Table VI C-1

The byte by byte description of the contents of the header record of a SEM incremental file.

Byte	Contents	Comments
001-003	3-character code for incremental file creation site	EBCDIC, normally NSS, ASCII
004	ASCII blank character	ASCII 032 decimal
005-006	Level 1b data format version number	currently 001
007-008	Year of level 1b data format creation	currently 1998
009-010	Day of level 1b data format creation	currently 051
011-012	Number of bytes in logical record	currently 512
013-014	Record block size	currently 512
015-016	Number of header records in this incremental file	normally 001
017-018	not used	
019-060	42-character name of this incremental data file	EBCDIC, ASCII as of 2005
061-068	8-character processing block ID	EBCDIC, ASCII as of 2005
069-070	Spacecraft ID	note (1)
071-072	Instrument ID	normally 000
073-074	Data type code	is 009 for SEM
075-076	TIP source code	normally 000
077-080	Day number from 1 Jan. 1950 at start of this data set	19546 for July 8, 2003
081-082	Year at start of this data set	4-digit year
083-084	Day of year at start of this data set	3-digit day of year
085-088	UT time in milliseconds at start of this data set	all 4 bytes used
089-092	Day number from 1 Jan. 1950 at end of this data set	19546 for July 8, 2003
093-094	Year at end of this data set	4-digit year
095-096	Day of year at end of this data set	3-digit day of year
097-100	UT time in milliseconds at end of this data set	all 4 bytes used
101-102	Year of last CPIDS update	note (2)
103-104	Day of year of last CPIDS update	note (2)
105-112	Not used	
113-116	TIP word 08, status 1 and 2 at start of this data set	note (3)
117-118	Not used	
119-120	Data record number of any status change in TIP 08	note (4)
121-124	TIP word 08, status 1 and 2 after a status change	note (4)
125-126	Number of 2-second data records in this data set	note (5)
127-128	Number of data gaps in this data set	
129-130	Number of TIP minor frames without sync errors	note (5)
131-132	Number of TIP parity errors detected by PACS	
133-134	Sum of all sync errors detected in this data set	
135-136	Time sequence error flag	note (6)
137-138	Time sequence error code	note (7)
139-140	SOCC clock update indicator	note (8)
141-142	Earth location error indicator	note (9)
143-144	Earth location error code	note (10)
145-146	PACS status bit field	note (11)
147-148	PACS data source	1 is Fairbanks, 2 is Wallops
149-176	Not used	
177-184	8-character code for reference ellipsoid model ID	EBCDIC
185-186	Nadir earth location tolerance	units are tenths of km

Byte	Contents	Comments
187-188	Earth location bit field	note (12)
189-190	Not used	
191-192	Spacecraft roll attitude error	units are .001 degrees
193-194	Spacecraft pitch attitude error	units are .001 degrees
195-196	Space craft yaw attitude error	units are .001 degrees
197-198	Epoch year for satellite orbit vector	4-digit year
199-200	Epoch day of year for satellite orbit vector	3-digit day, near byte 083-084
201-204	Epoch UT time in milliseconds for orbit vector	all 4 bytes used
205-208	Semi-major axis of orbit	note (13)
209-212	Orbit eccentricity	note (14)
213-216	Orbit inclination	note (15)
217-220	Argument of perigee	note (16)
221-224	Right ascension of the ascending node	note (16)
225-228	Mean anomaly	note (16)
229-232	Satellite location, x coordinate	note (17)
233-236	Satellite location, y coordinate	note (17)
237-240	Satellite location, z coordinate	note (17)
241-244	Satellite velocity vector, x component	note (18)
245-248	Satellite velocity vector, y component	note (18)
249-252	Satellite velocity vector, z component	note (18)
253-256	Earth/sun distance ratio	note (19)
257-512	Not used	

Notes for Table VI C-1

The bit numbering convention used below is the least significant bit within a byte is bit 01 and the most significant bit is bit 08. In the case of multiple bytes, the bit count increments from bit 01 of the highest numbered byte to bit 08 of the lowest numbered byte.

(1) Satellite ID is 2 for NOAA-15, 4 for NOAA-16 and 6 for NOAA-17

(2) CPIDS refers to a comprehensive calibration data set and these bytes provides the year and day-of-year of the latest data set update.

