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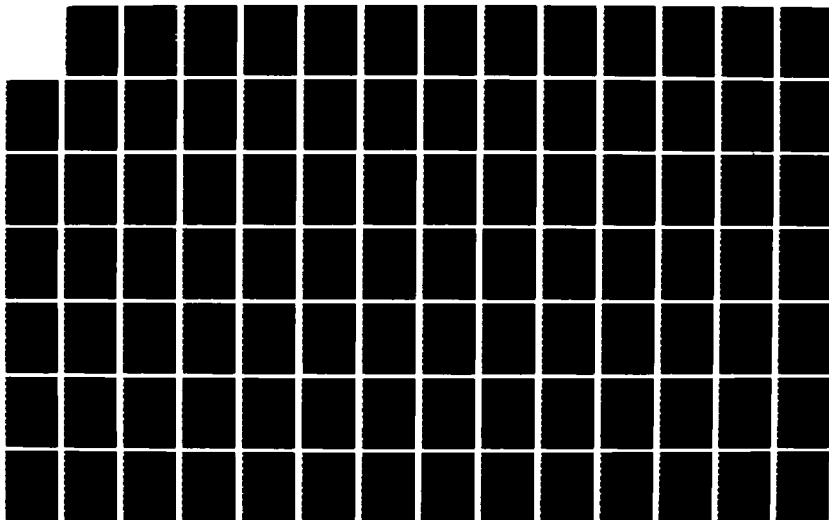
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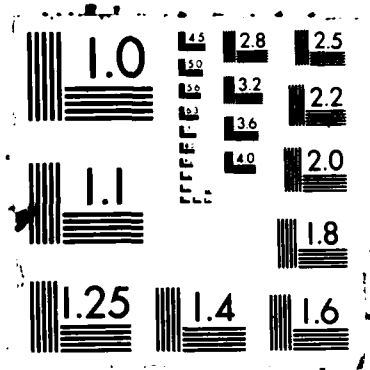
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ANALYSIS SYSTEMS FOR AIR FORCE MISSIONS

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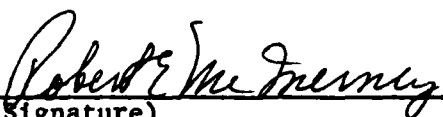
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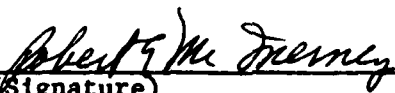
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TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
1.0	Overview	1
2.0	HILAT Analyses	2
3.0	Polar Bear Analyses	8
4.0	Accelerometer Analyses	16
5.0	Shuttle Analyses	24

APPENDICES

A.	HILAT Tape Log sample	33
B.	HILAT Summary Tape Format	43
C.	HILAT Data Base Formats	57
D.	AIRS Data Base Format	85
E.	Accelerometer Data Base Tapes and Formats	91

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1.0 Overview

The Space Data Analysis Laboratory (SDAL) of Boston College was contracted by the Air Force Geophysics Laboratory (AFGL) Aerospace Engineering Division (Data Systems Branch) to perform multiple tasks related to spacecraft missions. These tasks included the developing of data bases for a multitude of scientific instruments; developing and implementing analyses using the data bases as the prime input; and providing significant input to Data Management Plans for several missions.

The contract number under which these efforts were performed was F19628-83-C0100.

Data systems were designed for several satellite projects. Satellites involved in these efforts include HILAT, Polar Bear, and S85-1. Systems were also designed, developed and implemented for flights of the Space Transportation System. In addition, analytic systems were setup for several rocket projects.

System design used modular programming techniques to provide the necessary flexibility in satisfying requirements in a cost effective manner. Subroutine libraries were developed for use in the overall systems. These libraries allow for the performance of common tasks and assure that these tasks are executed in identical manners.

2.0 HILAT Analyses

The HILAT spacecraft designated P83-1 was launched into polar orbit on a Scout rocket on 27 June 1983 from Vandenberg AFB. The HILAT payload was designed to provide data for the study of plasma density irregularity dynamics in the high latitude ionosphere. The spacecraft orbit is near circular at 800km with an orbital period of approximately 101 minutes. In addition, the vehicle is near three axis stabilized (drifts in pitch, yaw and roll can be seen on each acquisition).

HILAT operates in real time mode only with data transmitted to any of four ground stations. Three of these stations are at fixed high latitude sites (Tromso, Norway; Sondrestrom, Sweden; and Fort Churchill, Canada). The remaining station, referred to as the Rover, is moveable from location to location although it's most frequent site is Seattle, Washington.

The HILAT payload consists of a coherent beacon which provides scintillation and total electron content data; a Thermal Plasma Monitor which consists of an Electron Sensor, Retarding Potential Analyzer (RPA), and Ion Driftmeter (IDM); an Electron Spectrometer for the measurement of electron flux in the energy range between 20 eV and 20 keV; the Auroral Ionospheric Mapper (AIM) which consists of a scanning imager (which failed on 23 July 1983) and two photometers; and a triaxial fluxgate magnetometer. Attitude data is computed using the triaxial magnetometer along with a sun sensor.

For each station pass, the downlinked data is digitized by the station computer onto a disk file of the raw telemetry data. Between station passes, the raw data is semi-processed and put onto a disk file in "Summary Tape" form. As time permits, the raw data files are off-loaded onto "Raw Tapes" and the "Summary files" off-loaded onto tapes referred to as Summary Tapes.

Data on the raw tapes consists of station coordinates, Keplerian elements, spacecraft position, time tagged raw telemetry data in packed form, and raw scintillation data. Raw tapes from Tromso are received at AFGL where they are logged and archived.

The Summary Tape structure has evolved into a form of interlaced records which contain time, geometry and model magnetic field data; raw telemetry data; scintillation summary data; and science summary data. Each file contains data from one station pass. Summary tapes from all stations are received at AFGL where they are quality checked, copied for dissemination to other user agencies and used as the basic input to the Scientific Satellite Data Analysis System (SSDAS) efforts. SDAL personnel were deeply involved in the design of and parameter selection for the Summary tapes.

Under this contract SDAL personnel were responsible for the design, development and implementation of the SSDAS for HILAT. This system, as with SSDAS design for other vehicles, was built in modular form to minimize effort duplication where commonality of requirements exist; to insure that common efforts are performed in exactly the same way in all routines; and to provide the flexibility necessary as spacecraft anomalies occur or requirements change. A library of HILAT routines has been developed which is used by all processing routines as necessary.

Upon receipt of a shipment of Summary tapes, the quality check (Q/C) and tape copy effort must be immediately initiated since the tape copies are to be shipped to the appropriate outside agencies for performance of their own analyses. The Q/C-Copy routine was designed to also produce a Summary Tape log which includes tape number and start and stop times of all passes on each tape. One such tape log is created for data from each station.

Since the tapes are written on a Hewlett Packard computer with various combinations of 16 and 32 bit fixed and floating point words, the initial SSDAS effort consists of reformatting the summary tapes for use on the central site computer. Upon completion of the reformatting effort, the original Summary Tapes are archived.

The AFGL payloads on HILAT consist of the AIM, Electron Spectrometer and Thermal Plasma Monitor. Data bases for these instruments along with the magnetometer and scintillation data are created in time history form. These data bases are then used as input to modular routines which produce microfiche displays of computed parameters. For the AIM, Electron Spectrometer, Thermal Plasma Experiment and Magnetometer two types of displays are produced; summary and detailed data. The summary displays consist of averaged data for entire passes. Thus, these plots provide a survey of the instrument data on a pass by pass basis. The detailed displays contain all point data plotted on a sequence of time overlapped frames for each pass. These displays are useful for event studies. The displays for each of the instruments are on common time scales to allow for correlation.

For the Thermal Plasma Experiment, individual modules were developed for each of the three independent experiments. For these, data is readout of telemetry in 64 second blocks which can be further subdivided into 8 second segments. The initial effort consists of identifying the beginning of an 8 second block and determining the subsection number within the 64 second cycle. Once found, the data must be accumulated in 64 second groups. These 64 second sections contain all readouts for the Electron Sensor, RPA and IDM.

The Electron Sensor is used to obtain electron density and frequency data. For the swept portion of the cycle, the beginning of each sweep must be determined. Once found the telemetry values are converted to sweep voltage. The sensor output, which is readout 4 times more frequently than the

sweep voltage, is converted to telemetry voltage and then to current. The sensor potential must be calculated from the subcommutated data. A modular routine developed for electron density determination then receives as input the array of ordered pairs of sweep voltage and current along with sensor potential and returns electron density, electron temperature, and vehicle potential with respect to the plasma. Electron frequency data is also obtained at 4 fixed frequency values. The frequency determinations must first be made. The root-mean-square (RMS) values for each of the frequencies are then computed.

The RPA data consists of 2 and 4 second sweeps. The beginning of each 2 and 4 second sweep must first be determined. Once determined, the sweep voltage values are converted to actual sweep voltage and the sensor output converted to current. A modular routine then receives as input the ordered pairs of voltage and current along with total spacecraft velocity and sensor potential. The routine then computes and returns the ion temperature and drift velocity of ions normal to the RPA aperture.

The IDM cycle is 8 seconds. The horizontal and vertical telemetry values must first be identified and converted to horizontal and vertical drift tangents. A combination of 8, 9 and 10 bit words must be deconvolved from exponent and mantissa telemetry in order to obtain offset and re-zero values which are used in the calculation of tangent values. From the tangent data another modular routine is used which applies formulae to compute ion density and drift velocities.

A data base of TPE parameters along with selected ephemeris and magnetic parameters is created.

The Electron Spectrometer, referred to as the J-Sensor, has three modes of operation. Three sensors are mounted at zenith, 40 degrees from zenith, and nadir. Mode 1 consists of zenith data with 8 points per spectra; mode 2 also consists of zenith data with 16 points per spectra; in mode 3

data from all three detectors is acquired. Bit flags identify 'even' and 'odd' blocks. Initially, even blocks must be identified in order to determine the instrument mode. Once identified, data must be accumulated into 1 second blocks since this is the instrument cycle. The J-Sensor data base consists of structured records which identify instrument mode, the deconvolved instrument counts arranged from lowest to highest energy, decompressed magnetometer counts, and the required ephemeris parameters. This data base has been stored in counts because of the fact that for particle detectors, calibrations are likely to change as a function of time from launch and had calibrations been directly applied yet changed, data base recreation would have been necessary. A modular routine exists which has the calibration parameters stored as a function of time from launch. This routine is applied whenever differential flux or distribution function computations are required. For instance, in the summary plot display routine total flux, total energy flux and total energy are computed by integrating the spectra. This display routine utilizes the calibration subroutine. The deconvolved magnetometer counts were included in the J-Sensor data base because magnetic pitch angle is often required in the interpretation of differential flux data. Again, the magnetometer data was retained in counts to allow for modified calibrations. A simple change to the calibration module has taken care of upgrades to the magnetometer and J-sensor calibrations.

For the AIM sensors, individual modules were developed to handle the various sensor modes (i.e. imaging, spectrometer and photometer). This proved to be a most useful design concept since the imaging mode failed approximately one month after launch. The AIM data base has been successfully created for all operational passes. Upon notification that the imager had failed, the "CALLS" to the imager subroutine were simply deleted from the AIM routine as opposed to rewriting the routine to accomodate the failure.

The photometer portion of the routine remains intact as originally designed and the photometer data base continues to be created. This data base consists of the photometer counts along with required ephemeris and attitude parameters. A calibration subroutine is used whenever calibrated photometer data in Rayleighs is required.

The scintillation data base continues to be created from parameters contained on the time/geometry/magnetic field records along with the scintillation records from the summary tape. A by-product of this data base is the scintillation statistics data base. This data base is created by inputting the overall scintillation data base and extracting segments based on quantized time periods and averaging the parameters on ephemeris constraints. Analysis techniques and computer routines have been developed to input the statistics data base and perform the necessary statistical analyses.

The appendix contains a sample of the HILAT tape log, the Summary Tape format and the data base formats for the various experiments.

3.0 Polar Bear Analyses

The Polar Bear satellite was launched on a Scout rocket in the fourth quarter of 1986. The spacecraft is very similar in design to HILAT. It was launched from Vandenburg AFB with an inclination of nearly 90 degrees and an orbital period of approximately 105 minutes. Mission duration is estimated for 3 years.

The requirements for Polar Bear were similar to those of HILAT: Raw and Summary tapes were to be archived; data was to be quality checked and prepared for shipment to outside agencies; and a scintillation data base was to be created. In addition, however, a data base was to be created for the Auroral Ionospheric Remote Sensor (AIRS). Since the common requirements between HILAT and Polar Bear were discussed in the preceding chapter, discussions here will concern Polar Bear in general and AIRS in particular.

The telemetry system aboard the vehicle is similar to HILAT and is referred to as the Science Data Formatter (SDF). The SDF outputs science data at a rate of 4.098kbps. The spacecraft is 3 axis stabilized to ± 10 degrees in the pitch, yaw and roll axes.

The payload for Polar Bear includes the AIRS, the beacon and the triaxial fluxgate magnetometer. The AIRS is a more sophisticated version of the Auroral Ionospheric Mapper (AIM) detector flown on HILAT. It obtains simultaneous multispectral UV and visual images for both daylight and night operations. The beacon, similar in design to the one flown on HILAT, is used to measure scintillation effects at radio frequencies used for radar and communications. The magnetometer is also of similar design to the system used on HILAT. It measures field aligned currents as well as providing a means of attitude determination along with the digital sun sensor. These three instruments will be operated concurrently in real time mode over the remote stations

located in the northern polar region. The AIRS, however, can be operated independently over mid-latitude regions.

There are, thus, great similarities between Polar Bear and HILAT. The Polar Bear Scientific Satellite Data Analysis System (SSDAS) consists of a modified version of the HILAT system. Many of the modular routines developed for HILAT have direct application for Polar Bear.

The input data for SSDAS applications is the Summary Tape which is in a similar format to that used for HILAT.

The AIRS data base is being archived on digital tape. A log of digital tape number and the passes contained on the tape is maintained. Separate logs will exist for each of the remote stations receiving the AIRS data.

The AIRS sensor consists of four integrated detectors each of which obtains 326 pixel values per line scan. The time duration of a line scan is 2.9987 seconds which is readout over 6 SDF telemetry frames. Also contained in these 6 frames is AIRS housekeeping data, the sequencer values and status words. The instrument can be operated in any of three modes: imaging, spectrometer and photometer. A high degree of flexibility exists for commanding the wavelengths to be selected for detectors 1 and 2 in imaging and photometer mode. Detectors 3 and 4 can be commanded to either of two fixed wavelengths.

In imaging mode, a mirror line scan consisting of 326 pixels takes place for each of the 4 detectors. Each step in the line scan corresponds to approximately .4 degrees. Although the instrument actually moves through 336 steps, no data is taken in the first and last 5 steps. Only the data from the 326 good pixels is readout to telemetry. The full mirror scan corresponds to plus and minus 67.2 degrees from nadir. At the end of each forward scan, the mirror direction is reversed by stepping the motor at 4 times the forward scan rate.

In photometer mode, the mirror is fixed at nadir. As in imaging mode 336 pixels are readout over 6 SDF telemetry frames but valid photometer data is obtained for all pixels except the first and last 5. In this mode, detectors 1 and 2 are used for VUV measurements while detectors 3 and 4 are for UV measurements.

Spectrometer mode has the mirror fixed at nadir while the wavelength range is swept. Detector 1 covers the wavelength range from 1189 to 2164 Angstroms while detector 2 scans the range from 924 to 1924 Angstroms. Of the 336 pixel values readout over the 6 SDF telemetry frames, valid spectrometer data is obtained from pixels 6 through 331. In this mode, detectors 3 and 4 operate as photometers.

The pixel data is in 8 bit compressed count form. The exponent (3 most significant bits) and mantissa (5 least significant bits) must be extracted and used in the decompression algorithm in order to obtain counts per accumulation period.

The AIRS data base was designed with sufficient flexibility to be used in follow on analyses and display routines. The data base contains structured records corresponding to a full set of pixel readouts starting at pixel 1 and ending at the last pixel.

Decompressed counts are stored in packed form to minimize storage requirements. The frames are time tagged to the beginning of the scan. Selected ephemeris and magnetic parameters as well as vehicle pitch, yaw and roll are extracted from the Time/Geometry/Magnetic Field records on the summary tape and stored in each data base record. In addition, the magnetometer data is stored in compressed and packed form to be readily available in the event it is needed for correlation with the AIRS data. By storing the magnetometer data in compressed counts data base compaction is further enhanced.

All instrument housekeeping data is included in the data base.

Each data base file represents data from one pass. A history file of orbit start and stop times along with instrument mode is created using automated procedures. This file is useful in providing a history of instrument operations and also for selecting particular passes for studies.

Since there is a great similarity between the AIRS and the AIM sensor flown on HILAT, techniques developed to handle the AIM data were directly applied to the AIRS. Moreover, many of the computer modules in the HILAT library of subroutines have direct application while others required only minor modification to have applicability.

The AIRS telemetry consists of 221 8-bit words per SDF frame. A full set of AIRS readouts is acquired over 6 telemetry frames. The first of the 221 words in each frame contains the AIRS frame counter which cycles from 1 to 6 along with a sequencer A value. This word is referred to as the Identifier word. There are five A sequencers and one B sequencer which are used to control the instrument.

In lines 1-5, the telemetry format is the same: the identifier word followed by 220 pixel readouts. The order of the pixel data is as follows for each detector: 1,2,3,4,1,2,...4. Thus there are 55 readouts for each of the four detectors on each of the first 5 lines of telemetry. Line six begins the same way as the other 5 lines but ends in a different way. The first word is the identifier word; the next 204 words contain pixel data (structured as in the previous 5 frames); words 206-221 contain AIRS housekeeping and status information. There are 16 AIRS housekeeping words which are readout in 4 groups of 4 words.

