS in "Short Science" mode, otherwise called "neutron burst" mode. In short science mode the data telemetered from the spacecraft is a subset of the data in "Full Science" mode. It may be generated as a result of telemetry constrained situations. The data includes 3 spectra histogram arrays - BPS, BPET and BPLT stored in a binary table. Each Short Science EDR file will contain all the data with timestamps that correspond to a given Earth day.

This EDR essentially renames the "so-called" NS Neutron Burst Spectra EDR as a result of the flight software update. Also the BPS spectrum is added in the update. And the changes made in the relevant spectra and scaling by the update apply (mentioned above for the Full Science Spectra).

NS Time-Correlated Counts EDR
The STANDARD_DATA_PRODUCT_ID is "NS_TIME_CORRELATED_COUNTS". Contains data collected by the NS in "TC Counters" mode, otherwise called "neutron burst" counter mode. Contains the BP TC Early Counter, whose value equals the summation of every channel in the early time-correlated spectra, and the BP TC late counter, whose value equals the summation of every channel in the late time-correlated spectra. Data is stored in a binary table. Each Time-Correlated counters EDR file will contain all the Neutron burst counters with timestamps that correspond to one Earth day. This EDR essentially renames the NS Neutron Burst Counter EDR.

NS Status EDR
The STANDARD_DATA_PRODUCT_ID is "NS_STATUS". Contains critical state information recorded in the NS Status Telemetry packet. Data is stored in an ASCII table. Each Status EDR file will contain all the status data with timestamps that correspond to one Earth day. This EDR had some fields omitted, added, or modified by the software update.

NS Calibration/Diagnostic EDR

The STANDARD_DATA_PRODUCT_ID is "NS_CALIBRATION_DIAGNOSTIC". Contains the calibration event series data recorded in the NS Calibration/Diagnostic telemetry packet for all three sensors. Each Calibration/Diagnostic EDR file will contain all the diagnostic event data with a time stamp that corresponds to one Earth day. A calibration/diagnostic telemetry packet contains data for the first 96 events that are recorded in a given accumulation period. If less than 96 events are collected then the packet only contains data on the events that did occur. The event data collected by the calibration/diagnostic telemetry packet are not individually time tagged. Instead, the MET recorded by the packet, which corresponds to the start of the accumulation period, will be assigned to all 96 events (or the actual events that were recorded, if less than 96). Thus, 1-96 events will share the same MET time tag in a given Calibration/Diagnostic EDR. This mode is expected to be used only by the instrument engineer, for event diagnostics.

NS Command Echo EDR
The STANDARD_DATA_PRODUCT_ID is "NS_COMMAND_ECHO". Contains the commands executed by the spacecraft as well as information on command arguments, command success, and time tags of the command. Each EDR file will contain all the command echo data with timestamps that correspond to one Earth day.

5.3. Data Processing

5.3.1. Data Processing Level

There is one EDR Data Archive Volume for the NS instrument. The data volume will contain level 2 CODMAC data products or EDRs. Each product will have a unique file name and conform to the file naming convention in section 6.4. All EDR products will be stored at the Applied Physics Laboratory/Science Operations Center (APL/SOC) during mission operations. The data volume will be electronically transferred to the PDS Geosciences Node following the procedure in section 5.3.3.

5.3.2. Data Product Generation

The Neutron Spectrometer EDR files will be produced by the MESSENGER Science Operations Center (SOC) operated jointly by APL and ACT. Data downlink is telemetered through NASA's Deep Space Network (DSN) managed by the Jet Propulsion Laboratory in Pasadena, CA, and then forwarded to APL. Inputs to the SOC will consist of telemetry in the form of CCSDS packets. Level-1 NS raw spectral and engineering data is then broken out of the data stream and stored online at the SOC. The 'PIPE-NS2EDR' software packages the Level 1 CODMAC data to the PDS formats defined in this SIS (section 5.3.4 and Appendices). The resulting files are designated as Level 2 CODMAC data or EDRs. The EDR data products are made available to the MESSENGER Science Team for initial evaluation and validation. At the end of the evaluation and validation period, the data are organized and stored in the directory

structure described in section 6.5 for transmittal to the Geosciences Node. The transmittal process is described in section 5.3.3.

5.3.3. Data Flow

The MESSENGER SOC operates under the auspices of the MESSENGER Project Scientist to plan data acquisition and generate and validate data archives. The SOC supports and works with the Mission Operations Center (MOC), the Science Team, instrument scientists, and the PDS. The SOC will produce early versions of products that can be used by the science and instrument teams. The following chart shows the data flow from the different groups. The MOC handles raw data flow to and from the MESSENGER spacecraft and the SOC converts the telemetry into EDRs. The science team validates the EDRs and notifies the SOC if corrections are needed. Documentation and EDRs are delivered to the PDS Geosciences node. SPICE kernels are delivered to the PDS Navigation and Ancillary Information (NAIF) node.

The MESSENGER SOC will deliver data for the NS EDR data volume to the PDS Geosciences Node in standard product packages. Each package will comprise data and files organized into directory structures consistent with the volume design described in section 6.5.

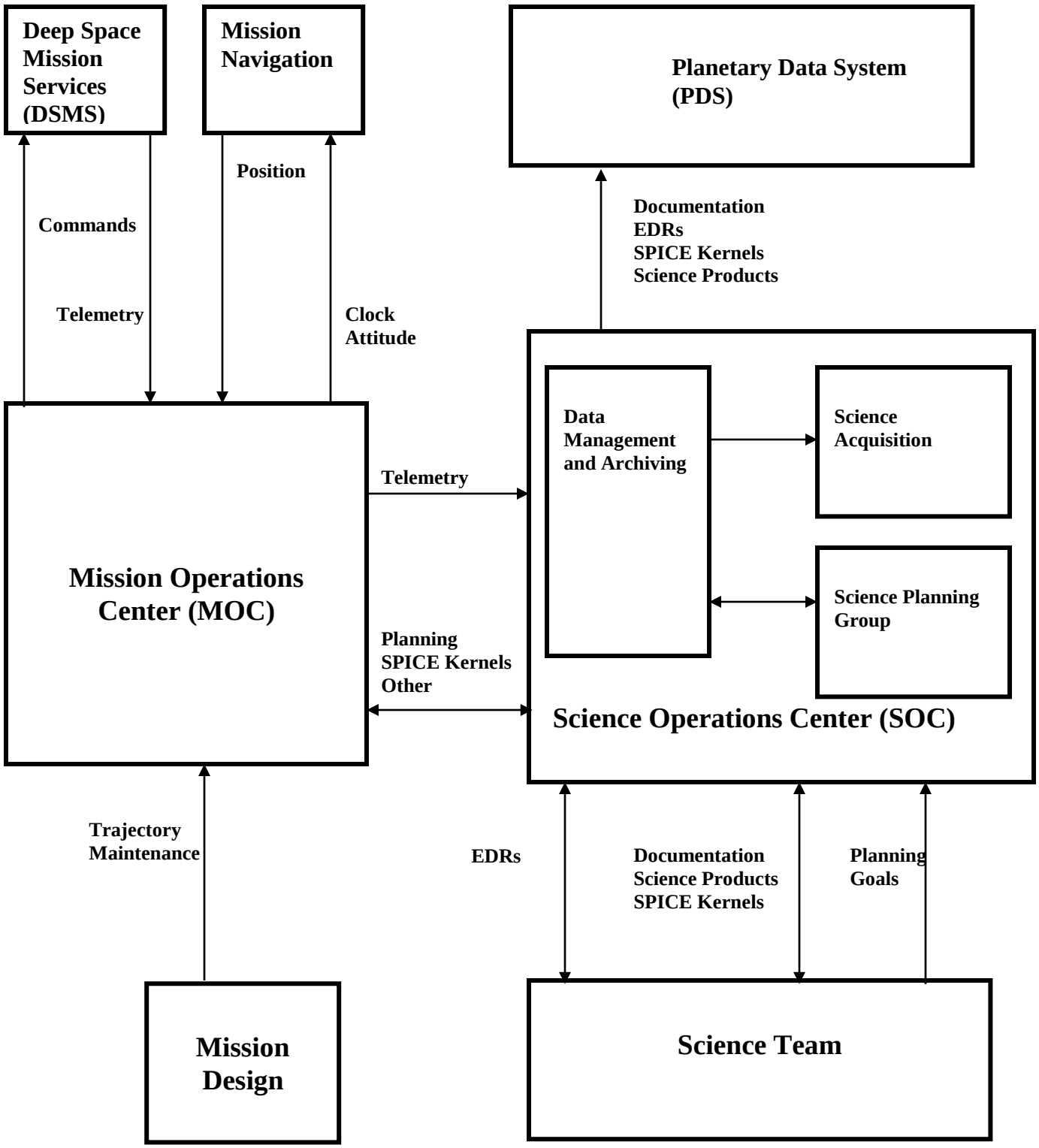


Figure 1. MESSENGER data flow

The following describes the electronic transfer process of releasing data to PDS. This transfer process will be used for the first PDS delivery. Future data deliveries will be assumed to follow the same process unless otherwise noted in an update of this document. Given the long duration of the mission the project is reserving the option of exploring alternate data delivery methods for subsequent deliveries. As such, the method of electronic transfer may change and will be revised accordingly in the SIS. Any changes to the delivery process will be noted in an update to the SIS document and will include the specific dates which will use the new delivery process. The delivery of products to the data volume will follow the schedule in the MESSENGER Data Management and Archiving Plan.

In the week prior to the delivery date the directory structure will be compressed into a single "zip archive" file for transmittal to the PDS node. The zip archive preserves the directory structure internally so that it can be recreated after electronic delivery to the PDS node. The zip archive file is transmitted to the PDS node via FTP to an account set up by the receiving node. Also transmitted will be a checksum file created using the MD5 algorithm. This provides an independent method of verifying the integrity of the zip file after it has been sent. Within days of transmittal the PDS node will acknowledge receipt of the archive and checksum file. If acknowledgement is not received, or if problems are reported, the MESSENGER SOC will immediately take corrective action to effect successful transmittal.

After transmittal the PDS node will uncompress the zip archive file and check for data integrity using the checksum file. The node will then perform any additional verification and validation of the data provided and will report any discrepancies or problems to the MESSENGER SOC. It is expected that the node will perform these checks in about two weeks. After inspection has been completed to the satisfaction of the PDS node, the node will issue to the MESSENGER SOC acknowledgement of successful receipt of the data. Following receipt of a data delivery the PDS node will organize the data into a PDS volume archive structure within its online data system. Newly delivered data will be made available publicly from PDS once accompanying labels and other documentation have been validated.

5.3.4. Labeling and Identification

For every EDR data file there exists a detached PDS label file. Detached means that the label file is separate from the data file, as opposed to being in the header portion of the data file. The following are examples of PDS labels for each of the NS EDRs. Details about the label format are specified later in Section 6.3.

Each PDS label file will contain a pointer to an external format file. This format file describes the table structure of the EDR data file. Details for each format file are found in the Appendices.

5.3.4.1. NS Full Science Spectra PDS Label

```
PDS_VERSION_ID                = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS                  = 1439
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 1514

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                    = "NS_FSP2006172ZZZ_DAT"
PRODUCT_VERSION_ID            = "V1"
PRODUCT_CREATION_TIME         = 2007-01-22T16:51:04
PRODUCT_TYPE                  = "DATA"
STANDARD_DATA_PRODUCT_ID      = "NS_FULLSPECTRA"
SOFTWARE_NAME                 = "PIPE-NS2EDR"
SOFTWARE_VERSION_ID           = "1.0"
INSTRUMENT_HOST_NAME          = "MESSENGER"
INSTRUMENT_NAME               = "NEUTRON SPECTROMETER"
INSTRUMENT_ID                 = "NS"
DATA_SET_ID                   = "MESS-E/V/H-GRNS-2-NS-RAWDATA-V1.0"
MISSION_PHASE_NAME            = "VENUS 1 CRUISE"
TARGET_NAME                   = "CALIBRATION"
START_TIME                    = 2006-06-21T12:00:38.000
STOP_TIME                     = 2006-06-21T23:59:37.000
SPACECRAFT_CLOCK_START_COUNT  = 59378381
SPACECRAFT_CLOCK_STOP_COUNT   = 59421521
^TABLE                        = "NS_FSP2006172ZZZ.DAT"

OBJECT                        = TABLE
COLUMNS                       = 38
INTERCHANGE_FORMAT            = BINARY
ROWS                          = 1439
ROW_BYTES                     = 1514
DESCRIPTION                   = "
 This table contains one set of spectra data, status, and software event
 counters collected from the MESSENGER Neutron Spectrometer (NS) and telemetered
 via the NS Full Science Data packet. A set is defined as  all data with time
 stamps corresponding to a given Earth day.
 The complete column definitions are contained in an external structure file
 found in the LABEL directory of the archive volume. Additional details are
 contained in the EDR SIS document.
"
^STRUCTURE      = "NS_FULLSPE.FMT"
END_OBJECT                    = TABLE
END
```

5.3.4.2. NS Spectra PDS Label

```
PDS_VERSION_ID                = "PDS3"
```

```
/*** FILE FORMAT ***/
FILE_RECORDS                    = 1140
RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 378

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                      = "NS_SPE2005108ZZZ_DAT"
PRODUCT_VERSION_ID              = "V1"
PRODUCT_CREATION_TIME           = 2006-07-14T17:59:54
PRODUCT_TYPE                    = "DATA"
STANDARD_DATA_PRODUCT_ID        = "NS_SPECTRA"
SOFTWARE_NAME                   = "PIPE-NS2EDR"
SOFTWARE_VERSION_ID             = "1.0"
INSTRUMENT_HOST_NAME            = "MESSENGER"
INSTRUMENT_NAME                 = "NEUTRON SPECTROMETER"
INSTRUMENT_ID                   = "NS"
DATA_SET_ID                     = "MESS-E/V/H-GRNS-2-NS-RAWDATA-V1.0"
MISSION_PHASE_NAME              = "EARTH CRUISE"
TARGET_NAME                     = "CALIBRATION"
START_TIME                      = 2005-04-18T14:00:17.000
STOP_TIME                       = 2005-04-18T23:59:46.000
SPACECRAFT_CLOCK_START_COUNT    = 22319954
SPACECRAFT_CLOCK_STOP_COUNT     = 22355923
^TABLE                          = "NS_SPE2005108ZZZ.DAT"

OBJECT                          = TABLE
COLUMNS                         = 30
INTERCHANGE_FORMAT              = BINARY
ROWS                            = 1140
ROW_BYTES                       = 378

DESCRIPTION                     = "
 This table contains one set of spectra data, status, and software event
 Counters collected from the MESSENGER Neutron Spectrometer (NS). A set is
 defined as all data with time stamps corresponding to a given Earth day.
 The complete column definitions are contained in an external structure file
 found in the LABEL directory of the archive volume. Additional details are
 contained in the EDR SIS document.
"
^STRUCTURE      = "NS_SPE.FMT"
END_OBJECT                      = TABLE
END
```

5.3.4.3. NS Events PDS Label

```
PDS_VERSION_ID                  = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS                    = 1090
RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 1538

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                      = "NS_EVT2005108ZZZ_DAT"
PRODUCT_VERSION_ID              = "V1"
PRODUCT_CREATION_TIME           = 2006-07-14T18:00:46
PRODUCT_TYPE                    = "DATA"
STANDARD_DATA_PRODUCT_ID        = "NS_EVENTS"
SOFTWARE_NAME                   = "PIPE-NS2EDR"
SOFTWARE_VERSION_ID             = "1.0"
INSTRUMENT_HOST_NAME            = "MESSENGER"
INSTRUMENT_NAME                 = "NEUTRON SPECTROMETER"
INSTRUMENT_ID                   = "NS"
DATA_SET_ID                     = "MESS-E/V/H-GRNS-2-NS-RAWDATA-V1.0"

MISSION_PHASE_NAME              = "EARTH CRUISE"
TARGET_NAME                     = "CALIBRATION"
START_TIME                      = 2005-04-18T14:00:17.000
STOP_TIME                       = 2005-04-18T23:59:46.000
SPACECRAFT_CLOCK_START_COUNT    = 22319954
```

```
SPACECRAFT_CLOCK_STOP_COUNT    = 22355923
^TABLE                         = "NS_EVT2005108ZZZ.DAT"

OBJECT                         = TABLE
COLUMNS                        = 6
INTERCHANGE_FORMAT             = BINARY
ROWS                           = 1090
ROW_BYTES                      = 1538
DESCRIPTION                    = "
 This table contains one set of events data collected from the MESSENGER
 Neutron Spectrometer. A set is defined as all data with timestamps
 corresponding to a given Earth day. The complete column definitions are
 contained in an external structure file found in the LABEL directory of the
 archive volume. Additional details are contained in the EDR SIS document.
"
^STRUCTURE        = "NS_EVT.FMT"
END_OBJECT                     = TABLE
END
```

