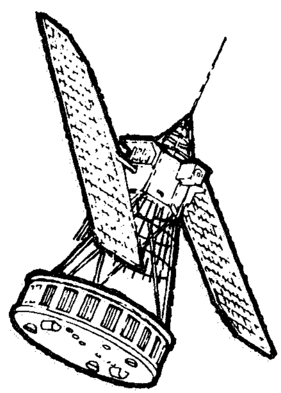
NIMBUS I
HIGH RESOLUTION RADIATION DATA CATALOG AND USERS' MANUAL

Volume 2

Nimbus Meteorological Radiation Tapes - HRIR



By

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of the

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National Aeronautics and Space Administration

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FOREWORD

This Volume, "Nimbus Meteorological Radiation Tapes – HRIR," is the second of two volumes documenting the data from the High Resolution Infrared Radiometer (HRIR) experiment carried on the Nimbus I Meteorological Satellite. Volume I, "Photofacsimile Film Strips," documented essentially the same data before reduction to a format suitable for automatic data processing on a digital computer.

It is not feasible to list by name all of the many people who contributed to the success of the HRIR experiment, but their patience and tireless efforts are sincerely appreciated and gratefully acknowledged.

The special purpose equipment used to digitize the analog signal from the HRIR system was designed and constructed by the following members of the Information Processing Division, Goddard Space Flight Center.

Mr. V. R. Colburn
Mr. A. M. Demmerle
Mr. R. L. Gibbs
Mr. R. G. Holmes
Mr. R. C. Lee
Mr. P. J. McCeney
Mr. R. H. Stagner

The development of computer programs to process digital HRIR data, the preparation of Nimbus Meteorological Radiation Tapes, and the assembling of information into a format suitable for publication were largely accomplished by the following persons.

Laboratory for Atmospheric and Biological Science,
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Mr. W. R. Bandeen
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ABSTRACT

The Nimbus I Meteorological Satellite contained a High Resolution Infrared Radiometer (HRIR) designed to map nighttime cloud cover and measure surface temperatures from radiation emitted within the 3.5 to 4.1 micron atmospheric window. HRIR data were acquired from a near polar orbit during the period from August 28, 1964 to September 22, 1964, after which a spacecraft malfunction occurred and no usable data were obtained from the sensory subsystems.

This volume contains a discussion of the spacecraft performance, the HRIR subsystem, data acquisition and processing, and documentation of the available data. The successfully reduced data are documented in the "Index of Available Nimbus Meteorological Radiation Tapes – HRIR," and are available in binary format on digital magnetic tapes.

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I. INTRODUCTION

The Nimbus meteorological satellite was designed to provide both day and night global coverage of the earth's surface characteristics and cloud cover. The following three sensory systems were developed to accomplish this objective:

1. Advanced Vidicon Camera System (AVCS)
2. Automatic Picture Transmission System (APT)
3. High Resolution Infrared Radiometer System (HRIR)

The Advanced Vidicon Camera System and the Automatic Picture Transmission System and their data have been described and documented in Reference 1. A description of the High Resolution Infrared System and the documentation of the photofacsimile film strips have been reported in Reference 2. This volume documents essentially the same data included in Reference 2, but describes the reduction of digitized HRIR data and the preparation of magnetic tapes for automatic processing on a large digital computer.

The data documented in this catalog are available to the scientific community in the following formats:

1. Nimbus Meteorological Radiation Tape (NMRT)
2. Grid print maps based on a mercator or polar stereographic map projection
3. Listings of data

As resources permit, limited quantities of digitized HRIR data will be provided to scientific investigators without charge. Otherwise, data will be furnished for production costs or less. Whenever it is determined that a charge is required, a cost quotation will be provided to the requestor prior to filling the request.

All requests for digitized HRIR data should be mailed to:

Nimbus Data, Code 601
National Space Science Data Center
Goddard Space Flight Center
Greenbelt, Maryland 20771

Scientific investigators desiring limited quantities of digitized HRIR data are requested to include the information listed below in their requests. Some flexibility in the computer programs is possible, and investigators having requirements which are not satisfied by the standard formats listed below should write to the above address for further information.

A. Magnetic Tapes (NMRT-HRIR)

The NMR Tape is regarded as the basic repository of data from the HRIR system. These tapes are produced on the IBM 7094 computer in binary format, and are usable on electronic data processing equipment compatible with IBM format and having a storage capacity of at least 4096 36 bit words. The following information should be specified when requesting NMR Tapes:

1. Date and time of data desired
2. Data orbit number
3. NMRT-HRIR Reel Number
4. Data Block Number

B. Grid Print Maps

A series of computer programs produce printed and contoured data referenced to a square mesh grid on a polar stereographic or mercator map base. A mercator grid print map for data orbit 258 is illustrated in Figure 1. The following standard options should be specified when requesting grid print maps.

1. Date and time of data desired
2. Data Orbit Number
3. Polar Stereographic or Mercator Map Base
4. Projection Scale of Map
5. Geographic Region of Interest

C. Data Listings

A computer program is available which produces a printed listing of the calibrated radiation data for a specified time interval. Requests for these listings should include the following information.