(3) These bytes contain the contents of status1 and status2 from TIP word 08 at the beginning time of this data set. The bit assignments are

bytes 113 and 114	not used
bit 8, MSB of byte 115	microprocessor system identifier
bit 7	TED IFC flag
bit 6	MEPED IFC Flag
bit 5	MSB of the TED electron pulse discriminator level setting
bit 4	LSB of the TED electron pulse discriminator level setting
bit 3	not used
bit 2	not used
bit 1, LSB of byte 115	not used
bit 8, MSB of byte 116	microprocessor A watchdog error
bit 7	microprocessor B watchdog error
bit 6	MSB of the TED proton pulse discriminator level setting
bit 5	LSB of the TED proton pulse discriminator level setting
bits 4-1	not used

See also the Notes for Table VI B-2

(4) If the contents of status1 or status2 change during the course of this data set, bytes 119-120 contain the data record number of that change. Bytes 121-124 contain the contents of status1 and status2 after that change with the bit assignments in note (3). Normally a change in the contents of status1 or status2 is associated with an in-flight calibration.

(5) Bytes 125-126 contain the number of 2-second SEM data records in this incremental file. Bytes 129-130 contain the number of TIP minor frames within this incremental file that did not have sync errors. If there were no sync errors records, the integer number in bytes 129-130 should be exactly 20 times the integer number in bytes 125-126 because there are 20 TIP minor frames in each 2-second data record. If sync errors are present, the value of bytes 129-130 will be less than 20 times the integer value of bytes 125-126.

(6) 0 = no time error; otherwise the record number of the first occurrence of an error

(7) If there is a time error, the following provides details of that error.
if a bit is set to 1, then the statement is true.

byte 137	not used
bit 8, MSB of byte 138	time field is bad but can probably be inferred from the previous good time.
bit 7	time field is bad and can't be inferred from the previous good time.
bit 6	this record starts a sequence that is inconsistent with previous times (i.e., there is a time discontinuity). This may or may not be associated with a spacecraft clock update.
bit 5	start of a sequence that apparently repeats scan times that have been previously accepted.
bit 4 to 1	not used

(8) =0 if no clock update during this orbit; otherwise the record number of the first occurrence of a clock update. Typically there is a spacecraft clock update of a few milliseconds each day.

(9) =0 if no error during this orbit; otherwise the record number of the first error in earth location.

(10) If there is an earth location error, the following provides details of that error.
if a bit is set to 1, then the statement is true.

byte 143	not used
bit 8, MSB of byte 144	not earth located because of bad time; earth location fields zero filled.
bit 7	earth location questionable because of questionable time code (See time problem flags.)
bit 6	earth location questionable—only marginal agreement with reasonableness check.
bit 5	earth location questionable—fails reasonableness check
bit s 4 to 1	not used

(11) These bytes not used in SEM data processing. For the record,

byte 145,	not used
bit 8 MSB of byte 146	not used
bits 7-4	not used
bit 3	0 if data stream is normal, 1 if data is pseudo noise
bit 2	0 if tape playback was in reverse, 1 if forward
bit 1, LSB of byte 146	0 if data stream is test, 1 if data stream is flight data

Normally, the value of byte 146 is decimal 3, bits 1 and 2 set to 1

(12) This is not used in SEM processing

(13) The integer number in bytes 205-208 is divided by decimal 100000. to obtain the semi-major axis in kilometers.

(14) The integer number in bytes 209-212 is divided by 100000000. to obtain the orbit eccentricity. Note that a survey of header files shows the eccentricity (and the semi-major axis) varies a great deal day to day. The orbit eccentricity given in the 2-line NORAD orbit elements obtained from
http://celestrak.com/NORAD/elements/noaa.txt
do not show nearly that variation and the NORAD eccentricities generally do not agree with those obtained from this header record. There is no explanation for this.

(15) The orbit inclination in degrees is obtained from the integer number in bytes 213-216 by dividing by decimal 100000. The orbital inclination is used in SEM data processing.

(16) The integer values of these parameters are divided by decimal 100000. to obtain the physical parameters in degrees.