5.3.4.4. Galactic Cosmic Ray PDS Label

```
PDS_VERSION_ID                 = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS                   = 379
RECORD_TYPE                    = FIXED_LENGTH
RECORD_BYTES                   = 288

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                     = "NS_GCR2006172ZZZ_DAT"
PRODUCT_VERSION_ID             = "V1"
PRODUCT_CREATION_TIME          = 2007-01-16T21:38:53
PRODUCT_TYPE                   = "DATA"
STANDARD_DATA_PRODUCT_ID       = "NS_GALACTIC_COSMICRAY"
SOFTWARE_NAME                  = "PIPE-NS2EDR"
SOFTWARE_VERSION_ID            = "1.0"
INSTRUMENT_HOST_NAME           = "MESSENGER"
INSTRUMENT_NAME                = "NEUTRON SPECTROMETER"
INSTRUMENT_ID                  = "NS"
DATA_SET_ID                    = "MESS-E/V/H-GRNS-2-NS-RAWDATA-V1.0"
MISSION_PHASE_NAME             = "VENUS 1 CRUISE"
TARGET_NAME                    = "CALIBRATION"
START_TIME                     = 2006-06-21T12:00:37.000
STOP_TIME                      = 2006-06-21T15:09:37.000
SPACECRAFT_CLOCK_START_COUNT   = 59378381
SPACECRAFT_CLOCK_STOP_COUNT    = 59389721
^TABLE                         = "NS_GCR2006172ZZZ.DAT"

OBJECT                         = TABLE
COLUMNS                        = 16
INTERCHANGE_FORMAT             = BINARY
ROWS                           = 379
ROW_BYTES                      = 288
DESCRIPTION                    = "
 This table contains one set of galactic cosmic ray spectra data collected
 from the MESSENGER Neutron Spectrometer (NS).
 A set is defined as all data with time stamps corresponding to a given
 Earth day.
 The complete column definitions are contained in an external structure file
 found in the LABEL directory of the archive volume. Additional details are
 contained in the EDR SIS document.
"
^STRUCTURE      = "NS_GCR.FMT"
END_OBJECT                     = TABLE
END
```

5.3.4.5. Gamma Burst PDS Label

```
PDS_VERSION_ID                 = "PDS3"
```

```
/*** FILE FORMAT ***/
FILE_RECORDS                  = 62
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 346

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                    = "NS_GAB2005133ZZZ_DAT"
PRODUCT_VERSION_ID            = "V1"
PRODUCT_CREATION_TIME         = 2006-03-10T15:42:19
PRODUCT_TYPE                  = "DATA"
STANDARD_DATA_PRODUCT_ID      = "NS_GAMMA_BURST"
SOFTWARE_NAME                 = "PIPE-NS2EDR"
SOFTWARE_VERSION_ID           = "1.0"
INSTRUMENT_HOST_NAME          = "MESSENGER"
INSTRUMENT_NAME               = "NEUTRON SPECTROMETER"
INSTRUMENT_ID                 = "NS"
DATA_SET_ID                   = "MESS-E/V/H-GRNS-2-NS-RAWDATA-V1.0"
MISSION_PHASE_NAME            = "EARTH CRUISE"
TARGET_NAME                   = "CALIBRATION"
START_TIME                    = 2005-05-13T19:36:06.000
STOP_TIME                     = 2005-05-13T23:55:04.000
SPACECRAFT_CLOCK_START_COUNT  = 24500110
SPACECRAFT_CLOCK_STOP_COUNT   = 24515648
^TABLE                        = "NS_GAB2005133ZZZ.DAT"

OBJECT                        = TABLE
COLUMNS                       = 8
INTERCHANGE_FORMAT            = BINARY
ROWS                          = 62
ROW_BYTES                     = 346
DESCRIPTION                   = "
 This table contains one set of Gamma burst data collected from the
 MESSENGER Neutron Spectrometer (NS). A set is defined as all data with time
 stamps corresponding to a given Earth day. The complete column definitions
 are contained in an external structure file found in the LABEL directory of
 the archive volume. Additional details are contained in the EDR SIS
 document.
"
^STRUCTURE           = "NS_GAB.FMT"
END_OBJECT                    = TABLE
END
```

5.3.4.6. Short Science PDS Label

```
PDS_VERSION_ID                = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS                  = 6
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 1184

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                    = "NS_SSP2006167ZZZ_DAT"
PRODUCT_VERSION_ID            = "V1"
PRODUCT_CREATION_TIME         = 2007-01-12T22:04:20
PRODUCT_TYPE                  = "DATA"
STANDARD_DATA_PRODUCT_ID      = "NS_SHORTSPECTRA"
SOFTWARE_NAME                 = "PIPE-NS2EDR"
SOFTWARE_VERSION_ID           = "1.0"
INSTRUMENT_HOST_NAME          = "MESSENGER"
INSTRUMENT_NAME               = "NEUTRON SPECTROMETER"
INSTRUMENT_ID                 = "NS"
DATA_SET_ID                   = "MESS-E/V/H-GRNS-2-NS-RAWDATA-V1.0"
MISSION_PHASE_NAME            = "VENUS 1 CRUISE"
TARGET_NAME                   = "CALIBRATION"
START_TIME                    = 2006-06-16T13:08:39.000
```

```
STOP_TIME                       = 2006-06-16T13:11:09.000
SPACECRAFT_CLOCK_START_COUNT    = 58950463
SPACECRAFT_CLOCK_STOP_COUNT     = 58950613
^TABLE                          = "NS_SSP2006167ZZZ.DAT"

OBJECT                          = TABLE
COLUMNS                         = 17
INTERCHANGE_FORMAT              = BINARY
ROWS                            = 6
ROW_BYTES                       = 1184
DESCRIPTION                     = "
 This table contains one set of spectra data collected from the MESSENGER
 Neutron Spectrometer (NS) and telemetered via the NS Short Science Data
 packet. A set is defined as all data with time stamps corresponding to a
 given Earth day.
 The complete column definitions are contained in an external structure file
 found in the LABEL directory of the archive volume. Additional details are
 contained in the EDR SIS document.
"
^STRUCTURE      = "NS_SHORTSCI.FMT"
END_OBJECT                      = TABLE
END
```

5.3.4.7. Time-Correlated Counts PDS Label

```
PDS_VERSION_ID                  = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS                    = 57
RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 14

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                      = "NS_TCC2006068ZZZ_DAT"
PRODUCT_VERSION_ID              = "V1"
PRODUCT_CREATION_TIME           = 2007-01-18T17:01:12
PRODUCT_TYPE                    = "DATA"
STANDARD_DATA_PRODUCT_ID        = "NS_TIME_CORRELATED_COUNTS"
SOFTWARE_NAME                   = "PIPE-NS2EDR"
SOFTWARE_VERSION_ID             = "1.0"
INSTRUMENT_HOST_NAME            = "MESSENGER"
INSTRUMENT_NAME                 = "NEUTRON SPECTROMETER"
INSTRUMENT_ID                   = "NS"
DATA_SET_ID                     = "MESS-E/V/H-GRNS-2-NS-RAWDATA-V1.0"
MISSION_PHASE_NAME              = "VENUS 1 CRUISE"
TARGET_NAME                     = "CALIBRATION"
START_TIME                      = 2006-03-09T14:49:32.000
STOP_TIME                       = 2006-03-09T14:58:52.000
SPACECRAFT_CLOCK_START_COUNT    = 50402916
SPACECRAFT_CLOCK_STOP_COUNT     = 50403476
^TABLE                          = "NS_TCC2006068ZZZ.DAT"

OBJECT                          = TABLE
COLUMNS                         = 4
INTERCHANGE_FORMAT              = BINARY
ROWS                            = 57
ROW_BYTES                       = 14
DESCRIPTION                     = "
 This table contains one set of time-correlated spectra counters collected from the
 MESSENGER Neutron Spectrometer (NS). A set is defined as all data with
 timestamps corresponding to a given Earth day. The complete column
 definitions are contained in an external structure file found in the LABEL
 directory of the archive volume. Additional details are contained in the
 EDR SIS document.
"
^STRUCTURE                 = "NS_TCC.FMT"
END_OBJECT                      = TABLE
END
```

5.3.4.8. Status PDS Label

```
PDS_VERSION_ID                = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS                  = 1680
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 622

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                    = "NS_STA2005108ZZZ_TAB"
PRODUCT_VERSION_ID            = "V1"
PRODUCT_CREATION_TIME         = 2006-07-14T21:24:46
PRODUCT_TYPE                  = "ANCILLARY"
STANDARD_DATA_PRODUCT_ID      = "NS_STATUS "
SOFTWARE_NAME                 = "PIPE-NS2EDR"
SOFTWARE_VERSION_ID           = "1.0"
INSTRUMENT_HOST_NAME          = "MESSENGER"
INSTRUMENT_NAME               = "NEUTRON SPECTROMETER"
INSTRUMENT_ID                 = "NS"
DATA_SET_ID                   = "MESS-E/V/H-GRNS-2-NS-RAWDATA-V1.0"
MISSION_PHASE_NAME            = "EARTH_CRUISE"
TARGET_NAME                   = "CALIBRATION"
START_TIME                    = 2005-04-18T13:53:23.000
STOP_TIME                     = 2005-04-18T23:59:48.000
SPACECRAFT_CLOCK_START_COUNT  = 22319540
SPACECRAFT_CLOCK_STOP_COUNT   = 22355925
^TABLE                        = "NS_STA2005108ZZZ.TAB"

OBJECT                        = TABLE
   COLUMNS                    = 103
   INTERCHANGE_FORMAT         = ASCII
   ROWS                       = 1680
   ROW_BYTES                  = 622

   DESCRIPTION                = "
    This table contains one set of status telemetry information gathered by
    the MESSENGER Neutron Spectrometer (NS). A set is defined as all data
    with timestamps corresponding to a given Earth day. The complete
    column definitions are contained in an external file found in the LABEL
    directory of the archive volume. Additional details are contained in the
    EDR SIS document.
   "
^STRUCTURE                   = "NS_STATUS.FMT"
END_OBJECT                     = TABLE
END
```

5.3.4.9. Calibration/Diagnostic PDS Label

```
PDS_VERSION_ID                = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS                  = 58841
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 80

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                    = "NS_CAD2004225ZZZ_TAB"
PRODUCT_VERSION_ID            = "V1"
PRODUCT_CREATION_TIME         = 2006-03-13T15:45:27
PRODUCT_TYPE                  = "ANCILLARY"
STANDARD_DATA_PRODUCT_ID      = "NS_CALIBRATION_DIAGNOSTIC"
SOFTWARE_NAME                 = "PIPE-NS2EDR"
SOFTWARE_VERSION_ID           = "1.0"
INSTRUMENT_HOST_NAME          = "MESSENGER"
INSTRUMENT_NAME               = "NEUTRON SPECTROMETER"
```

```
INSTRUMENT_ID                  = "NS"
DATA_SET_ID                    = "MESS-E/V/H-GRNS-2-NS-RAWDATA-V1.0"
MISSION_PHASE_NAME             = "LAUNCH"
TARGET_NAME                    = "CALIBRATION"
START_TIME                     = 2004-08-12T20:44:41.000
STOP_TIME                      = 2004-08-12T21:22:01.000
SPACECRAFT_CLOCK_START_COUNT   = 830719
SPACECRAFT_CLOCK_STOP_COUNT    = 832959
^TABLE                         = "NS_CAD2004225ZZZ.TAB"

OBJECT                         = TABLE
COLUMNS                        = 11
INTERCHANGE_FORMAT             = ASCII
ROWS                           = 58841
ROW_BYTES                      = 80
DESCRIPTION                    = "
 This table contains one set of calibration and diagnostic data collected
 from the MESSENGER Neutron Spectrometer (NS). A set is defined as all
 data with timestamps corresponding to a given Earth day. The complete
 column definitions are contained in an external structure file found in
 the LABEL directory of the archive volume. Additional details are
 contained in the EDR SIS document.
"
^STRUCTURE                 = "NS_CAL_DIAG.FMT"
END_OBJECT                     = TABLE
END
```

5.3.4.10. Command Echo PDS Label

```
PDS_VERSION_ID                 = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS                   = 59
RECORD_TYPE                    = FIXED_LENGTH
RECORD_BYTES                   = 125

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                     = "NS_CMD2008214ZZZ_TAB"
PRODUCT_VERSION_ID             = "V1"
PRODUCT_CREATION_TIME          = 2008-12-05T20:04:15
PRODUCT_TYPE                   = "ANCILLARY"
STANDARD_DATA_PRODUCT_ID       = "NS_COMMAND_ECHO"
SOFTWARE_NAME                  = "PIPE-NS2EDR"
SOFTWARE_VERSION_ID            = "1.0"
INSTRUMENT_HOST_NAME           = "MESSENGER"
INSTRUMENT_NAME                = "NEUTRON SPECTROMETER"
INSTRUMENT_ID                  = "NS"
DATA_SET_ID                    = "MESS-E/V/H-GRNS-2-NS-RAWDATA-V1.0"
MISSION_PHASE_NAME             = "MERCURY 2 CRUISE"
TARGET_NAME                    = "CALIBRATION"
START_TIME                     = 2008-08-01T14:46:19
STOP_TIME                      = 2008-08-01T15:22:28
SPACECRAFT_CLOCK_START_COUNT   = 126089415
SPACECRAFT_CLOCK_STOP_COUNT    = 126091584
^TABLE                         = "NS_CAD2004225ZZZ.TAB"

OBJECT                         = TABLE
COLUMNS                        = 11
INTERCHANGE_FORMAT             = ASCII
ROW_BYTES                      = 125
ROWS                           = 59
DESCRIPTION                    = "
 This table contains one set of the commands executed by the MESSENGER
 Neutron Spectrometer (NS). A set is defined as all data with timestamps
 corresponding to a given Earth day. The complete column definitions are
 contained in an external structure file found in the LABEL directory of
 the archive volume. Additional details are contained in the EDR SIS
 document.
"
^STRUCTURE = "NS_CMDECHO.FMT"
```

```
END_OBJECT                      = TABLE
END
```

5.4.Standards Used in Generating Data Products

5.4.1. PDS Standards

The NS EDR data products are constructed according to the data object concepts developed by the PDS. By adopting the PDS format, the data products are consistent in content and organization with other planetary data collections. In the PDS standard, the EDR data file is grouped into objects with PDS labels describing the objects. Each EDR data product consists of the following:

- A data file containing an ASCII or binary table object, in fixed field format. ASCII table objects are additionally in comma separated value (CSV) format. This makes the ASCII data extremely easy to read by many commercial off-the-shelf programs. See section 5.2 for a listing of the data products and whether the data is contained in an ASCII or binary table object.
- A label file which serves as a high-level description of the parameters which correspond to the data file. The label file contains a pointer to an external format file which details the structure of the table object in the data file.

5.4.2. Coordinate Systems

SPICE kernels will be archived at the PDS NAIF node. Coordinate systems will be included in the appropriate RDR SIS documents.