1. Date and time of data desired
2. Data Orbit Number

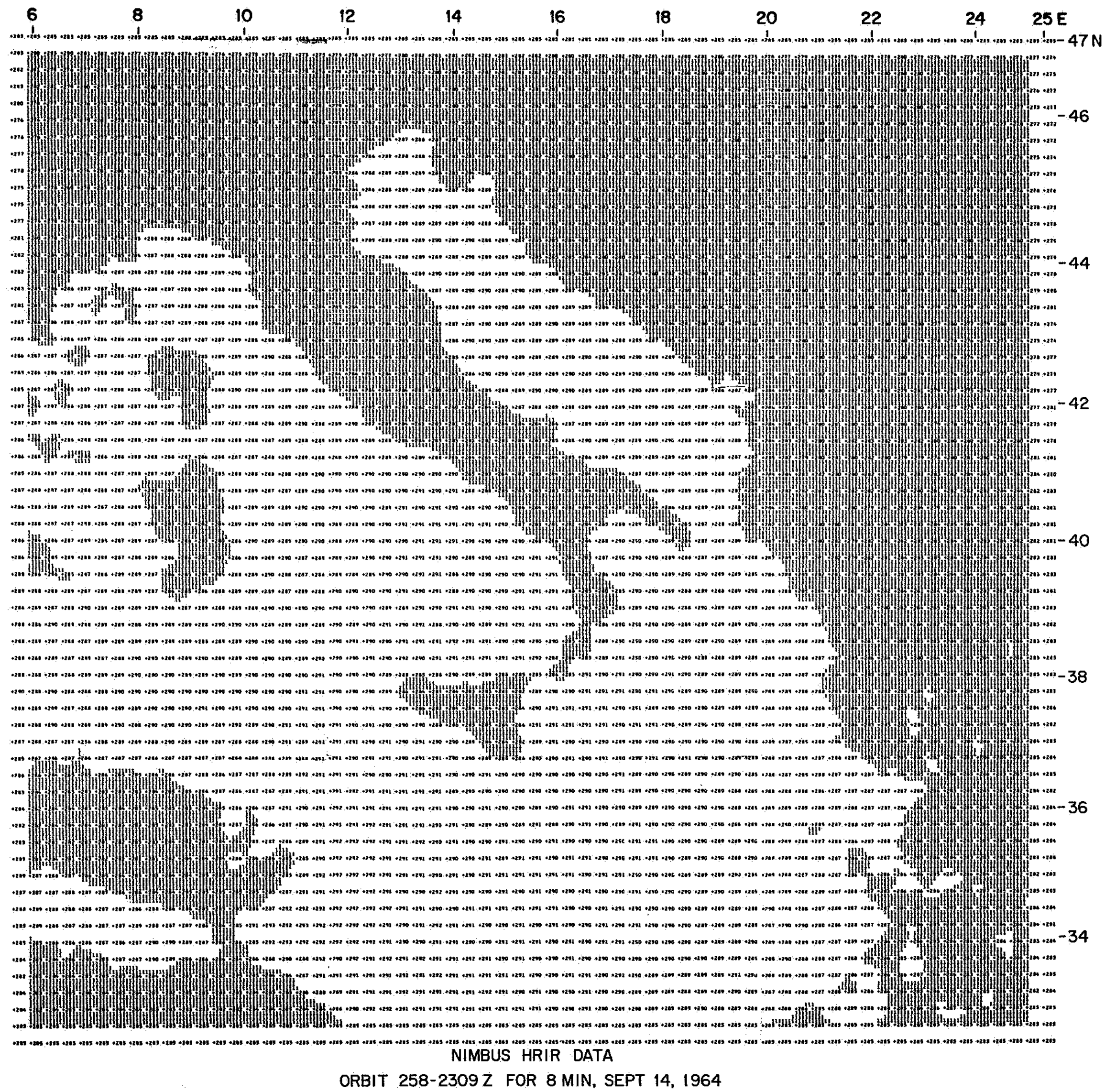

Figure 1—Mercator Grid Print Map of HRIR Data

II. SPACECRAFT PERFORMANCE

2.1 General

The Nimbus I meteorological satellite was injected into orbit at 0852 U.T. on August 28, 1964 from the Western Test Range in California. The nominal and actual mean definitive orbital elements as determined by the Goddard Space Flight Center are shown in Table I.

TABLE I
Mean Definitive Orbital Elements for Nimbus I

	Nominal	Actual	
Epoch Time		Aug. 28, 1964; 0852 UT	
Semi-major axis		7056.35	kilometers
Eccentricity	0.0003	0.03610	
Inclination	99.025	98.663	degrees
Mean Anomaly		177.097	degrees
Argument of Perigee		160.744	degrees
Perigee Motion		-3.1083	degrees/day
R.A. of Ascending Node		150.201	degrees
Motion of Node		+1.0562	degrees/day
Anomalistic Period	103.362	98.31401	minutes
Period Motion		-0.00012	minutes/day
Height of perigee	915.32	423.22	kilometers
Height of apogee	919.70	932.22	kilometers
Velocity at perigee		28053	kilometers per hour
Velcoity at apogee		26098	kilometers per hour
Geocentric Latitude of perigee		19.028	degrees

A circular orbit near the apogee height had been planned, but an elliptical orbit resulted from a shortened Agena second stage burn. The retrograde near-polar orbit was designed to be sun-synchronous, and the eastward (+) motion of the line of nodes would equal the mean motion of the right ascension of the sun (0.9856 degrees per day). The launch was selected so that the ascending node would always occur at local noon and the descending node at local midnight.

These design objectives were not quite achieved as illustrated in Table I and by the occurrence of the ascending node at 11:34 a.m. local time at time of injection and the descending node at 11:34 p.m. The slight excess in the motion of the line of nodes caused the time of equator crossings to advance so that by orbit 368 on September 22, 1964 the ascending node occurred at 11:41 a.m. local time and the descending node at 11:41 p.m. local time.

The spacecraft performed successfully for 26 days until a mechanical malfunction of the solar paddles occurred on September 22, 1964. This unfortunately reduced the power available to the spacecraft to such a level that further useful operation of the attitude control and scientific sensor subsystem was impossible.

The Nimbus I spacecraft was interrogated throughout its active life (orbits 1 through 379) and 199 orbits of HRIR data were played back to the ground stations at Fairbanks, Alaska or Rosman, North Carolina. There was no communication with the spacecraft from orbit 380 to orbit 1231. Interrogation was resumed for selected orbits between orbit 1234 and orbit 1793; but no useful data were obtained from the experimental subsystems.

2.2 Stabilization and Attitude Control Subsystem

The primary function of the stabilization and attitude control subsystem is to orient and stabilize the spacecraft by constantly maintaining a fixed attitude with respect to the earth and the orbital plane. The orbit axes system is a set of three orthogonal axes centered at the center of gravity of the spacecraft and rotating in space so that the yaw axis coincides with the local vertical and is positive downward. The roll axis is orthogonal to the vertical axis and lies in the orbital plane with the positive sense in the direction of the velocity vector. The pitch axis is orthogonal to the local vertical and the orbital plane and positive to the right when looking in the direction of the velocity vector. The orbit axes are illustrated in Figure 2.

The spacecraft axes system, defined by the sensing elements of the control subsystem, is a set of three orthogonal axes having the same center and sense as the orbit axes, but fixed in the spacecraft. The spacecraft axes are illustrated in Figure 3.

1. The yaw axis coincides with the spacecraft local vertical with a positive direction pointing toward the center of the earth. A positive yaw error is a clockwise rotation about the axis when looking toward the earth.

2. The roll axis is orthogonal to the vertical axis and lies in the orbital plane with a positive sense in the direction of the velocity vector. A positive roll error is a clockwise rotation about the roll axis when looking in the direction of the spacecraft orbital movement.

3. The pitch axis is orthogonal to the roll and yaw axes with a positive direction to the right when looking forward along the spacecraft velocity vector. A positive pitch error is a clockwise rotation when looking in the direction of the positive pitch axis.