The prime functions of the A sequencers are:

<u>SEQ NO.</u>	<u>FUNCTION</u>
A0	Selects one of 16 wavelength positions for imaging or photometer mode.
A1	Selects imaging, photometer or spectrometer mode.
A2	Controls backup functions such as increasing power for spectrometer grating motor.
A3	Selects test modes such as dark shutter and optical
A4	Switches power off to any of the detectors
A5	Controls spectrometer grating mode selection and other housekeeping functions.

The B sequencer is used to select the A sequencer which is to be commanded.

The correlation between the AIRS frame counter and the A sequencer number is:

<u>Frame Counter</u>	<u>A Sequencer</u>
1	A0
2	A1
3	A2
4	A3
5	A4
6	A5 .

For sequencer A0, the sequencer value reflects the wavelength selected for detectors 1 and 2.

<u>Seq A0 value</u>	<u>Det 1/Det 2 (Angstroms)</u>
0	1216/ 976
1	1304/1064
2	1356/1116
3	1410/1170
4	1456/1216
5	1493/1253
6	1544/1304
7	1596/1356
8	1625/1385
9	1654/1414
10	1670/1430
11	1733/1493
12	1750/1510
13	1833/1593
14	1910/1670
15	1990/1750 .

Sequencer A1 is used to determine instrument scan mode:

Seq A1 value Mode(I=Imaging,S=Spectrometer,P=Photometer)

0	I
1	S
2	I
3	P
4	I
5	S
6	I
7	P
8	I
9	S
10	I
11	P
12	I
13	S
14	I
15	P .

Sequencer A3 is used to determine the instrument test mode.

<u>Seq. A3 value</u>	<u>Test Mode</u>
0	Normal
1	Dark Shutter
2	Normal
3	Optical Test
4	Normal
5	Extended Dark
6	Normal
7	Optical Test
8	Normal
9	Dark Shutter
10	Normal
11	Optical Test
12	Normal
13	Extended Dark
14	Normal
15	Optical Test

In addition to the wavelengths for detectors 1 and 2 which are obtained from sequencer A0, other wavelengths may be selected. The selected wavelength can be determined by use of the A1 and A3 sequencers.

The AIRS data base routine performs the following prime functions:

1. Find the first occurrence of a line counter value of 1. (This will initiate processing for the pass.)
2. Test for telemetry dropout and 1's fill within scans as necessary. Missing frames can be determined by the use of the AIRS line counter and the SDF frame counter.
3. Interpolate ephemeris/magnetic/attitude data to the time at the beginning of the line scan.
4. Extract and decompress pixel counts for each detector.
5. Structure data by detector in packed word form.
6. Extract and retain AIRS status and housekeeping data. These words will be kept in telemetry counts.
7. Extract and retain data from the science magnetometer.

8. Create 2 data base header records. The first contains a summary of instrument status at the beginning of the pass. The second contains ephemeris parameters which may be required in future AIRS analyses.
9. Create structured AIRS data base records designed to allow for easy input to analysis routines yet provide for data compression.

The AIRS data base format is contained in the appendix.

4.0 Accelerometer Analyses

The problem presented to the laboratory was to develop and implement analytic techniques necessary to create and maintain neutral atmospheric density data bases for three satellite missions referred to as NP5, NP6 and S85-1. Analysis and software system development was carried out in order to process data from the triaxial accelerometer systems onboard these satellites. Atmospheric density was obtained in the altitude region from 170 km to 240 km. These data were merged with satellite ephemeris parameters and stored in geophysical history data bases for later analysis.

The triaxial accelerometer systems were designed to determine atmospheric density by measuring the satellite deceleration caused by aerodynamic drag. Each system consisted of three accelerometer sensors mounted on orthogonal axes. Thus highly accurate measurements of aerodynamic accelerations acting on the satellite's long track (z), cross track (x) and radial direction (y) were made.

The problem consists of an analysis of calibration data for the accelerometers, calculation of drag coefficients for the individual satellites, removal of bias and noise effects from the accelerometer signal, calculation of ephemeris parameters, computation of atmospheric model values and their comparison to derived values, and the calculation of density.

Each acceleration sensor consisted of an electrostatically suspended proof mass which was also electrostatically rebalanced along a sensitive axis with a force equal to the applied acceleration. Any acceleration of the sensor covering caused the proof mass to move in the opposite direction relative to the covering. The rate at which pulses of a given voltage were required to restore the proof mass to the center position was directly proportional to the applied acceleration along the sensitive axis.

For each axis of the accelerometer, the output signal was generated as pulse counts, representing the integrated acceleration over the sampling period of about 2 seconds. The calibration data consisted of tables of pulse counts per second versus acceleration for known gravitational accelerations applied to each axis of the accelerometer. Data was taken at different ambient temperatures for the accelerometer to determine the possible temperature dependence of the counts-to-acceleration conversion.

The scale factor is defined as the ratio of counts to acceleration. Polynomial best fits of various orders were performed for variation of scale factor with temperature for each of the various operating ranges.

In order to obtain the density data from the instrument output pulse rate, the following conditions were required: the data was merged with ephemeris and satellite aspect data; a correction was applied to the measured pulse rate to account for temperature sensitivity and scale factors; the pulses due to air drag were separated from those due to all other causes; the drag acceleration was determined; and the density calculated.

For each axis of the accelerometer, the measured acceleration is related to the atmospheric density (ρ) and apparent atmospheric velocity (V) according to:

$$A = \frac{\rho V^2 C_i(V)}{2M}, \quad (4-1)$$

where: $C_i(V)$ is the drag coefficient for axis i ($i=x,y,z$), and M is the satellite mass.

Because the drag coefficient cannot be determined by direct measurement for such low densities and high velocities, it has been calculated from a theoretical representation of the satellite shape. The computation of drag coefficients was dependent on the ambient temperature of

the gas, it's mean molecular weight and the velocity components relative to the accelerometer coordinate system. These results were incorporated into subroutines for use in the bias determination and density calculation stages of the processing.

In addition to the accelerations produced by atmospheric forces, the accelerometers also respond to satellite vibrations, attitude and orbital dynamics, and the accelerometer output signal contains noise intrinsic to the electronics. Because the output signal is sampled at a rate of about 0.5 Hz, the extraneous signals can make a contribution to the slowly varying atmospheric signal through aliasing, although some attenuation of aliased signal does occur because of the 2-second integration time per sample. High-frequency noise is further reduced by an electronic filter associated with the accelerometer electronics. This is done prior to sampling so that contributions at the aliased frequency are also eliminated.

The attitude adjustments and vibrations were treated by low pass digital filtering of the various accelerometer signals. The parameters chosen for the low-pass filters for the individual axes were:

	<u>Pass Bandwidth</u>	<u>Transition Bandwidth</u>
x-axis	0.05 Hz	0.0167 Hz
y-axis	0.05 Hz	0.0167 Hz
z-axis	0.05 Hz	0.0167 Hz

In the case of the NP5 vehicle an additional data base was created using a low-pass filter with the following characteristics:

	<u>Pass Bandwidth</u>	<u>Transition Bandwidth</u>
x-axis	0.005 Hz	0.005 Hz
y-axis	0.005 Hz	0.005 Hz
z-axis	0.010 Hz	0.010 Hz

Extraordinary noise contributions could not be treated by digital filtering, and were of such a magnitude as to overwhelm the aerodynamic signal. Data segments affected by these were simply skipped when density values were calculated.

One characteristic of the accelerometers was a non-zero response to zero aerodynamic acceleration while in orbit. The bias values are different for each of the three accelerometer axes and are not constant as a function of time. Thus, a method of removing these bias values from acceleration signal was needed.

For each pass, atmospheric drag at satellite apogee contributed to the accelerometer signal. This contribution was estimated by using a model atmospheric density (Jacchia 1971) and equation (4-1) to compute expected drag accelerations for each accelerometer axis in the vicinity of apogee. For each axis, the bias was calculated as the difference between the measured signal from the accelerometer and the corresponding expected drag acceleration. Thusly, averaged biases were taken over various time periods centered on apogee.

The resulting bias values showed some scatter about a much slower trend over each vehicle's lifetime. This scatter was attributed to the estimations of the atmosphere model and noise in the accelerometer signal, after filtering. Thus, a smooth fit to the data was used to represent the bias value. For each vehicle and accelerometer axis, polynomial fits were performed over vehicle lifetime.

Accelerometer data was merged with orbital ephemeris data based on corresponding time values, although orbital data was interpolated from values spaced at 60 second intervals to the roughly 2 second interval of the accelerometer data. A quadratic interpolation process was used for this evaluation for the fundamental ephemeris parameters (e.g., latitude, longitude, altitude) and also for

some derived parameters (e.g., heading direction, velocities). Other derived parameters were computed on a point-by-point basis from more fundamental parameters (e.g., magnetic local time, local time).

The following parameters were added to the accelerometer data base using the supplied ephemeris values:

- a) altitude
- b) latitude
- c) longitude (positive east)
- d) geocentric velocity (km/sec)
- e) local time .

The remaining parameters were derived from the ephemeris values:

- a) velocity with respect to atmosphere (km/sec)
- b) angle between geocentric and atmospheric velocities
- c) solar declination
- d) x-direction relative to North
- e) magnetic local time .

Density values were derived from the measured accelerations using the following equation,

$$\rho = \frac{2 M A_z}{V^2 C_z(\vec{V})} , \quad \text{where}$$

A_z is the aerodynamic acceleration for axis z (long track),

M is the satellite mass,

$\vec{V}$ is the total atmospheric velocity relative to the satellite,

V is the satellite velocity,

$C_z(\vec{V})$ is the drag coefficient for axis z, and

ρ is the atmospheric density.

The total atmospheric velocity relative to the satellite is given by

$$\vec{V} = -\vec{V}_g + \vec{V}_a + \vec{V}_w, \quad \text{where}$$

$\vec{V}_g$ = geocentric velocity of the satellite,

$\vec{V}_a$ = rotational contribution of atmospheric velocity, and
 $\vec{V}_w$ = wind contribution of atmospheric velocity.

For this study, the wind contribution being small in relation to the known contribution $-\vec{V}_g + \vec{V}_a$, was ignored.

A set of existing computer routines were modified and adapted to process each system, uniquely. In the case of NP5 and NP6, digital tapes, referred to as DMA tapes, containing raw and filtered accelerometer data were received at AFGL. In the case of S85-1, LPARL tapes containing raw accelerometer data were provided. The data was processed on a daily basis to the final density stage. Associated displays, listings and data bases were created as noted below.

For each day in question, the filtered and raw data was reformatted onto a magnetic tape. In the case of S85-1, the raw data was filtered initially.

Time history displays were produced which exhibit the data for each of the 3 accelerometer axes, along with temperature on a daily basis. The data was then merged with appropriate ephemeris parameters and stored on a magnetic tape. A decimated merged data base was stored on permanent file for further plotting. The merged data along with appropriate Kp, Ap and flux values was accessed in the generation of bias values for the 3 axes on an orbit-by-orbit basis and a daily average calculation. The bias calculations were based on fitting the filtered data to model drag components over 500 seconds of apogee data for each orbit. In the case of S85-1, 180 seconds of apogee data were used in the averaging process. Paper plots and listings were generated for each day in question. Also, the decimated merged data file was accessed in the generation of paper plots exhibiting filtered outputs for each of the 3 axes on an orbit-by-orbit basis. At this point, the bias files (orbit-by-orbit and daily average files) augmented by the day being processed were updated. The files were sorted day-by-

day, EOR's removed and duplicate days eliminated prior to usage by the density program.

On the basis of 'quiet' vs. all days, plots exhibiting bias values as a function of time were generated resulting in a bias fit technique being used for density calculations. Based on a study of the raw and filtered data plots, skip times, necessary to the density program run, were determined for each day. A density data base was created on tape and on permanent file with the JACCHIA program. Paper plots and listings were generated from the density file exhibiting density and normalized density and selected model and ephemeris parameters as functions of time on an orbit-by-orbit basis. Microfiche displays of density as a function of altitude were generated. In the case of S85-1, microfiche displays were not required. Finally, follow on density plots (normalized with respect to the MSIS model) were generated for a wave structure study.

Raw and filtered digital data were provided for 156 days of NP5 and 160 days of NP6. A total of 150 days of NP5 and 150 days of NP6 were processed to the final density stage. The remaining 6 days of NP5 and 10 days of NP6 were unprocessable.

For S85-1, 78 days of raw data were provided for processing. Each day contained approximately ten 28 minute passes centered on maximum north latitude, six 20 minute passes centered on perigee and eight 6 minute passes centered on apogee for bias determination. For each data base tape, accelerometer words, clocks and marker bits were stripped off, and the data was time correlated and reconstructed in proper time sequence. The accelerometer words were then calibrated to mg's and temperature and data base files were created. For this purpose calibrations and clock correlation factors were utilized. Analyses and associated computer routines were developed and successfully utilized to convert the time correlated raw data to filtered data. Raw and

filtered data tapes were thereby generated in the same format as the reformatted DMA tapes for the 78 days of interest. A total of 74 of the 78 days were subsequently processed to the final density stage. The remaining 4 days were unprocessable.

The density data bases, noted above, were generated at high data rate outputs (a point every 4 seconds). These data bases provided the opportunity to store data from many orbits into common data banks which were structured to allow global studies to be performed.

Tape formats associated with raw/filtered accelerometer data, merged ephemeris data and model/density data are contained in the appendix.

5.0 Shuttle Analyses

Analysis systems have been developed and implemented for space shuttle missions. Data bases consisting of experiment data along with shuttle related parameters have been successfully created. Systematic techniques analagous to those described in preceding sections were employed for the experiment data. New techniques were necessary for the data products received at AFGL from NASA. This chapter will discuss the NASA products.

For early missions two sets of tapes were typically received. The preliminary data (on tapes refered to as CP011F) was received shortly after landing. The CP011F tapes contained unprocessed orbiter data as it was downlinked over several asynchronous PCM systems. Time tagging was accomplished by using appropriate delta time values contained on the records. The final tapes (CBET04) contained smoothed and processed data but these tapes begin to arrive approximately 12 weeks after the mission. On these two tape types, the orbit, attitude and ancillary data are blocked together in large records.

For recent missions, the NASA data has been received on Shuttle POCC Interface Facility (SPIF) tapes. These tapes are similar to a combination of CP011F and CBET04 tapes but the orbit, attitude and ancillary data is interlaced on each file. Moreover, the tapes were generated on a VAX computer and the standard byte reversal techniques had to be applied before the informational parameters could be extracted. Analytic techniques developed for the CP011F and CBET04 tapes had direct application for the SPIF tapes.

Routines and techniques were developed for the extraction of parameters from these NASA products. This, however, is frequently only the first phase of the effort since additional analyses must be performed in order to provide the experimenter with the parameters which are required.

With respect to the ephemeris data, the preliminary Johnson Space Center (JSC) CP011F tape contains two sets of vehicle position and velocity vectors (referred to as state vectors) in an Earth Centered Inertial (ECI) true of date coordinate system. This coordinate system (XYZ) is right handed, where X is the component in the direction of the Vernal Equinox; Z is in the direction of the North pole; and $Y = Z \times X$. One set of provided vectors consists of the filtered components outputted by the telemetry, and the others are the current state vectors of the spacecraft. The CBET04 JSC tape contains processed information. The spacecraft's state vector is provided in many coordinate systems such as mean of 50 ECI, true of date ECI, and Aries true of date polar.

Existing ephemeris computation routines were then used to produce a standardized ephemeris file. This ephemeris file is created at a sufficiently high sample rate so that it can be interpolated upon whenever necessary without loss of data structure.

The direct correlation between ephemeris parameters and generated geomagnetic and solar models is well known. Since experimenters often require magnetic pitch angles to properly interpret their sensor data, various geomagnetic parameters have to be determined. Thus, using a standardly formatted ephemeris file as input, the model geomagnetic field parameters can be determined using the appropriate set of IGRF eighth degree Gaussian coefficients. The proper set depends upon the year of the flight. For each time related value, the cartesian components of the Earth's magnetic field (North, East, and vertical), the magnetic declination and inclination (dip) angles, can be determined. The spatial parameters commonly required include the total magnetic field intensity and the L shell (in Earth radii). Other geomagnetic parameters which can be computed are geomagnetic

local time, geomagnetic latitude and longitude, and corrected geomagnetic latitude, longitude, and local time.

For certain sensors meaningful interpretation of the instrument's output can be accomplished only when the orientation of the sensor is known. The orientation of the sensing axis of an experiment with respect to a fixed coordinate system in space is referred to as its attitude.

The NASA CP011F tape provides vehicle attitude information in the form of quaternions which relate the vehicle's axes in the M50 coordinate system to the local vertical, local horizontal (LVLH) coordinate system. Vehicle pitch, yaw, and roll in the M50 coordinate system are also provided.

The CBET04 tape contains processed and filtered results at a fixed data rate. This tape contains attitude of the vehicle axes in quaternion or matrix form. This data is given in the M50 coordinate system. The attitude of the shuttle axes is given in the form of 3x3 matrices or quaternions. Euler's theorem states that any finite rotation of a rigid body can be expressed as a rotation through some angle about a fixed axis, namely a quaternion. Thus, any three axis Euler rotation 3x3 matrix can be described as a rotation by some angle about some fixed axis.