5.4.3. Time Standards

The MET field in the NS EDR tables matches the spacecraft time in integer seconds that is transmitted to MESSENGER subsystems by the Integrated Electronics Module (IEM). This is referred to by the MESSENGER project as Mission Elapsed Time (MET). MET = 0 is August 3, 2004, at 05:59:16 UTC, which is 1000 seconds prior to the MESSENGER launch. Relativistic effects and circumstances occurring during the mission would result in MET not being a true account of seconds since launch. Following a planned spacecraft clock reset[1] on January 8, 2013, partition numbers (1/, or 2/) were added to product labels to disambiguate MET seconds after the spacecraft clock reset (if partition number is not present, SPICE defaults to partition 1/). For this reason the MESSENGER spacecraft clock coefficients file is archived at the PDS Navigation and Ancillary Information Facility (NAIF) Node. This file is used in conjunction with the leapseconds kernel file in order to calculate the conversion between MET and UTC.

[1] See instrument host catalog file in NS EDR volume catalog directory for more information on MESSENGER spacecraft clock reset.

The conversion is easily done through the use of SPICE kernels and the CHRONOS Utility. CHRONOS is a utility included with the SPICE package that is distributed by the PDS NAIF node. The SPICE kernels are files that contain the information needed to perform the conversion. Two SPICE kernels are required. One is the Leapseconds Kernel (LSK) and the other is the MESSENGER Spacecraft Clock Kernel (SCLK). The SCLK file is used by CHRONOS to convert between spacecraft clock time and ephemeris time, while the LSK file is used to convert from ephemeris time to UTC time. The CHRONOS utility is self-documenting and the SPICE package itself contains full documentation on each of the utilities (including CHRONOS) and how they are used.

5.4.4. Data Storage Conventions

The data are organized following PDS standards and stored on hard disk and an SQL (Structured Query Language) relational database for rapid access during mission operations. The MESSENGER SOC will transfer data to PDS via electronic transfer and delivery methods as detailed in section 5.3.3. After verification of the data transfer PDS will provide public access to MESSENGER science data products through its online data distribution system.

5.5. Data Validation

The NS EDR data products will be validated by the NS Instrument scientist for science content and for compliance with PDS archive standards [MESSENGER Data Management and Archiving Plan].

6. Detailed Data Product Specification

6.1. Data Product Structure and Organization

The MESSENGER NS data set will be archived at the PDS Geosciences node as a data archive volume. The NS EDR products in the data archive volume are intended to store the data in a form closest to the raw telemetry data received from the spacecraft. The automated production and release of EDRs will follow the release schedule in the MESSENGER Data Management and Archiving Plan. There is only one NS EDR data archive volume which will be created at the first delivery to PDS. Subsequent deliveries to PDS will update this data volume. If errors are discovered the data will be replaced with corrected EDRs on the next scheduled delivery date.

The EDRs are organized in the data archive volume according to the structure defined in section 6.5. First there is the top level <DATA> directory. Then subsequent directories are organized into folders by year. In each year folder there are directories organized by month. The PDS START_TIME keyword in the EDR is used to determine the year and month directory in which the EDR will be placed.

6.2. Data Format Description

Data is stored in ASCII table format or in binary table format. A detached PDS label file will provide a detailed description of the structure of each table. See section 5.2 for details on which EDR contains a binary table or an ASCII table.

6.3. Label and Header Descriptions

6.3.1. PDS Label File Format

The following are the keyword definitions for the detached PDS label file. The detached PDS label file has the same name as the data file it describes, except for the extension .LBL to distinguish it as a label file.

PDS_VERSION_ID
Represents the version number of the PDS standards documents that is valid when a data product label is created. PDS3 is used for the MESSENGER Data products.

RECORD_TYPE
The record_type element indicates the record format of a file. The FIXED_LENGTH value is appropriate for the BINARY table object used for the MESSENGER NS EDR data products.

FILE_RECORDS
The file_records element indicates the number of physical file records, including both label records and data records.

RECORD_BYTES
The number of bytes in a physical file record, including record terminators and separators.

PRODUCT_ID
The product_id data element represents a permanent, unique identifier assigned to a data product by its producer.

PRODUCT_CREATION_TIME
Defines the UTC system format time when the product was created.

PRODUCT_VERSION_ID
Identifies the version of an individual product within a data set.
Example: V1, V2, V3
Product_version_id will be incremented if a given EDR has to be regenerated and sent to PDS to replace a previously submitted EDR.

PRODUCT_TYPE
Identifies the type or category of a product within a data set.

STANDARD_DATA_PRODUCT_ID
Used to link a NS EDR file to one of the 7 types of NS data products defined within the NS EDR SIS.

SOFTWARE_NAME
Identifies the data processing software used to generate the EDR products.

SOFTWARE_VERSION_ID

Indicates the version of the data processing software used to generate the EDR products from the spacecraft telemetry.

INSTRUMENT_HOST_NAME
The full name of the host on which an instrument is based. In this case it is the MESSENGER spacecraft.

INSTRUMENT_NAME
The full, unabbreviated name of the instrument.

INSTRUMENT_ID
Unique id associated with the Neutron Spectrometer instrument.

DATA_SET_ID
The data_set_id element is a unique alphanumeric identifier for a data set or a data product. The data_set_id value for a given data set or product is constructed according to flight project naming conventions. There is only one data_set_id for the NS EDRs.

MISSION_PHASE_NAME
Provides the commonly used identifier of a mission phase.

TARGET_NAME
The target of the observation.

START_TIME
Provides the date and time of the beginning of an event or observation (whether it be a spacecraft, ground-based, or system event) in UTC system format.

STOP_TIME
Provides the date and time of the end of an observation or event (whether it be a spacecraft, ground-based, or system event) in UTC system format.

SPACECRAFT_CLOCK_START_COUNT
Mission Elapsed Time (MET) corresponding to the first record in the data table.

SPACECRAFT_CLOCK_STOP_COUNT
Mission Elapsed Time (MET) corresponding to the last record in the data table.

^TABLE
Pointer to the external data file which contains the table object.

OBJECT
Specifies that the PDS object containing the data. In the case of the NS EDRs the object is a binary or ASCII table. This object contains its own elements. NOTE: the end of the object definition is always marked with an END_OBJECT line.

COLUMNS
Identifies the number of columns (fields) in the table.

INTERCHANGE_FORMAT
Specifies the format of the table.

ROWS
The number of rows in the binary table.

ROW_BYTES

Specifies the number of bytes for each row in the table.

^STRUCTURE
This is a pointer to the external file which provides the structure definition for the table object.

6.3.2. Table Object Keyword Definitions

The following describes the keywords used to define the PDS table object:

OBJECT = COLUMN
Identifies this as a column in the table object.

COLUMN_NUMBER
Identifies the location of the column within the larger data object (such as a table). For tables consisting of rows (I= 1, N) and columns (j = 1, M) the column_number is the j-th index of any row.

NAME
Indicates a literal value representing the common term used to identify the column object.

BYTES
Specifies the number of bytes allocated for this particular column element.

DATA_TYPE
Specifies the internal representation and/or mathematical properties of the value being stored in this column.

START_BYTE
Identifies the location of the first byte of the particular column, counting from 1.

ITEMS
Defines the number of multiple, identical occurrences of a single object. Ex. For the NS Spectra EDR it indicates that column 8 is a 32-bin histogram.

ITEM_BYTES
Represents the size in bytes of an individual item.

6.4.File Naming Conventions

The general form of the NS EDR file name is "NS_ZZZYYYYDDDWWW.XXX", where:

```
NS          instrument identifier: represents the NS instrument
ZZZ         EDR product identifier:
                  FSP  - Full Science Spectra EDR
                  SPE – Spectra EDR
                  EVT – Events EDR
                  GCR  - Galactic Cosmic Ray EDR
                  GAB – Gamma Burst EDR

                  SSP  - Short Science EDR
                  TCC – Time-Correlated Counts EDR
                  STA – Status EDR
                  CAD – Calibration/Diagnostic EDR
                  CMD – Command Echo EDR
```

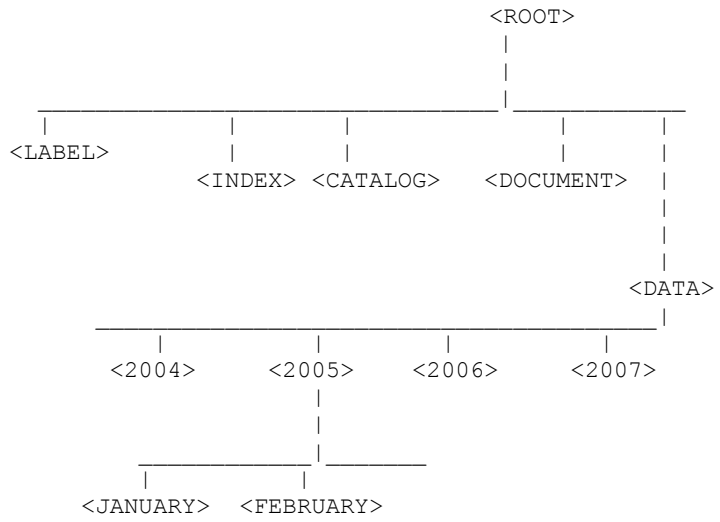
YYYY	The four digit year corresponding to the start time of the first record in the data table.
DDD	The three digit day of year corresponding to the start time of the first record in the data table.
WWW	Reserved 3 character string to use during the course of the mission as necessary to identify "special" data products. Nominal data products will be identified with 'ZZZ'.
XXX	The file extension: detached PDS label files will be 'LBL', the binary data files will be 'DAT', ASCII data files are 'TAB'.

6.5. Directory Structure and Contents for Static Volumes

The following illustration shows the directory structure overview for the NS EDR Data Archive Volume. This volume contains the NS EDR data products, supporting documentation, and any additional files required for the volume to be compliant with PDS standards. The content of the volume is expected to be updated with periodic releases according to the schedule in the MESSENGER Data Management and Archiving Plan. Revised EDRs (if needed) will also be delivered according to the same schedule. Revised EDRs will have an incremented version number in the PDS label.

Directory Structure Overview

Directory Structure Overview



6.5.1. Directory Contents

<ROOT> Directory

This is the top-level directory of a volume. The following are files contained in the root directory.

AAREADME.TXT - General information file. Provides users with an overview of the contents and organization of the associated volume, general instructions for its use, and contact information.

VOLDESC.CAT - PDS file containing the VOLUME object. This gives a high-level description of the contents of the volume. Information includes: production date, producer name and institution, volume ID, etc.

ERRATA.TXT - Text file for identifying and describing errors and/or anomalies found in the current volume, and possibly previous volumes of a set. Any known errors for the associated volume will be documented in this file.

<DOCUMENT> Directory

This subdirectory contains the documentation that will be needed in order to understand and analyze the EDR data products. Multiple copies of each document will be stored, each one in a different format. Files will be stored in PDF and ASCII format.

DOCINFO.TXT – Identifies and describes the function of each file in the DOCUMENT directory.

<CATALOG> Directory

This subdirectory contains the catalog object files for the entire volume. The following files are included in the catalog subdirectory.

CATINFO.TXT: Identifies and describes the function of each file in the catalog directory**.**

DATASET.CAT: Describes the general content of the dataset and includes information about the duration of the mission and the person or group responsible for producing the data.

INSTRUMENT.CAT: Describes physical attributes of the NS instrument and provides relevant references to published literature.

INSTRUMENT_HOST.CAT: Describes the MESSENGER spacecraft.

MISSION.CAT: Describes the scientific goals and objectives of the MESSENGER program. It also identifies key people and institutions.

REF.CAT: Contains the reference objects. These reference additional documents that may be useful to the person using the MLA EDR.

<INDEX> Directory

This subdirectory contains the indices for all data products on the volume. The following files are contained in the index subdirectory.

INDEXINFO.TXT – Identifies and describes the function of each file in the index subdirectory. This includes a description of the structure and contents of each index table in the subdirectory AND usage notes.

INDEX.TAB - The EDR index file is organized as a table: there is a row for each observation on the volume; the columns contain parameters that describe the observation and instrument and spacecraft parameters.

INDEX.LBL - Detached PDS label for INDEX.TAB. It contains the INDEX_TABLE object which identifies and describes the columns of the NS index table.

< LABEL > Directory

This subdirectory contains the format files for each of the different EDR product types. The format file describes the structure of the PDS Binary (or ASCII) table object in the EDR data file.

<DATA> - Data Directory
This is the top level of the directory in which the EDRs are contained. The data directories are organized by year (YYYY) followed by month. The EDRs reside in the month folders. The START_TIME of the EDR is used to determine the year and month in which the EDR will be placed.

6.6.Archive Volume and File Size

The final NS EDR archive volume has a size of approximately 40 GB.

7. Archive Release Schedule to PDS

The MESSENGER NS EDR archive will be transferred from the SOC to the PDS Geosciences Node using the electronic transfer process detailed in section5.3.3. The transfer will follow the schedule documented in the MESSENGER Data Management and Archiving Plan.

8. Appendices

8.1. NS_FULLSPE.FMT Table Fields

Below is a table that shows the structure of the binary table containing the NS Full Science Spectra data. Following this is the content of the format file itself.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	4	MSB Unsigned Integer	MET	Time tag in seconds of the start of the associated reporting/accumulation period.
5	2	MSB Unsigned Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury
7	4	MSB Unsigned Integer	ACTUAL_ACCUM	Actual accumulation period for software counters and energy histograms.
11	2	MSB Unsigned Integer	GCR_MODE	Galactic Cosmic Ray (GCR) Coincidence mode.
13	2	MSB Unsigned Integer	SENSOR_CFG_CHANGED	Sensor configuration changed flag.
15	2	MSB Unsigned Integer	LG_SAFING	Maximum Lithium Glass (LG) safing level reached.
17	2	MSB Unsigned Integer	BP_SAFING	Maximum Borated Plastic (BP) safing level reached.
19	2	MSB Unsigned Integer	LOG_COMRPESSION	Identifies when the log compression data mode has been enabled.
21	2	MSB Unsigned Integer	SENSOR_TEMP	Sensor Temperature
23	2	MSB Unsigned Integer	TEMP_MONITOR	LVPS Temperature Monitor
25	2	MSB Unsigned Integer	LG1_SCALE	LG1 Singles spectrum scale
27	2	MSB Unsigned Integer	LG2_SCALE	LG2 Singles spectrum sclae
29	2	MSB Unsigned Integer	BP_SCALE	BP Singles spectrum scale
31	2	MSB Unsigned Integer	TC_SCALE	Time-correlated spectrum scale
33	2 X 64	MSB Unsigned Integer	SINGLES_LG1	64 channel histogram of event energies that arrived as a single event. Lithium Glass 1 sensor.
161	2 X 64	MSB Unsigned Integer	SINGLES_LG2	64 channel histogram of event energies that arrived as a single event. Lithium Glass 2 sensor.
289	2 X 64	MSB Unsigned Integer	SINGLES_BP_SPECTRA	64 channel histogram of event energies that arrived as a solo event. Borated Plastic sensor.
417	2 X 256	MSB Unsigned Integer	TC_EARLY	A histogram of prompt BP events that had a delayed BP event occurring during the early capture window.
929	2 X 256	MSB Unsigned Integer	TC_LATE	A histogram of prompt BP events that had a delayed BP event occurring during the late capture window.
1441	4	MSB Unsigned Integer	LG1_RAW_EVENTS	LG1 raw event software counter.
1445	4	MSB Unsigned Integer	LG2_RAW_EVENTS	LG2 raw event software counter.
1449	4	MSB Unsigned Integer	BP_RAW_EVENTS	BP raw event software counter.
1453	4	MSB Unsigned Integer	SW_TOTAL_EVENTS	Total events processed by software in the current accumulation period.
1457	4	MSB Unsigned Integer	DEAD_TIME	Dead time software counter.
1461	4	MSB Unsigned Integer	LG1_RESET	LG1 charge reset software counter.