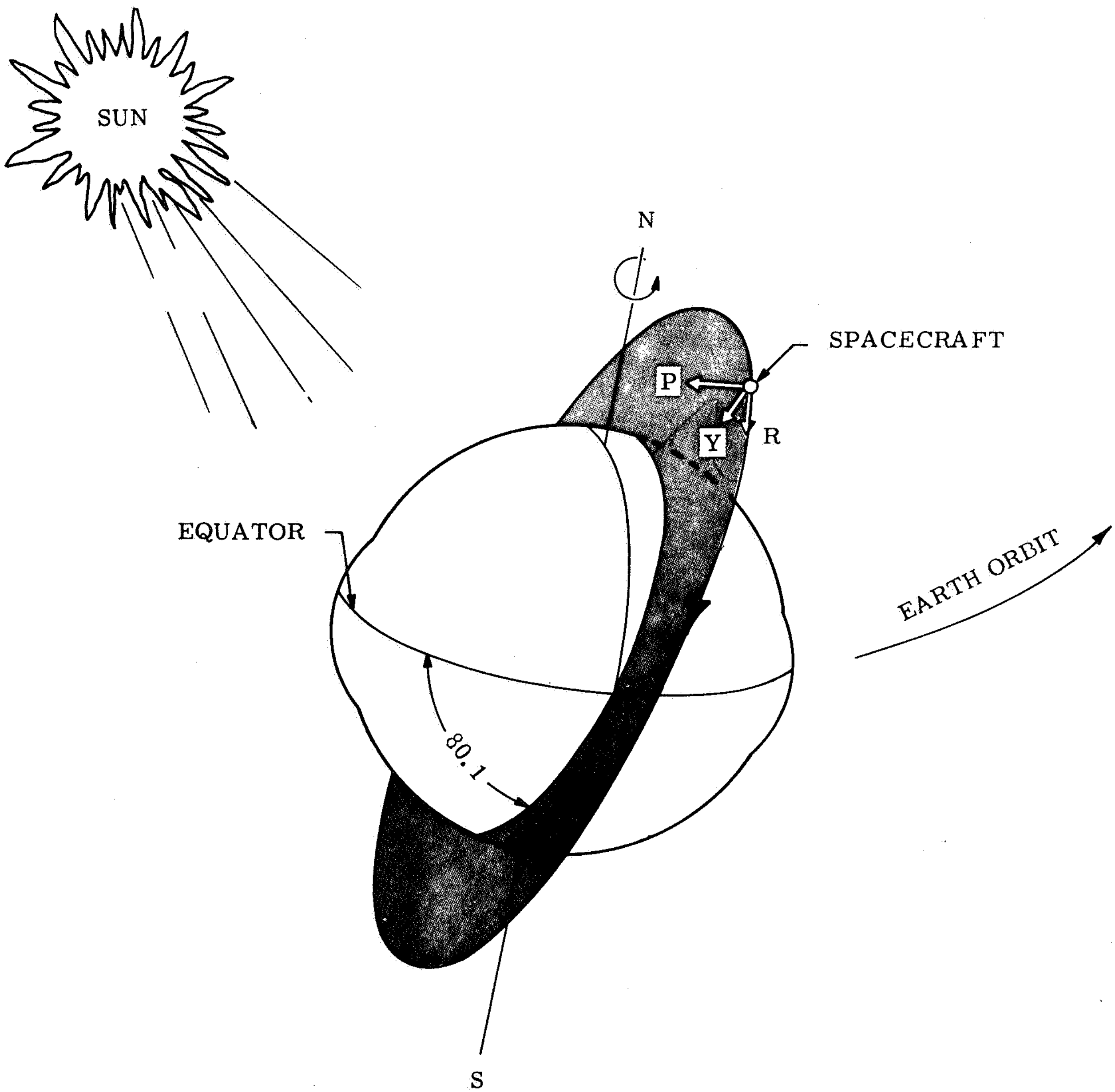

Figure 2–Orbit Axes

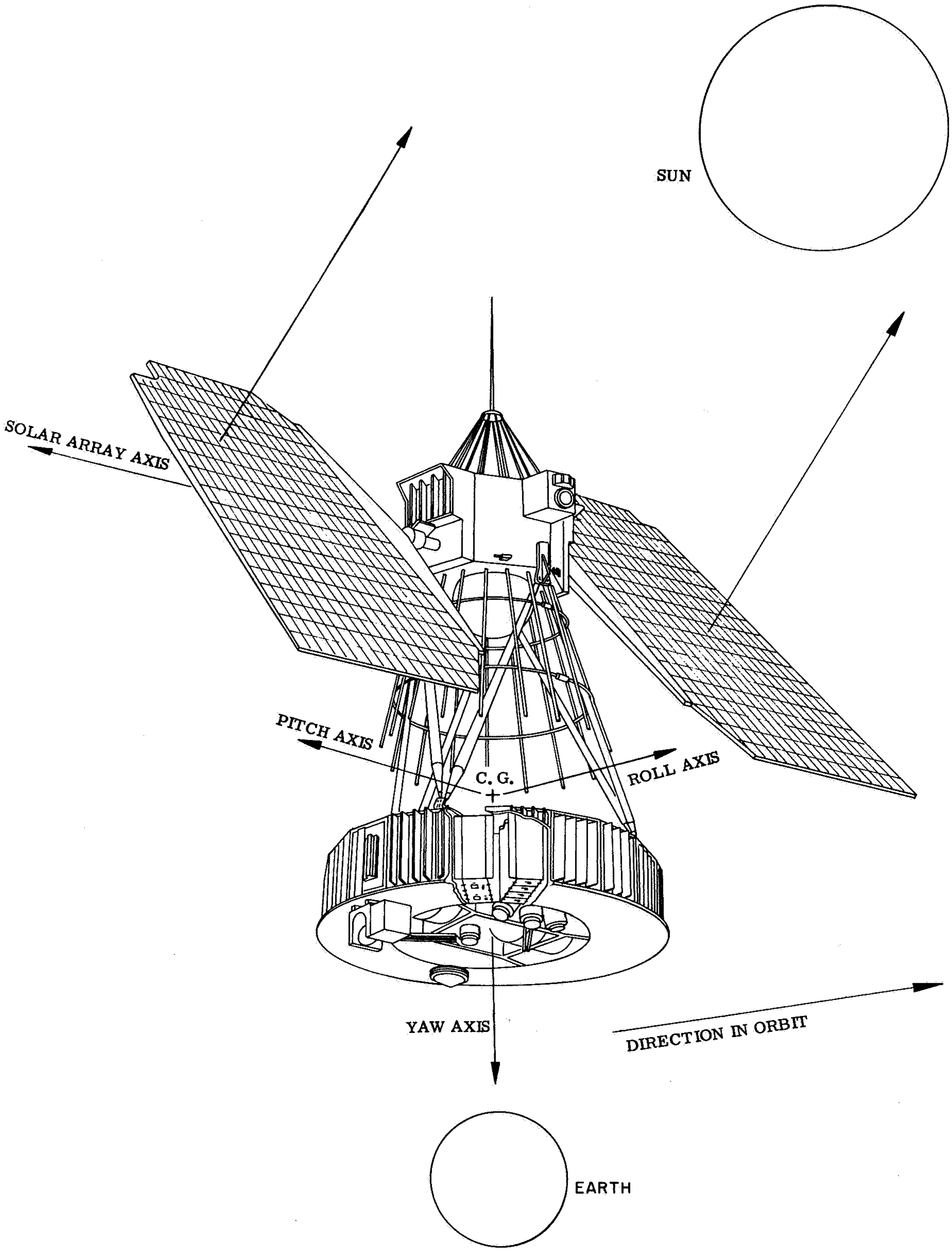

Figure 3–Spacecraft Axes

Under ideal conditions, the spacecraft vertical axis coincides with the local orbital vertical and roll, pitch, and yaw errors are zero. In actual telemetry data, attitude errors are measured by two infrared horizon scanners, one located at each end of the spacecraft along the roll axis (Figure 4). These scanners measure changes in radiation intensity (12-18 micron wavelength region) as they scan the earth and sky while rotating in the roll plane. The infrared energy is