A three angle Euler rotation, which relates system A to system B, can be represented by a 3x3 rotation matrix R comprised of elements R_{ij} such that

$$B = \begin{pmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{pmatrix} A .$$

The quaternion is a vector with four components which relates system A to system B. It is denoted

$$Q_{BA} = (q_1, q_2, q_3, q_4) .$$

The rotation angle and the single Euler axis that defines the quaternion relationship between the two systems can be determined from the 3x3 matrix components. The rotation angle is given by

$$\cos a = 1/2 (R_{11} + R_{22} + R_{33} - 1.) ,$$

and the single Euler axis

$$E = (EX, EY, EZ)$$

where

$$EX = (R_{23} - R_{32}) / 2 \sin a$$

$$EY = (R_{31} - R_{13}) / 2 \sin a$$

$$EZ = (R_{12} - R_{21}) / 2 \sin a .$$

Thus QBA = (q₁, q₂, q₃, q₄) is given by

$$QBA = (\cos(a/2), EX \sin(a/2), EY \sin(a/2), EZ \sin(a/2)) .$$

Similarly, the 3x3 rotation matrix can be determined from the quaternion. In this case, the transpose must be taken in order to obtain the proper matrix. The 3x3 matrix determined from QBA = (q₁, q₂, q₃, q₄) is

$$R_{11} = q_1 q_1 + q_2 q_2 - q_3 q_3 - q_4 q_4$$

$$R_{12} = 2 (q_2 q_3 - q_1 q_4)$$

$$R_{13} = 2 (q_2 q_4 + q_1 q_3)$$

$$R_{21} = 2 (q_2 q_3 + q_1 q_4)$$

$$R_{22} = q_1 q_1 - q_2 q_2 + q_3 q_3 - q_4 q_4$$

$$R_{23} = 2 (q_3 q_4 - q_1 q_2)$$

$$R_{31} = 2 (q_2 q_4 - q_1 q_3)$$

$$R_{32} = 2 (q_3 q_4 + q_1 q_2)$$

$$R_{33} = q_1 q_1 - q_2 q_2 - q_3 q_3 + q_4 q_4 .$$

The most basic coordinate system used is the body axis coordinate system. In this system X is parallel to the orbiter structural axis positive toward the nose, Y is parallel to the right wing, and Z is positive out of the bottom of the orbiter. The Euler rotation associated with this system is a pitch, yaw, roll sequence.

The vehicle body system is frequently required to be expressed in the Local Vertical Local Horizontal (LVLH) coordinate system (or landing reference frame). This is a local orbital coordinate system where the Z axis goes from the vehicle to center of the Earth, Y axis is normal to the orbital plane and opposite sense of the vehicle's momentum vector, and $X = Y \times Z$.

For attitude given in the Mean 1950 (M50) coordinate system, X is directed towards the mean vernal equinox of 1950, the Z is in the direction of the mean 1950 North celestial pole, and Y completes the right hand coordinate system. Another frequently required attitude reference frame is the true of date ECI coordinate system. In this coordinate system X is the direction of the actual vernal equinox, Z is in the direction of the true North celestial pole, and Y completes the right hand system.

Since different parameters can be expressed in various coordinate systems, a series of matrix transformations has been developed to allow for mappings between systems. These routines have been developed in modular form to keep within the overall SSDAS philosophy.

Transformation matrices relating the M50 reference frame to the true of date, the true of date to the LVLH, and the true of date to the local cartesian system exist.

The (X_L, Y_L, Z_L) axes of the LVLH are determined from the true of date state vectors. R is the position of the shuttle from the center of the Earth in ECI system and it is given by

$$R = iR1 + jR2 + kR3$$

Let the absolute value of a vector, R, be denoted by [R], then

$$[R] = \sqrt{R_1^2 + R_2^2 + R_3^2} .$$

Then expressing R as a unit vector,

$$R = R/[R] = iR_1/[R] + jR_2/[R] + kR_3/[R] .$$

The vehicle's velocity vector is given by

$$V = iV_1 + jV_2 + kV_3$$

where [V] is defined similarly.

In the LVLH coordinate system

$$Z_L = -R/[R]$$

$$Y_L = -(R \times V) / [(R \times V)]$$

$$X_L = Y_L \times Z_L .$$

Then (X_L, Y_L, Z_L) in matrix form is given by

$$\begin{pmatrix} X_L \\ Y_L \\ Z_L \end{pmatrix} = \begin{pmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \end{pmatrix} \begin{pmatrix} i \\ j \\ k \end{pmatrix} \text{ or } \begin{pmatrix} X_L \\ Y_L \\ Z_L \end{pmatrix} = C \begin{pmatrix} i \\ j \\ k \end{pmatrix}$$

Taking the transpose

$$\begin{pmatrix} i \\ j \\ k \end{pmatrix} = C^T \begin{pmatrix} X_L \\ Y_L \\ Z_L \end{pmatrix} .$$

Thus, by substituting, the vehicle axes are now represented in the LVLH coordinate system by

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = A \begin{pmatrix} i \\ j \\ k \end{pmatrix} = AC^T \begin{pmatrix} X_L \\ Y_L \\ Z_L \end{pmatrix}$$

Similar transformation matrices have been developed for the determination of shuttle pitch, yaw and roll.

The attitude of the LOS of the vehicles' axes is normally determined in all the above coordinate systems for the CP011F and CBET04 data. Additionally, the LOS of probes aboard the shuttle are normally computed.

Attack angles and tangent height calculations are frequently required by experimenters for proper data interpretation.

Attack angles are defined as the angles between the LOS of a probe or axis and a given vector. The more frequently required attack angles involve the angle between a sensor LOS and the magnetic field, velocity vector or the sun vector.

Tangent height is the minimum altitude above the surface of the Earth which an unrefracted light ray coming from behind the Earth through the CO₂ layer to the spacecraft. Thus, tangent height is apparent height (at the horizon) from which radiation is coming. Tangent height calculations assume an oblate spheroid earth model and is a geometric solution rather than the method of closest approach. These calculations also require attitude of the LOS in the local cartesian system, (elevation and azimuth angles), the vehicle's positional data of latitude, altitude and distance from the center of Earth to vehicle, and an equation to calculate the radius of the Earth as a function of the geodetic latitude.

A final irreducible data base consisting of attitudinal, positional, and geomagnetic parameters was created for each mission. This data base was designed to include all the parameters necessary for the satisfaction of experimenter requirements. Moreover, the data base is constructed with an even time spacing to facilitate interpolation.

With respect to the ancillary data, techniques and computer routines have been developed for the determination of thruster firings, occurrences of water dumps, OMS burns. These parameters as well as others such as fuel cell purges and relief of the cryogenic supplies are considered to be contaminants since they can drastically effect sensor outputs. Typically, a full mission data base of thruster firings and water dumps was created.

Onboard the orbiter there are 38 main and 6 Vernier thrusters which are included in the Reaction Control System (RCS). Twelve main jets and 2 Vernier thrusters are located forward, and 24 main jets (2 systems of 12 pairs) and 4 Vernier thrusters are located in the aft section. Knowledge of precisely which thruster (or thrusters) were fired at any instant of time can be essential to data interpretation.

There are two water storage systems onboard the vehicle. One is a supply water system (which consists of six tanks) and the other is a waste water system (one tank). Only one tank can be dumped at a time. The waste water tank is full at launch and is dumped in orbit, and then the tank's water level is restored to its condition at launch. Bi-levels within the spacecraft's telemetry indicate the occurrence and type of water dump in progress. Analog monitors onboard the spacecraft indicate the percentage of water in each tank. Knowing the capacity of each tank allows the calculation of the amount of water being dumped. Thus, for any water dump the following information can be determined; the type of water dump (waste or supply); the start and end time of each dump; the duration and quantity of water discharged at any instant while the dump is in progress; and the total amount of water expelled during the dump.

Data bases structured for use on the AFGL Control Data Cyber computer have been archived.

APPENDIX A
HILAT TAPE LOG SAMPLE

87/04/15.

CHURCHILL

SUMMARY

HILAT

1

87/04/15.

CHURCHILL

SUMMARY

HILAT

HHMM:SS-HHMM:SS

SEC1-SEC2

YEAR DAY

TAPE/FILE

1

HHMM:SS-HHMM:SS

CHURCHILL

SUMMARY

HILAT

CU0088/ 7 84 151 71121-71691 1945:21-1954:51
 84 152 26087-26657 0714:47-0724:17
 84 152 32172-32772 0856:12-0906:12
 84 152 63429-64044 1737:09-1747:24
 84 152 69549-70149 1919:09-1929:09
 84 153 24555-25080 0649:15-0658:00
 84 153 30590-31220 0829:50-0840:20
 84 153 24555-25080 0649:15-0658:00
 84 153 30590-31220 0829:50-0840:20
 84 154 29024-29654 0803:44-0814:14
 84 154 66406-67051 1826:46-1837:31
 84 155 27462-28092 0737:42-0748:12

CU0092/ 1 84 155 58752-59262 1619:12-1627:42
 84 155 64839-65484 1800:39-1811:24
 84 155 70997-71477 1943:17-1951:17
 84 156 25909-26524 0711:49-0722:04
 84 156 32053-32623 0854:13-0903:43
 84 156 57195-57660 1553:15-1601:00
 84 156 63275-63920 1734:35-1745:20
 84 156 69419-69959 1916:59-1925:59
 84 157 24361-24946 0646:01-0655:46
 84 157 30466-31066 0827:46-0837:46
 84 157 61713-62343 1708:33-1719:03
 84 157 67839-68424 1850:39-1900:24
 84 158 22820-23375 0620:20-0629:35
 84 158 28883-29498 0801:23-0811:38
 84 158 60152-60767 1642:32-1652:47
 84 158 66268-66883 1824:28-1834:43
 84 159 21293-21788 0554:53-0603:08
 84 159 27312-27942 0735:12-0745:42
 84 159 33559-34024 0919:19-0927:04

CU0096/ 1 84 159 58593-59178 1616:33-1626:18
 84 159 64696-65341 1758:16-1809:01
 84 160 19780-20215 0529:40-0536:55
 84 160 25741-26371 0709:01-0719:31
 84 160 31952-32477 0852:32-0901:17
 84 160 63128-63788 1732:08-1743:08
 84 161 24186-24816 0643:06-0653:36
 84 161 30353-30923 0825:53-0835:23
 84 161 61564-62224 1706:04-1717:04
 84 162 22637-23237 0617:17-0627:17
 84 162 28756-29356 0759:16-0809:16
 84 162 60002-60647 1640:02-1650:47
 84 162 66133-66703 1822:13-1831:43
 84 163 21091-21661 0551:31-0601:01
 84 163 27172-27787 0732:52-0743:07
 84 164 19561-20086 0526:01-0534:46
 84 164 25595-26225 0706:35-0717:05

87/04/15.

CHURCHILL

SUMMARY

HILAT

1

87/04/15.

CHURCHILL

SUMMARY

HILAT

HHMM:SS-HHMM:SS

SEC1-SEC2

YEAR DAY

TAPE/FILE

1

HHMM:SS-HHMM:SS

SEC1-SEC2

YEAR DAY

TAPE/FILE

CU0096/18 84 164 31866-32316 0851:06-0858:36

CU0100/ 1 84 164 56881-57481 1548:01-1558:01

2 84 164 62986-63616 1729:46-1740:16

3 84 165 18038-18518 0500:38-0508:38

4 84 165 24030-24675 0640:30-0651:15

5 84 165 30254-30764 0824:14-0833:44

6 84 165 55320-55890 1522:00-1531:30

7 84 165 61420-62065 1703:40-1714:25

8 84 166 22467-23097 0614:27-0624:57

9 84 166 28652-29207 0757:32-0806:47

10 84 166 53763-54288 1456:03-1504:48

11 84 166 59851-60511 1637:31-1648:31

12 84 166 66009-66504 1820:09-1828:24

13 84 167 20511-21526 0548:31-0558:46

14 84 167 58289-58934 1611:29-1622:14

15 84 167 6426-64981 1753:46-1803:01

16 84 168 19363-19963 0522:43-0532:43

17 84 168 25465-26080 0704:25-0714:40

18 84 168 56726-57356 1545:26-1555:56

19 84 169 23887-24517 0638:07-0648:37

CU0112/ 1 84 179 14370-14985 0359:30-0409:45

2 84 179 20476-21106 0541:16-0551:46

3 84 179 51741-52371 1422:21-1432:51

4 84 179 57863-58448 1604:23-1614:08

5 84 180 12833-13403 0333:53-0343:23

6 84 180 18894-19539 0514:54-0525:39

7 84 180 50179-50794 1356:19-1406:34

8 84 180 56294-56909 1538:14-1548:29

9 84 181 11303-11828 0308:23-0317:08

10 84 181 17318-17978 0448:38-0459:38

11 84 181 23569-24064 0632:49-0641:04

12 84 181 48616-49201 1330:16-1340:01

13 84 181 54721-55351 1512:01-1522:31

14 84 182 15754-16399 0422:34-0433:19

15 84 182 21961-22501 0606:01-0615:01

16 84 182 47058-47598 1304:18-1313:18

17 84 182 53157-53802 1445:57-1456:42

18 84 183 14197-14842 0359:37-0407:22

19 84 183 20359-20944 0539:19-0549:04

CU0116/ 1 84 183 51588-52233 1419:48-1430:33

2 84 184 12646-13276 0330:46-0341:16

3 84 184 18769-19384 0512:49-0523:04

4 84 184 50025-50655 1353:45-1404:15

5 84 185 11103-11688 0305:03-0314:48

6 84 185 17187-17817 0446:27-0456:57

7 84 185 48462-49077 1327:42-1337:57

8 84 185 54586-55186 1509:46-1519:46

9 84 186 9570-10125 0239:30-0248:45

10 84 186 15608-16253 0420:08-0430:53

11 84 186 46902-47502 1301:42-1311:42

12 84 186 53013-53643 1443:33-1454:03

13 84 187 14041-14701 0354:01-0405:01

14 84 187 20265-20790 0537:45-0546:30

15 84 187 45345-45900 1235:45-1245:00

16 84 187 51446-52076 1417:26-1427:56

17 84 188 12480-13125 0328:00-0338:45

87/04/15.

ROVER

SUMMARY

HILAT

87/04/15.

ROVER

SUMMARY

HILAT

HHMM:SS-HHMM:SS

SEC1-SEC2

YEAR DAY

TAPE/FILE

HHMM:SS-HHMM:SS

SEC1-SEC2

YEAR DAY

TAPE/FILE

RU00006/29
 84 134 79662-79872 2207:42-2211:12
 84 134 85732-85927 2348:52-2352:07
 84 135 40399-40789 1113:19-1119:49
 84 135 46466-46886 1254:26-1301:26
 84 135 84140-84365 2322:20-2326:05
 84 136 44903-45368 1228:23-1236:08
 84 136 82563-82788 2256:03-2259:48
 84 137 43341-43821 1202:21-1210:21
 84 137 80976-81291 2229:36-2234:51
 84 138 41885-42290 1138:05-1144:50
 84 138 79408-79783 2203:28-2209:43
 84 139 40318-40708 1111:58-1118:28
 84 139 77827-78217 2137:07-2143:37
 84 140 76285-76645 2111:25-2117:25
 84 140 82398-82713 2253:18-2258:33
 84 141 43244-43664 1200:44-1207:44
 84 141 80866-81136 2227:46-2232:16
 84 142 41675-42125 1134:35-1142:05
 84 142 79221-79566 2200:21-2206:06
 84 143 40104-40509 1108:24-1115:09

RU00001/ 1
 84 31 7989- 8604 0213:09-0223:24
 84 32 376- 916 0006:16-0015:16
 84 60 78136-78751 2142:16-2152:31
 84 61 76583-77183 2116:23-2126:23
 84 65 76505-77000 2115:03-2123:20
 84 66 27565-28000 0739:25-0746:40
 84 66 74938-75433 2048:58-2057:13
 84 67 25990-26440 0713:10-0720:40
 84 67 73380-73860 2023:00-2031:00
 84 68 71816-72296 1956:56-2004:56
 84 70 74863-75298 2047:43-2054:58
 84 71 25863-26343 0711:03-0719:03
 84 71 73285-73735 2021:25-2028:55
 84 72 71715-72165 1955:15-2002:45
 84 75 19659-20049 0527:39-0534:09
 84 75 73075-73570 2017:55-2026:10
 84 76 71630-72050 1953:50-2000:50
 84 77 22604-23084 0616:44-0624:44
 84 77 70063-70483 1927:43-1934:43
 84 78 21033-21558 0550:33-0559:18
 84 79 66928-67333 1835:28-1842:13

RU0006A/ 1
 84 109 9334- 9679 0235:34-0241:19
 84 118 48790-48865 1333:10-1334:25
 84 120 4308- 4713 0111:48-0118:33
 84 120 51704-51944 1421:44-1425:44
 84 121 2780- 3140 0046:20-0052:20
 84 122 1227- 1572 0020:27-0026:12
 84 123 47212-47362 1306:52-1309:22
 84 124 4304- 4589 0111:44-0116:29
 84 124 51637-51862 1420:37-1424:22
 84 125 2770- 3040 0046:10-0050:40
 84 126 1136- 1481 0018:56-0024:41
 84 126 86118-86178 2355:18-2356:18
 84 127 84481-84691 2328:01-2331:31
 84 128 82822-83197 2300:22-2306:37
 84 129 81241-81631 2234:01-2240:31
 84 130 970- 1285 0016:10-0021:25
 84 130 85759-86119 2349:19-2355:19
 84 131 46710-47085 1258:30-1304:45
 84 132 82738-82978 2258:58-2302:58
 84 133 43586-43961 1206:26-1212:41
 84 133 81165-81420 2232:45-2237:00
 84 134 42023-42353 1140:23-1145:53
 84 134 79736-79856 2208:56-2210:56
 84 134 85773-85908 2349:33-2351:48
 84 135 40451-40766 1114:11-1119:26
 84 135 46515-46875 1255:15-1301:15
 84 136 84178-84343 2322:58-2325:43
 84 136 44935-45355 1228:55-1235:55
 84 136 82605-82785 2256:45-2259:45

RU00006/ 1
 84 109 9274- 9724 0234:34-0242:04
 84 118 48729-48879 1332:09-1334:39
 84 120 4236- 4731 0110:36-0118:51
 84 120 51661-51991 1421:01-1426:31
 84 121 2677- 3157 0044:37-0052:37
 84 122 1096- 1591 0018:16-0026:31
 84 122 48527-48872 1328:47-1334:32
 84 123 47020-47410 1303:40-1310:10
 84 123 84518-84938 2328:38-2335:38
 84 124 4226- 4601 0110:26-0116:41
 84 124 45517-45667 1238:37-1241:07
 84 124 51575-51875 1419:35-1424:35
 84 125 2598- 3048 0043:18-0050:48
 84 125 50011-50176 1353:31-1356:16
 84 126 1041- 1491 0017:21-0024:51
 84 126 86014-86194 2353:34-2356:34
 84 127 46872-46872 1301:12-1301:12
 84 127 84372-84702 2326:12-2331:42
 84 128 45336-45336 1235:36-1235:36
 84 128 82741-83206 2259:01-2306:46
 84 129 81195-81645 2233:15-2240:45
 84 130 884- 1304 0014:44-0021:44
 84 130 85715-86135 2348:35-2355:35
 84 131 46667-47102 1257:47-1305:02
 84 132 82708-82993 2258:28-2303:13
 84 133 43533-43983 1205:33-1213:03
 84 133 81136-81436 2232:16-2237:16
 84 134 41971-42376 1139:31-1146:16

87/04/15.