(17) The integer values of these 4-byte signed integers are divided by decimal 100000. to obtain the satellite location in kilometers at the epoch time given in bytes 197-204 in earth-centered inertial coordinates. That is, the Z axis directed north parallel to earth's axis of rotation, X axis directed toward the vernal equinox, and the Y axis completing the right handed Cartesian coordinate system.

(18) The integer values of these 4-byte signed integers are divided by decimal 100000000. to obtain the satellite velocity vector in kilometers per second at the epoch time given in bytes 197-204. The coordinate system is earth-centered inertial.

(19) The earth/sun distance ratio is obtained by dividing the integer value of bytes 253-256 by decimal 1000000. The definition of the earth/sun distance ratio is not known although the numerical value of this ratio is close to 1.0

Table VI C-2

A sequence of data records follow the header record in an incremental file. Usually an incremental file contains about one orbit's data or about 6000 seconds. A single physical 512 byte data record in the file contains 2-seconds of data so that each incremental file contains about 3000 physical data records. Each 2-second data record contains 20 TIP minor frames of data, parsed so that the first minor frame is always mod 020. That is, the first TIP minor frame in each data record is either 000, 020, 040, 060, 080, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, or 300. The following is a byte by byte description of the contents of an incremental file data record.

Byte	Contents	Comments
001-002 003-004	TIP major frame number 0 to 7 TIP minor frame number at start of this 2-second data record	
005-006	4-digit year at start of this 2-second data record	
007-008	3 digit day of year at start of this 2-second data record	
009-010	Not used	
011-012	Satellite clock drift relative to UTC in milliseconds	nominally near zero
013-016	Time in milliseconds the day at start of this 2-second record	
017-018	Satellite travel direction indicator, north or south	note (1)
019-028	Not used	
029-032	Quality indicator flags	note (2)
033-036	Time quality and satellite location quality flags	note (3)
037-048	Not used	
049-052	Satellite orbital navigation/attitude status flags	note (4)
053-056	Time associated with TIP Euler angles	note (5)
057-058	Roll Euler angle	note (5)
059-060	Pitch Euler angle	note (5)
061-062	Yaw Euler angle	note (5)
063-064	Satellite altitude above reference geoid in tenths km	
065-068	Geodetic sub-satellite latitude	note (6)
069-072	Geodetic sub-satellite longitude	note (6)
073-080	Not used	
081-088	Missing data flags, 20 entries each for TIP word 20 and 21	note (7)
089	TIP word 20, start TIP minor frame plus 00	
090	TIP word 21, start TIP minor frame plus 00	
091	TIP word 20, start TIP minor frame plus 01	
092	TIP word 21, start TIP minor frame plus 01	
093	TIP word 20, start TIP minor frame plus 02	
094	TIP word 21, start TIP minor frame plus 02	
095	TIP word 20, start TIP minor frame plus 03	
096	TIP word 21, start TIP minor frame plus 03	
097	TIP word 20, start TIP minor frame plus 04	
098	TIP word 21, start TIP minor frame plus 04	
099	TIP word 20, start TIP minor frame plus 05	
100	TIP word 21, start TIP minor frame plus 05	
101	TIP word 20, start TIP minor frame plus 06	
102 103	TIP word 21, start TIP minor frame plus 06 TIP word 20, start TIP minor frame plus 07	

Byte	Contents	Comments
104	TIP word 21, start TIP minor frame plus 07	
105	TIP word 20, start TIP minor frame plus 08	
106	TIP word 21, start TIP minor frame plus 08	
107	TIP word 20, start TIP minor frame plus 09	
108	TIP word 21, start TIP minor frame plus 09	
109	TIP word 20, start TIP minor frame plus 10	
110	TIP word 21, start TIP minor frame plus 10	
111	TIP word 20, start TIP minor frame plus 11	
112	TIP word 21, start TIP minor frame plus 11	
113	TIP word 20, start TIP minor frame plus 12	
114	TIP word 21, start TIP minor frame plus 12	
115	TIP word 20, start TIP minor frame plus 13	
116	TIP word 21, start TIP minor frame plus 13	
117	TIP word 20, start TIP minor frame plus 14	
118	TIP word 21, start TIP minor frame plus 14	
119	TIP word 20, start TIP minor frame plus 15	
120	TIP word 21, start TIP minor frame plus 15	
121	TIP word 20, start TIP minor frame plus 16	
122	TIP word 21, start TIP minor frame plus 16	
123	TIP word 20, start TIP minor frame plus 17	
124	TIP word 21, start TIP minor frame plus 17	
125	TIP word 20, start TIP minor frame plus 18	
126	TIP word 21, start TIP minor frame plus 18	
127	TIP word 20, start TIP minor frame plus 19	
128	TIP word 21, start TIP minor frame plus 19	
129-132	Not used	
133-134	TIP word 08 status1 and status2 availability flags	note (8)
135-136	TIP word 08 status1 and status2 contents	note (9)
137-140	Not used	
141-144	TIP word 09 and word 10 housekeeping availability flags	note (10)
145-166	TIP word 09 and word 10 housekeeping values	note (11)
167-512	Not used	