1465	4	MSB Unsigned Integer	LG2_RESET	LG2 charge reset software counter.
1469	4	MSB Unsigned Integer	BP_RESET	BP charge reset software counter.
1473	4	MSB Unsigned Integer	BPP_LGXS	Software counter for prompt pulse in BP detector with delayed secondary pulse in LG1 or LG2 detector.
1477	4	MSB Unsigned Integer	LG1_OVER_RANGE	LG1 prompt over range software counter.
1481	4	MSB Unsigned Integer	LG2_OVER_RANGE	LG2 prompt over range software counter.
1485	4	MSB Unsigned Integer	BP_OVER_RANGE	BP prompt over range software counter.
1489	4	MSB Unsigned Integer	VALID_TC_EVENT	Valid time-correlated software counter.
1493	4	MSB Unsigned Integer	LG1_BPP_COIN	LG1/BPP coincidence event software counter.
1497	4	MSB Unsigned Integer	LG2_BPP_COIN	LG2/BPP coincidence event software counter.
1501	4	MSB Unsigned Integer	LG1_BPP_LG2_COIN	LG1/BPP/LG2 coincidence event software counter.
1505	4	MSB Unsigned Integer	TC_EARLY_COUNTER	Summation of all channels of early time-correlated spectra
1509	4	MSB Unsigned Integer	TC_LATE_COUNTER	Summation of all channels of late time-correlated spectra
1513	2	MSB Unsigned Integer	EVENT_MODE_DATA_LEN	Event mode data length.

```
OBJECT        = COLUMN
   NAME           = MET
   COLUMN_NUMBER  = 1
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1
   DESCRIPTION    = "Time tag in seconds of the start of the associated
   Reporting/Accumulation period."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ORBIT_NUMBER
   COLUMN_NUMBER  = 2
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 5
   DESCRIPTION    = "Orbit number is a unique identifier for a given orbit of
   the MESSENGER spacecraft around Mercury. Orbit number is defined as
   starting at apoherm and is calculated using the MET value and the
   appropriate SPICE kernels. Orbit numbering does not start until MESSENGER
   performs the Mercury orbit insertion. Until that time the value for orbit
   number is 0."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ACTUAL_ACCUM
   COLUMN_NUMBER  = 3
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 7
   DESCRIPTION    = "Actual accumulation period for software counters and
    energy histograms."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = GCR_MODE
   COLUMN_NUMBER  = 4
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 11
   DESCRIPTION    = "Galactic Cosmic Ray (GCR) Coincidence mode.
   =1 Doubles, =2 Triples, =3 Either."
END_OBJECT    = COLUMN
```

```
OBJECT        = COLUMN
   NAME           = SENSOR_CFG_CHANGED
   COLUMN_NUMBER  = 5
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 13
   DESCRIPTION    = "Sensor Configuration Changed Flag.
     =0 config unchanged, =1 config changed."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG_SAFING
   COLUMN_NUMBER  = 6
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 15
   DESCRIPTION    = "Maximum Lithium Glass (LG) safing level reached during
   current reporting period.
   =0 nominal, =1 seeking, =2 level1_rampdown,
   =3 level1_waiting, =4 level1_seeking, =5 level2_safing.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_SAFING
   COLUMN_NUMBER  = 7
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 17
   DESCRIPTION    = "Maximum safing level reached during current reporting
   period for the Borrated Plastic (BP) sensor.
   =0 nominal, =1 seeking, =2 level1_rampdown,
   =3 level1_waiting, =4 level1_seeking, =5 level2_safing
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LOG_COMPRESSION
   COLUMN_NUMBER  = 8
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 19
   DESCRIPTION    = "Identifies when the log compression data mode has
   been enabled. The NS flight software uses 32-bit to 16-bit log compression
   on software counters when the log compression data mode is enabled.
   See the NS Flight Software document for details on the log compression
   algorithm.
   =0 no log compression. =1 log compression enabled.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SENSOR_TEMP
   COLUMN_NUMBER  = 9
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 21
   DESCRIPTION    = "Sensor Temperature, External Channel 4 (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TEMP_MONITOR
   COLUMN_NUMBER  = 10
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 23
   DESCRIPTION    = "LVPS Temperature monitor."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_SCALE
```

```
   COLUMN_NUMBER  = 11
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 25
   DESCRIPTION    = "LG1 singles spectrum scale."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_SCALE
   COLUMN_NUMBER  = 12
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 27
   DESCRIPTION    = "LG2 singles spectrum scale."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_SCALE
   COLUMN_NUMBER  = 13
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 29
   DESCRIPTION    = "BP singles spectrum scale."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TC_SCALE
   COLUMN_NUMBER  = 14
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 31
   DESCRIPTION    = "Time-correlated spectra scale."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SINGLES_LG1
   COLUMN_NUMBER  = 15
   BYTES          = 128
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 33
   ITEMS          = 64
   ITEM_BYTES     = 2
   DESCRIPTION    = "Spectrum is a 64 channel histogram of event energies
   that arrived as a single event with no time correlation to the other
   sensors. LG1 is the Lithium Glass 1 sensor."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SINGLES_LG2
   COLUMN_NUMBER  = 16
   BYTES          = 128
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 161
   ITEMS          = 64
   ITEM_BYTES     = 2
   DESCRIPTION    = "Spectrum is a 64 channel histogram of event energies
   that arrived as a single event with no time correlation to the other
   sensors. LG2 is the Lithium Glass 2 sensor."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SINGLES_BP_SPECTRA
   COLUMN_NUMBER  = 17
   BYTES          = 128
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 289
   ITEMS          = 64
   ITEM_BYTES     = 2
   DESCRIPTION    = "BP is the Borated Plastic sensor. Spectrum is a 64
   channel histogram of event energies that arrived as a solo event with
   respect to the other sensors."
```

```
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TC_EARLY
   COLUMN_NUMBER  = 18
   BYTES          = 512
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 417
   ITEMS          = 256
   ITEM_BYTES     = 2
   DESCRIPTION    = "The time-correlated early spectrum is a histogram of
   prompt BP events that had a delayed BP event occurring during the early
   capture window, as defined by commandable software parameters provided
   in columns 83 and 84 of the NS Status EDR, and no additional events in
   the event set.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TC_LATE
   COLUMN_NUMBER  = 19
   BYTES          = 512
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 929
   ITEMS          = 256
   ITEM_BYTES     = 2
   DESCRIPTION    = "The time-correlated late spectrum is a histogram of
   prompt BP events that had a delayed BP event occurring during the late
   capture window, as defined by commandable software parameters provided
   in columns 85 and 86 of the NS Status EDR, and no additional events in
   the event set.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_RAW_EVENTS
   COLUMN_NUMBER  = 20
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1441
   DESCRIPTION    = "LG1 raw event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_RAW_EVENTS
   COLUMN_NUMBER  = 21
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1445
   DESCRIPTION    = "LG2 raw event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_RAW_EVENTS
   COLUMN_NUMBER  = 22
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1449
   DESCRIPTION    = "BP raw event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SW_TOTAL_EVENTS
   COLUMN_NUMBER  = 23
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1453
   DESCRIPTION    = "Total events processed by software in the current
   accumulation period."
END_OBJECT    = COLUMN
```

```
OBJECT        = COLUMN
   NAME           = DEAD_TIME
   COLUMN_NUMBER  = 24
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1457
   DESCRIPTION    = "Dead time software counter. Units are in
   microseconds/16. Multiply by 16 to get back to microseconds."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_RESET
   COLUMN_NUMBER  = 25
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1461
   DESCRIPTION    = "LG1 charge reset software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_RESET
   COLUMN_NUMBER  = 26
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1465
   DESCRIPTION    = "LG2 charge reset software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_RESET
   COLUMN_NUMBER  = 27
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1469
   DESCRIPTION    = "BP charge reset software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BPP_LGXS
   COLUMN_NUMBER  = 28
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1473
   DESCRIPTION    = "Software counter for prompt pulse in BP detector with
   delayed secondary pulse in LGx detector (x=1 or 2)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_OVER_RANGE
   COLUMN_NUMBER  = 29
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1477
   DESCRIPTION    = "LG1 prompt over range software counter (pulse height
   larger than maximum specified)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_OVER_RANGE
   COLUMN_NUMBER  = 30
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1481
   DESCRIPTION    = "LG2 prompt over range software counter (pulse height
   larger than maximum specified)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_OVER_RANGE
   COLUMN_NUMBER  = 31
   BYTES          = 4
```

```
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1485
   DESCRIPTION    = "BP prompt over range software counter (pulse height
   larger than maximum specified)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = VALID_TC_EVENT
   COLUMN_NUMBER  = 32
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1489
   DESCRIPTION    = "Time-correlated software counter: non-coincidence and not
   over range events."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_BPP_COIN
   COLUMN_NUMBER  = 33
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1493
   DESCRIPTION    = "LG1/BPP coincidence event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_BPP_COIN
   COLUMN_NUMBER  = 34
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1497
   DESCRIPTION    = "LG2/BPP coincidence event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_BPP_LG2_COIN
   COLUMN_NUMBER  = 35
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1501
   DESCRIPTION    = "LG1/BPP/LG2 coincidence event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TC_EARLY_COUNTER
   COLUMN_NUMBER  = 36
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1505
   DESCRIPTION    = "Summation of all channels of early time-correlated spectra."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TC_LATE_COUNTER
   COLUMN_NUMBER  = 37
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1509
   DESCRIPTION    = "Summation of all channels of late time-correlated spectra."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = EVENT_MODE_DATA_LEN
   COLUMN_NUMBER  = 38
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1513
   DESCRIPTION    = "Event mode data length. A value greater than
   zero indicates that events were observed by the instrument. A
   corresponding NS Full Science Events EDR will archive
   the event data."
```

```
END_OBJECT    = COLUMN
```

8.2. NS_SPE.FMT Table Fields

Below is a table that shows the structure of the binary table containing the NS Spectra data. Following this is the content of the format file itself.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	4	MSB Unsigned Integer	MET	Time tag in seconds of the start of the associated reporting/accumulation period.
5	2	MSB Unsigned Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury
7	4	MSB Unsigned Integer	ACTUAL_ACCUM	Actual accumulation period for software counters and energy histograms.
11	2	MSB Unsigned Integer	SENSOR_CFG_CHANGED	Sensor configuration changed flag.
13	2	MSB Unsigned Integer	LG_SAFING	Maximum Lithium Glass (LG) safing level reached.
15	2	MSB Unsigned Integer	BP_SAFING	Maximum Borated Plastic (BP) safing level reached.
17	2	MSB Unsigned Integer	LOG_COMRPESSION	Identifies when the log compression data mode has been enabled.
19	2 X 32	MSB Unsigned Integer	SINGLES_LG1	32 channel histogram of event energies that arrived as a single event. Lithium Glass 1 sensor.
83	2 X 32	MSB Unsigned Integer	SINGLES_LG2	32 channel histogram of event energies that arrived as a single event. Lithium Glass 2 sensor.
147	2 X 64	MSB Unsigned Integer	SINGLES_BP_SPECTRA	64 channel histogram of event energies that arrived as a solo event. Borated Plastic sensor.
275	2 X 8	MSB Unsigned Integer	TC_EARLY	A histogram of prompt BP events that had a delayed BP event occurring during the early capture window.
291	2 X 8	MSB Unsigned Integer	TC_LATE	A histogram of prompt BP events that had a delayed BP event occurring during the late capture window.
307	4	MSB Unsigned Integer	LG1_RAW_EVENTS	LG1 raw event software counter.
311	4	MSB Unsigned Integer	LG2_RAW_EVENTS	LG2 raw event software counter.
315	4	MSB Unsigned Integer	BP_RAW_EVENTS	BP raw event software counter.
319	4	MSB Unsigned Integer	SW_TOTAL_EVENTS	Total events processed by software in the current accumulation period.
323	4	MSB Unsigned Integer	DEAD_TIME	Dead time software counter.
327	4	MSB Unsigned Integer	LG1_RESET	LG1 charge reset software counter.
331	4	MSB Unsigned Integer	LG2_RESET	LG2 charge reset software counter.
335	4	MSB Unsigned Integer	BP_RESET	BP charge reset software counter.
339	4	MSB Unsigned Integer	BPP_LGXS	Software counter for prompt pulse in BP detector with delayed secondary pulse in LG1 or LG2 detector.
343	4	MSB Unsigned Integer	LG1_OVER_RANGE	LG1 prompt over range software counter.
347	4	MSB Unsigned Integer	LG2_OVER_RANGE	LG2 prompt over range software counter.
351	4	MSB Unsigned Integer	BP_OVER_RANGE	BP prompt over range software counter.
355	4	MSB Unsigned Integer	VALID_TC_EVENT	Time-correlated software counter.
359	4	MSB Unsigned Integer	LG1_BPP_COIN	LG1/BPP coincidence event software