SUMMARY ROVER

1

87/04/15.

SUMMARY ROVER

HILAT

TAPE/FILE YEAR DAY SEC1-SEC2 HHMM:SS-HHMM:SS

TAPE/FILE YEAR DAY SEC1-SEC2 HHMM:SS-HHMM:SS

RU0006A/30 84 137 43375-43810 1202:55-1210:10
 31 84 137 81043-81268 2230:43-2234:28
 32 84 138 41946-42276 1139:06-1144:36
 33 84 138 79447-79762 2204:07-2209:22
 34 84 139 40375-40690 1112:55-1118:10
 35 84 139 77860-78205 2137:40-2143:25
 36 84 140 76341-76626 2112:21-2117:06
 37 84 140 82500-82695 2255:00-2258:15
 38 84 141 43293-43653 1201:33-1207:33
 39 84 141 80913-81123 2228:33-2232:03
 40 84 142 41727-42102 1135:27-1141:42
 41 84 142 79264-79564 2201:04-2206:04
 42 84 143 40155-40500 1109:15-1115:00

RU0014/37
 38 84 168 25420-25900 0703:40-0711:40
 39 84 168 31484-32009 0844:44-0853:29
 40 84 168 69042-69387 1910:42-1916:27
 41 84 169 29923-30418 0818:43-0826:58
 42 84 169 67574-67814 1846:14-1850:14
 43 84 170 28368-28893 0752:48-0801:33
 44 84 171 26815-27340 0726:55-0735:40
 45 84 171 64367-64802 1752:47-1800:02
 46 84 172 25332-25782 0702:12-0709:42
 47 84 173 61258-61663 1700:58-1707:43
 48 84 173 67389-67734 1843:09-1848:54
 49 84 174 22202-22622 0610:02-0617:02
 50 84 174 28260-28725 0751:00-0758:45
 51 84 174 65839-66154 1817:19-1822:34
 52 84 175 26692-27172 0724:52-0732:52
 53 84 177 23598-24018 0633:18-0640:18
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 56 84 178 59618-59888 1633:38-1638:08

HILAT

TAPE/FILE YEAR DAY SEC1-SEC2 HHMM:SS-HHMM:SS

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 3 84 144 76092-76437 2108:12-2113:57
 4 84 145 36981-37431 1016:21-1023:51
 5 84 145 74626-74956 2043:46-2049:16
 6 84 145 80881-81031 2228:01-2230:31
 7 84 146 79200-79485 2200:00-2204:45
 8 84 150 72709-73204 2011:49-2020:04
 9 84 151 33756-34131 0922:36-0928:51
 10 84 151 77591-77711 2133:11-2135:11
 11 84 152 38249-38639 1037:29-1043:59
 12 84 152 75930-76140 2105:30-2109:00
 13 84 153 36683-37043 1011:23-1017:23
 14 84 153 74311-74581 2038:31-2043:01
 15 84 154 35113-35548 0945:13-0952:28
 16 84 154 72693-73008 2011:33-2016:48
 17 84 155 33581-33971 0919:41-0926:11
 18 84 155 71152-71452 1945:52-1950:52
 19 84 157 74033-74498 2033:53-2041:38
 20 84 158 72560-72920 2009:20-2015:20
 21 84 159 33459-33879 0917:39-0924:39
 22 84 159 70990-71365 1943:10-1949:25
 23 84 161 30332-30707 0825:32-0831:47
 24 84 161 67878-68223 1851:18-1857:03
 25 84 162 28772-29147 0759:32-0805:47
 26 84 162 34843-35188 0940:43-0946:28
 27 84 162 66256-66646 1824:16-1830:46
 28 84 162 72423-72723 2007:03-2012:03
 29 84 163 27213-27588 0733:33-0739:48
 30 84 163 70850-71135 1940:50-1945:35
 31 84 164 69284-69509 1914:44-1918:29
 32 84 165 30125-30515 0822:05-0828:35
 33 84 165 67717-68017 1848:37-1853:37
 34 84 166 28552-29032 0755:52-0803:52
 35 84 167 26991-27516 0729:51-0738:36
 36 84 167 64457-64892 1754:17-1801:32

HILAT

TAPE/FILE YEAR DAY SEC1-SEC2 HHMM:SS-HHMM:SS

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 18 84 155 71152-71452 1945:52-1950:52
 19 84 157 74033-74498 2033:53-2041:38
 20 84 158 72560-72920 2009:20-2015:20
 21 84 159 33459-33879 0917:39-0924:39
 22 84 159 70990-71365 1943:10-1949:25
 23 84 161 30332-30707 0825:32-0831:47
 24 84 161 67878-68223 1851:18-1857:03
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 27 84 162 66256-66646 1824:16-1830:46
 28 84 162 72423-72723 2007:03-2012:03
 29 84 163 27213-27588 0733:33-0739:48
 30 84 163 70850-71135 1940:50-1945:35
 31 84 164 69284-69509 1914:44-1918:29
 32 84 165 30125-30515 0822:05-0828:35
 33 84 165 67717-68017 1848:37-1853:37
 34 84 166 28552-29032 0755:52-0803:52
 35 84 167 26991-27516 0729:51-0738:36
 36 84 167 64457-64892 1754:17-1801:32

87/04/15.

87/04/15.

HILAT

SUMMARY

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1

HILAT

SUMMARY

SONDRE

REDO

87/04/15.

TAPE/FILE YEAR DAY SEC1-SEC2 HHMM:SS-HHMM:SS

TAPE/FILE YEAR DAY SEC1-SEC2 HHMM:SS-HHMM:SS

SUR001/

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 83 250 4878-5493 0121:18-0131:33
 83 250 11017-11497 0303:37-0311:37
 83 250 52624-53059 1437:04-1444:19
 83 250 58733-59333 1618:53-1628:53
 83 250 64961-65456 1802:41-1810:56
 83 251 3323-3938 0055:23-0105:38
 83 251 9454-9979 0237:34-0246:19
 83 251 51083-51653 1411:23-1420:53
 83 251 57165-57780 1552:45-1603:00
 83 251 63378-63888 1736:18-1744:48
 83 251 82042-82582 2247:22-2256:22
 83 252 7886-8441 0211:26-0220:41
 83 252 49545-50085 1345:45-1354:45
 83 252 61792-62332 1709:52-1718:52
 83 252 80478-81003 2221:18-2230:03
 83 253 202-817 0003:22-0013:37
 83 253 6326-6911 0145:26-0155:11
 83 253 48022-48517 1320:22-1328:37
 83 253 54045-54660 1500:45-1511:00
 83 253 60210-60645 1643:30-1650:45
 83 253 78918-79413 2155:18-2203:33
 83 253 85486-86086 2344:46-2354:46
 83 254 46496-46961 1254:56-1302:41
 83 254 52488-53103 1434:48-1445:03
 83 254 58635-59220 1617:15-1627:00
 83 254 83482-84082 2311:22-2321:22
 83 255 3203-3818 0053:23-0103:38
 83 255 50944-51544 1409:04-1419:04
 83 255 57063-57663 1551:03-1601:03

SUR007/

83 255 81922-82507 2245:22-2255:07
 83 256 1643-2273 0027:23-0037:53
 83 256 7777-8287 0209:37-0218:07
 83 256 49398-49883 1343:18-1353:03
 83 256 55492-56092 1524:52-1534:52
 83 256 61717-62227 1708:37-1717:07
 83 256 80362-80917 2219:22-2228:37
 83 257 83-713 0001:23-0011:53
 83 257 6213-6753 0143:33-0152:33
 83 257 47858-48413 1317:38-1326:53
 83 257 53928-54543 1458:48-1509:03
 83 257 79807-79347 2153:27-2202:27
 83 258 4647-5217 0117:27-0126:57
 83 258 46327-46852 1252:07-1300:52
 83 258 52368-52983 1432:48-1443:03
 83 258 58549-59104 1615:49-1625:04
 83 258 77243-77753 2127:23-2135:53
 83 258 83367-83982 2309:27-2319:42
 83 259 3087-3687 0051:27-0101:27

SUR007/20

83 259 44797-45292 1226:37-1234:52
 83 259 50813-51428 1406:53-1417:08
 83 259 56967-57537 1549:27-1558:57
 83 259 75675-76170 2101:15-2109:30
 83 259 81807-82422 2243:27-2253:42
 83 260 1526-2141 0025:26-0035:41
 83 260 49257-49872 1340:57-1351:12
 83 260 55392-55992 1523:12-1533:12
 83 260 80246-80846 2217:26-2227:26
 83 261 47712-48312 1315:12-1325:12
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 83 261 78687-79272 2151:27-2201:12
 83 261 84802-85432 2333:22-2343:52
 83 262 4538-5063 0115:38-0124:23
 83 262 52248-52863 1430:48-1441:03
 83 262 58462-58987 1614:22-1623:07

SUR013/

83 262 77126-77681 2125:26-2134:41
 83 262 83246-83876 2307:26-2317:56
 83 263 2970-3540 0049:30-0059:00
 83 263 44632-45187 1223:52-1233:07
 83 263 50688-51303 1404:48-1415:03
 83 263 56884-57424 1548:04-1557:04
 83 263 75567-76107 2059:27-2108:27
 83 263 81686-82316 2241:26-2251:56
 83 264 1411-2011 0023:31-0033:31
 83 264 43103-43613 1158:23-1206:53
 83 264 49128-49743 1338:48-1349:03
 83 264 55301-55871 1521:41-1531:11
 83 264 80130-80745 2215:30-2225:45
 83 265 41581-42046 1133:01-1140:46
 83 265 47576-48191 1312:56-1323:11

SUR021/

83 301 59138-59708 1625:38-1635:08
 83 301 65257-65917 1807:37-1818:37
 83 301 71388-71973 1949:48-1959:33
 83 302 26637-27207 0723:57-0733:27
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 83 302 38876-39461 1047:56-1057:41
 83 302 63701-64346 1741:41-1752:26
 83 302 69825-70440 1923:45-1934:00
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 83 303 62142-62772 1715:42-1726:12
 83 303 68261-68891 1857:41-1908:11
 83 303 74412-74862 2040:12-2047:42
 83 304 23587-24082 0633:07-0641:22
 83 304 29577-30222 0812:57-0823:42
 83 304 35715-36345 0955:15-1005:45
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HILAT SUMMARY SONDRE REDO 87/04/15.

TAPE/FILE YEAR DAV SEC1-SEC2 HHMM:SS-HHMM:SS

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 83 305 28023-28653 0747:03-0757:33
 83 305 34141-34786 0929:01-0939:46
 83 305 65137-65782 1805:37-1816:22
 83 306 26483-27098 0721:23-0731:38
 83 306 32573-33038 0902:53-0910:38
 83 306 63581-64226 1739:41-1750:26
 83 307 31005-31665 0836:45-0847:45
 83 307 62026-62671 1713:46-1724:31
 83 307 68145-68745 1855:45-1905:45
 83 308 29445-30105 0810:45-0821:45
 83 308 60465-61095 1647:45-1658:15
 83 308 66582-67017 1829:42-1836:57

SUR027/ 1 83 311 61901-62546 1711:41-1722:26
 83 312 23253-23853 0627:33-0637:33
 83 312 29328-29988 0808:48-0819:48
 83 312 60341-60986 1645:41-1656:26
 83 313 27766-28426 0742:46-0753:46
 83 313 58785-59415 1619:45-1630:15
 83 313 64906-65341 1801:46-1809:01
 83 314 26206-26866 0716:46-0727:46
 83 314 57222-57852 1553:42-1604:12
 83 314 63346-63961 1735:46-1746:01
 83 315 24652-25297 0650:52-0701:37
 83 315 30796-31426 0833:16-0843:46
 83 315 55658-56273 1527:38-1537:53
 83 315 61785-62265 1709:45-1717:45
 83 316 23103-23733 0625:03-0635:33
 83 316 29223-29853 0807:03-0817:33
 83 316 60221-60866 1643:41-1654:26
 83 317 27652-28297 0740:52-0751:37
 83 317 58666-59311 1617:46-1628:31
 83 318 26089-26734 0714:49-0725:34
 83 318 57102-57537 1551:42-1558:57
 83 319 24525-25170 0648:45-0659:30
 83 319 30709-31294 0831:49-0841:34
 83 319 55541-56171 1525:41-1536:11
 83 321 21416-22061 0556:56-0607:41
 83 321 27548-28178 0739:08-0749:38
 83 321 52425-53025 1433:45-1443:45
 83 321 58545-59175 1615:45-1626:15
 83 322 19871-20501 0531:11-0541:41
 83 322 25977-26622 0712:57-0723:42
 83 322 56981-57506 1549:41-1558:26
 83 323 24409-25054 0646:49-0657:34
 83 323 55421-56051 1523:41-1534:11
 83 324 22845-23490 0620:45-0631:30
 83 324 53862-54492 1457:42-1508:12
 83 325 21289-21934 0554:49-0605:34

REDO 87/04/15.

TAPE/FILE YEAR DAV SEC1-SEC2 HHMM:SS-HHMM:SS

SUR033/ 1 83 325 46173-46683 1249:33-1258:03
 83 325 52302-52917 1431:42-1441:57
 83 325 58426-59041 1613:46-1624:01
 83 326 13741-14236 0349:01-0357:16
 83 326 19729-20374 0528:49-0539:34
 83 326 25876-26491 0711:16-0721:31
 83 326 32130-32625 0855:30-0903:45
 83 326 44606-45086 1223:26-1231:26
 83 326 50742-51342 1405:42-1415:42
 83 326 56862-57477 1547:42-1557:57
 83 326 63001-63466 1730:01-1737:46
 83 327 18184-18814 0503:04-0513:34
 83 327 24301-24931 0645:01-0655:31
 83 327 30540-31050 0829:00-0837:30
 83 327 43036-43501 1157:16-1205:01
 83 327 49177-49762 1339:37-1349:22
 83 327 55301-55931 1521:41-1532:11
 83 327 61432-61942 1703:52-1712:22
 83 328 16635-17250 0437:15-0447:30
 83 328 22728-23373 0618:48-0629:33
 83 328 28951-29491 0802:31-0811:31
 83 328 47618-48173 1313:38-1322:53
 83 328 53742-54372 1455:42-1506:12
 83 328 59869-60409 1637:49-1646:49
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 83 329 21166-21811 0552:46-0603:31
 83 329 27368-27923 0736:08-0745:23
 83 329 46054-46594 1247:34-1256:34
 83 329 52178-52808 1429:38-1440:08
 83 329 58302-58887 1611:42-1621:27

SUR039/ 1 83 330 19602-20247 0526:42-0537:27
 83 330 50618-51233 1403:38-1413:53
 83 331 18045-18675 0500:45-0511:15
 83 331 55177-55792 1519:37-1529:52
 83 332 16492-17122 0434:52-0445:22
 83 332 22624-23239 0617:04-0627:19
 83 332 28876-29371 0801:16-0809:31
 83 332 47497-48082 1311:37-1321:22
 83 332 53614-54229 1453:34-1503:49
 83 332 59753-60233 1635:53-1643:53
 83 333 14943-15558 0409:03-0419:18
 83 333 27285-27810 0734:45-0743:30
 83 333 45937-46507 1245:37-1255:07
 83 333 52054-52684 1427:34-1438:04
 83 333 58185-58710 1609:45-1618:30
 83 334 13403-13988 0343:23-0353:08
 83 334 19481-20111 0524:41-0535:11

87/04/15.

87/04/15.

HILAT

SUMMARY

TROMSO

REDO

87/04/15.

1

HILAT

SUMMARY

TROMSO

REDO

87/04/15.