Notes for Table VI C-1

This documentation is obtained from Table 8.3.1.8.3-1 of the NOAA KLM Users Guide available from URL http://www2.ncdc.noaa.gov/docs/klm/index.htm. As noted below, it appears some of this documentation is in error.

(1) The direction of satellite travel is required for calculation of sensor look angles with respect to the geomagnetic field

(2) These bytes key various timing and earth location problems according to the following bit assignments. If the bit is set to 1, the statement is true.

bit 8, MSB of byte 29	this 2-second frame is not valid
bit 7	time sequence error in this 2-second frame
bit 6	a data gap precedes this 2-second frame
bit 5	not used
bit 4	earth location data not available (bytes 65-72 set to zero)
bit 3	first good time following a s/c clock update
bit 2	SEM instrument status changed beginning this frame
bit 1, LSB of byte 29	not used
bytes 30-32	not used

(3) These bytes provide details of the problems flagged in bytes 29-32. If the bit is set to 1 the statement is true.

byte 33	not used
bit 8, MSB of byte 34	time is bad but probably can be inferred from previous time
bit 7	time is bad and cannot be inferred from previous time
bit 6	there is a time discontinuity, including a clock update
bit 5	this time starts a sequence that duplicates previous times
bits 4-1	not used
byte 35	not used
bit 8, MSB of byte 36	no earth location because of bad time. (bytes 65-72 set to zero)
bit 7	earth location questionable because of questionable time
bit 6	earth location questionable – marginal agreement with 'reasonableness check'
bit 5	earth location questionable – fails 'reasonableness check'
bits 04-01	not used.

(4) These bytes key satellite location and attitude problems. Detailed documentation of the contents of these bytes is given in the NOAA KLM Users Guide. However, a survey of the data in the incremental files shows that bytes 49-52 are always zero and it seems that satellite attitude quality flags are not introduced in the SEM-2 incremental data file

(5) These bytes contain information about the actual satellite attitude. Detailed documentation of the contents of these bytes is given in the NOAA KLM Users Guide. However, a survey of data in the incremental files shows that bytes 53-62 are always zero and it seems that satellite attitude status data are not introduced in the SEM-2 incremental data file

(6) The signed integer values bytes 65-68 and 69-72 are divided by decimal 10000. to obtain the sub-satellite latitude and longitude respectively. Latitudes are negative in the southern hemisphere and the longitude is negative in the western hemisphere.

(7) The incremental data file flags those instances when data from TIP words 20 and 21 could not be recovered because of bit sync loss and the data padded with value 000. This information is important to the further processing of SEM-2 data. The bit assignments in bytes 81-88 are as follows