				counter.
363	4	MSB Unsigned Integer	LG2_BPP_COIN	LG2/BPP coincidence event software counter.
367	4	MSB Unsigned Integer	LG1_BPP_LG2_COIN	LG1/BPP/LG2 coincidence event software counter.
371	4	MSB Unsigned Integer	LG1_BPS_COIN	LG1/BPS coincidence event software counter.
375	4	MSB Unsigned Integer	LG2_BPS_COIN	LG2/BPS coincidence event software counter.

```
OBJECT        = COLUMN
   NAME           = MET
   COLUMN_NUMBER  = 1
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1
   DESCRIPTION    = "Time tag in seconds of the start of the associated
   Reporting/Accumulation period."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ORBIT_NUMBER
   COLUMN_NUMBER  = 2
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 5
   DESCRIPTION    = "Orbit number is a unique identifier for a given orbit of
   the MESSENGER spacecraft around Mercury. Orbit number is defined as
   starting at apoherm and is calculated using the MET value and the
   appropriate SPICE kernels. Orbit numbering does not start until MESSENGER
   performs the Mercury orbit insertion. Until that time the value for orbit
   number is 0."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ACTUAL_ACCUM
   COLUMN_NUMBER  = 3
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 7
   DESCRIPTION    = "Actual accumulation period for software counters and
     energy histograms."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SENSOR_CFG_CHANGED
   COLUMN_NUMBER  = 4
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 11
   DESCRIPTION    = "Sensor Configuration Changed Flag.
     =0 config unchanged, =1 config changed."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG_SAFING
   COLUMN_NUMBER  = 5
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 13
   DESCRIPTION    = "Maximum Lithium Glass (LG) safing level reached during
   current reporting period.
   =0 nominal, =1 seeking, =2 level1_rampdown,
   =3 level1_waiting, =4 level1_seeking, =5 level2_safing.
   "
END_OBJECT    = COLUMN
```

```
OBJECT        = COLUMN
   NAME           = BP_SAFING
   COLUMN_NUMBER  = 6
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 15
   DESCRIPTION    = "Maximum safing level reached during current reporting
   period for the Borated Plastic (BP) sensor.
   =0 nominal, =1 seeking, =2 level1_rampdown,
   =3 level1_waiting, =4 level1_seeking, =5 level2_safing
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LOG_COMPRESSION
   COLUMN_NUMBER  = 7
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 17
   DESCRIPTION    = "The Log Compression flag identifies when the log compression data
mode has
   been enabled. The NS flight software uses 32-bit to 16-bit log compression on software
   counters when the log compression data mode is enabled. See the NS Flight Software
document
   for details on the log compression algorithm.
      =0 no log compression. =1 log compression enabled.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SINGLES_LG1
   COLUMN_NUMBER  = 8
   BYTES          = 64
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 19
   ITEMS          = 32
   ITEM_BYTES     = 2
   DESCRIPTION    = "Spectrum is a 32 channel histogram of event energies
   that arrived as a single event with no time correlation to the other
   sensors. LG1 is the Lithium Glass 1 sensor."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SINGLES_LG2
   COLUMN_NUMBER  = 9
   BYTES          = 64
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 83
   ITEMS          = 32
   ITEM_BYTES     = 2
   DESCRIPTION    = "Spectrum is a 32 channel histogram of event energies
   that arrived as a single event with no time correlation to the other
   sensors. LG2 is the Lithium Glass 2 sensor."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SINGLES_BP_SPECTRA
   COLUMN_NUMBER  = 10
   BYTES          = 128
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 147
   ITEMS          = 64
   ITEM_BYTES     = 2
   DESCRIPTION    = "BP is the Borated Plastic sensor. Spectrum is a 64
   channel histogram of event energies that arrived as a solo event with
   respect to the other sensors."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TC_EARLY
   COLUMN_NUMBER  = 11
```

```
   BYTES          = 16
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 275
   ITEMS          = 8
   ITEM_BYTES     = 2
   DESCRIPTION    = "The time-correlated early spectrum is a histogram of
   prompt BP events that had a delayed BP event occurring during the early
   capture window, as defined by commandable software parameters provided
   in columns 83 and 84 of the NS Status EDR, and no additional events in
   the event set.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TC_LATE
   COLUMN_NUMBER  = 12
   BYTES          = 16
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 291
   ITEMS          = 8
   ITEM_BYTES     = 2
   DESCRIPTION    = "The time-correlated late spectrum is a histogram of
   prompt BP events that had a delayed BP event occurring during the late
   capture window, as defined by commandable software parameters provided
   in columns 85 and 86 of the NS Status EDR, and no additional events in
   the event set.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_RAW_EVENTS
   COLUMN_NUMBER  = 13
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 307
   DESCRIPTION    = "LG1 Raw event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_RAW_EVENTS
   COLUMN_NUMBER  = 14
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 311
   DESCRIPTION    = "LG2 Raw event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_RAW_EVENTS
   COLUMN_NUMBER  = 15
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 315
   DESCRIPTION    = "BP Raw event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SW_TOTAL_EVENTS
   COLUMN_NUMBER  = 16
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 319
   DESCRIPTION    = "Total events processed by software in the current
   accumulation period."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = DEAD_TIME
   COLUMN_NUMBER  = 17
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
```

```
   START_BYTE     = 323
   DESCRIPTION    = "Dead time software counter. Units are in
   microseconds/16. Multiply by 16 to get back to microseconds."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_RESET
   COLUMN_NUMBER  = 18
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 327
   DESCRIPTION    = "LG1 charge reset software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_RESET
   COLUMN_NUMBER  = 19
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 331
   DESCRIPTION    = "LG2 charge reset software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_RESET
   COLUMN_NUMBER  = 20
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 335
   DESCRIPTION    = "BP charge reset software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BPP_LGXS
   COLUMN_NUMBER  = 21
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 339
   DESCRIPTION    = "Software counter for prompt pulse in BP detector with
   delayed secondary pulse in LGx detector (x=1 or 2)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_OVER_RANGE
   COLUMN_NUMBER  = 22
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 343
   DESCRIPTION    = "LG1 prompt over range software counter (pulse height
   larger than maximum specified)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_OVER_RANGE
   COLUMN_NUMBER  = 23
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 347
   DESCRIPTION    = "LG2 prompt over range software counter (pulse height
   larger than maximum specified)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_OVER_RANGE
   COLUMN_NUMBER  = 24
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 351
   DESCRIPTION    = "BP prompt over range software counter (pulse height
   larger than maximum specified)."
END_OBJECT    = COLUMN
```

```
OBJECT        = COLUMN
   NAME           = VALID_TC_EVENT
   COLUMN_NUMBER  = 25
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 355
   DESCRIPTION    = "Time-correlated software counter: non-coincidence and not
   over range events."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_BPP_COIN
   COLUMN_NUMBER  = 26
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 359
   DESCRIPTION    = "LG1/BPP coincidence event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_BPP_COIN
   COLUMN_NUMBER  = 27
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 363
   DESCRIPTION    = "LG2/BPP coincidence event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_BPP_LG2_COIN
   COLUMN_NUMBER  = 28
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 367
   DESCRIPTION    = "LG1/BPP/LG2 coincidence event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_BPS_COIN
   COLUMN_NUMBER  = 29
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 371
   DESCRIPTION    = "LG1/BPS coincidence event software counter."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_BPS_COIN
   COLUMN_NUMBER  = 30
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 375
   DESCRIPTION    = "LG2/BPS coincidence event software counter."
END_OBJECT    = COLUMN
```

8.3.NS_EVT.FMT Table Fields

Below is a table that shows the structure of the binary table containing the NS Events EDR data. Following this is the content of the format file.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	4	MSB Unsigned Integer	MET	Time tag in seconds of the start of the associated reporting/accumulation period.
5	2	MSB Unsigned Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury
7	2	MSB Unsigned Integer	EVT_MODE_LEN	Event mode data length.
9	2 X 255	MSB Unsigned Integer	EVT_MODE_TTSP	Event mode data for Time-to-Second-Pulse (TTSP) values.
519	2 X 255	MSB Unsigned Integer	EVT_MODE_BPP	Event mode data containing the BPP event energies.
1029	2 X 255	MSB Unsigned Integer	EVT_MODE_BPS	Event mode data containing the BPS event energies.

```
OBJECT         = COLUMN
   NAME            = MET
   COLUMN_NUMBER   = 1
   BYTES           = 4
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 1
   DESCRIPTION     = "Time tag in seconds of the start of the associated
     reporting/accumulation period."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = ORBIT_NUMBER
   COLUMN_NUMBER   = 2
   BYTES           = 2
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 5
   DESCRIPTION     = "Orbit number is a unique identifier for a given orbit of
   the MESSENGER spacecraft around Mercury. Orbit number is defined as
   starting at apoherm and is calculated using the MET value and the
   appropriate SPICE kernels. Orbit numbering does not start until MESSENGER
   performs the Mercury orbit insertion. Until that time the value for orbit
   number is 0."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = EVT_MODE_LEN
   COLUMN_NUMBER   = 3
   BYTES           = 2
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 7
   DESCRIPTION     = "Event mode data length. This specifies the N number of
   items containing data in the following event mode data fields.  Event mode
   data length is commandable and can vary from 0-255."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = EVT_MODE_TTSP
   COLUMN_NUMBER   = 4
   BYTES           = 510
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 9
   ITEMS           = 255
   ITEM_BYTES      = 2
   DESCRIPTION     = "Event mode data for Time-To-Second-Pulse (TTSP) values.
   The Ith item in the TTSP field is the TTSP for the Ith correlated time
   event. If EVT_MODE_LEN is less than 255 then the item columns greater
   than N do not contain valid data and will default to 0."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = EVT_MODE_BPP
   COLUMN_NUMBER   = 5
```

```
   BYTES          = 510
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 519
   ITEMS          = 255
   ITEM_BYTES     = 2
   DESCRIPTION    = "Event mode data containing the BPP event energies, in
   raw ADC units. The Nth item corresponds to the prompt energy of the Nth
   time-correlated event. If EVT_MODE_LEN is less than 255 then the item
   columns greater than N do not contain valid data and will default to 0."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = EVT_MODE_BPS
   COLUMN_NUMBER  = 6
   BYTES          = 510
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1029
   ITEMS          = 255
   ITEM_BYTES     = 2
   DESCRIPTION    = "Event mode data containing the BPS event energies, in
   Raw ADC units. The Nth item in the field corresponds to the
   delayed-deposited energies of the Nth time-correlated event. If
   EVT_MODE_LEN is less than 255 then the item columns greater than N do not
   contain valid data and will default to 0."
END_OBJECT    = COLUMN
```

8.4.NS_GCR.FMT Table Fields

Below is a table that shows the structure of the binary table containing the NS Gamma-Ray Burst EDR data. Following this is the content of the format file.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	4	MSB Unsigned Integer	MET	Time tag in seconds of the gamma-ray burst trigger.
5	2	MSB Unsigned Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury
7	4	MSB Unsigned Integer	ACTUAL_ACCUM	Actual accumulation period.
11	2	MSB Unsigned Integer	GCR_MODE	Galactic Cosmic Ray Coincidence Mode
13	2	MSB Unsigned Integer	SENSOR_CFG_CHANGED	Sensor configuration changed flag.
15	2	MSB Unsigned Integer	LG_SAFING	Maximum Lithium Glass (LG) safing level reached.
17	2	MSB Unsigned Integer	BP_SAFING	Maximum Borated Plastic (BP) safing level reached.
19	2	MSB Unsigned Integer	LOG_COMPRESSION	Identifies when the log compression data mode has been enabled.
21	2	MSB Unsigned Integer	SENSOR_TEMP	Sensor temperature.
23	2	MSB Unsigned Integer	TEMP_MONITOR	LVPS temperature monitor.
25	2	MSB Unsigned Integer	LG1_SCALE	LG1 Singles spectrum scale
27	2	MSB Unsigned Integer	LG2_SCALE	LG2 Singles spectrum scale
29	2	MSB Unsigned Integer	BP_SCALE	BP Singles spectrum scale
31	2	MSB Unsigned Integer	TC_SCALE	Time-correlated spectrum scale
33	2 X 64	MSB Unsigned Integer	LG1_GCR_SPECTRUM	LG1 Galactic Cosmic Ray spetrum.
161	2 X 64	MSB Unsigned Integer	LG2_GCR_SPECTRUM	LG2 Galactic Cosmic Ray spectrum.

```
OBJECT        = COLUMN
   NAME           = MET
   COLUMN_NUMBER  = 1
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1
   DESCRIPTION    = "Time tag in seconds of the start of the associated
```

```
   Reporting/Accumulation period."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ORBIT_NUMBER
   COLUMN_NUMBER  = 2
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 5
   DESCRIPTION    = "Orbit number is a unique identifier for a given orbit of
   the MESSENGER spacecraft around Mercury. Orbit number is defined as
   starting at apoherm and is calculated using the MET value and the
   appropriate SPICE kernels. Orbit numbering does not start until MESSENGER
   performs the Mercury orbit insertion. Until that time the value for orbit
   number is 0."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ACTUAL_ACCUM
   COLUMN_NUMBER  = 3
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 7
   DESCRIPTION    = "Actual accumulation period."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = GCR_MODE
   COLUMN_NUMBER  = 4
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 11
   DESCRIPTION    = "Galactic Cosmic Ray (GCR) Coincidence mode.
   =1 Doubles, =2 Triples, =3 Either."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SENSOR_CFG_CHANGED
   COLUMN_NUMBER  = 5
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 13
   DESCRIPTION    = "Sensor Configuration Changed Flag.
     =0 config unchanged, =1 config changed."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG_SAFING
   COLUMN_NUMBER  = 6
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 15
   DESCRIPTION    = "Maximum Lithium Glass (LG) safing level reached during
   current reporting period.
   =0 nominal, =1 seeking, =2 level1_rampdown,
   =3 level1_waiting, =4 level1_seeking, =5 level2_safing.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_SAFING
   COLUMN_NUMBER  = 7
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 17
   DESCRIPTION    = "Maximum safing level reached during current reporting
   period for the Borrated Plastic (BP) sensor.
   =0 nominal, =1 seeking, =2 level1_rampdown,
   =3 level1_waiting, =4 level1_seeking, =5 level2_safing
   "
END_OBJECT    = COLUMN
```

```
OBJECT        = COLUMN
   NAME           = LOG_COMPRESSION
   COLUMN_NUMBER  = 8
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 19
   DESCRIPTION    = "Identifies when the log compression data mode has
   been enabled. The NS flight software uses 32-bit to 16-bit log compression
   on software counters when the log compression data mode is enabled.
   See the NS Flight Software document for details on the log compression
   algorithm.
   =0 no log compression. =1 log compression enabled.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SENSOR_TEMP
   COLUMN_NUMBER  = 9
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 21
   DESCRIPTION    = "Sensor Temperature, External Channel 4 (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TEMP_MONITOR
   COLUMN_NUMBER  = 10
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 23
   DESCRIPTION    = "LVPS Temperature monitor."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_SCALE
   COLUMN_NUMBER  = 11
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 25
   DESCRIPTION    = "LG1 singles spectrum scale."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_SCALE
   COLUMN_NUMBER  = 12
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 27
   DESCRIPTION    = "LG2 singles spectrum scale."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_SCALE
   COLUMN_NUMBER  = 13
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 29
   DESCRIPTION    = "BP singles spectrum scale."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TC_SCALE
   COLUMN_NUMBER  = 14
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 31
   DESCRIPTION    = "Time-correlated spectra scale."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
```

```
   NAME            = LG1_GCR_SPECTRUM
   COLUMN_NUMBER   = 15
   BYTES           = 128
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 33
   ITEMS           = 64
   ITEM_BYTES      = 2
   DESCRIPTION     = "LG1 Galactic Cosmic Ray spectrum."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = LG2_GCR_SPECTRUM
   COLUMN_NUMBER   = 16
   BYTES           = 128
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 161
   ITEMS           = 64
   ITEM_BYTES      = 2
   DESCRIPTION     = "LG2 Galactic Cosmic Ray spectrum."
END_OBJECT     = COLUMN
```

8.5.NS_GAB.FMT Table Fields

Below is a table that shows the structure of the binary table containing the NS Gamma-Ray Burst EDR data. Following this is the content of the format file.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	4	MSB Unsigned Integer	MET	Time tag in seconds of the gamma-ray burst trigger.
5	2	MSB Unsigned Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury
7	2	MSB Unsigned Integer	GAMMA_RAY_MODE	Gamma ray mode.
9	2	MSB Unsigned Integer	BP_CH_UPPER_LIMIT	The highest BP channel that will be used as part of the source of the Gamma-Ray burst BP counts.
11	4	MSB Unsigned Integer	TRIG_BOXCAR_ACCUM	Number of counts in the running box car accumulator at the time of the trigger.
15	2	MSB Unsigned Integer	BURST_THRESHOLD	Burst lower pulse threshold for trigger.
17	2	MSB Unsigned Integer	POST_TRIGGER_COUNTS	Number of post trigger counts.
19	2 X 164	MSB Unsigned Integer	GAMMA_RAY_BURST	Collection of 164 (1-sec) BP counts.

```
OBJECT         = COLUMN
   NAME            = MET
   COLUMN_NUMBER   = 1
   BYTES           = 4
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 1
   DESCRIPTION     = "Time tag in seconds of the gamma-ray burst trigger."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = ORBIT_NUMBER
   COLUMN_NUMBER   = 2
   BYTES           = 2
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 5
   DESCRIPTION     = "Orbit number is a unique identifier for a given orbit of
   the MESSENGER spacecraft around Mercury. Orbit number is defined as
   starting at apoherm and is calculated using the MET value and the
   appropriate SPICE kernels. Orbit numbering does not start until MESSENGER
   performs the Mercury orbit insertion. Until that time the value for orbit
   number is 0."
END_OBJECT     = COLUMN
```

```
OBJECT        = COLUMN
   NAME           = GAMMA_RAY_MODE
   COLUMN_NUMBER  = 3
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 7
   DESCRIPTION    = "Gamma Ray mode. =0 RAW, =1 PROCESSED."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_CH_UPPER_LIMIT
   COLUMN_NUMBER  = 4
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 9
   DESCRIPTION    = "The highest BP channel that will be used as part of the source
   of the Gamma-Ray burst BP counts."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TRIG_BOXCAR_ACCUM
   COLUMN_NUMBER  = 5
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 11
   DESCRIPTION    = "Number of counts in the running box car accumulator at
   the time of the trigger. Box car length is 164 events."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BURST_THRESHOLD
   COLUMN_NUMBER  = 6
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 15
   DESCRIPTION    = "Burst lower pulse threshold for trigger in raw ADC
   units."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = POST_TRIGGER_COUNTS
   COLUMN_NUMBER  = 7
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 17
   DESCRIPTION    = "Number of post trigger counts."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = GAMMA_RAY_BURST
   COLUMN_NUMBER  = 8
   BYTES          = 328
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 19
   ITEMS          = 164
   ITEM_BYTES     = 2
   DESCRIPTION    = "Collection of 164 (1-sec) BP counts."
END_OBJECT    = COLUMN
```