focused on a bolometer where changes in radiation intensity cause a corresponding change in the bolometer output signal. The pulses generated from the earth-sky scans are fed to the horizon attitude computer.

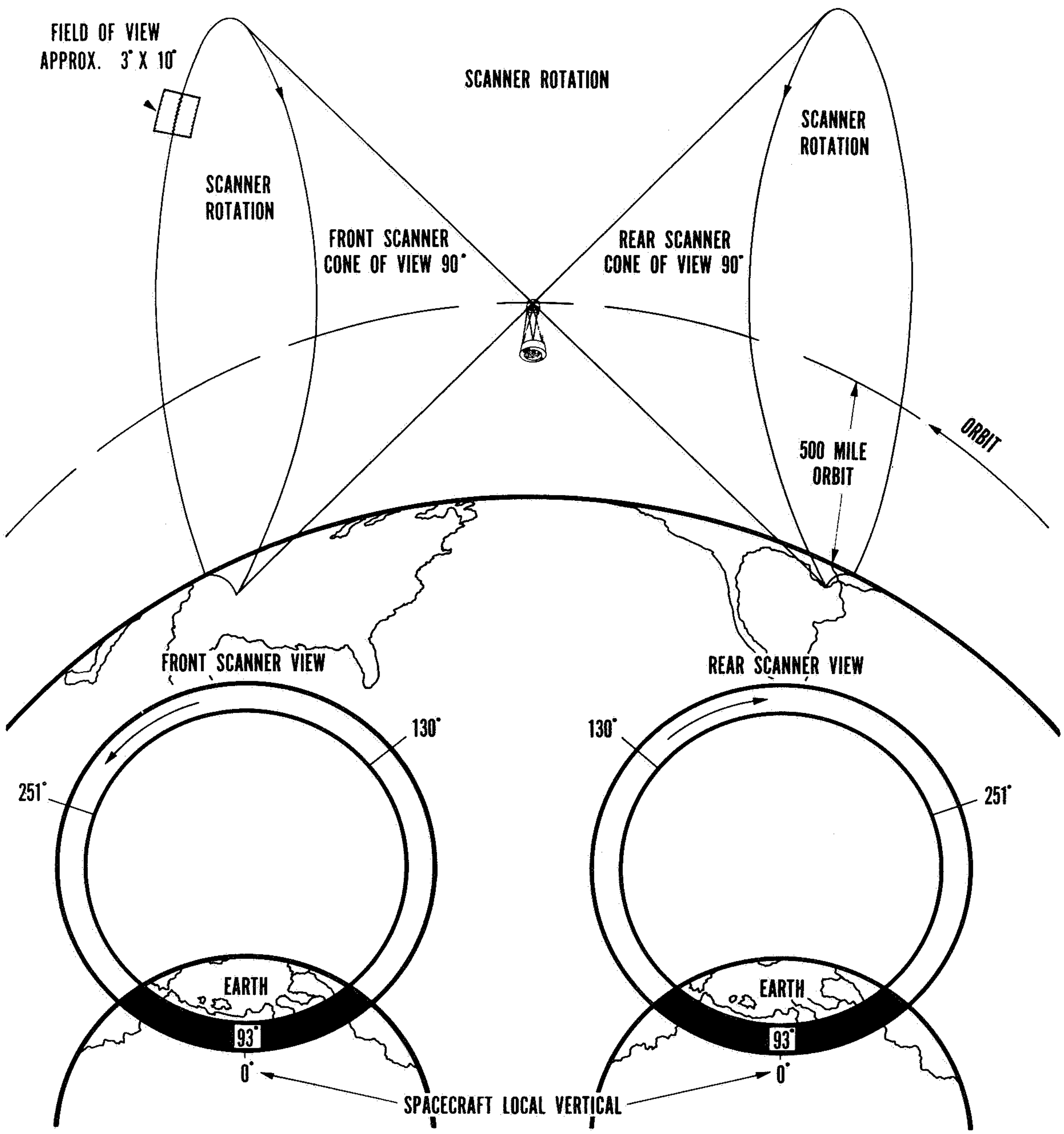

Figure 4—Earth as Seen by Scanners in Stabilized Nimbus

When the spacecraft is properly stabilized both sensors provide earth signals of equal width. As the spacecraft pitches, these signals vary in width according to the amount of pitch error. The horizon attitude computer measures the pitch error by comparing the widths of the earth pulses (Figure 5).