bits 8-1, byte 81	not used
bits 8-1, byte 82	not used
bits 8-2, byte 83	not used
bit 1 LSB of byte 83	if 1, TIP word 21, minor frame +19 is padded
bit 8, MSB of byte 84	if 1, TIP word 20, minor frame +19 is padded
bit 7	if 1, TIP word 21, minor frame +18 is padded
bit 6	if 1, TIP word 20, minor frame +18 is padded
bit 5	if 1, TIP word 21, minor frame +17 is padded
bit 4	if 1, TIP word 20, minor frame +17 is padded
bit 3	if 1, TIP word 21, minor frame +16 is padded
bit 2	if 1, TIP word 20, minor frame +16 is padded
bit 1, LSB of byte 84	if 1, TIP word 21, minor frame +15 is padded
bit 8, MSB of byte 85	if 1, TIP word 20, minor frame +15 is padded
bit 7	if 1, TIP word 21, minor frame +14 is padded
bit 6	if 1, TIP word 20, minor frame +14 is padded
bit 5	if 1, TIP word 21, minor frame +13 is padded
bit 4	if 1, TIP word 20, minor frame +13 is padded
bit 3	if 1, TIP word 21, minor frame +12 is padded
bit 2	if 1, TIP word 20, minor frame +12 is padded
bit 1, LSB of byte 85	if 1, TIP word 21, minor frame +11 is padded
bit 8, MSB of byte 86	if 1, TIP word 20, minor frame +11 is padded
bit 7	if 1, TIP word 21, minor frame +10 is padded
bit 6	if 1, TIP word 20, minor frame +10 is padded
bit 5	if 1, TIP word 21, minor frame +09 is padded
bit 4	if 1, TIP word 20, minor frame +09 is padded
bit 3	if 1, TIP word 21, minor frame +08 is padded
bit 2	if 1, TIP word 20, minor frame +08 is padded
bit 1, LSB of byte 86	if 1, TIP word 21, minor frame +07 is padded
bit 8, MSB of byte 87	if 1, TIP word 20, minor frame +07 is padded
bit 7	if 1, TIP word 21, minor frame +06 is padded
bit 6	if 1, TIP word 20, minor frame +06 is padded
bit 5	if 1, TIP word 21, minor frame +05 is padded
bit 4	if 1, TIP word 20, minor frame +05 is padded
bit 3	if 1, TIP word 21, minor frame +04 is padded
bit 2	if 1, TIP word 20, minor frame +04 is padded
bit 1, LSB of byte 87	if 1, TIP word 21, minor frame +03 is padded
bit 8, MSB of byte 88	if 1, TIP word 20, minor frame +03 is padded
bit 7	if 1, TIP word 21, minor frame +02 is padded
bit 6	if 1, TIP word 20, minor frame +02 is padded
bit 5	if 1, TIP word 21, minor frame +01 is padded
bit 4	if 1, TIP word 20, minor frame +01 is padded
bit 3	if 1, TIP word 21, minor frame +00 is padded
bit 2	if 1, TIP word 20, minor frame +00 is padded
bit 1, LSB of byte 88	not used

(8) Bytes 133 to 134 key whether updated instrument status data from TIP word 08 is in this minor frame. The bit assignments are as follows

bit 8, MSB of byte 133	if 0, update of microprocessor system ID occurred
bit 7	if 0, update of TED IFC status occurred
bit 6	if 0, update of MEPED IFC status occurred
bit 5	if 0, update of TED electron PHD level occurred, MSB
bit 4	if 0, update of TED electron PHD level occurred, LSB
bits 3-1	not used
bit 8, MSB of byte 134	if 0, update of microprocessor A watchdog occurred
bit 7	if 0, update of microprocessor B watchdog occurred
bit 6	if 0, update of TED proton PHD level occurred, MSB
bit 5	if 0, update of TED proton PHD level occurred, LSB
bits 4-1	not used

(9) Bytes 135-136 contain the actual instrument status bits according to the following assignments

bit 8, MSB of byte 135	microprocessor system ID, 0 for processor A
bit 7	TED IFC, 0=off, 1=on
bit 6	MEPED IFC, 0=off, 1=on
bit 5	TED electron PHD level, MSB
bit 4	TED electron PHD level, LSB
bits 3-1	not used
bit 8, MSB of byte 136	microprocessor A watchdog, 0=normal
bit 7	microprocessor B watchdog, 0=normal
bit 6	TED proton PHD level, MSB
bit 5	TED proton PHD level, LSB
bits 4-1	not used