8.6.NS_SHORTSCI.FMT Table Fields

Below is a table that shows the structure of the binary table containing the NS Short Science EDR data. Following this is the content of the format file.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	4	MSB Unsigned Integer	MET	Time tag in seconds of the start of the associated reporting/accumulation period.
5	2	MSB Unsigned Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury
7	4	MSB Unsigned Integer	ACTUAL_ACCUM	Actual accumulation period for software counters and energy histograms.
11	2	MSB Unsigned Integer	GCR_MODE	Galactic Cosmic Ray (GCR) Coincidence mode.
13	2	MSB Unsigned Integer	SENSOR_CFG_CHANGED	Sensor configuration changed flag.
15	2	MSB Unsigned Integer	LG_SAFING	Maximum Lithium Glass (LG) safing level reached.
17	2	MSB Unsigned Integer	BP_SAFING	Maximum Borated Plastic (BP) safing level reached.
19	2	MSB Unsigned Integer	LOG_COMRPESSION	Identifies when the log compression data mode has been enabled.
21	2	MSB Unsigned Integer	SENSOR_TEMP	Sensor Temperature
23	2	MSB Unsigned Integer	TEMP_MONITOR	LVPS temperature monitor.
25	2	MSB Unsigned Integer	LG1_SCALE	LG1 singles spectrum scale.
27	2	MSB Unsigned Integer	LG2_SCALE	LG2 singles spectrum scale.
29	2	MSB Unsigned Integer	BP_SCALE	BP singles spectrum scale.
31	2	MSB Unsigned Integer	TC_SCALE	Time-correlated spectrum scale.
33	2 X 64	MSB Unsigned Integer	SINGLES_BP_SPECTRA	64 channel histogram of event energies that arrived as a solo event. Borated Plastic sensor.
161	2 X 256	MSB Unsigned Integer	TC_EARLY	A histogram of prompt BP events that had a delayed BP event occurring during the early capture window.
673	2 X 256	MSB Unsigned Integer	TC_LATE	A histogram of prompt BP events that had a delayed BP event occurring during the late capture window.

```
OBJECT         = COLUMN
   NAME            = MET
   COLUMN_NUMBER   = 1
   BYTES           = 4
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 1
   DESCRIPTION     = "Time tag in seconds of the start of the associated
   Reporting/Accumulation period."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = ORBIT_NUMBER
   COLUMN_NUMBER   = 2
   BYTES           = 2
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 5
   DESCRIPTION     = "Orbit number is a unique identifier for a given orbit of
   the MESSENGER spacecraft around Mercury. Orbit number is defined as
   starting at apoherm and is calculated using the MET value and the
   appropriate SPICE kernels. Orbit numbering does not start until MESSENGER
   performs the Mercury orbit insertion. Until that time the value for orbit
   number is 0."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = ACTUAL_ACCUM
   COLUMN_NUMBER   = 3
   BYTES           = 4
```

```
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 7
   DESCRIPTION    = "Actual accumulation period for software counters and
    energy histograms."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = GCR_MODE
   COLUMN_NUMBER  = 4
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 11
   DESCRIPTION    = "Galactic Cosmic Ray (GCR) Coincidence mode.
   =1 Doubles, =2 Triples, =3 Either."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SENSOR_CFG_CHANGED
   COLUMN_NUMBER  = 5
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 13
   DESCRIPTION    = "Sensor Configuration Changed Flag.
     =0 config unchanged, =1 config changed."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG_SAFING
   COLUMN_NUMBER  = 6
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 15
   DESCRIPTION    = "Maximum Lithium Glass (LG) safing level reached during
   current reporting period.
   =0 nominal, =1 seeking, =2 level1_rampdown,
   =3 level1_waiting, =4 level1_seeking, =5 level2_safing.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_SAFING
   COLUMN_NUMBER  = 7
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 17
   DESCRIPTION    = "Maximum safing level reached during current reporting
   period for the Borrated Plastic (BP) sensor.
   =0 nominal, =1 seeking, =2 level1_rampdown,
   =3 level1_waiting, =4 level1_seeking, =5 level2_safing
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LOG_COMPRESSION
   COLUMN_NUMBER  = 8
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 19
   DESCRIPTION    = "Identifies when the log compression data mode has
   been enabled. The NS flight software uses 32-bit to 16-bit log compression
   on software counters when the log compression data mode is enabled.
   See the NS Flight Software document for details on the log compression
   algorithm.
   =0 no log compression. =1 log compression enabled.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SENSOR_TEMP
   COLUMN_NUMBER  = 9
   BYTES          = 2
```

```
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 21
   DESCRIPTION    = "Sensor Temperature, External Channel 4 (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TEMP_MONITOR
   COLUMN_NUMBER  = 10
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 23
   DESCRIPTION    = "LVPS Temperature monitor."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_SCALE
   COLUMN_NUMBER  = 11
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 25
   DESCRIPTION    = "LG1 singles spectrum scale."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_SCALE
   COLUMN_NUMBER  = 12
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 27
   DESCRIPTION    = "LG2 singles spectrum scale."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_SCALE
   COLUMN_NUMBER  = 13
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 29
   DESCRIPTION    = "BP singles spectrum scale."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TC_SCALE
   COLUMN_NUMBER  = 14
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 31
   DESCRIPTION    = "Time-correlated spectra scale."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SINGLES_BP_SPECTRA
   COLUMN_NUMBER  = 15
   BYTES          = 128
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 33
   ITEMS          = 64
   ITEM_BYTES     = 2
   DESCRIPTION    = "Spectrum is a 64 channel histogram of event energies
   that arrived as a single event with no time correlation to the other
   sensors. LG1 is the Lithium Glass 1 sensor."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TC_EARLY
   COLUMN_NUMBER  = 16
   BYTES          = 512
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 161
   ITEMS          = 256
   ITEM_BYTES     = 2
```

```
   DESCRIPTION    = "The time-correlated early spectrum is a histogram of
   prompt BP events that had a delayed BP event occurring during the early
   capture window, as defined by commandable software parameters provided
   in columns 83 and 84 of the NS Status EDR, and no additional events in
   the event set.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TC_LATE
   COLUMN_NUMBER  = 17
   BYTES          = 512
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 673
   ITEMS          = 256
   ITEM_BYTES     = 2
   DESCRIPTION    = "The time-correlated late spectrum is a histogram of
   prompt BP events that had a delayed BP event occurring during the late
   capture window, as defined by commandable software parameters provided
   in columns 85 and 86 of the NS Status EDR, and no additional events in
   the event set.
   "
END_OBJECT    = COLUMN
```

8.7.NS_TCC.FMT Table Fields

Below is a table that shows the structure of the binary table containing the NS Time-Correlated Counts EDR data. Following this is the content of the format file.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	4	MSB Unsigned Integer	MET	Time tag in seconds of the first sample in the neutron burst counters packet.
5	2	MSB Unsigned Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury
7	4	MSB Unsigned Integer	TC_EARLY_COUNTER	Summation of all channels of early time-correlated spectra.
11	4	MSB Unsigned Integer	TC_LATE_COUNTER	Summation of all channels of late time-correlated spectra.

```
OBJECT        = COLUMN
   NAME           = MET
   COLUMN_NUMBER  = 1
   BYTES          = 4
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 1
   DESCRIPTION    = "Time tag in seconds of the first sample in the neutron burst
     counters packet."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ORBIT_NUMBER
   COLUMN_NUMBER  = 2
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 5
   DESCRIPTION    = "Orbit number is a unique identifier for a given orbit of
   the MESSENGER spacecraft around Mercury. Orbit number is defined as
   starting at apoherm and is calculated using the MET value and the
   appropriate SPICE kernels. Orbit numbering does not start until MESSENGER
   performs the Mercury orbit insertion. Until that time the value for orbit
   number is 0."
END_OBJECT    = COLUMN
```

```
OBJECT         = COLUMN
   NAME            = TC_EARLY_COUNTER
   COLUMN_NUMBER   = 3
   BYTES           = 4
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 7
   DESCRIPTION     = "Summation of all channels of early time-correlated spectra."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = TC_LATE_COUNTER
   COLUMN_NUMBER   = 4
   BYTES           = 4
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 11
   DESCRIPTION     = "Summation of all channels of late time-correlated spectra."
END_OBJECT     = COLUMN
```

8.8. NS_STATUS.FMT Table Fields

Below is a table that shows the structure of the ASCII table containing the NS Status EDR data. The ASCII table is both fixed-width and comma delimited. Note that in PDS ASCII table format, the Start Byte has to take into account the comma delimiter and empty spaces. Following this is the content of the format file.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	12	ASCII Integer	MET	Time tag in seconds of the start of the associated reporting/accumulation period.
15	6	ASCII Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury
23	5	ASCII Integer	STATUS_INTERVAL	Defines the interval at which status is reported.
30	5	ASCII Integer	MACRO_BLOCKS	Number of macro blocks free.
37	5	ASCII Integer	TLM_VOLUME	Telemetry volume (KB) produced by NS.
44	5	ASCII Integer	WATCH_ADDR	Address loaded for peaking into memory for diagnostic purposes.
51	3	ASCII Integer	WATCH_MEM	Memory watch address id loaded to complete 20-bit address.
56	5	ASCII Integer	WATCH_DATA1	Watched memory, byte 1 value.
63	5	ASCII Integer	WATCH_DATA2	Watched memory, byte 2 value.
70	3	ASCII Integer	SW_VERSION	Software version number.
75	3	ASCII Integer	ALARM_ID	Latest alarm id.
80	1	ASCII Integer	ALARM_TYPE	Latest alarm type.
83	3	ASCII Integer	ALARM_COUNT	Count of alarms.
88	3	ASCII Integer	CMD_EXEC	Number of commands executed.
93	3	ASCII Integer	CMD_REJECT	Number of commands rejected.
98	3	ASCII Integer	MAC_EXEC	Number of macro commands executed.
103	3	ASCII Integer	MAC_REJECT	Number of macro commands rejected.
108	3	ASCII Integer	MACRO_ID	ID of most recent macro executed.
113	1	ASCII Integer	MACRO_LEARN	Macro learn mode.
116	1	ASCII Integer	MONITOR_RESP	Monitor response.
119	1	ASCII Integer	WRITE_ENABLE	Memory write enable.
122	3	ASCII Integer	SPARE	Spare column.
127	6	ASCII Integer	PLUS_5V	+5 volt monitor (LVPS).
135	6	ASCII Integer	NEG_5V	-5 volt monitor (LVPS).
143	6	ASCII Integer	PLUS_12V	+12 volt monitor (LVPS).

151	6	ASCII Integer	NEG_12V	-12 volt monitor (LVPS).
159	6	ASCII Integer	EXTERNAL_CH1	External channel 1 (LVPS).
167	6	ASCII Integer	EXTERNAL_CH2	External channel 2 (LVPS).
175	6	ASCII Integer	EXTERNAL_CH3	External channel 3 (LVPS).
183	6	ASCII Integer	EXTERNAL_CH4	External channel 4 (LVPS).
191	6	ASCII Integer	EXTERNAL_CH5	External channel 5 (LVPS).
199	6	ASCII Integer	PLUS5V_I	+5V current monitor (LVPS).
207	6	ASCII Integer	NEG5V_I	-5V current monitor (LVPS).
215	6	ASCII Integer	PLUS12V_I	+12V current monitor (LVPS).
223	6	ASCII Integer	NEG12V_I	-12V current monitor (LVPS).
231	6	ASCII Integer	TEMP_MON	Temperature monitor (LVPS).
239	6	ASCII Integer	PRIMARY_I	Primary current monitor (LVPS).
247	6	ASCII Integer	SWITCHED_PRI_I	Switched primary current monitor (LVPS).
255	5	ASCII Integer	VOLT_LG_HVPS	Voltage of LG HVPS(1).
262	5	ASCII Integer	VOLT_BP_HVPS	Voltage of BP HVPS(2).
269	5	ASCII Integer	TEMP_LG	Temperature of LG.
276	5	ASCII Integer	TEMP_BP	Temperature of BP.
283	5	ASCII Integer	HVPS_SPARE1	Spare column.
290	5	ASCII Integer	HVPS_SPARE2	Spare column.
297	5	ASCII Integer	CAPTURE_E_LIMIT	Capture energy limit.
304	3	ASCII Integer	EVENT_MODE_LEN	Event mode length.
309	3	ASCII Integer	FAILED_PACKETS	Failed packets.
314	6	ASCII Integer	POWER_MANAGEMENT	Power management bit register.
322	6	ASCII Integer	TRIG_SAMPLE_TAP	Trigger sample tap.
330	6	ASCII Integer	GAIN_DAC	Controls BP channel gain by changing ADC reference voltage.
338	6	ASCII Integer	BP_CHARGE_RESET	BP charge reset.
346	6	ASCII Integer	BP_PRMPT_THRESH	Channel 0 (BP) prompt trigger threshold.
354	6	ASCII Integer	BP_SEC_THRESH	Channel 0 (BP) secondary trigger threshold.
362	6	ASCII Integer	LG1_TRIG_THRESH	Channel 1 (LG) trigger threshold.
370	6	ASCII Integer	LG2_TRIG_THRESH	Channel 2 (LG) trigger threshold.
378	6	ASCII Integer	BP_RAW_EVENT	Channel 0 (BP) raw event hardware counter (1-sec accumulation).
386	6	ASCII Integer	LG1_RAW_EVENT	Channel 1 (LG1) raw event hardware counter (1-sec accumulation).
394	6	ASCII Integer	LG2_RAW_EVENT	Channel 2 (LG2) raw event hardware counter (1-sec accumulation).
402	1	ASCII Integer	LG_SAFING_STATE	LG current sensor state.
405	1	ASCII Integer	BP_SAFING_STATE	BP current sensor state.
408	1	ASCII Integer	SPARE	Spare column.
411	1	ASCII Integer	SCREEN_ON_DQ	Set calibration/diagnostic mode to screen out data with DQ bit set.
414	1	ASCII Integer	NON_COMP_SCI_DATA	Science data mode enabled.
417	1	ASCII Integer	FAST_COMP_SCI_DATA	Fast compression of science data enabled.
420	1	ASCII Integer	LOG_COMP_SCI_DATA	Log compression of spectra enabled.
423	1	ASCII Integer	DIAG_DATA_PACKET	Diagnostic packet enabled.
426	1	ASCII Integer	SPARE_DATA_PACKET	Spare data packet enabled.
429	1	ASCII Integer	HV1_ENABLED	HV1 (BP) enabled.
432	1	ASCII Integer	HV2_ENABLED	HV2 (LG1 or LG2) enabled.
435	1	ASCII Integer	ACCUM_FLAG	Flag for instrument accumulation.
438	5	ASCII Integer	ACCUM_PERIOD	Currently commanded accumulation period.
445	5	ASCII Integer	REPORT_PERIOD	Currently commanded reporting period.
452	5	ASCII Integer	LG1_ULD	LG1 Upper-Level Discriminator.
459	5	ASCII Integer	LG2_ULD	LG2 Upper-Level Discriminator.
466	5	ASCII Integer	BP_ULD	BPP Upper-Level Discriminator.