The measurement of roll error is made with only one sensor. A bimetallic slug on the rotating scanner housing generates a zero reference pulse each time it crosses the satellite vertical. As the spacecraft rolls, the amount of earth pulse occurring on

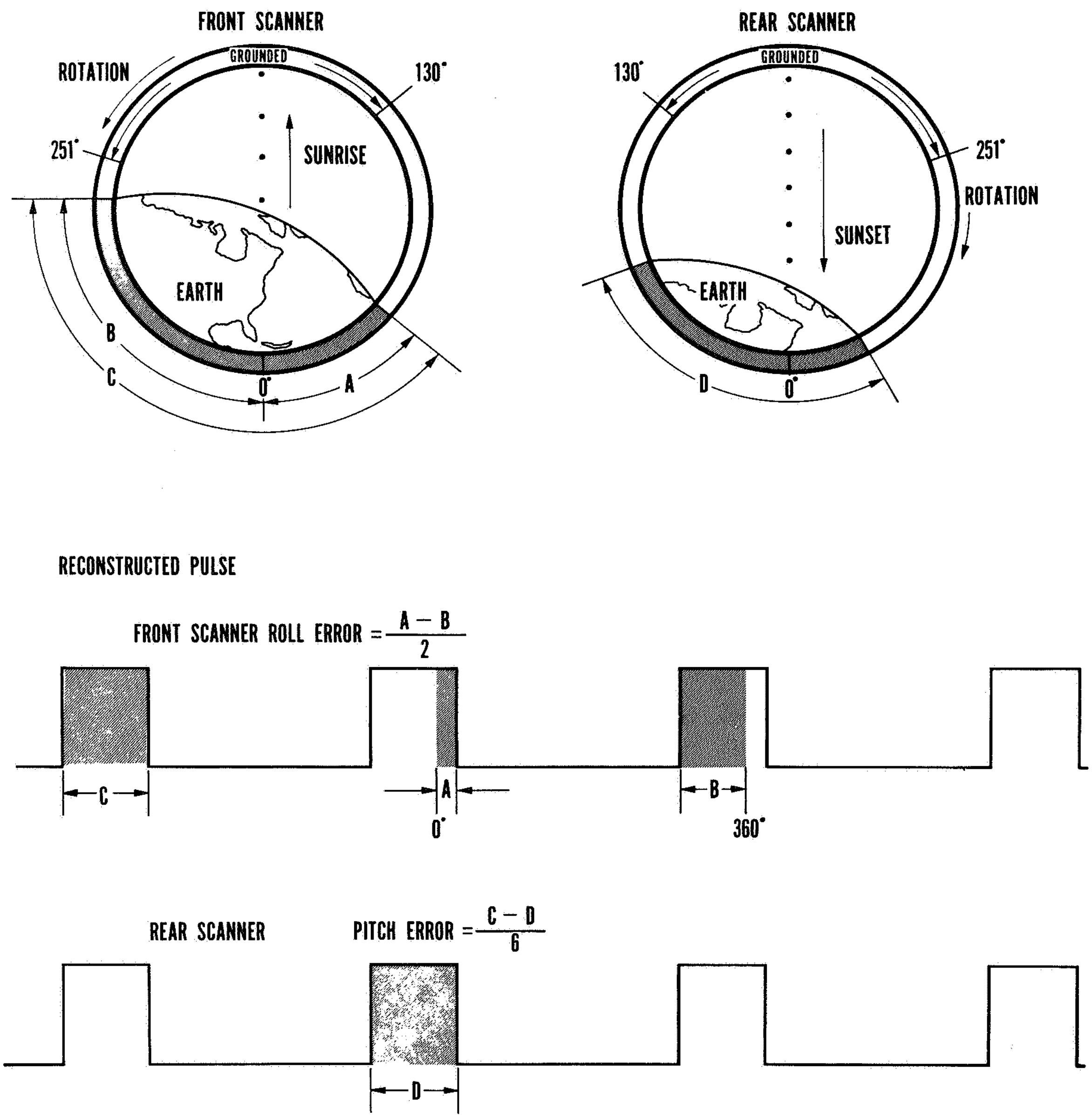

Figure 5–Roll and Pitch Error Computation from Front and Rear Scanners

either side of this reference will vary. The horizon attitude computer compares the two portions of this pulse to determine the roll error (Figure 5).

The horizon attitude computer is a special purpose digital computer consisting of control, counter, and memory logic. New pitch error information is available approximately four times per second. New roll error information is available approximately eight times per second. Corrections based on the attitude error computations are achieved by means of a cold gas jet stream for coarse control and variable speed flywheel system for fine control.

The yaw control loop can operate in two modes. The first is the coarse sun sensor mode in which yaw position with respect to the sun is determined by two yaw coarse sun sensors. These sensors have a field of view of 360 degrees in yaw and a +70 to -40 degree field of view in pitch. The response characteristic of the coarse sun sensor is such that it will attempt to drive the negative roll axis to point toward the sun. The error sensed by the coarse sun sensor is processed as an error signal through electronics, pneumatics, and flywheels similar to those used in the pitch and roll loops.

The second mode of control is an integrating gyroscope used in the rate mode to sense yaw error. An error signal is generated when the gyro's input axis is rotated. The input axis of the gyro is aligned in the roll-yaw plane so that it senses the components of orbital pitch due to yaw error.

The control subsystem can also be commanded from the ground to move large angles in yaw to compensate for orbits which differ from the nominal. Yaw bias commands in 6 degree increments from -30 to +30 degrees can be provided. This signal allows rotation of the spacecraft about the yaw axis to maintain the solar paddles perpendicular to the sun.

In practice, it has not been possible to apply yaw corrections routinely to these data. Therefore, yaw uncertainties of several degrees are inherent in the Nimbus I data.

2.3 Telemetry Subsystem

The Nimbus spacecraft must transmit a large volume of engineering type data (voltage, current, temperature, pressure, etc.) to permit accurate evaluation of its spacecraft subsystems and critical components in space and establish the validity of the scientific measurements. The Nimbus spacecraft is equipped with two PCM telemetry systems that can operate in three different modes and transmit telemetry data from the spacecraft to the ground when activated by specific commands.

A Real Time Mode—Information is transmitted at a rate of 500 bits per second and simultaneously recorded by an on-board tape recorder.

A Stored Mode—Information is recorded on board the spacecraft and transmitted to the ground upon command at 30 times the recording speed which results in a bit rate of 15,000 bits per second. The 220 foot storage tape loop contains 120 minutes worth of information and is played back to the ground in about 4 minutes.

B Real Time Mode—Information representing 62 key parameters from the A directory is transmitted at a rate of 10 bits per second yielding two samples for each function in 102 seconds.

An analog to digital converter samples signals delivered by transducers located throughout the spacecraft and converts each sample to a 7 bit binary word to which an eighth bit is added for sync. Both telemetry systems use pulse-code modulation because of the generally recognized advantages of digital systems. A telemetry word transmitted to the ground from the spacecraft contains eight bits. The sync word is all ones and the word sync bit is a zero.

In the A Stored Mode a 500 pulse per second bit rate is supplied by the clock (or a 500 cps tuning fork oscillator can be substituted by command from the ground). A master frame of telemetry data consists of 1024 words and is divided into 16 subframes of 64 words each. The first word of each subframe is a master frame sync word having a binary pattern of all ones. The second word identifies the subframe and the remaining 62 words represent values of specific functions.

Currently 338 distinct functions are recorded, some of which are sampled once per master frame, and others of which are sampled one or more times per subframe. The A telemetry system permits sampling a complete master frame in 16.384 seconds ($1024 \times 8/500$) or at a rate of 1.024 seconds per subframe.