(10) Bytes 141-144 key whether updated instrument analog housekeeping data from TIP words 09 and 10 are in this minor frame. The bit assignments are as follows

byte 141	not used
bit 8, MSB of byte 142	not used
bit 7	if 0, update of primary bus voltage monitor
bit 6	if 0, update of backup pitch coil driver monitor (attitude control)
bit 5	if 0, update of primary pitch coil driver monitor (attitude control)
bit 4	if 0, update of backup roll/yaw coil driver
bit 3	if 0, update of primary roll/yaw coil driver
bit 2	if 0, update of Z axis gyro torque current monitor
bit 1, LSB of byte 142	if 0, update of Y axis gyro torque current monitor
bit 8, MSB of byte 143	if 0, update of X axis gyro torque current monitor
bit 7	if 0, update of S gyro torque current monitor
bit 6	if 0, update of DPU temperature monitor
bit 5	if 0, update of TED temperature monitor
bit 4	if 0, update MEPED proton telescope temperature monitor
bit 3	if 0, update of MEPED circuit temperature monitor
bit 2	if 0, update of Omni detector bias voltage monitor
bit=1, LSB of byte 143	if 0, update of TED proton CEM high voltage monitor

bit 8, MSB of byte 144	if 0, update of TED electron CEM high voltage monitor
bit 7	if 0, update of TED sweep voltage monitor
bit 6	if 0, update of TED +5V monitor
bit 5	if 0, update of MEPED +5V monitor
bit 4	if 0, update of DPU +5V monitor
bit 3	if 0, update of microprocessor B +5V monitor
bit 2	if 0, update of microprocessor A +5V monitor
bit 1, LSB of byte 144	not used

(11) Actual values of TIP analog housekeeping words 09 and 10 refreshed only when the corresponding bit in bytes 142-144 is set to 0.

byte 145	microprocessor A +5V monitor
byte 146	microprocessor B +5V monitor
byte 147	DPU +5V monitor
byte 148	MEPED +5V monitor
byte 149	TED +5V monitor
byte 150	TED sweep voltage monitor
byte 151	TED electron CEM high voltage monitor
byte 152	TED proton CEM high voltage monitor
byte 153	MEPED Omni detector bias voltage monitor
byte 154	MEPED electronics circuit temperature monitor
byte 155	MEPED proton telescope temperature monitor
byte 156	TED temperature monitor
byte 157	DPU temperature monitor
byte 158	S gyro torque current monitor
byte 159	X gyro torque current monitor
byte 160	Y gyro torque current monitor
byte 161	Z gyro torque current monitor
byte 162	Primary roll/yaw coil driver current monitor
byte 163	Backup roll/yaw coil driver current monitor
byte 164	Primary pitch coil driver current monitor
byte 165	Backup pitch coil driver current monitor
byte 166	Primary bus voltage monitor

An extensive survey of SEM incremental data files was done to verify this documentation. Of the bytes between 29 and 62 inclusive, that include navigation error flags and information about the Euler angles, only bytes 29, 34, and 36 ever show values other than 000. The conclusion is that, the documentation notwithstanding, navigation/attitude status flags (bytes 49-52) and Euler angle information (bytes 53-62) are not provided.

Moreover, certain bits in bytes 29, 34, and 36, that are defined as providing status, never seem to be used. Specifically: bit 3 in byte 29 (first good time following a s/c clock update) is never set to 1; bit 8 in byte 34 (time is bad but probably can be inferred from previous time) nor bit 5 in byte 34 (this time starts a sequence that duplicates previous times) are never set to 1; bit 6 in byte 36 (earth location questionable – marginal agreement with 'reasonableness check') nor bit 5 in byte 36 (earth location questionable – fails 'reasonableness check') are never set to 1.

The study did confirm that bit 2 in byte 29 (SEM instrument status changed beginning this frame) is a reliable indicator of when the TED or MEPED are undergoing IFC. The combination of bit 8 in byte 29 (this 2-second frame is not valid) set to 1, bit 7 in byte 29 (time sequence error in this 2-second frame) set to 1, bit 4 in byte 29 (earth location data not available) set to 1, AND bit 8 in

byte 36 (no earth location because of bad time) set to 1 proves to be a reliable indicator of zero fill in the earth location field (bytes 65 to 72.)

Information about when the magnetic torque coils were energized, a procedure required to maintain S/C attitude control, was introduced into the SEM data record. This was done because of concern that when the coils were energized the measurement of low energy particles by the TED would be compromised. The analysis to determine whether or not the TED observations are influenced by the torque coils has not been done. However, it was verified that data in bytes 162 to 165 do reflect those times when the roll/yaw and pitch coils are energized and so that analysis of any impact on TED can be done.