473	5	ASCII Integer	HI_VOLT_SETP_BP	Currently commanded High Voltage set point for BP HVPS.
480	5	ASCII Integer	HI_VOLT_SEPT_LG	Currently commanded High Voltage set point for LG HVPS.
487	5	ASCII Integer	HVPS_1_MAX_VAL	Maximum commandable HVPS 1 value.
494	5	ASCII Integer	HVPS_2_MAX_VAL	Maximum commandable HVPS 2 value.
501	5	ASCII Integer	SAFING_RETRY	Sensor safing retry value.
508	5	ASCII Integer	SAFING_INTERVAL	Sensor safing interval value.
515	5	ASCII Integer	SAFING_THRESHOLD	LG1, LG2, BP Safing threshold.
522	3	ASCII Integer	EARLY_CAPTURE_START	Early capture window start time.
527	3	ASCII Integer	EARLY_CAPTURE_END	Early capture window end time.
532	3	ASCII Integer	LATE_CAPTURE_START	Late capture window start time.
537	3	ASCII Integer	LATE_CAPTURE_END	Late capture window end time.
542	3	ASCII Integer	CH0_LATCH_UPS	Total number of latch-ups on Channel 0 since last boot.
547	3	ASCII Integer	CH1_2_LATCH_UPS	Total number of latch-ups on Channels 1 and 2 since last boot.
552	3	ASCII Integer	GAMMA_BURST_CNT	Cumulative number of gamma ray bursts.
557	1	ASCII Integer	TELEMETRY_PRIORITY	Priority level for science telemetry.
560	1	ASCII Integer	SPARE	Spare column.
563	1	ASCII Integer	GCR_COINCIDENCE_MODE	Galactic Cosmic Ray coincidence mode.
566	1	ASCII Integer	GCR_PACKET	Galactic Cosmic Ray packet enabled.
569	1	ASCII Integer	GAMMARAY_BURST_RESPONSE	Gamma Ray burst response macro enabled.
572	5	ASCII Integer	GAMMA_BURST_THRESH	Gamma Ray burst threshold value.
579	3	ASCII Integer	GAMMA_CH_LIMIT	Gamma Ray channel limit.
584	1	ASCII Integer	GAMMA_MODE	Gamma Ray mode.
587	1	ASCII Integer	TC_COUNTERS	Time-correlated counters mode enabled.
590	3	ASCII Integer	SPARE	Spare column.
595	5	ASCII Integer	GAMMA_POST_TRIG_LEN	Gamma Ray post trigger length.
602	5	ASCII Integer	SPARE	Spare column.
609	5	ASCII Integer	SPARE	Spare column.
616	5	ASCII Integer	SPARE	Spare column.

```
OBJECT         = COLUMN
   NAME            = MET
   COLUMN_NUMBER   = 1
   BYTES           = 12
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 1
   DESCRIPTION     = "Time tag in seconds associated with the field values in
   the same row."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = ORBIT_NUMBER
   COLUMN_NUMBER   = 2
   BYTES           = 6
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 15
   DESCRIPTION     = "Orbit number is a unique identifier for a given orbit of
   the MESSENGER spacecraft around Mercury. Orbit number is defined as
   starting at apoherm and is calculated using the MET value and the
   appropriate SPICE kernels. Orbit numbering does not start until MESSENGER
   performs the Mercury orbit insertion. Until that time the value for orbit
   number is 0."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = STATUS_INTERVAL
   COLUMN_NUMBER   = 3
   BYTES           = 5
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 23
```

```
   DESCRIPTION    = "Status interval (in seconds). Valid values: 1-65535
   (0=off)". Defines the interval at which status is reported. Not an
   accumulation interval. All status fields are either stationary values of
   registers or 1-second accumulations (such as for hardware counters)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MACRO_BLOCKS
   COLUMN_NUMBER  = 4
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 30
   DESCRIPTION    = "Number of macro blocks free."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TLM_VOLUME
   COLUMN_NUMBER  = 5
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 37
   DESCRIPTION    = "Telemetry volume produced (KB) by NS (compressed data
   with telemetry headers, etc.). For telemetry control purposes."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = WATCH_ADDR
   COLUMN_NUMBER  = 6
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 44
   DESCRIPTION    = "Memory watch address. Address loaded for peaking into
   memory for diagnostic purposes."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = WATCH_MEM
   COLUMN_NUMBER  = 7
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 51
   DESCRIPTION    = "Memory watch address id (page number) loaded to complete
   20-bit address."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = WATCH_DATA1
   COLUMN_NUMBER  = 8
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 56
   DESCRIPTION    = "Watched memory, byte 1 value of the stack-errors word
   maintained by the common code."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = WATCH_DATA2
   COLUMN_NUMBER  = 9
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 63
   DESCRIPTION    = "Watched memory, byte 2 value of the stack-errors word
   maintained by the common code."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SW_VERSION
   COLUMN_NUMBER  = 10
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 70
```

```
   DESCRIPTION    = "Software version number."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ALARM_ID
   COLUMN_NUMBER  = 11
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 75
   DESCRIPTION    = "Latest alarm id. See NS Flight Software document,
   Table 2.12 Alarm ID and compiled in Monitor limits."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ALARM_TYPE
   COLUMN_NUMBER  = 12
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 80
   DESCRIPTION    = "Latest alarm type. =0 Persistent. =1 Transient."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ALARM_COUNT
   COLUMN_NUMBER  = 13
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 83
   DESCRIPTION    = "Count of alarms."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = CMD_EXEC
   COLUMN_NUMBER  = 14
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 88
   DESCRIPTION    = "Number of commands executed."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = CMD_REJECT
   COLUMN_NUMBER  = 15
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 93
   DESCRIPTION    = "Number of commands rejected."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MAC_EXEC
   COLUMN_NUMBER  = 16
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 98
   DESCRIPTION    = "Number of macro commands executed."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MAC_REJECT
   COLUMN_NUMBER  = 17
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 103
   DESCRIPTION    = "Number of macro commands rejected."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MACRO_ID
   COLUMN_NUMBER  = 18
   BYTES          = 3
```

```
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 108
   DESCRIPTION    = "ID of most recent macro executed."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MACRO_LEARN
   COLUMN_NUMBER  = 19
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 113
   DESCRIPTION    = "Macro learn mode. =0 not learning, =1 learning."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MONITOR_RESP
   COLUMN_NUMBER  = 20
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 116
   DESCRIPTION    = "Monitor response. =0 disabled, =1 enabled."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = WRITE_ENABLE
   COLUMN_NUMBER  = 21
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 119
   DESCRIPTION    = "Memory write enable. =0 disabled, =1 enabled."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SPARE
   COLUMN_NUMBER  = 22
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 122
   DESCRIPTION    = "Spare column."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = PLUS_5V
   COLUMN_NUMBER  = 23
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 127
   DESCRIPTION    = "+5 volt monitor. (LVPS)"
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = NEG_5V
   COLUMN_NUMBER  = 24
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 135
   DESCRIPTION    = "-5 volt monitor (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = PLUS_12V
   COLUMN_NUMBER  = 25
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 143
   DESCRIPTION    = "+12 volt monitor (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = NEG_12V
   COLUMN_NUMBER  = 26
```

```
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 151
   DESCRIPTION    = "-12 volt monitor (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = EXTERNAL_CH1
   COLUMN_NUMBER  = 27
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 159
   DESCRIPTION    = "External channel 1 (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = EXTERNAL_CH2
   COLUMN_NUMBER  = 28
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 167
   DESCRIPTION    = "External channel 2 (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = EXTERNAL_CH3
   COLUMN_NUMBER  = 29
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 175
   DESCRIPTION    = "External channel 3 (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = EXTERNAL_CH4
   COLUMN_NUMBER  = 30
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 183
   DESCRIPTION    = "External channel 4 (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = EXTERNAL_CH5
   COLUMN_NUMBER  = 31
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 191
   DESCRIPTION    = "External channel 5 (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = PLUS5V_I
   COLUMN_NUMBER  = 32
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 199
   DESCRIPTION    = "+5V current monitor (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = NEG5V_I
   COLUMN_NUMBER  = 33
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 207
   DESCRIPTION    = "-5V current monitor (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = PLUS12V_I
```

```
   COLUMN_NUMBER  = 34
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 215
   DESCRIPTION    = "+12V current monitor (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = NEG12V_I
   COLUMN_NUMBER  = 35
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 223
   DESCRIPTION    = "-12V current monitor (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TEMP_MON
   COLUMN_NUMBER  = 36
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 231
   DESCRIPTION    = "Temperature Monitor (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = PRIMARY_I
   COLUMN_NUMBER  = 37
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 239
   DESCRIPTION    = "Primary current Monitor (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SWITCHED_PRI_I
   COLUMN_NUMBER  = 38
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 247
   DESCRIPTION    = "Switched Primary current Monitor (LVPS)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = VOLT_LG_HVPS
   COLUMN_NUMBER  = 39
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 255
   DESCRIPTION    = "Voltage of LG HVPS(1)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = VOLT_BP_HVPS
   COLUMN_NUMBER  = 40
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 262
   DESCRIPTION    = "Voltage of BP HVPS(2)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TEMP_LG
   COLUMN_NUMBER  = 41
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 269
   DESCRIPTION    = "Temperature of LG."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
```

```
   NAME            = TEMP_BP
   COLUMN_NUMBER   = 42
   BYTES           = 5
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 276
   DESCRIPTION     = "Temperature of BP."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = HVPS_SPARE1
   COLUMN_NUMBER   = 43
   BYTES           = 5
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 283
   DESCRIPTION     = "Spare column."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = HVPS_SPARE2
   COLUMN_NUMBER   = 44
   BYTES           = 5
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 290
   DESCRIPTION     = "Spare column."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = CAPTURE_E_LIMIT
   COLUMN_NUMBER   = 45
   BYTES           = 5
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 297
   DESCRIPTION     = "Capture energy limit."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = EVENT_MODE_LEN
   COLUMN_NUMBER   = 46
   BYTES           = 3
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 304
   DESCRIPTION     = "Event mode length."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = FAILED_PACKETS
   COLUMN_NUMBER   = 47
   BYTES           = 3
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 309
   DESCRIPTION     = "Failed packets."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = POWER_MANAGEMENT
   COLUMN_NUMBER   = 48
   BYTES           = 6
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 314
   DESCRIPTION     = "Power Management bit register. Defines various circuit
   parameters, including normal and sleep modes."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = TRIG_SAMPLE_TAP
   COLUMN_NUMBER   = 49
   BYTES           = 6
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 322
   DESCRIPTION     = "Trigger sample tap."
END_OBJECT     = COLUMN
```

```
OBJECT        = COLUMN
   NAME           = GAIN_DAC
   COLUMN_NUMBER  = 50
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 330
   DESCRIPTION    = "Controls BP channel Gain by changing ADC reference
   voltage."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_CHARGE_RESET
   COLUMN_NUMBER  = 51
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 338
   DESCRIPTION    = "BP Charge reset."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_PRMPT_THRESH
   COLUMN_NUMBER  = 52
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 346
   DESCRIPTION    = "Channel 0 (BP) Prompt Trigger Threshold."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_SEC_THRESH
   COLUMN_NUMBER  = 53
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 354
   DESCRIPTION    = "Channel 0 (BP) Secondary Trigger Threshold."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_TRIG_THRES
   COLUMN_NUMBER  = 54
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 362
   DESCRIPTION    = "Channel 1 (LG) Trigger Threshold."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_TRIG_THRESH
   COLUMN_NUMBER  = 55
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 370
   DESCRIPTION    = "Channel 2 (LG) Trigger Threshold."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_RAW_EVENT
   COLUMN_NUMBER  = 56
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 378
   DESCRIPTION    = "Channel 0 (BP) Raw Event Hardware Counter
   (1-second accumulation)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_RAW_EVENT
   COLUMN_NUMBER  = 57
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
```

```
   START_BYTE     = 386
   DESCRIPTION    = "Channel 1 (LG1) Raw Event Hardware Counter
   (1-second accumulation)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_RAW_EVENT
   COLUMN_NUMBER  = 58
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 394
   DESCRIPTION    = "Channel 2 (LG2) Raw Event Hardware Counter
   (1-second accumulation)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG_SAFING_STATE
   COLUMN_NUMBER  = 59
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 402
   DESCRIPTION    = "LG Current sensor state.
     =0 Nominal, =1 Seeking, =2 Level 1 Rampdown, =3 Level 1 Waiting,
     =4 Level 1 Seeking, =5 Level 2 Safing.
     "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_SAFING_STATE
   COLUMN_NUMBER  = 60
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 405
   DESCRIPTION    = "BP current sensor state.
     =0  Nominal, =1 Seeking, =2 Level 1 Rampdown, =3 Level 1 Waiting,
     =4 Level 1 Seeking, =5 Level 2 Safing.
     "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = Spare
   COLUMN_NUMBER  = 61
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 408
   DESCRIPTION    = "Spare column."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SCREEN_ON_DQ
   COLUMN_NUMBER  = 62
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 411
   DESCRIPTION    = "Set Calibration/Diagnostic mode to screen out data with
   DQ bit set. =0 No Screen, =1 Screen.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = NON_COMP_SCI_DATA
   COLUMN_NUMBER  = 63
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 414
   DESCRIPTION    = "Science data mode enabled. =1 Enabled, =0 Disabled"
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = FAST_COMP_SCI_DATA
   COLUMN_NUMBER  = 64
```

```
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 417
   DESCRIPTION    = "Fast compression of science data enabled. =1 Enabled,
   =0 Disabled."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LOG_COMP_SCI_DATA
   COLUMN_NUMBER  = 65
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 420
   DESCRIPTION    = "Log Compression of Spectra enabled. =1 Enabled,
   =0 Disabled."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = DIAG_DATA_PACKET
   COLUMN_NUMBER  = 66
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 423
   DESCRIPTION    = "Diagnostic Packet enabled. =1 Enabled, =0 Disabled."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SPARE_DATA_PACKET
   COLUMN_NUMBER  = 67
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 426
   DESCRIPTION    = "Spare data packet enabled. =1 Enabled, =0 Disabled.
   Used to enable Gamma Burst mode packets."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HV1_ENABLED
   COLUMN_NUMBER  = 68
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 429
   DESCRIPTION    = "HV1 (BP) Enabled. =1 Enabled, =0 Disabled."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HV2_ENABLED
   COLUMN_NUMBER  = 69
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 432
   DESCRIPTION    = "HV2 (LG1 and LG2) Enabled. =1 Enabled, =0 Disabled."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ACCUM_FLAG
   COLUMN_NUMBER  = 70
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 435
   DESCRIPTION    = "Flag for instrument accumulation. =0 Not accumulating,
   =1 Accumulating."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ACCUM_PERIOD
   COLUMN_NUMBER  = 71
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 438
   DESCRIPTION    = "Currently commanded accumulation period."
```

```
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = REPORT_PERIOD
   COLUMN_NUMBER  = 72
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 445
   DESCRIPTION    = "Currently commanded reporting period."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG1_ULD
   COLUMN_NUMBER  = 73
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 452
   DESCRIPTION    = "LG1 Upper-Level Discriminator. Raw ADC units."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LG2_ULD
   COLUMN_NUMBER  = 74
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 459
   DESCRIPTION    = "LG2 Upper-Level Discriminator. Raw ADC units."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BP_ULD
   COLUMN_NUMBER  = 75
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 466
   DESCRIPTION    = "BPP Upper-Level Discriminator. Raw ADC units."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HI_VOLT_SETP_BP
   COLUMN_NUMBER  = 76
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 473
   DESCRIPTION    = "Currently commanded High Voltage set point for BP HVPS."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HI_VOLT_SETP_LG
   COLUMN_NUMBER  = 77
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 480
   DESCRIPTION    = "Currently commanded High Voltage set point for LG HVPS."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HVPS_1_MAX_VAL
   COLUMN_NUMBER  = 78
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 487
   DESCRIPTION    = "Maximum commandable HVPS 1 value."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HVPS_2_MAX_VAL
   COLUMN_NUMBER  = 79
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 494
```

```
   DESCRIPTION    = "Maximum commandable HVPS 2 value."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SAFING_RETRY
   COLUMN_NUMBER  = 80
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 501
   DESCRIPTION    = "Sensor safing Retry value."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SAFING_INTERVAL
   COLUMN_NUMBER  = 81
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 508
   DESCRIPTION    = "Sensor Safing Interval value."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SAFING_THRESHOLD
   COLUMN_NUMBER  = 82
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 515
   DESCRIPTION    = "LG1, LG2, BP Safing Threshold."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = EARLY_CAPTURE_START
   COLUMN_NUMBER  = 83
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 522
   DESCRIPTION    = "Early Capture Window Start Time."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = EARLY_CAPTURE_END
   COLUMN_NUMBER  = 84
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 527
   DESCRIPTION    = "Early Capture Window End Time."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LATE_CAPTURE_START
   COLUMN_NUMBER  = 85
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 532
   DESCRIPTION    = "Late Capture Window Start Time."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LATE_CAPTURE_END
   COLUMN_NUMBER  = 86
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 537
   DESCRIPTION    = "Late Capture Window End Time."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = CH0_LATCH_UPS
   COLUMN_NUMBER  = 87
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
```

```
   START_BYTE     = 542
   DESCRIPTION    = "Total number of Latch-ups on Channel 0 since last boot."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = CH1_2_LATCH_UPS
   COLUMN_NUMBER  = 88
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 547
   DESCRIPTION    = "Total number of Latch-ups on Channels 1 and 2 since last
   boot."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = GAMMA_BURST_CNT
   COLUMN_NUMBER  = 89
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 552
   DESCRIPTION    = "Cumulative number of gamma ray bursts (mod 256)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TELEMETRY_PRIORITY
   COLUMN_NUMBER  = 90
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 557
   DESCRIPTION    = "Priority level for science telemetry."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SPARE
   COLUMN_NUMBER  = 91
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 560
   DESCRIPTION    = "Spare column."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = GCR_COINCIDENCE_MODE
   COLUMN_NUMBER  = 92
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 563
   DESCRIPTION    = "Gamma Cosmic ray coincidence mode.
   Value is set to 0 when SW_VERSION is less than 5 due to non-existence of
   this telemetry point in prior software versions. Otherwise values are
   =1 Doubles, =2 triples, =3 Either."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = GCR_PACKET
   COLUMN_NUMBER  = 93
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 566
   DESCRIPTION    = "Gamma Cosmic ray packet enabled. Value is set to 0
   when SW_VERSION is less than 5 due to non-existence of this
   telemetry point in prior software versions.
   =0 Disabled, =1 Enabled."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = GAMMARAY_BURST_RESPONSE
   COLUMN_NUMBER  = 94
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 569
```

```
   DESCRIPTION    = "Gamma Ray Burst Response Macro enabled. Value is set to
   0 when SW_VERSION is less than 5 due to non-existence of this
   telemetry point in prior software versions.
   =0 Disabled, =1 Enabled."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = GAMMA_BURST_THRESH
   COLUMN_NUMBER  = 95
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 572
   DESCRIPTION    = "Gamma Ray Burst Threshold value. (Repeated in column 6
   in Gamma Burst data.)"
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = GAMMA_CH_LIMIT
   COLUMN_NUMBER  = 96
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 579
   DESCRIPTION    = "Gamma Ray (processed count) Channel Limit."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = GAMMA_MODE
   COLUMN_NUMBER  = 97
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 584
   DESCRIPTION    = "Gamma Ray mode. =0 raw count, =1 processed count."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TC_COUNTERS
   COLUMN_NUMBER  = 98
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 587
   DESCRIPTION    = "Time-correlated (TC) counters mode enabled. Value is set
   to 0 when SW_VERSION is less than 5 due to the non-existence of this
   telemetry point in prior software versions. "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SPARE
   COLUMN_NUMBER  = 99
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 590
   DESCRIPTION    = "Spare column."
END_OBJECT    = COLUMN


OBJECT        = COLUMN
   NAME           = GAMMA_POST_TRIG_LEN
   COLUMN_NUMBER  = 100
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 595
   DESCRIPTION    = "Gamma Ray Post Trigger Length."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SPARE
   COLUMN_NUMBER  = 101
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 602
   DESCRIPTION    = "Spare column."
```

```
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SPARE
   COLUMN_NUMBER  = 102
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 609
   DESCRIPTION    = "Spare column."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SPARE
   COLUMN_NUMBER  = 103
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 616
   DESCRIPTION    = "Spare column."
END_OBJECT    = COLUMN
```