The A Real Time Mode differs slightly from the A Stored Mode because of a direct transmission to the ground station reflecting functional status at that very moment (simultaneously with the recording of identical values aboard the spacecraft). The rate of transmission cannot exceed the recording speed, therefore, the subcarrier that modulates the transmitter is not converted to 15 KC (as in the stored mode) but remains at 500 cps.

In the B telemetry system, a limited number of test points are encoded for direct transmission to the ground without attendant recording of the data aboard the spacecraft; and, therefore, there is no stored data capability. The B system can be commanded to transmit functional values (that accurately describe conditions at the moment) from the spacecraft to the ground at the slow rate of 10 bits per second in a single data frame comprising 128 time slots. The first three words are used for synchronization (first word all ones, second word all zeros, third word all ones). Transmission time is 102.4 seconds for one frame after which the system normally shuts itself off. The B telemetry directory currently contains 62 key functions each of which is to occupy two time slots spaced 51.2 seconds apart.

III. HRIR SUBSYSTEM

The High Resolution Infrared Radiometer (HRIR) is one of the primary sensory subsystems designed for the Nimbus spacecraft. The radiometer is a single channel scanning instrument designed to (1) provide information about the earth's cloud cover during the nighttime portion of the orbit when the AVCS coverage is not practical, and (2) measure the radiative temperatures of cloud tops and surface terrain features.

The HRIR subsystem consists of an optical system, infrared detector, electronics, and a magnetic tape recorder. The radiometer, pictured in Figure 6, contains a lead selenide photoconductive material which is sensitive to radiant energy in the 3.5 to 4.1

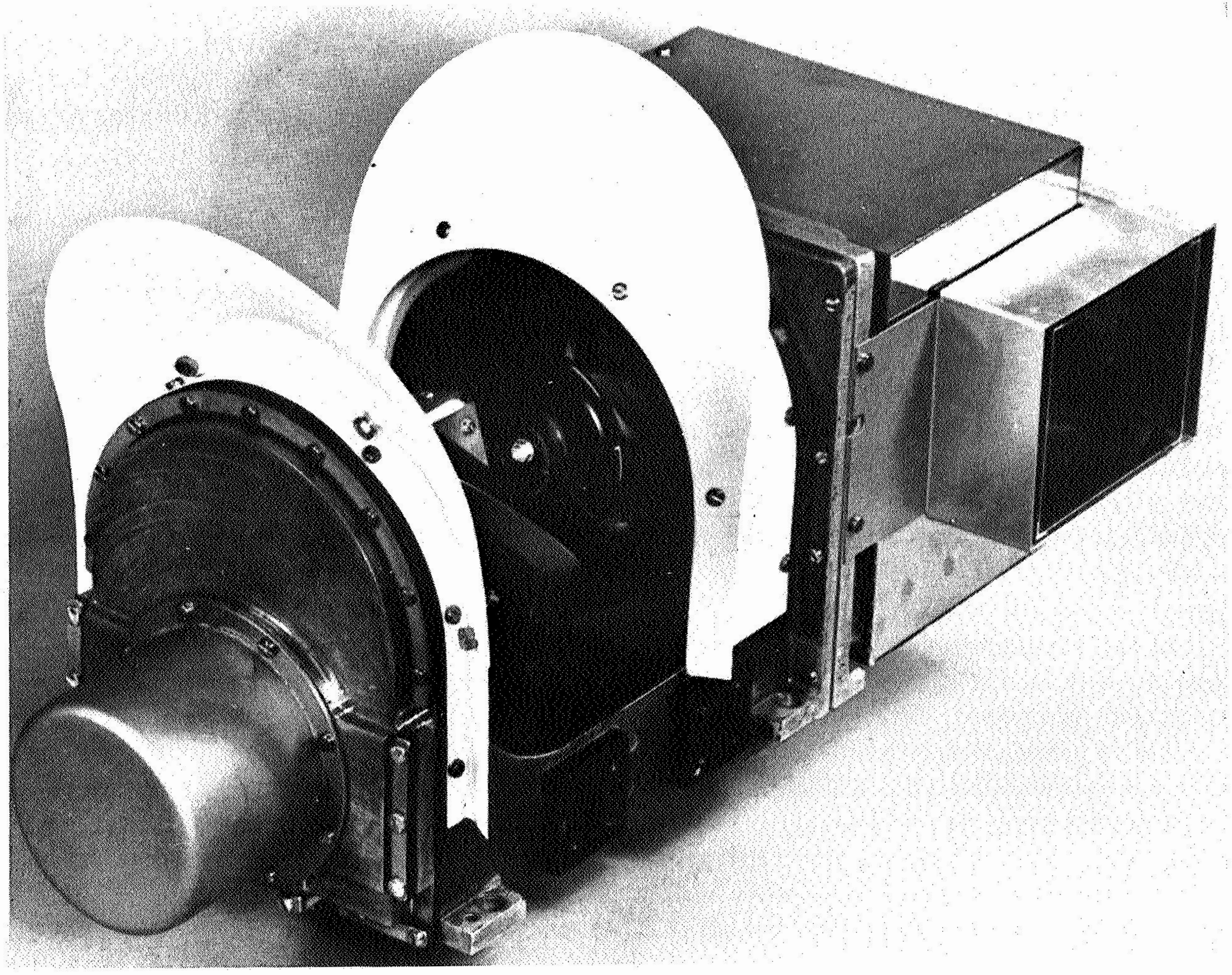

Figure 6–HRIR Radiometer

micron region of the infrared spectrum. The radiometer also contains a filter designed to minimize attenuation effects by water vapor and carbon dioxide.

The infrared detector is radiatively cooled to -75°C. Radiative cooling is accomplished by means of a highly reflective gold coated pyramidal horn containing a black cooling patch at the bottom. The pyramidal horn is oriented so that it views outer space throughout the entire orbit, and the patch is suspended by thin wires to reduce heat conduction from the radiometer housing. The lead selenide detector is connected to the cooling patch by a high thermal conductive transfer bar.

The radiometer is attached to the earth oriented sensory ring of the Nimbus spacecraft in such a manner that an unobstructed view of the earth from horizon to horizon is obtained. In contrast to television techniques, the radiometer forms no image of the subject viewed but integrates the radiant energy received from the target. Composition of a picture is achieved by a scanning mirror technique. The mirror, located in the radiometer, is inclined 45 degrees to its axis of rotation which coincides with the spacecraft velocity vector assuming no attitude errors. The optical axis of the radiometer thus scans the earth in a plane perpendicular to the spacecraft velocity vector as the spacecraft advances in orbit. The scanning mirror driven by a motor at 0.7453 revolutions per second rotates the field of view continuously from earth to sky, to spacecraft, to sky and earth again.