TAPE/FILE YEAR DAY SEC1-SEC2 HHMM:SS-HHMM:SS

TAPE/FILE YEAR DAY SEC1-SEC2 HHMM:SS-HHMM:SS

TUR0001/ 1 83 316 35853-36453 0957:33-1007:33
 2 83 316 41978-42623 1139:38-1150:23
 3 83 316 48106-48691 1321:46-1331:31
 4 83 317 9487-10147 0238:07-0249:07
 5 83 317 15657-16272 0420:57-0431:12
 6 83 317 46546-47146 1258:46-1305:46
 7 83 318 1909-2464 0031:49-0041:04
 8 83 318 7932-8577 0212:12-0222:57
 9 83 318 14082-14712 0354:42-0405:12
 10 83 318 20311-20851 0538:31-0547:31
 11 83 318 32722-33292 0905:22-0914:52
 12 83 318 39858-39488 1047:38-1058:08
 13 83 318 44981-45596 1229:41-1239:56
 14 83 319 378-888 0006:18-0014:48
 15 83 319 6379-7024 0146:19-0157:04
 16 83 319 12506-13136 0328:26-0338:56
 17 83 319 18731-19256 0512:11-0520:56
 18 83 319 37302-37932 1021:42-1032:12
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 20 83 320 4830-5460 0120:30-0131:00
 21 83 320 10938-11583 0302:18-0313:03
 22 83 320 17145-17715 0445:45-0455:15
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 24 83 320 35737-36352 0955:37-1005:52
 25 83 320 41662-42492 1137:42-1148:12
 26 83 320 48003-48513 1320:03-1328:33
 27 83 321 3286-3901 0054:46-0105:01
 28 83 321 9371-10016 0236:11-0246:56
 29 83 321 15563-16148 0419:23-0429:08
 30 83 321 28016-28541 0746:56-0755:41
 31 83 321 34173-34773 0929:33-0939:33

TUR0007/19
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TUR013/ 1 83 329 33934-34564 0925:34-0936:04
 2 83 329 40062-40662 1107:42-1117:42
 3 83 330 1458-2088 0024:18-0034:48
 4 83 330 7590-8205 0206:30-0216:45
 5 83 330 13808-14348 0350:08-0359:08
 6 83 330 26236-26776 0717:16-0726:16
 7 83 330 32378-32993 0859:38-0909:53
 8 83 330 38497-39112 1041:37-1051:52
 9 83 330 44632-45112 1223:52-1231:52
 10 83 330 86310-86925 2358:30-2408:45
 11 83 331 6019-6649 0140:19-0150:49
 12 83 331 12221-12776 0323:41-0332:56
 13 83 331 24672-25197 0651:12-0659:57
 14 83 331 84762-85362 2332:42-2342:42
 15 83 332 4452-5082 0114:12-0124:42
 16 83 332 10642-11212 0257:22-0306:52
 17 83 332 23096-23606 0624:56-0633:26
 18 83 332 29251-29836 0807:31-0817:16
 19 83 332 35377-36007 0949:37-1000:07
 20 83 332 41501-42041 1131:41-1140:41
 21 83 332 83221-83806 2307:01-2316:46
 22 83 333 2888-3533 0048:08-0058:53
 23 83 333 9063-9648 0231:03-0240:48
 24 83 333 15304-15814 0415:04-0423:34
 25 83 333 27686-28256 0741:26-0750:56
 26 83 333 33818-34448 0923:38-0934:08
 27 83 333 39938-40508 1105:38-1115:08
 28 83 333 81690-82245 2241:30-2250:45
 29 83 334 1327-1957 0022:07-0032:37
 30 83 334 7485-8085 0204:45-0214:45
 31 83 334 13718-14243 0348:38-0357:23
 32 83 334 26122-26677 0715:22-0724:37

TUR013/ 1
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TUR007/ 1 83 321 46425-46980 1253:45-1303:00
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 3 83 322 7808-8453 0210:08-0220:53
 4 83 322 13984-14584 0353:04-0403:04
 5 83 322 32614-33199 0903:34-0913:19
 6 83 322 38742-39372 1045:42-1056:12
 7 83 323 6251-6896 0144:11-0154:56
 8 83 323 37178-37808 1019:38-1030:08
 9 83 324 4691-5336 0118:11-0128:56
 10 83 324 40046-40676 1107:26-1117:56
 11 83 325 40178-40808 1109:38-1120:08
 12 83 325 46308-46818 1251:48-1300:18
 13 83 326 1598-2213 0026:38-0036:53
 14 83 326 7695-8340 0208:15-0219:00
 15 83 326 13997-14467 0351:37-0401:07
 16 83 326 26340-26865 0719:00-0727:45
 17 83 326 32502-33102 0901:42-0911:42
 18 83 326 44742-45282 1225:42-1234:42

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HILAT SUMMARY TROMSO REDO 87/04/15.
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83 334 32253-32868 0857:33-0907:48
83 334 80156-80681 2215:56-2224:41
83 334 86172-86802 2356:12-2406:42
83 335 30894-31308 0831:34-0841:49
83 335 36817-37417 1013:37-1023:37

83 335 84615-85245 2330:15-2340:45
83 336 4336-4966 0112:16-0122:46
83 336 10552-11092 0255:52-0304:52
83 336 83071-83686 2304:31-2314:46
83 337 2768-3398 0046:08-0056:38
83 337 8967-9522 0229:27-0238:42
83 337 27566-28151 0739:26-0749:11
83 337 33690-34305 0921:30-0931:45
83 337 81525-82110 2238:45-2248:30
83 338 7388-7958 0203:08-0212:38
83 338 26003-26573 0713:23-0722:53
83 338 32131-32746 0855:31-0905:46
83 338 38253-38808 1037:33-1046:48
83 338 79991-80546 2213:11-2222:26
83 338 86041-86671 2354:01-2404:31
83 339 5809-6394 0136:49-0146:34
83 339 24439-24994 0647:19-0656:34
83 339 30566-31181 0829:26-0839:41
83 339 36591-37261 1011:31-1021:01
83 339 78457-78982 2147:37-2156:22
83 339 84484-85114 2328:04-2338:34
83 340 4231-4831 0110:31-0120:31
83 340 22872-23412 0621:12-0630:12
83 340 29007-29622 0803:27-0813:42
83 340 35126-35726 0945:26-0955:26
83 340 82927-83542 2302:07-2312:22
83 341 2658-3273 0044:18-0054:33
83 341 8980-9405 0228:00-0238:45
83 341 21303-21828 0555:03-0603:48
83 341 27443-28043 0737:23-0747:23
83 341 33562-34162 0919:22-0929:22

83 341 81379-81994 2236:19-2246:34
83 342 1092-1707 0018:12-0028:27
83 342 7297-7837 0201:37-0210:37
83 342 19740-20250 0529:00-0537:30
83 342 25883-26483 0711:23-0721:23
83 342 32006-32621 0853:26-0903:41
83 342 79833-80433 2210:33-2220:33
83 342 85920-86550 2352:00-2402:30
83 343 5716-6271 0135:16-0144:31
83 343 24319-24904 0645:19-0655:04
83 343 30443-31058 0827:23-0837:38
83 343 36571-37111 1009:31-1018:31

83 343 78292-78862 2144:52-2154:22
83 343 84357-84987 2325:57-2336:27
83 344 4132-4702 0108:52-0118:22
83 344 22758-23328 0619:18-0628:48
83 344 28882-29497 0801:22-0811:37
83 344 35011-35566 0843:31-0852:46
83 344 76756-77296 2119:16-2128:16
83 344 82797-83427 2259:57-2310:27
83 345 2557-3142 0042:37-0052:22
83 345 21191-21746 0553:11-0602:26
83 345 27322-27937 0735:22-0745:37
83 345 33443-34028 0917:23-0927:08
83 345 81240-81855 2234:00-2244:15
83 346 982-1582 0016:22-0026:22
83 346 25758-26358 0709:18-0719:18
83 346 31883-32483 0851:23-0901:23
83 346 79687-80302 2208:07-2218:22
83 346 85808-86423 2350:08-2400:23
83 347 5625-6150 0133:45-0142:30
83 347 18052-18577 0500:52-0509:37
83 347 24195-24795 0643:15-0653:15
83 347 30316-30931 0825:16-0835:31

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83 347 78143-78743 2142:23-2152:23
83 348 28755-29370 0759:15-0809:30
83 348 34886-35396 0941:26-0949:56
83 348 76593-77163 2116:33-2126:03
83 348 82672-83287 2257:52-2308:07
83 349 2456-3026 0040:56-0050:26
83 349 21071-21641 0551:11-0600:41
83 349 27196-27811 0733:16-0743:31
83 349 33318-33858 0915:18-0924:18
83 349 75056-75611 2050:56-2100:11
83 349 81113-81728 2231:53-2242:08
83 350 878-1448 0014:38-0024:08
83 350 19504-20059 0525:04-0534:19
83 350 25632-26247 0707:12-0717:27
83 350 31755-32325 0849:15-0858:45
83 350 79523-74048 2025:23-2034:08
83 350 79552-80167 2205:52-2216:07
83 350 85702-86287 2348:22-2358:07
83 351 17937-18477 0458:57-0507:57
83 351 24071-24671 0641:11-0651:11
83 351 30191-30776 0823:11-0832:56
83 351 77996-78611 2139:56-2150:11
83 351 84128-84728 2322:08-2332:08
83 352 3949-4474 0105:49-0114:34
83 352 16372-16897 0432:52-0441:37
83 352 22507-23107 0615:07-0625:07
83 352 28628-29228 0757:08-0807:08

APPENDIX B
HILAT SUMMARY TAPE FORMAT

HILAT
SUMMARY TAPE FORMAT

TIME/GEOMETRY/MAGNETIC FIELD SUMMARY DATA
330 16-bit word record (note 1)
(one per 15-second summary block)

	Parameter	Number of 16-bit Words
- Universal time	Year	1
	Day	1
	Hour	1
	Minute	1
	Second	1
	Millisecond	1
- Station	Geodetic latitude--degree +N	2
	Longitude--degree +E	2
	Geodetic altitude--km	2
	NORAD ephemeris elements, line 1	35
	NORAD ephemeris elements, line 2	35
	Azimuth angle to satellite--degree	2
	Elevation angle to satellite--degree	2
	Range to satellite--km	2
	Local earth radius--km	2
	(spares)	48
- Satellite	Geodetic latitude--degree +N	2
	Longitude--degree +E	2
	Geodetic altitude--km	2
	Geocentric position X--km (note 2)	2
	Geocentric position Y--km (note 2)	2
	Geocentric position Z--km (note 2)	2
	Geocentric velocity X--km/s (note 2)	2
	Geocentric velocity Y--km/s (note 2)	2
	Geocentric velocity Z--km/s (note 2)	2
	Orbital attitude pitch--degree (note 3)	2
	Orbital attitude yaw--degree (note 3)	2
	Orbital attitude roll--degree (note 3)	2
	Invariant magnetic latitude, APL eccentric dipole--degree	2
	Magnetic local time, APL eccentric dipole--seconds	2
	Magnetic dip, IGRF80--degree	2
	Magnetic declination, IGRF80--degree	2
	Magnetic strength north, IGRF80--mG	2
	Magnetic strength east, IGRF80--mG	2
	Magnetic strength vertical, IGRF80--mG	2

HILAT
SUMMARY TAPE FORMAT (Cont.)

	Parameter	Number of 16-bit Words
- Satellite	Solar right ascension--degree	2
	Solar declination--degree	2
	Solar zenith angle--degree	2
	Sun-shade angle--degree	2
	Invariant magnetic latitude, Gustafsson model--degree	2
	Magnetic longitude, Gustafsson model--degree	2
	(spares)	4
- Magnetic field line through satellite (IGRF80)	Geodetic latitude (350 km)--degree +N	2
	Longitude (350 km)--degree +E	2
	Geodetic altitude (350 km)--km	2
	Solar zenith angle (350 km)--degree	2
	Sun-shade angle (350 km)--degree	2
	Geodetic latitude (100 km)--degree +N	2
	Longitude (100 km)--degree +E	2
	Geodetic altitude (100 km)--km	2
	Solar zenith angle (100 km)--degree	2
	Sun-shade angle (100 km)--degree	2
	Geodetic latitude (surface)--degree +N	2
	Longitude (surface)--degree +E	2
	Geodetic altitude (surface)--km	2
	Solar zenith angle (surface)--degree	2
	Sun-shade angle (surface)--degree	2
	(spares)	4
- F-region penetration (350 km)	Geodetic latitude--degree +N	2
	Longitude--degree +E	2
	Geodetic altitude--km	2
	Invariant magnetic latitude, APL eccentric dipole--degree	2
	Magnetic local time, APL eccentric dipole--seconds	2
	Magnetic dip, IGRF80--degree	2
	Magnetic declination, IGRF80--degree	2
	Magnetic strength north, IGRF80--mG	2
	Magnetic strength east, IGRF80--mG	2
	Magnetic strength vertical, IGRF80--mG	2
	Propagation zenith angle--degree	2
	Propagation magnetic azimuth--degree	2
	Off-magnetic field propagation angle, IGRF80--degree	2
	Off-magnetic meridian propagation angle, IGRF80--degree 2	
	Off-magnetic L-shell propagation angle, IGRF80--degree	2

HILAT
SUMMARY TAPE FORMAT (Cont.)

	Parameter	Number of 16-bit Words
- F-region penetration (350 km)	Reduced propagation range--km	2
	Magnetic penetration velocity X--km/s (note 4)	2
	Magnetic penetration velocity Y--km/s (note 4)	2
	Magnetic penetration velocity Z--km/s (note 4)	2
	(spares)	6
- E-region penetration (100 km)	Geodetic latitude--degree +N	2
	Longitude--degree +E	2
	Geodetic altitude--km	2
	Invariant magnetic latitude, APL eccentric dipole--degree	2
	Magnetic local time, APL eccentric dipole--seconds	2
	Magnetic dip, IGRF80--degree 2	2
	Magnetic declination, IGRF80--degree	2
	Magnetic strength north, IGRF80--mG	2
	Magnetic strength east, IGRF80--mG	2
	Magnetic strength vertical, IGRF80--mG	2
	Propagation zenith angle--degree	2
	Propagation magnetic azimuth--degree	2
	Off-magnetic field propagation angle, IGRF80--degree	2
	Off-magnetic meridian propagation angle, IGRF80--degree	2
	Off-magnetic L-shell propagation angle, IGRF80--degree	2
	Reduced propagation range--km	2
	Magnetic penetration velocity X--km/s (note 4)	2
	Magnetic penetration velocity Y--km/s (note 4)	2
	Magnetic penetration velocity Z--km/s (note 4)	2
	(spares)	6
- Magnetic field line through F-region penetration	Geodetic latitude (100 km)--degree +N	2
	Longitude (100 km)--degree +E	2
	Geodetic altitude (100 km)--km	2
	(spares)	2

HILAT
SUMMARY TAPE FORMAT (Cont.)

	Parameter	Number of 16-bit Words
- Processing tag	Year	1
	Day	1
	Hour	1
	Minute	1
	(spares)	2

note 1 - one word parameters are 16-bit integers, two word parameters are HP 32-bit real words, and the NORAD elements are ASCII coded FORTRAN F10.5 format

note 2 - geocentric coordinates are right-hand earth-centered inertial with X through the line of Aries and Z through the north pole

note 3 - attitude procesing/error flags are as follows:

- 999 no attitude solution attempted
- 998 telemetry frame error
- 997 all sensors dark
- 996 solar sensor word unpack error
- 995 model-data magnetic field magnitude error
- 994 model-data magnetic field/sunline angle error
- 993 orthogonalization error
- 992 orthogonalization error
- 991 orthogonalization error
- 990 miscellaneous error

note 4 - penetration magnetic coordinates are right-hand, X magnetic north and Z nadir

HILAT

TM SUMMARY DATA

7830 16-bit words, split into two 3915 word records (note 1)
(one pair, two records, per 15-second summary block)

	<u>Parameter</u>	<u>Number of 16-bit words</u>
- Span	Start time of 1st TM	
	frame--second (note 2)	2
	End time of 31st TM	
	frame--second (note 2)	2
	(spares)	6
- Unpacked TM	(sequence repeated 31 times)	7812
	Frame count (note 3) (2)	
	Overrange bit and sync status (note 4) (1)	
	SDF timer (1)	
	NSD/SAD (1)	
	Beacon housekeeping (1)	
	Magnetometer (31)	
	Particle detector (97)	
	AIM (62)	
	Drift meter (56)	
- Ancillary data	(spares)	8

note 1 - all parameters are 16-bit integer words, except as noted

note 2 - times are with respect to the time/geometry/magnetic field
point in Table 3

note 3 - frame count is in 32-bit integer format

note 4 - overrange bit and sync status is as follows:

- 0 frame sync, no overrange
- 1 frame sync, overrange
- 2 frame sync error, no overrange
- 3 frame sync error, overrange
- 4 no frame sync, no overrange
- 5 no frame sync, overrange
- 6 replacement for missing frame

HILAT

SCINTILLATION SUMMARY DATA

990 16-bit word record (note 1)
(one per 15-second summary block)

	<u>Parameter</u>	<u>Number of 16-bit words</u>
- Span	Start time of data--second (note 2)	2
	End time of data--second (note 2)	2
	(spares)	6
- 137 MHz	Mean signal level--db	2
	Intensity scintillation index S4	2
	Intensity fade period--second	2
	Intensity decorrelation time--second	2
	Standard deviation of phase--rad	2
	Intensity power spectral density function decimated in log frequency--db S4 units sq/Hz	100
	Phase power spectral density function decimated in log frequency--db rad sq/Hz	100
	Frequencies of above power spectral density samples--Hz	100
- 413 MHz antenna 1	Mean signal level--db	2
	Intensity scintillation index S4	2
	Intensity fade period--second	2
	Intensity decorrelation time--second	2
	Standard deviation of phase--rad	2
	Intensity power spectral density function decimated in log frequency--db S4 units sq/Hz	100
	Phase power spectral density function decimated in log frequency--db rad sq/Hz	100
	Frequencies of above power spectral density samples--Hz	100
- 1239 MHz	Mean signal level--db	2
	Intensity scintillation index S4	2
	Intensity fade period--second	2
	Intensity decorrelation time--second	2
	Intensity power spectral density function decimated in log frequency--db S4 units sq/Hz	100
	Frequencies of above power spectral density samples--Hz	100

HILAT

SCINTILLATION SUMMARY DATA (Cont.)