8.9. NS_CAL_DIAG.FMT Table Fields

Below is a table that shows the structure of the ASCII table containing the NS Calibration/Diagnostic EDR data. The ASCII table is both fixed-width and comma delimited. Note that in PDS ASCII table format, the Start Byte has to take into account the comma delimiter and empty spaces. Following this is the content of the format file.

Events can be filtered using the Data Quality flag (bit 12 in the Status Register column), but even then events may or may not have valid values for the BP or LG fields, depending on the type of event. The instrument engineer must determine the event type using the Status Register bit flags. This mode is expected to be used only by the instrument engineer, for event diagnostics.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	12	ASCII Integer	MET	Time tag of each event recorded in the calibration/diagnostic data packet.
15	5	ASCII Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury
22	5	ASCII Integer	SEQUENCE_CT	Continuous sequence count for each AppID.
29	5	ASCII Integer	LENGTH	Number of bytes in the calibration/diagnostic packet.
36	5	ASCII Integer	BPP_ENERGY	Borated Plastic (BP) detector prompt pulse energy.
43	5	ASCII Integer	BPS_ENERGY	BP detector delayed secondary pulse energy.
50	3	ASCII Integer	TTSP	Time from first to second pulse for valid BP events.
55	3	ASCII Integer	DATA_QUALITY	Data quality indicator flags (16 bits, one flag/bit).
60	5	ASCII Integer	LG1_ENERGY	LG1 energy.
67	5	ASCII Integer	LG2_ENERGY	LG2 energy.
74	5	ASCII Integer	STATUS_REGISTER	Status register.

```
OBJECT        = COLUMN
   NAME           = MET
```

```
   COLUMN_NUMBER  = 1
   BYTES          = 12
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 1
   DESCRIPTION    = "Time tag of each event recorded in the
   Calibration/Diagnostic data packet. All events recorded in a given
   packet will have the same MET time tag value.
   "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = ORBIT_NUMBER
   COLUMN_NUMBER  = 2
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 15
   DESCRIPTION    = "Orbit number is a unique identifier for a given orbit of
   the MESSENGER spacecraft around Mercury. Orbit number is defined as
   starting at apoherm and is calculated using the MET value and the
   appropriate SPICE kernels. Orbit numbering does not start until MESSENGER
   performs the Mercury orbit insertion. Until that time the value for orbit
   number is 0."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SEQUENCE_CT
   COLUMN_NUMBER  = 3
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 22
   DESCRIPTION    = "Continuous sequence count for each AppID."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = LENGTH
   COLUMN_NUMBER  = 4
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 29
   DESCRIPTION    = "Number of bytes
   [packet secondary header  + packet data field] - 1.
   The number of events (N) collected at a given MET is determined by
   N = (Length-3)/12."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BPP_ENERGY
   COLUMN_NUMBER  = 5
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 36
   DESCRIPTION    = "Borated Plastic (BP) detector prompt pulse energy."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = BPS_ENERGY
   COLUMN_NUMBER  = 6
   BYTES          = 5
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 43
   DESCRIPTION    = "BP detector delayed secondary pulse energy."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = TTSP
   COLUMN_NUMBER  = 7
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 50
   DESCRIPTION    = "Time from first to second pulse for valid BP events."
END_OBJECT    = COLUMN
```

```
OBJECT         = COLUMN
   NAME            = DATA_QUALITY
   COLUMN_NUMBER   = 8
   BYTES           = 3
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 55
   DESCRIPTION     = "Data quality indicator flags (16 bits, one flag/bit).
   Indicate whether event is in energy range, if pileup is detected, etc."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = LG1_ENERGY
   COLUMN_NUMBER   = 9
   BYTES           = 5
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 60
   DESCRIPTION     = "LG1 energy."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = LG2_ENERGY
   COLUMN_NUMBER   = 10
   BYTES           = 5
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 67
   DESCRIPTION     = "LG2 energy."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = STATUS_REGISTER
   COLUMN_NUMBER   = 11
   BYTES           = 5
   DATA_TYPE       = ASCII_INTEGER
   START_BYTE      = 74
   DESCRIPTION     = "Status register. Contains flags allowing determination
   of event type (16 bits, one flag/bit)."
END_OBJECT     = COLUMN
```

8.10. NS_CMDECHO.FMT Table Fields

Below is a table that shows the structure of the ASCII table containing the NS Command Echo EDR data. The ASCII table is both fixed-width and comma delimited. Note that in PDS ASCII table format, the Start Byte has to take into account the comma delimiter and empty spaces. Following this is the content of the format file.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	12	ASCII Integer	MET	Mission Elapsed time in seconds.
15	19	ASCII Integer	CMD_UTC_TIME	UTC time in YYYY-MM-DDTHH:MM:SS format derived from the MET using SPICE kernels.
37	3	ASCII Integer	MACRO_FLAG	Identifies as single command or part of a macro.
43	3	ASCII Integer	CMD_RESULT	Indicates level of success for the command.
49	4	ASCII Integer	CMD_OPCODE	Command opcode expressed as hexadecimal.
57	40	ASCII Integer	CMD_OPCODE_STRING	Hex command translated into string mnemonic.
101	22	ASCII Integer	CMD_ARG_PARAMETERS	Up to the first 10 command arguments.

```
OBJECT         = COLUMN
   NAME            = MET
   COLUMN_NUMBER   = 1
   BYTES           = 12
   DATA_TYPE       = ASCII_INTEGER
```

```
   START_BYTE     = 1
   DESCRIPTION    = "Mission Elapsed Time in seconds."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = CMD_UTC_TIME
   COLUMN_NUMBER  = 2
   BYTES          = 19
   DATA_TYPE      = CHARACTER
   START_BYTE     = 15
   DESCRIPTION    = "UTC time in YYYY-MM-DDTHH:MM:SS format derived from the
   MET using SPICE kernels."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MACRO_FLAG
   COLUMN_NUMBER  = 3
   BYTES          = 3
   DATA_TYPE      = CHARACTER
   START_BYTE     = 37
   DESCRIPTION    = "Identifies the command echo as a single command (CMD) or
    part of a command macro (MAC)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = CMD_RESULT
   COLUMN_NUMBER  = 4
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 43
   DESCRIPTION    = "Indicates the level of success for the command.
    The success level is command dependent and is described for each
    separate command in the NS Flight Software Document."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = CMD_OPCODE
   COLUMN_NUMBER  = 5
   BYTES          = 4
   DATA_TYPE      = CHARACTER
   START_BYTE     = 49
   DESCRIPTION    = "The command opcode expressed as a hexidecimal string."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = CMD_OPCODE_STRING
   COLUMN_NUMBER  = 6
   BYTES          = 40
   DATA_TYPE      = CHARACTER
   START_BYTE     = 57
   DESCRIPTION    = "The hex command translated into a string mnemonic.
    A hex command without an associated string map is set to
    UNDEFINED_CMD_STRING."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = CMD_ARG_PARAMETERS
   COLUMN_NUMBER  = 7
   BYTES          = 22
   DATA_TYPE      = CHARACTER
   START_BYTE     = 101
   DESCRIPTION    = "The command echo packet returns up to the first 10
    command arguments. Most commands contain less than 10. The
    arguments are represented by a single hex string. The decoding of
    the hex string is command dependent and described for each separate
    command in the NS Flight Software Document."
END_OBJECT    = COLUMN
```

8.11. SPICE Kernel Files used in MESSENGER Data Products

The following SPICE kernel files will be used to compute the UTC time and any geometric quantities found in the PDS labels. Kernel files will be generated throughout the mission with a filenaming convention specified by the MESSENGER project. SPICE kernel files will be archived with the PDS NAIF node.

***.bsp**:
MESSENGER spacecraft ephemeris file. Also known as the Planetary Spacecraft Ephemeris Kernel (SPK) file.

*.**bc:**
Messenger spacecraft orientation file. Also known as the Attitude C-Kernel (CK) file.

*.tf:
MESSENGER reference frame file. Also known as the Frames Kernel. Contains the MESSENGER spacecraft, science instrument, and communications antennae frame definitions.

***.ti:**
MESSENGER instrument kernel (I-kernel). Contains references to mounting alignment, operation modes, and timing as well as internal and field of view geometry for the NS instrument.

***.tsc:**
Messenger spacecraft clock coefficients file. Also known as the Spacecraft Clock Kernel (SCLK) file.

***.tpc:**
Planetary constants file. Also known as the Planetary Constants Kernel (PcK) file.

***.tls:**
NAIF leapseconds kernel file. Used in conjunction with the SCLK kernel to convert between Universal Time Coordinated (UTC) and MESSENGER Mission Elapsed Time (MET). Also called the Leap Seconds Kernel (LSK) file.

8.12. CODMAC/NASA Definition of Processing Levels

CODMAC/NASA Definition of processing levels for science data sets

CODMAC Level	Proc. Type	Data Processing Level Description
1	Raw Data	Telemetry data stream as received at the ground station, with science and engineering data embedded. Corresponds to NASA packet data.
2	Edited Data	Instrument science data (e.g. raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed. Referred to in the MESSENGER program as Experiment Data Records (EDRs). Corresponds to NASA Level 0 data.
3	Calibrated	Edited data that are still in units produced by instrument, but have transformed (e.g.

	Data	calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g. radiances with calibration equations applied). Referred to in the MESSENGER Program as Calibrated Data Records (CDRs). In some cases these also qualify as derived data products (DDPs). Corresponds to NASA Level 1A.
4	Resampled data	Irreversibly transformed (e.g. resampled, remapped, calibrated) values of the instrument measurements (e.g. radiances, magnetic field strength). Referred to in the MESSENGER program as either derived data products (DDPs) or derived analysis products (DAPs). Corresponds to NASA Level 1B.
5	Derived Data	Derived results such as maps, reports, graphics, etc. Corresponds to NASA Levels 2 through 5
6	Ancillary Data	Non-Science data needed to generate calibrated or resampled data sets. Consists of instrument gains, offsets; pointing information for scan platforms, etc.
7	Corrective Data	Other science data needed to interpret space-borne data sets. May include ground based data observations such as soil type or ocean buoy measurements of wind drift.
8	User Description	Description of why the data were required, any peculiarities associated with the data sets., and enough documentation to allow secondary user to extract information from the data.

The above is based on the national research council committee on data management and computation (CODMAC) data levels.

8.13. MESSENGER Glossary and Acronym List

ACT Applied Coherent Technology Corporation
ADC Analog-to-Digital Converter
AM Atmosphere and Magnetosphere Group
APL The Johns Hopkins university Applied Physics Laboratory
ApID Application Identifier code for telemetry packet type
ASCII American Standard Code for Information Interchange
BP Borated Plastic detector
CCD Charged-Coupled Device
CCSDS Consultative Committee for Space Data Systems
CDR Calibrated Data Record
CK C-Kernel (SPICE)
CODMAC Committee on Data Management and Computation
CO-I Co-Investigator
DAC Digital-to-Analog converter
DPU Data Processing Unit
DSMS Deep Space Mission Services
EDR Experiment Data Records
EK Event Kernel
EPPS Energetic Particle and Plasma Spectrometer
EPU Event Processing Unit
ET Ephemeris Time
FIPS Fast Imaging Plasma Spectrometer
FITS Flexible Image Transport System
FOV Field-of-View
FPA Focal Plane Assembly
FTP File Transfer protocol
GC Geochemistry Group
GCR Galactic Cosmic Ray
GP Geophysics Group
GRNS Gamma-ray and Neutron Spectrometer
GSFC Goddard Space Flight Center
HVPS High Voltage Power Supply
I&T Integration and Test
I2C Inter-Integrated Circuit
IEM Integrated Electronic Module
IK Instrument Measurement Kernel (SPICE)
LG Lithium Glass detector

LSK	Leapseconds Kernel (SPICE)
LVPS	Low Voltage Power Supply
MAG	Magnetometer
MASCS	Mercury Atmospheric and Surface Composition Spectrometer
MDIS	Mercury Dual Imaging System
MESSENGER	MErcury, Surface, Space ENvironment, Geochemistry, and Ranging
MET	Mission Elapsed Time
MOC	Mission Operations Center
NAIF	Navigation and Ancillary Information Facility
NASA	National Aeronautics and Space Administration
PCK	Planetary Constant Kernel (SPICE)
PDS	Planetary Data System
SCLK	Space Clock Kernel (SPICE)
SIS	Software Interface Specification
SOC	MESSENGER Science Operations Center
SPICE	Spacecraft, Planet, Instrument, C-matrix Events
SPK	Spacecraft and Planets Kernel (SPICE)
SQL	Structured Query Language
UTC	Coordinated Universal Time
XRS	X-Ray Spectrometer