The radiometer has an instantaneous field of view of 7.9×10^{-3} radians or about 0.5 degrees. The relative motion of the spacecraft with respect to the earth enables the optical axis to progress sequentially to new picture elements. The scan rate of the mirror was chosen to be one rotation every 1.3418 seconds, or the time required for the spacecraft to advance the distance of one resolution element along the subsatellite track. At a height of 930 kilometers, the HRIR scan rate, 290 cps bandwidth and optical system provide an earth resolution of approximately 5 miles (7.5 kilometers) at the nadir.

Under normal conditions the HRIR subsystem operates during "subpoint night" i.e., when the subpoint and the general area of observation are on the dark side of the earth. However, occassionally the HRIR subsystem was commanded on during the daylight portion of the orbit, and direct comparisons with the AVCS photographic data can be made in addition to observing the reflective characteristics of clouds and terrestrial surface features in the 3.5 to 4.1 micron region of the spectrum.

Prior to detection, the radiant energy is modulated by interrupting the reflected energy from the mirror with a mechanical chopper. This avoids the drift problems associated with D.C. amplifiers. The video signal varies from some finite amplitude during the horizon to horizon scan down to approximately zero when the sky is in the field of view. At the initiation of a sky sweep a permanent magnet on the mirror axis triggers a gate and multivibrator thus generating seven pulses which are used to synchronize the equipment used to process and display the data.

Prior to tape storage on the spacecraft, the video signal from the radiometer frequency modulates a 10 KC subcarrier oscillator. The signal is then recorded on tape at 3.75 inches per second. A four track recording combination is used. One track records the FM radiometer signal while a second track records a 10 KC carrier AM modulated by the spacecraft time code. Each track has sufficient capacity to record data from one orbit. When the end of tape is reached in the clockwise direction, the tape motion is reversed and runs in the counterclockwise direction. With the reversal in tape motion, the time and radiometer signals are switched to the remaining two tracks. The recorder continues to record in the reverse direction until end of tape at which time the tape again reverses direction and switches the signals back to the first two tracks.

Playback speed is eight times the record speed or 30 inches per second. Normally playback will be commanded before the second reversal in tape motion takes place. During playback, the signal from each of the four recorded tracks is simultaneously translated to a specific local oscillator frequency, multiplexed, and relayed to the ground via the "S" band transmitter.

The direction of tape transport rotation during playback depends upon the tape position when playback is commanded. If more than one minute of recording time has passed since the last tape direction change, the tape transport will change direction at playback. If less than one minute has passed, the tape transport will continue in the same direction at playback.

The length of the HRIR tape is such that 57 minutes of data can be recorded in each direction. Thus, the system can record up to 114 minutes of data. Since playback speed is eight times the recording speed, the tape can be played back in a maximum of 7.25 minutes.

In normal operation, the HRIR subsystem will record about 51 minutes of data. Since this is less than the one-way length of the tape all data can be played back with only one command. If data are recorded for more than 57 minutes, but less than 114 minutes, two commands will be needed to retrieve all data.

IV. DATA ACQUISITION AND PROCESSING

4.1 General

The Nimbus spacecraft and the principal subsystems associated with the High Resolution Infrared subsystem have been described in the previous sections of this Manual. This section describes the processing and archiving of the experimental sensory data after transmission to the ground.

The Nimbus I spacecraft was interrogated at either Fairbanks, Alaska or Rosman, North Carolina. The data received from each interrogation of the spacecraft were then transmitted to the Goddard Space Flight Center for final processing and archiving on the IBM 7094 computer. The final output from the data processing operation is the Nimbus Meteorological Radiation Tape (NMRT), which is considered to be the basic repository of experimental data from the High Resolution Infrared Radiometer. The following sources of experimental data are required in preparing the Nimbus Meteorological Radiation Tape:

1. The raw analog HRIR signal and its associated time code transmitted from the HRIR subsystem
2. Selected functions from the A stored telemetry data
3. Roll, pitch, and yaw attitude errors
4. Definitive orbital elements, or X, Y, Z position vectors at minute intervals
5. Prelaunch calibration data for the particular radiometer in orbit
6. Miscellaneous documentation data, including date and time of interrogation, CDA station, playback mode etc.

In addition to the above data sources, four computer programs are required on the IBM 7094 in producing the Nimbus Meteorological Radiation Tape. A system flow chart showing the interaction of these four computer programs, and the general flow of information is shown in Figure 7. Each component of this system is described in more detail in the following sections.

4.2 HRIR Analog Signal

The HRIR analog data and its related time code are transmitted from the CDA Station to the Goddard Space Flight Center and recorded on tape at the Nimbus Data Handling System (NDHS). These data are then input to the Nimbus HRIR data processing system which accomplishes an analog to digital conversion, edits, and formats the data for final processing on the IBM 7094 computer. The HRIR data processing system