	<u>Parameter</u>	<u>Number of 16-bit words</u>
- 390 MHz	Mean signal level--db	2
	Intensity scintillation index S4	2
	Intensity fade period--second	2
	(spare)	2
	Standard deviation of phase--rad	2
	(spares)	10
- 413 MHz antenna 2	Mean signal level--db	2
	Intensity scintillation index S4	2
	Intensity fade period--second	2
	Intensity decorrelation time--second	2
	Standard deviation of phase--rad	2
	(spares)	10
- 413 MHz antenna 3	Mean signal level--db	2
	Intensity scintillation index S4	2
	Intensity fade period--second	2
	Intensity decorrelation time--second	2
	Standard deviation of phase--rad	2
	(spares)	10
- 435 MHz	Mean signal level--db	2
	Intensity scintillation index S4	2
	Intensity fade period--second	2
	(spare)	2
	Standard deviation of phase--rad	2
	(spares)	10
- TEC	Total electron content along propagation raypath, three equispaced samples--el/m sq	6
- Irregularity anisotropy and drift	Axial ratio of receiver plane correlation surface	2
	Geographic azimuth of receiver plane correlation surface--degree	2
	Receiver plane correlation surface velocity, magnetic north--km/s	2
	Receiver plane correlation surface velocity, magnetic east--km/s	2

HILAT

SCINTILLATION SUMMARY DATA (Cont.)

<u>Parameter</u>		<u>Number of 16-bit words</u>
- Angular deviation	Standard deviation of phase difference, antennas 1,2--rad	2
	Standard deviation of phase difference, antennas 1,3--rad	2
	Standard deviation of phase difference, antennas 2,3--rad	2
- Ancillary data (spares)		52

 note 1 - all parameters are HP 32-bit real words; items not
 calculated are dummy filled with -999

note 2 - times are with respect to the time/geometry/magnetic field
 point and will always be -15. and +15. seconds

HILAT

SCIENCE SUMMARY DATA

1875 16-bit word record (note 1)
(one per 15-second summary block)

	<u>Parameter</u>	<u>Number of 16-bit Words</u>
- Span	Start time of data--second (note 2)	2
	End time of data--second (note 2)	2
	(spares)	6
- Vector Magnetometer	X-axis data--counts	30
	Y-axis data--counts	30
	Z-axis data--counts	30
	X-axis calibration offset (note 3)	2
	Y-axis calibration offset (note 3)	2
	Z-axis calibration offset (note 3)	2
	calibration matrix (3x3)	18
	B-x deviation, 30 s detrend--nT	20
	B-y deviation, 30 s detrend--nT	20
	B-x current density estimate--A/m*m	20
	B-y current density estimate--A/m*m	20
	B-x power spectral density function decimated in log frequency--db nT sq/Hz	40
	B-y power spectral density function decimated in log frequency--db nT sq/Hz	40
	Frequencies of above power spectral density samples--Hz	40
	B magnitude, rms model-data, fit--nT (note 4)	2
	B-sunline angle, rms model-data fit--deg (note 4)	2
	(spares)	12

HILAT
SCIENCE SUMMARY DATA (Cont.)

	<u>Parameter</u>	<u>Number of 16-bit Words</u>
- Particle Detector	Instrument mode	2
	(spare)	2
	Scaled data, mode	
	dependent--counts (note 5)	960
	mode 1: vertical sensor, 0.25 s average channel 1, 60 samples through channel 8, 60 samples	
	mode 2: vertical sensor, 0.5 s average channel 1, 30 samples through channel 16, 30 samples	
	mode 3: all sensors, 1.5 s average channel 1, vertical sensor, 10 samples through channel 16, vertical sensor, 10 samples	
	channel 1, 45 degree sensor, 10 samples through channel 16, 45 degree sensor, 10 samples	
	channel 1, nadir sensor, 10 samples through channel 16, nadir sensor, 10 samples	
	Log integral number flux, energy <630 eV, vertical sensor-- e/cm/cm-s-sr	20
	Log integral energy flux, energy <630 eV, vertical sensor-- keV/cm/cm-s-sr	20
	Log integral number fluxenergy >1 keV, vertical sensor-- e/cm/cm-s-sr	20
	Log integral energy flux, energy >1 keV, vertical sensor-- keV/cm/cm-s-sr	20
	Integral energy flux energy <630 eV, power spectral density function decimated in log frequency --db flux units sq/Hz	40

HILAT
SCIENCE SUMMARY DATA (Cont.)

	<u>Parameter</u>	<u>Number of 16-bit Words</u>
- Particle Detector	Integral energy flux energy >1 keV, power spectral density function decimated in log frequency --db flux units sq/Hz	40
	Frequencies of above power spectral density samples--Hz (spares)	40 10
- IDM/RPA	Ion density, IDM--cm ⁻³	20
	Ion temperature--degrees K	20
	Ion density, RPA--cm ⁻³	20
	(spares)	20
	Ram velocity--km/s	20
	Crosstrack velocity--km/s	20
	Vertical velocity--km/s	20
	(spares)	20
	Ion density power spectral density function decimated in log frequency--db e/cm ⁻³ sq/Hz	16
	Cross-track velocity power spectral density function decimated in log frequency--db km/s sq/Hz	40
	Frequencies of above power spectral density samples--Hz (spares)	40 40
- Nadir Photometers	3914 A intensity--rayleighs 20	
	6300 A intensity--rayleighs 20	
- Spacecraft Attitude	Rotation matrix (3x3), vehicle to geographic (note 4)	18
	B-x rms model-data fit--nT (note 4)	2
	B-y rms model-data fit--nT (note 4)	2
	B-z rms model-data fit--nT (note 4)	2

HILAT
SCIENCE SUMMARY DATA (Cont.)

- note 1 - all parameters are HP 32-bit real words, except for magnetometer counts, which are 16-bit integers
- note 2 - times are with respect to the time/geometry/magnetic field point and will correspond to those in the telemetry records
- note 3 - nominal (February 1984) values are used if the offsets are not optimized, e.g. the pass is sunlit for less than two minutes
- note 4 - dummy values (-999) are used if the pass is sunlit for less than two minutes
- note 5 - the particle detector channel energies are as follows:

channel 1	.020 keV
channel 2	.032 keV
channel 3	.054 keV
channel 4	.088 keV
channel 5	.144 keV
channel 6	.235 keV
channel 7	.385 keV
channel 8	.632 keV
channel 9	.632 keV
channel 10	1.035 keV
channel 11	1.700 keV
channel 12	2.780 keV
channel 13	4.550 keV
channel 14	7.450 keV
channel 15	12.200 keV
channel 16	20.000 keV

APPENDIX C
HILAT DATA BASE FORMATS

HILAT J SENSOR/THERMAL PLASMA EXPERIMENT/SCINTILLATION

DATA BASE

Data Base Tapes 9 Track
6250 bpi
Labeled
W-I

General Structure:

Each tape has multiple passes. Each file has data from one station pass. Each file has two preface records (preceding the measurement data). There is an EOF after each station pass and a double EOF following the data for each experiment.

Structure is as follows:

- Multiple passes of J Sensor (J/SENSOR Program)
 - Double EOF
- Multiple passes of IDM density (TAPE2)
 - Double EOF
- Multiple passes of IDM drift velocity (TAPE3)
 - Double EOF
- Multiple passes of Electron Sensor "current" (TAPE20)
 - Double EOF
- Multiple passes of Electron Sensor F1,F2,F3,F4 (TAPE22)
 - Double EOF
- Multiple passes of RPA data (TAPE21)
 - Double EOF
- Multiple passes of Scintillation Data (SCINT. Program)
 - Double EOF

Files may be accessed by using a combination of COPYBF & COPYBR.

Skip all files for "Experiments" using COPYBF. Skip files within an experiment type by using COPYBR.

For example, to position tape at beginning of 4th file of RPA data.

COPYBF,LFN,XX,5.
COPYBF,LFN,XX,3.

HILAT
Preface Record 1

<u>Word</u>	<u>Description</u>	<u>Format</u>
1	Year	F
2	Day of year	F
3	Geodetic latitude of station	F
4	Longitude of station	F
5-15	Orbital elements used in ephemeris computations for this pass	F

HILAT

Preface Record 2

The time spacing between 'frames' is 15 seconds. There are 'N' groups of 45 words in this record (since the maximum pass duration is less than 20 minutes, this record should never exceed 3600 words). The first word in this record is N (integer), the number of groups of 45 words. The format of each group in the record repeated N-1 times is as follows:

<u>Word No.</u>	<u>Description</u>	<u>Format</u>
1	UT (seconds)	F
2	Geodetic latitude (deg)	F
3	Longitude (+E)	F
4	Geodetic altitude (km)	F
5	Geocentric position X (km)	F
6	Geocentric position Y (km)	F
7	Geocentric position Z (km)	F
8	Geocentric velocity $\dot{X}$ (km/s)	F
9	Geocentric velocity $\dot{Y}$ (km/s)	F
10	Geocentric velocity $\dot{Z}$ (km/s)	F
11	Orbital attitude pitch	F
12	Orbital attitude yaw	F
13	Orbital attitude roll	F
14	Invariant magnetic latitude	F
15	Magnetic local time (seconds)	F
16	Magnetic dip (degrees)	F
17	Magnetic declination (degrees)	F
18	Magnetic strength - North (NT)	F
19	Magnetic strength - East (NT)	F
20	Magnetic strength - Vertical (NT)	F
21	Solar right ascension (degrees)	F
22	Solar declination (degrees)	F
23	Solar zenith angle	F
24	Sun-shade indicator	F
25	CGM latitude (deg)	F
26	CGM longitude (deg)	F

HILAT
Preface Record 2 (Cont.)

<u>Word No.</u>	<u>Description</u>	<u>Format</u>
27	CGM local time (hrs)	F
28	MF line thru satellite - Geod. lat. (350 km)	F
29	MF line thru satellite - Geod. long. (350 km)	F
30	MF line thru satellite - Geod. alt. (350 km)	F
31	MF line thru satellite - Geod. SZA (350 km)	F
32	MF line thru satellite - S/S indicator (350 km)	F
33	MF line thru satellite - Geod. lat. (100 km)	F
34	MF line thru satellite - Geod. long. (100 km)	F
35	MF line thru satellite - Geod. alt. (100 km)	F
36	MF line thru satellite - Geod. SZA (100 km)	F
37	MF line thru satellite - Geod. S/S (100 km)	F
38	MF line thru satellite - Geod. lat. (surface)	F
39	MF line thru satellite - Geod. long. (surface)	F
40	MF line thru satellite - Geod. alt. (surface)	F
41	Inv. Mag. Lat. of F region Pen (350 km)	F
42	Magnetic LT (hrs) {0-24}	F
43	Vacant	F
44	Vacant	F
45	Vacant	F

HILAT
J/Sensor Data Base

There will be one file per pass. Each file will have a header record followed by a series of data records.

Header Record

0.1	Word count (8)	(I)
1	Year	F
2	Day	F
3	Latitude of station (*)	F
4	Longitude of station (*)	F
5	Instrument mode (at beginning of pass (1., 2. or 3.))	F
6	Start time of pass (UT seconds)	F
7	Run date of file creation	A
8	Run time of file creation	A

(*) Indicates information obtained from SRI tape

(**) From AFGL/SUNY ephemeris

HILAT
J/Sensor Data Base (Cont.)

Data Records (One second per record)

0.1	Word count (112)	(I)
1	Mode indicator (1., 2. or 3.)	F
2	UT (sec)	
3	Alt (km)	
4	Longitude	
5	Geodetic latitude	
6	Local time (sec)	
7	Geomagnetic latitude	
8	Magnetic LT (sec)	
9	CGM latitude	
10	CGM longitude	
11	CGM LT (hours + <u>Frac of hours</u>)	
12	Invariant latitude	
13	Mag field Bx	
14	Mag field By	
15	Mag field Bz	
16	Pitch	
17	Yaw	
18	Roll	
19	X	
20	Y	
21	Z	
22	X	
23	Y	
24	Z	
25-35	Spares	
36	HV monitor (V) from most recent TLM readout	
37	LV monitor (V) from most recent TLM readout	

From AFGL/SUNY
ephemeris

From IGRF₈₀

From summary tape(*)

Spacecraft position
and velocity(*)

HILAT

J/Sensor Data Base (Cont.)

<u>Word</u>	<u>Description</u>	<u>Format</u>
38	Temp (°C) (V) from most recent TLM readout	F
	Particle counts words are the computed counts from the TLM data (i.e. counts = $2^E(AM+32)-33$) packed into 15 bit words. Frames missing due to TLM dropout will have 1 filled 15 bit words (77777_8). There are 192 15 bit words (48 60 bit words)	
39-86	Packed counts data stored as follows: (Z = Zenith detector; F = Forty deg; N = Nadir) - subscript indicates channel	I
	In mode 1:	
	$Z_1, Z_2, Z_3, \dots, Z_8$ repeated 24 times	
	In mode 2:	
	$Z_1, Z_2, \dots, Z_{16}$ repeated 12 times	
	In mode 3:	
	$Z_1, Z_2, \dots, Z_{16}$, $Z_1, \dots, Z_{16}$, $Z_1, \dots, Z_{16}$, $Z_1, \dots, Z_{16}$ $F_1, F_2, \dots, F_{16}$, $F_1, \dots, F_{16}$, $F_1, \dots, F_{16}$, $F_1, \dots, F_{16}$ $N_1, N_2, \dots, N_{16}$, $N_1, \dots, N_{16}$, $N_1, \dots, N_{16}$, $N_1, \dots, N_{16}$	
	(i.e. 4 groups of 16 zenith spectra, followed by 4 groups of forty degree detector spectra followed, by 4 groups of Nadir detector spectra.)	
87-102	The next group of words will be 31 words per telemetry frame (~1/2 sec) from the magnetometer (total of 62 words) packed into 15 bit words. (The 30 LSBS of word 102 will be vacant)	I
103	ID word from even block	I
104-110	Spares	I

HILAT

J/Sensor Data Base (Cont.)

<u>Word</u>	<u>Description</u>	<u>Format</u>
111	Time of telemetry frame for which Line No. = 6.	F
112	Packed photometer data (56 bits of information -right adjusted - the 6 photometer words plus housekeeping word 41 which contains photometer on/off discretes.)	I

HILAT

IDM DATA BASE (Density)

(5 words/record)

<u>Word</u>	<u>Description</u>	<u>Format</u>
1	Year (last 2 digits of 19xx)	I
2	Day of year	I
3	UT (seconds)	F
4	IDM frame counter	I
5	Ion density (cm ³)	F

Dummy fill value is -999999.

IDM DATA BASE (Drift Velocity)

(20 words/record)

<u>Word</u>	<u>Description</u>	<u>Format</u>
1	Year (last 2 digits of 19xx)	I
2	Day (day of year)	I
3	UT (seconds)	F
4	IDM frame counter	I
5-20	16 velocity values [order is a function of frame counter]	F

Dummy fill value is -999999.

HILAT

ELECTRON SENSOR DATA BASE (Current)

(20 words/record)

<u>Word</u>	<u>Description</u>	<u>Format</u>
1	Year (last 2 digits of 19xx)	I
2	Day (day of year)	I
3	UT (seconds)	F
4	Electron sensor frame counter	I
5-20	16 values of electron sensor tlm. volts	F

Dummy fill value is -999999.

ELECTRON SENSOR DATA BASE (F₁, F₂, F₃, F₄)

(8 words/record)

<u>Word</u>	<u>Description</u>	<u>Format</u>
1	Year (last 2 digits of 19xx)	I
2	Day (day of year)	I
3	UT (seconds)	F
4	Electron sensor frame counter	I
5	F ₁ (volts)	F
6	F ₂ (Volts)	F
7	F ₃ (volts)	F
8	F ₄ (volts)	F

Dummy fill value is -999999.

HILAT
RPA DATA BASE

(35 words/record)

<u>Word</u>	<u>Description</u>	<u>Format</u>
1	Year (last 2 digits of 19xx)	I
2	Day (day of year)	I
3	UT (seconds)	F
4	RPA frame counter	I
5	Velocity (km/s)	F
6	Sensor potential	F
7	Vehicle potential	F
8	Satellite potential w.r.t. instrument bias	F
9	Ion temperature (deg K)	F
10	Ion density 1 (cm ³)	F
11	Mass 1 (kg)	F
12	Ion density 2 (cm ³)	F
13	Mass 2 (kg)	F
14	Drift velocity (m/s)	F
15	Mass in AMU of light component (H+=1, HE+=4)	I
16	Total ion density (cm ³)	F
17	Est. variance of the linear ion current	F
18	Est. variance of the logarithmic ion current	F
19-35	FA(I,K) = Array containing final results (I=1,11 and K=1,3)	F
	FA(I,1) Contains values of the "Best Solution" with respect to the minimum of the linear variance, where only one parameter-position of the second characteristic slope is allowed to vary.	
	FA(I,K) Where K=2,3, contain values of the limiting solutions to the left/right of the "Best" position of the second characteristic slope	
	FA(1,K) Est. var. of the lin. ion current	
	FA(2,K) Est. var. of the log. ion current	
	FA(3,K) VHALF(2) position of the second char. slope	
	FA(4,K) Slope at VHALF(2)	

HILAT
RPA DATA BASE (Cont.)

(35 words/record)

<u>Word</u>	<u>Description</u>	<u>Format</u>
19-35	FA(5,K) Ion current at VHALF(2)	
	FA(6,K) Ion density 1 (cm ³)	
	FA(7,K) Ion density 2 (cm ³)	
	FA(8,K) Ion temp. (deg K)	
	FA(9,K) Drift velocity normal to RPA apert. (m/s)	
	FA(10,K) Satellite potential w.r.t. instrument bias (volts)	
	FA(11,K) Mode, 1=1 ion case, 2=2 ion case	

For no solution

Dummy fill value is 9.9×10^9 or 9.9×10^3

HILAT

SCINTILLATION STATISTICS DATA BASE

<u>Word No.</u>	<u>Desc.</u>
1	Year (I) e.g. 83,84,85,
2	Day of year (I)
3	Station code (I) (1=Sondre; 2=Tromso, 3=Churchill; 4=Rover)
4	UT (seconds)

Words 5-69 from TIME/GEOM/MF Record

<u>Word No.</u>	<u>Desc.</u>
5	- station Geodetic latitude - degree +N
6	Longitude - degree +E
7	Geodetic altitude - km
8	Azimuth angle to satellite - degree
9	Elevation angle to satellite - degree
10	- satellite Geodetic latitude - degree +N
11	Longitude - degree +E
12	Geodetic altitude - km
13	Orbital attitude pitch - degree
14	Orbital attitude yaw - degree
15	Orbital attitude roll - degree
16	Invariant magnetic latitude, APL eccentric dipole - degree
17	Magnetic local time, APL eccentric dipole - 0 seconds
18	Magnetic dip, IGRF80 - degree
19	Magnetic declination, IGRF ₈₀ - degree
20	Solar right ascension - degree
21	Solar declination - degree
22	Solar zenith angle - degree

HILAT

SCINTILLATION STATISTICS DATA BASE (Cont.)

Words 5-69 from TIME/GEOM/MF Record

<u>Word No.</u>	<u>Desc.</u>
23	- magnetic Geodetic latitude (350 km) field line - degree +N
24	through Longitude (350 km) - degree +E
25	satellite Geodetic altitude (350 km) - km
26	(IGRF80) Geodetic latitude (100 km) - degree +N
27	Longitude (100 km) - degree +E
28	Geodetic altitude (100 km) - km
29	- F-region Geodetic latitude - degree +N
30	penetration Longitude - degree +E
31	(350 km) Geodetic altitude -- km
32	Invariant magnetic latitude, APL eccentric dipole - degree
33	Magnetic local time, APL eccentric dipole - seconds
34	Magnetic dip, IGRF ₈₀ - degree
35	Magnetic declination, IGRF ₈₀ - degree
36	Magnetic strength north, IGRF ₈₀ - mg
37	Magnetic strength east, IGRF ₈₀ - mg
38	Magnetic strength vertical, IGRF ₈₀ - mg
39	Propagation zenith angle -- degree
40	Propagation magnetic azimuth - degree
41	Off-magnetic field propagation angle, IGRF ₈₀ - degree
42	Off-magnetic meridian propagation angle, IGRF ₈₀ - degree
43	Off-magnetic L-shell propagation angle, IGRF ₈₀ - degree
44	Reduced propagation range - km
45	Magnetic penetration velocity X - km/s
46	Magnetic penetration velocity Y - km/s

HILAT
SCINTILLATION STATISTICS DATA BASE (Cont.)

Words 5-69 from TIME/GEOM/MF Record

<u>Word No.</u>	<u>Desc.</u>
47	Magnetic penetration velocity Z - km/s
48	- E-region Geodetic latitude - degree +N
49	penetration Longitude - degree + E
50	(100 km) Geodetic altitude - km
51	Invariant magnetic latitude, APL eccentric dipole - degree
52	Magnetic local time, APL eccentric dipole - seconds
53	Magnetic dip, IGRF ₈₀ - degree
54	Magnetic declination, IGRF ₈₀ - degree
55	Magnetic strength north, IGRF ₈₀ - mg
56	Magnetic strength east, IGRF ₈₀ - mg
57	Magnetic strength vertical, IGRF ₈₀ - mg
58	Propagation zenith angle - degree
59	Propagation magnetic azimuth - degree
60	Off-magnetic field propagation angle, IGRF ₈₀ - degree
61	Off-magnetic meridian propagation angle, IGRF ₈₀ - degree
62	Off-magnetic L-shell propagation angle, IGRF ₈₀ - degree
63	Reduced propagation range - km
64	Magnetic penetration velocity X - km/s
65	Magnetic penetration velocity Y - km/s
66	Magnetic penetration velocity Z - km/s

HILAT
SCINTILLATION STATISTICS DATA BASE (Cont.)

Words 5-69 from TIME/GEOM/MF Record

<u>Word No.</u>	<u>Desc.</u>
67	- Magnetic Geodetic latitude (100 km) field line - degree +N through
68	F-region Longitude (100 km) - degree +E penetration
69	Geodetic altitude (100 km) - km

Words 70-84 from Scintillation Records

<u>Word No.</u>	<u>Desc.</u>
70	-137 MHz Mean signal level - db
71	Intensity scintillation index S4
72	Intensity fade period - second
73	Intensity decorrelation time - second
74	Standard deviation of phase - rad
75	- 413 MHz Mean signal level - db
76	antenna 1 Intensity scintillation index S4
77	Intensity fade period - second
78	Intensity decorrelation time - second
79	Standard deviation of phase - rad
80	- 1239 MHz Mean signal level - db
81	Intensity scintillation index S4
82-84	- TEC Total electron content along propagation ray path, three equispaced samples -- e /m sq

HILAT

SCINTILLATION SSTATISTICS DATA BASE (Cont.)

Words 85-204 from SCI/SUM Records

<u>Word No.</u>	<u>Desc.</u>
85-94	- Particle Detector Log integral number flux, energy <630 ev, vertical sensor -- e/cm/cm-s-sr, ten samples
95-104	Log integral energy flux, energy <630 ev, vertical sensor -- kev/cm/cm-s-sr, ten samples
105-114	Log integral number flux, energy >1 kev, vertical sensor -- e/cm/cm-s-sr, ten samples
115-124	Log integral energy flux, energy >1 kev, vertical sensor -- kev/cm/cm-s-sr, ten samples
125-134	- IDM/RPA Ion density, IDM -- cm-3, ten samples
135-144	Ram velocity -- km/s, ten samples
145-154	Crosstrack velocity -- km/s, ten samples
155-164	Vertical velocity -- km/s, ten samples
165-184	Frequencies of cross track velocity power spectral density samples -- Hz, twenty samples
185-194	- Nadir photometers 3914 A intensity-rayleights, 10 samples
195-204	6300 A intensity - rayleighs, 10 samples

As done for previous 'scintillation data base'*

<u>Word No.</u>	<u>Desc.</u>
205	Slope (p)
206	RMS
207	TI (1 Hz value)
} intensity } 137 MHz	

HILAT
SCINTILLATION STATISTICS DATA BASE (Cont.)

<u>Word No.</u>	<u>Desc.</u>			
208	Slope 1 (P1)	}	phase	
209	RMS 1			
210	Slope 2 (P2)			
211	RMS 2	}		
212	TP (1 Hz value)			
213	Slope (P)			
214	RMS	}	intensity	
215	TI (1 Hz value)			
216	Slope 1 (P1)			
217	RMS 1	}	413 MHz	
218	Slope 2 (P2)			
219	RMS 2			
220	TP (1 Hz value)	}		phase

Fits and integrations to science summary data parameters

221	Slope/10 (P)
222	1 Hz value (T) from By fit 1
223	RMS value (RMS)
224	Area (A)
225-228	As above for By fit 2
229-232	As above for integral energy flux <630 eV fit:
233-236	As above for integral energy flux <630 eV, fit 2
237-240	As above for integral energy flux >1 kev, fit 1
241-244	As above for integral energy flux >1 kev, fit 2
245-248	As above for cross track velocity, fit 1
249-252	As above for cross track velocity, fit 1
253-256	As above for ion density, 1 fit
257	$\dot{x}$
258	$\dot{y}$ satellite velocity (km/sec)
259	$\dot{z}$
260	Range to satellite (km)
261	J sensor instrument mode
262-270	Vacant

HILAT
SCINTILLATION DATA BASE STATISTICS FILE FORMAT

(24 Parameters)

Dimension STMEAN(12,12),ST10P(12,12),ST50P(12,12),
ST90P(12,12),STCNTS(12,12)

DO 10 KP=1,2

DO 1 IREAD=1,24

1 READ(1)STMEAN,ST10P,ST50P,ST90P,STCNTS

READ(1) NFILES,NR1,NR2,NR3,NR4,NR5,NR6,NR7,NR8,ISTNCD,
IDBEG,IDEND,NR9,NR10

10 Continue

Five arrays are read for each of 24 parameters:

STMEAN is mean value

ST10P is 10th percentile value

ST50P is 50th percentile value

ST90P is 90th percentile value

STCNTS is number of occurrences in each bin

Lastly, a preface record where NFILES = total number of
files (i.e. revs) in data set.

NR1 - Input data recs used after elevation, Inv. Lat. & K_p
exclusion for parameters 19 & 20

NR8 - Input data recs used after elevation, Inv. Lat. & K_p
exclusion for parameters 1 to 18

NR2 - Recs used after exclusion for scintillation freq's
all zero

NR3 - Recs remaining after S_4 exclusion

NR4 - Recs remaining after σ_ϕ exclusion

NR5 - Recs remaining after 10 ion density values outside
range 10^3 to 10^6

NR6 - Recs remaining after avg. energy exclusion for Mode
#2 or 3

NR7 - Recs excluded for avg. energy denominator $<10^3$

ISTNCD - Station code (1=Sondre; 2=Tromso; 3=Churchill)

IDBEG - Start day of data set (e.g. 83317)

HILAT SCINTILLATION DATA BASE STATISTICS FILE FORMAT (Cont.)

IDEND - End day of data set (e.g. 84031)
NR9 - Recs excluded from low energy of flux for
denominator <1000
NR10 - Recs excluded from high energy & flux for
denominator <1000

This sequence is done twice for 2 K_p values: $K_p \leq 3.5$ and $K_p > 3.5$.

For all arrays, the values are stored as 12x12, with rows 1→12 being Magnetic Local Time, starting at 23 hours, incrementing in 2 hour bins. Columns 1→12 are the Invariant Latitude bins, starting at 50°, incrementing in 2.5° bins.

In the case of 1 hour magnetic local time bins, for all arrays, the values are stored as 24x12, with rows 1-24 being magnetic local time, starting at 22.5 hours, incrementing in 1 hour bins. Columns 1-12 are the invariant latitude bins, starting at 50°, incrementing in 2.5° bins.

HILAT SCINTILLATION DATA BASE STATISTICS FILE FORMAT (Cont.)
(24 Parameters)

The names of the 24 parameters are:

<u>No.</u>	<u>Name</u>
1	Mean signal, 137 MHz
2	Scintillation index intensity, 137 MHz
3	Fade period intensity, 137 MHz
4	Decorrelation time intensity, 137 MHz
5	Phase std. deviation, 137 MHz
6	Mean signal, 413 MHz
7	Scintillation index intensity, 413 MHz
8	Fade period intensity, 413 MHz
9	Decorrelation time intensity, 413 MHz
10	Phase std. deviation, 413 MHz
11	Mean signal 1239 MHz
12	TEC
13	Phase slope 1, 137 MHz
14	Phase slope 2, 137 MHz
15	Phase T_p , 137 MHz
16	Phase slope 1, 413 MHz
17	Phase slope 2, 413 MHz
18	Phase T_p , 413 MHz
19	Average ion density
20	Average energy-particle detector
21	Average energy - particle detector (low)
22	Energy flux - particle detector (low)
23	Average energy - particle detector (high)
24	Energy flux - particle detector (high)

HILAT SCIENCE SUMMARY DATA BASE STATISTICS FILE FORMAT

(27 Parameters)

```
Dimension STMEAN(12,12), ST10P(12,12), ST50P(12,12),  
          ST90P(12,12),  
          STCNTS(12,12)  
  
DO 10 KP=1,2  
DO 1 IREAD=1,27  
  
1 READ(1) STMEAN,ST10P,ST50P,ST90P,STCNTS  
  READ(1) NFILES,(NR(I),I=1,10),ISTNCD,IDDBEG,IDEND  
  
10 Continue
```

Five arrays are read for each of 27 parameters:

STMEAN is mean value
ST10P is 10th percentile value
ST50P is 50th percentile value
ST90P is 90th percentile value
STCNTS is number of occurrences in each bin

Lastly, a preface record where:

NFILES = Total number of files (i.e. revs)
 in data set

(NR(I), I=1,10) = 1 total number of input data
 base records read.
 2-10) records used for each set of
 3 parameters, respectively.

ISTNCD = Station code (1=Sondre; 2=Tromso;
 3=Churchill)

IDBEG = Start day of data set (e.g. 84032)

IDEND = End day of data set (e.g. 84121)

 The preface is done twice for 2 K_p values: $K_p \leq 3.5$ and $K_p > 3.5$.

 For the 12 arrays, the values are stored as 12x12, with rows 1-12 being magnetic local time, starting at 23 hours, incrementing in 2 hour bins. Columns 1-12 are the invariant latitude bins, starting at 50°, incrementing in 2.5° bins.

 For the 12 arrays, the values are stored as 24x12, with rows 1-24 being magnetic local time, starting at 22.5 hours, incrementing in 1 hour bins. Columns 1-12 are the invariant latitude bins, starting at 50°, incrementing in 2.5° bins.

HILAT SCIENCE SUMMARY DATA BASE STATISTICS FILE FORMAT
(Cont.)

(27 Parameters)

The names of the 27 parameters are:

<u>No.</u>	<u>Name</u>
1	By slope 1
2	By T1
3	By area 1
4	By slope 2
5	By T2
6	By area 2
7	Loen slope 1
8	Loen T1
9	Loen area 1
10	Loen slope 2
11	Loen T2
12	Loen area 2
13	Hien slope 1
14	Hien T1
15	Hien area 1
16	Hien slope 2
17	Hien T2
18	Hien area 2
19	CRVEL slope 1
20	CRVEL T1
21	CRVEL area 1
22	CRVEL slope 2
23	CRVEL T2
24	CRVEL area 2
25	Ion den slope 1
26	Ion den T1
27	Ion den area 10

HILAT
PHOTOMETER DATA BASE

Record 1: Input pref record 1 from input (summary tape)

Record 2: Input ephemeris rec from input (summary tape)

Record 3: 100 words as follows:

Word No.

1-4	Not used
5	UT (secs)
6	Geod. altitude
7	Geod. longitude
8	not used
9	Geod. latitude
10	not used
11	CGM latitude
12	CGM longitude
13	CGM local time
14	Solar zenith angle
15	Sun-shade indicator
16	Geocentric position - X
17	Geocentric position - Y
18	Geocentric position - Z
19	Geocentric velocity - X
20	Geocentric velocity - Y
21	Geocentric velocity - Z
22	Orbital attitude pitch
23	Orbital attitude yaw
24	Orbital attitude roll
25	Inv. Mag. latitude
26	Mag. local time
27	Mag. strength - North
28	Mag. strength - East
29	Mag. strength - Vertical
30-40	Not used
41-87	Magnetometer (6 frames)
88-95	Photometer & Housekeeping words
95	ID
96-100	Not used

HILAT

AIM Data Base

There will be one file per station pass. Each file will have a 2 header records followed by a series of data records.

Header Record 1

1	Year	F
2	Day	F
3	Latitude of station	F
4	Longitude of station	F
5	AIM mode at beginning of pass 1. = Imaging; 2. = Spectrometer; 3. = photometer	F
6	Start time of pass - UT seconds	F
7	Run date of file creation	A
8	Run time of file creation	A
9	Wavelength (if in imaging or photometer mode - if spect mode value = -1.)	F

Header Record 2

Ephemeris data REC (45xN)
Same as Preface REC 2 under Input, part VIII

Data Records

Each data record is constructed from 6 telemetry frames (~3 seconds). The record is structured such that the first AIM word in a data record is the first word of a mode cycle. Data from the imager is packed into 15 bit words. Telemetry words missing due to dropout will be 1 filled (i.e. 77777g).

HILAT AIM Data Base (Cont.)

<u>Format</u>	<u>Word No.</u>	<u>Description</u>
	1	Mode indicator (1. = Imaging; 2. = Spectrometer; 3. = photometer)
	2	Code (0. = Normal; 1. = Electrical Test; 2. = Optical Test)
	3	Status (0. = Normal; 1. = Same words filled due to TLM dropout)
	4	Wavelength (meaningful only in imaging & photometer mode)
	5	UT (sec)
	6	Altitude (km)
	7	Longitude (+E)
	8	blank
	9	Geodetic latitude
	10	blank
	11	Corrected Geomagnetic latitude
	12	Corrected Geomagnetic longitude
	13	Corrected Geomagnetic local time (sec)
	14	Solar zenith angle
	15	Sun/shade indicator (-1. = shade; +1. = sun)
	16	X
	17	Y
	18	Z
	19	$\dot{X}$
	20	$\dot{Y}$
	21	$\dot{Z}$
	22	Pitch
	23	Yaw
	24	Roll
	25	Invariant mag. lat.
	26	Magnetic LT
	27	B _N
	28	B _E
	29	B _V

from Preface
Rec 2-Ephemeris

HILAT AIM Data Base (Cont.)

Format

Word No. Description

30	Sun sensor indicated	$\left\{ \begin{array}{l} 0 = \text{all s/s off;} \\ 1 = \text{photo A on;} \\ 2 = \text{photo B on} \\ 3 = \text{A \& B on;} \\ 4 = \text{AIM on;} \\ 5 = \text{A \& AIM on;} \\ 6 = \text{B \& AIM on;} \\ 7 = \text{all on)} \end{array} \right.$
31	Line counter	
32	Prescalar flag (0. = no prescalar; 1. = prescalar)	
33-40	Vacant	
41-87	Magnetometer data (31 words per telemetry frame x 6 frames are packed into 15 bit words. This requires 46.5 60-bit words; the 30 LSBS of word 47 are vacant magnetometer data	
88-171	Pixel data (336 15 bit words = 84 CDC words)	
172-180	The remaining words (15 bits/word) in the record are in the sequence below and result in 9 CDC words: Fixed photometer data (6 15-bit wds) λ position (1)Nadir point (1) Spectrometer Status words (6) AIM housekeeping (16) ID words from scan (6)	
181-190	Vacant (spares)	

APPENDIX D
AIRS DATA BASE FORMAT

HILAT

AIRS Data Base Format

The AIRS data base is created with one station pass per file. The data base is archived on 9-Track digital tape at a density of 6250cpi. Each tape contains the data from at least one Summary Tape.

Data base files will consist of 2 preface (or header) records followed by a series of AIRS data base records.

PREFACE RECORD 1

This record consists of 15 words.

Word No.	Description
1	Year (F)
2	Day of year (F)
3	Latitude of station (F)
4	Longitude of station (F)
5	AIRS operating mode at beginning of the pass (F) 1.=Imaging, 2.=Spectrometer, 3.=Photometer
6	Start time of pass -UT seconds (F)
7	Run date of file creation (A)
8	Run time of file creation (A)
9	Wavelength of Det 1 (-1. if in spectrometer mode)
10	Wavelength of Det 2 (" " ")
11	Wavelength of Det 3 (" " ")
12	Wavelength of Det 4 (" " ")
13-15	Vacant

PREFACE RECORD 2

This record contains satellite ephemeris, magnetic and attitude data extracted from the Summary Tape. Data stored in this record is written in block form to allow for interpolation of parameters not stored on data base records. The time spacing between blocks is 15 seconds (as is on the Summary Tape). There are 45 parameters contained in each block. A leading integer word is provided to indicate the number of blocks in the record (since record size will vary depending on the time duration of the pass). No pass should exceed 30 minutes and thus the record will not be larger than 9401 words. All words are 60 bit floating point.

HILAT
AIRS Data Base Format (Cont.)

A READ statement of the form

READ(x) N, ((D(I,J), I=1,45), J=1,N)

should be used to input the entire record.

The word order of the 45 words in each block is as follows:

Word No.	Description
1	UT - seconds
2	Geodetic latitude - deg
3	Longitude (+E) - deg
4	Geodetic altitude - km
5	Geocentric position X - km
6	" " Y - km
7	" " Z - km
8	Geocentric velocity X - km/sec
9	" " Y - km/sec
10	" " Z - km/sec
11	Pitch - deg
12	Yaw - deg
13	Roll - deg
14	Invariant mag. latitude (APL eccentric dipole)- deg
15	Magnetic local time (APL eccentric dipole) -sec
16	Magnetic dip - deg (IGRF 85)
17	Magnetic declination - deg (IGRF 85)
18	Magnetic strength North - mG (IGRF 85)
19	" " East - mG (IGRF 85)
20	" " Vertical - mG (IGRF 85)
21	Solar right ascension - deg
22	Solar declination - deg
23	Solar zenith angle - deg

HILAT

AIRS Data Base Format (Cont.)

Word No.	Description
24	Sun/shade angle - deg
25	Invariant mag. lat (Gustafsson model) - deg
26	Magnetic longitude (Gustaffson model) - deg
27	Magnetic local time (Gustafsson model) -hrs

Words 28 through 40 contain information on the magnetic field line through the satellite projected to 350 km, 100km, and the earth's surface.

28	350km geodetic latitude - deg
29	" longitude - deg
30	" altitude - km
31	" solar zenith angle
32	" Sun/shade angle - deg
33	100km geodetic latitude - deg
34	" longitude - deg
35	" altitude - km
36	" solar zenith angle - deg
37	" Sun/shade angle - deg
38	Surface geodetic latitude - deg
39	" longitude - deg
40	" altitude - km
41	Inv. Mag Lat of F-region penetration - deg
42	Magnetic local time of F-region penetration - hrs
43	Code word (0. = no science summary record on Summary Tape; 1. = science summary record on tape)
44	Vacant
45	Vacant

HILAT
AIRS Data Base Format (Cont.)

AIRS DATA BASE RECORDS

There are 419 words per record.

Word No.	Description
1	Mode indicator (1.=Imaging; 2.=Spectrometer;
3	3.=Photometer)
2	Test status (1.=Normal; 2.=Dark shutter;
	3.=Optical test; 4.=Extended dark shutter)
3	TLM status (0.=normal; 1.=some words 1's filled)
4	Detector 1 wavelength (-1. if spectrometer mode)
5	Detector 2 wavelength (" " " ")
6	Detector 3 wavelength (" " " ")
7	Detector 4 wavelength (" " " ")
8	UT - sec
9	Altitude - km
10	Longitude - deg
11	Vacant
12	Geodetic latitude - deg
13	Vacant
14	Invariant mag. lat (Gustafsson model) - deg
15	Magnetic longitude (Gustafsson model) - deg
16	Magnetic local time (Gustafsson model) -hrs
17	Solar zenith angle
18	Sun/shade angle - deg
19	X position - km
20	Y position - km
21	Z position - km
22	X velocity - km/sec
23	Y velocity - km/sec
24	Z velocity - km/sec
25	Pitch - deg
26	Yaw - deg
27	Roll - deg

HILAT
AIRS Data Base Format (Cont.)

Word No.	Description
28	Invariant mag. latitude (APL eccentric dipole)-deg
29	Magnetic local time (APL eccentric dipole)-sec
30	B-North - mG
31	B-East - mG
32	B-Vertical - mG
33	SDF frame count
34	AIRS line counter
35-40	Vacant
41-87	Magnetometer data stored in 15 bit words. (There are 31 15 bit magnetometer words for each SDF frame. There are 10 words for the X,Y and Z magnetometers and one flag word. The groups of 10 words represent one B-field measurement and 9 delta B values. Six such frames (accumulated over the AIRS scan) will be stored. The 30 LSB's of word 87 will be vacant.)
88-169	Detector 1 pixel data
170-251	Detector 2 pixel data
252-333	Detector 3 pixel data
334-415	Detector 4 pixel data (The telemetry counts for the 326 pixel words from each detector will be decompressed and stored in 15 bit words. This results in 82 CDC words per detector. The 30 LBS's of the 82nd word for each detector will be vacant.)
416-419	AIRS status and housekeeping words. (The 16 telemetry words (206-221) from line count 6 will be retained in counts and stored into 15 bit words.)

APPENDIX E

ACCELEROMETER DATA BASE TAPES AND FORMATS

ACCELEROMETER
DATA BASE TAPES AND FORMATS

MINIMUM DENSITY DATA BASE TAPES (100% FILTER)
NINE TRACK 1600 BPI NOSBE MULTI-FILE LABELLED TAPES (W-I)

	CC095	CC2101	CC2663	CC2918	CC0963	CC4674	CC0969	CC1850
1	140	142	143	144	152	154	158	185
2	144	145	169	183	153	184	159	-
3	149	148	202	220	195	244	160	156
4	141	146	228	231	-	194	162	226
5	141	227	-	164	199	235	163	147
6	144	151	233	234	200	191	165	198
7	146	216		161	157		166	
8	144				217		167	
9	144				218		249	
10					196			

	CC3406	CC3407	CC1184	CC1180	CC3415	CC1185	CC3426	CC3427
1	182	240	253	264	263	297	-	325
2	192	241	260	265	180	295	303	326
3	193	246	272	266	-	308	304	327
4	181	247	273	278	274	311	305	328
5	214	248	276	279	275	313	306	329
6	-	250	282	280	287	321	307	330
7	219	-	288		301	324	310	331
8	251	252	296		302		312	215

AD-A182 599 ANALYSIS SYSTEMS FOR AIR FORCE MISSIONS(U) BOSTON COLL 2/2

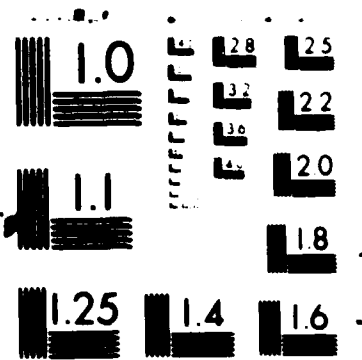
CHESTNUT HILL MA SPACE DATA ANALYSIS LAB

D E DELOREY ET AL 28 FEB 87 BC-SDAL-87-1

UNCLASSIFIED AFGL-TR-87-0100 F19628-83-C-0100

F/G 14/2 NL

END
8: 87
DTIC



ACCELEROMETER
DATA BASE TAPES AND FORMATS (Cont.)

NP5 1982 DENSITY DATA BASE TAPES (20/15 FILTER)
NINE TRACK 6250 BPI UNLABELLED (W-I)
(USE SKIPF OR COPYBF)

FILE CC3257 CC1158 CC3288 CC3322 CC1397 CC4071 CC1508

1	-	141	149	161	185	217	220
2	134	142	151	166	186	226	227
3	135	143	152	167	187	228	235
4	136	144	153	168	188	229	236
5	137	145	154	169	189	230	237
6	138	147	157	180	191	231	248
7	139	148	158	184	192	232	249
8	140	155	159	190	193	233	250
9	146	156	160	199	194	234	251
10		162		200	195		258
11		163		201	196		268
12		164		202	197		269
13		165		214	198		270
14		174		215	206		283
15		175		216	207		284
16		176			208		285
17					218		290
18					219		291
19							305
20							306
21							307

FILE CC4072 CC4472 CC4473 CC4498 CC4501 CC4503

1	235	259	271	280	301	313
2	240	260	272	281	302	321
3	241	261	273	282	303	322
4	244	262	274	287	304	323
5	245	263	275	288	308	324
6	246	264	276	295	309	325
7	247	265	277	296	310	326
8	252	266	278	-	311	327
9	253	267	279		312	328
10						329
11						330
12						331

ACCELEROMETER

DATA BASE TAPES AND FORMATS (Cont.)

NP6 1983-1984 DENSITY DATA BASE TAPES
NINE TRACK 6250 BPI UNLABELLED (W-I)
(USE SKIPF OR COPYBF)

FILE	CC4221	CC3206	CC4294	CC3209	CC3228	CC3232	CC4327	CC4353
1	201	214	265	274	332	1	37	58
2	202	215	266	275	333	2	38	59
3	203	216	273	282	334	3	39	60
4	204	228	276	283	338	4	40	61
5	205	229	277	284	339	5	42	62
6	206	230	278	294	340	6	43	63
7	207	234	285	300	341	7	44	64
8	213	235	289	304	342	8	45	65
9	217	236	290	309	343	18	46	66
10	218	237	291	315	344	-	47	67
11	219	238	292	316	345	-	48	68
12	220	239	293	317	346	29	49	69
13	221	248	301	318	347	30	50	70
14	222	249	302	319	354	31	51	71
15	247	250	303	320	355	32	52	72
16	257	258	310	321	363	34	53	73
17	261	259	311	326	364	35	54	74
18	262	260	312		365	36	55	
19	263	267	313				56	
20	264	268	314				57	
21		269	327					

ACCELEROMETER
DATA BASE TAPES AND FORMATS (Cont.)

S85-1 1984 DENSITY DATA BASE TAPES
NINE TRACK 6250 BPI UNLABELLED (W-I)
(USE SKIPF OR COPYBF)

TAPE/FILE	DAYS	TAPE/FILE	DAYS	TAPE/FILE	DAYS
CC0290/1	210,211	CC0887/1	239,240	CC0517/1	259,260
/2	212,213	/2	241,242	/2	261
/3	214,215	/3	241,242	/3	261,262
/4	213	/4	243,244	/4	263,264
/5	214	/5	245	/5	265
/6	215,216	/6	245,246	/6	265,266
/7	213	/7	247,248	/7	267,268
/8	214	/8	246,247	/8	269,270
/9	216,217	/9	250,251	/9	219,220
/10	218,219	/10	252	/10	221
		/11	247,248	/11	221,222
CC0828/1	229,230	/12	249,250	/12	222,223
/2	231	/13	251,252	/13	223,224
/3	231,232	/14	253,254	/14	225,226
/4	233	/15	254,255	/15	225,226
/5	233,234	/16	256,257	/16	227
/6	235	/17	256,257	/17	226,227
/7	235,236	/18	258,259	/18	228,229
/8	237				
/9	237,238			CC0833/1	269,270
/10	239			/2	271,272
/11	201			/3	272,273
				/4	274,275
				/5	276
				/6	275,276
				/7	277
				/8	280,281
				/9	282
				/10	277,278
				/11	279,280
				/12	271
				/13	275
				/14	281,282
				/15	283

ACCELEROMETER

RAW/FILTER TAPE FORMAT

HEADER	DESCRIPTION	FORMAT
0.1	word count (40)	I
0.2	group count (1)	I
1	satellite ID	A
2	year of data (since 1900) (YY)	F
3	Julian date of data (YYDDD)	F
4	vacant	F
5	order of temperature fit polynomial	F
6	A0 (temperature fit polynomial coefficients)	F
7	A1	F
8	A2	F
9	A3	F
10	A4	F
11	number of temperature points used in fit	F
12	start time of temperature fit	F
13	stop time of temperature fit	F
14	number of missing data frames	F
15	frame increment (time between xyz samples)	F
16	date of test DMA (raw data) run (MM/DD/YY)	A
17	Julian date of raw data run (YYDDD)	R
18	start time of accelerometer data	F
19	stop time of accelerometer data	F
20	vacant	F
21	start time of filtered data	F
22	stop time of filtered data	F
23	Julian date of filter run (YYDDD)	R
24	filter length	F
25	F3 X-axis filter parameters	F
26	F4 "	F
27	F3 Y-axis filter parameters	F
28	F4 "	F
29	F3 Z-axis filter parameters	F
30	F4 "	F
31	flag for treatment of missing points	F
32	number of missing points	F
33	flag for treatment of wild points	F
34	number of X-axis wild points	F
35	number of Y-axis wild points	F
36	number of Z-axis wild points	F
37-40	vacant	F

ACCELEROMETER
RAW/FILTER TAPE FORMAT

<u>DATA</u>	<u>DESCRIPTION</u>	<u>FORMAT</u>
0.1	word count (8)	I
0.2	group count (128)	I
1	Greenwich time (seconds)	F
2	X-axis acceleration (raw) g's	F
3	Y-axis acceleration (raw) g's	F
4	Z-axis acceleration (raw) g's	F
5	X-axis acceleration (filtered) g's	F
6	Y-axis acceleration (filtered) g's	F
7	Z-axis acceleration (filtered) g's	F
8	temperature	F
9-1024	cyclic repetition of 1-8	F

ACCELEROMETER
MERGE/EPHEMERIS TAPE FORMAT

HEADER

Same as raw/filter tape

<u>DATA</u>	<u>DESCRIPTION</u>	<u>FORMAT</u>
0.1	word count (30)	I
0.2	group count (64)	I
1	Julian date of data (YYDDD)	F
2	calendar month	F
3	calendar day	F
4	Greenwich time (seconds)	F
5	altitude (Km)	F
6	latitude (+ 90)	F
7	longitude (+E)	F
8	geocentric velocity (Km/sec)	F
9	velocity relative to atmosphere (Km/sec)	F
10	local time (seconds)	F
11	revolution number	F
12	angle between geocentric and atmospheric velocities (degrees)	F
13	vacant	F
14	vacant	F
15	solar declination (degrees)	F
16	vacant	F
17	vacant	F
18	vacant	F
19	X-axis acceleration (raw)	F
20	Y-axis acceleration (raw)	F
21	Z-axis acceleration (raw)	F
22	X-axis acceleration (filtered)	F
23	Y-axis acceleration (filtered)	F
24	Z-axis acceleration (filtered)	F
25	temperature	F
26	vacant	F
27	vacant	F
28	X-direction clockwise from north (degrees)	F
29	magnetic local time (seconds)	F
30	vacant	F
31-1920	cyclic repetition of 1-30	F

ACCELEROMETER
MODEL/DENSITY TAPE FORMAT

HEADER

Same format as raw/filter tape, except model run date (MM/DD/YY) added in word 37 and ref. area M added in word 40

DATA	DESCRIPTION	FORMAT
0.1	word count (30)	I
0.2	group count (64)	I
1	X-axis wind speed (Km/sec)	F
2	Y-axis wind speed (Km/sec)	F
3	Z-axis wind speed (Km/sec)	F
4	Greenwich time (seconds)	F
5	altitude (Km)	F
6	latitude (+ 90)	F
7	longitude (+E)	F
8	geocentric velocity (Km/sec)	F
9	atmospheric velocity (Km/sec)	F
10	local time (sec)	F
11	revolution number	F
12	angle (in degrees) between (8) and (9)	F
13	CDX	F
14	CDY	F
15	normalized density (200 Km)	F
16	J71 model density	F
17	MSIS model density	F
18	measured density	F
19	X-axis acceleration (raw)	F
20	Y-axis acceleration (raw)	F
21	Z-axis acceleration (raw)	F
22	X-axis acceleration (filtered)	F
23	Y-axis acceleration (filtered)	F
24	Z-axis acceleration (filtered)	F
25	temperature	F
26	Kp (6-hour lag)	F
27	F (one day lag)	F
28	X-direction clockwise from north	F
29	magnetic local time (seconds)	F
30	CDZ	F
31-1920	cyclic repetition of 1-30	F

END

8-87

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