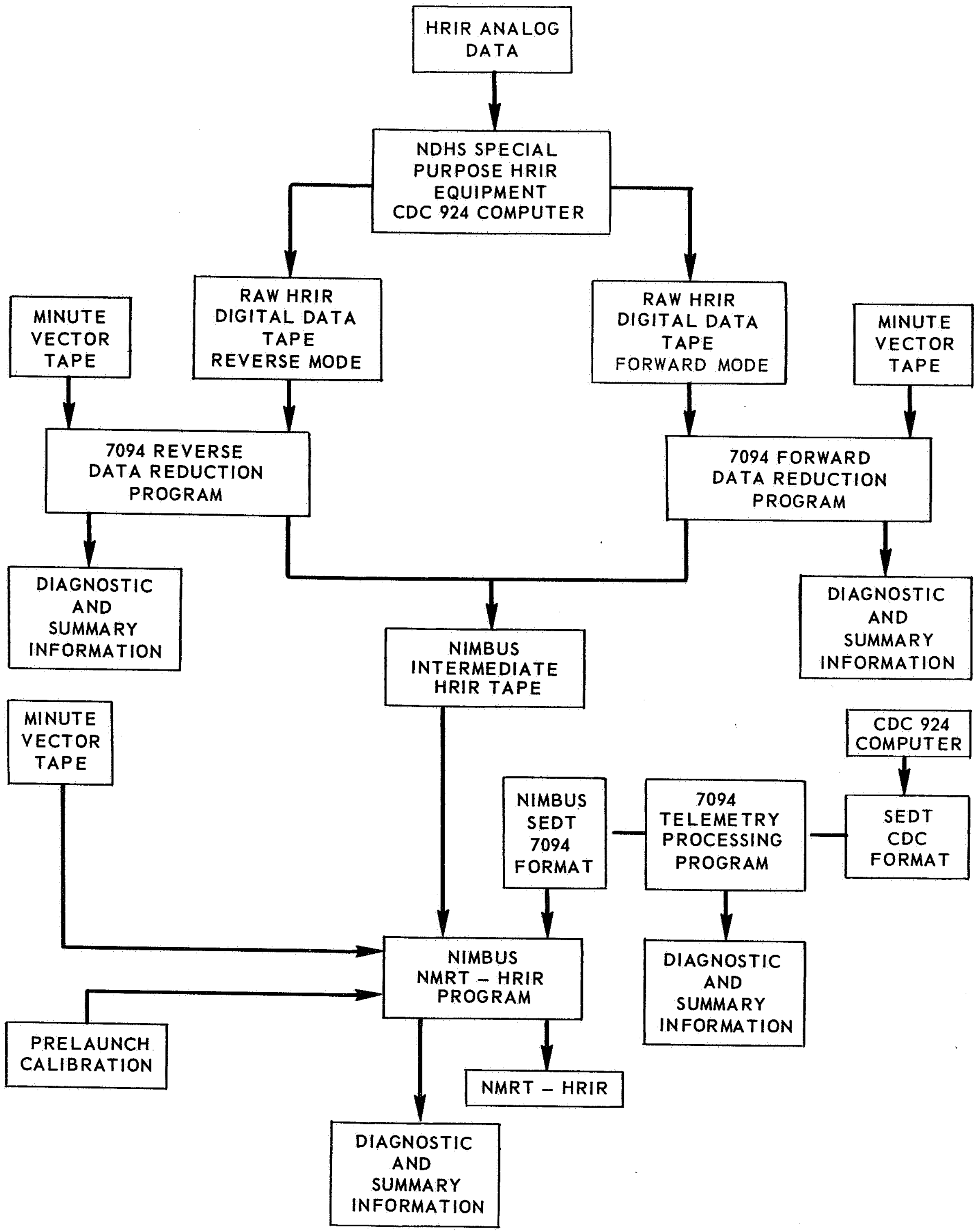

Figure 7—System Flow Chart for Nimbus HRIR Digital Data Processing

consists of special purpose equipment to provide analog to digital conversion, and a CDC 924 computer to provide editing and formatting of the digital data.

Optional operating modes for the special purpose digitizing equipment include (1) analog to digital sampling frequency, (2) vehicle time code flywheel bandwidth, (3) vehicle time code direction to be decoded, (4) tape track input, (5) tape or simulator input, and (6) operation of the oscillograph.

The special purpose equipment provides analog to digital conversion for both the time code and the radiation data. The time decoders detect synchronization patterns of the time code, extract the time information for each character, and transmit the time data, along with identification and status flags, to the computer through a time shared input channel. Both time codes have flywheels to maintain synchronization with the input signal through periods of short signal dropouts.

The data discriminator detects the frequency modulated HRIR data. The analog signal is provided to both the analog to digital converter for quantization and the data synchronizer for detection of the synchronizing pulses. The digital output of the analog to digital converter together with identification and status flags are transmitted to the computer for further processing.

The CDC 924 computer is a general purpose, stored program, digital computer with 32,768 words of random access storage. A word is 24 bits long and may be used as a 24 bit or a 48 bit operand (1604 mode). The cycle time for the storage unit is 6.4 microseconds.

The outputs of the system are a printed listing and a digital magnetic tape. One of each is produced for each pass of the analog magnetic tape. Since HRIR data can be transmitted from the Nimbus spacecraft in both forward and reverse modes with respect to time, two passes of the analog tape are frequently required to obtain all data. Therefore, when both forward and reverse data are processed from one analog tape, two listings and two digital magnetic tapes are produced. The data can also be output to the oscillograph. The oscillograph is not intended to provide a continuous output for every analog tape, but rather to provide an output only for selected segments of data.

The printed listing shows the quality of the data received from the spacecraft, and the performance of the system during processing. The printed information includes decoded ground and vehicle time, total number of records processed, and a quality analysis of the incoming time codes and data.

The digital magnetic tape contains one file of digital data with as many records as needed to record the digitized data, associated time codes, and status flags. All data records are of fixed length and compatible with both the CDC 924 and IBM 7094 formats. The tape is recorded with odd parity, binary format, and a density of 556 characters per inch.

The analog to digital converter samples the incoming analog data at rates of 2000, 4000, 8000, or 16,000 samples per second of playback time, or 250, 500, 1000, or 2000 samples per second of vehicle time. Normal operating procedure has been established at 1000 samples per second of vehicle time. Each data measurement consists of 12 binary bits. The HRIR data occupy 8 bits, and the remaining 4 bits are used to flag various conditions described below.

HRIR DATA = 8 BITS	F_D	F_C	F_B	F_A

F_A is identifier for dropout of signal. In the normal case F_A is zero when carrier signal is present. When absence of carrier signal is detected, F_A is set equal to one.

F_B is identifier for zero milliseconds in vehicle time. In the normal case F_B is zero. Each time the vehicle time accumulates to an integral second, F_B is set equal to one. This flag thus identifies each integral second in the data record. The time specified in word 4 of the data record refers to the first occurrence of this flag per record.

F_C is the sync pulse identifier. In the normal case F_C is zero. When the sync pulse is recognized, F_C is set equal to one. This flag will identify each sync pulse in the data record. The location specified in word 3 of the data record refers to the first occurrence of this flag in each word.

F_D is unassigned at the present time and available for future use.

The individual data measurements, time code, and status flags are fed into the CDC 924 computer and formatted for output to magnetic tape. All data records written on magnetic tape are of constant size and contain 7248 characters, or 1208 words of 36 bits each. Forty-eight characters are reserved for data documentation, and the HRIR experimental data occupy 7200 characters in each record. In order to satisfy this requirement, the last record in each data file will be completed by inserting ones in all eight data positions of each measurement.

The first record in each file of HRIR data will be a documentation record. This record is binary and contains 48 characters or 8 words of 36 bits each. The last six characters of this record will contain 36 binary ones as an identifier for the documentation record.

The format of the raw HRIR data tape is summarized in detail in Appendix D.

4.3 Telemetry and Attitude Data

Upon command from the ground, the telemetry data is played back from the Nimbus spacecraft to the ground station, and then transmitted to the Nimbus Data Handling System at the Goddard Space Flight Center. Here the telemetry data are input to unique electronic equipment and computer input circuitry consisting of (1) the A stored submodule, (2) the A real-time submodule, and (3) the B real-time submodule. One of the outputs from the A stored submodule during on-line data processing is the Calibrated Attitude Data Tape (CADT) which contains calibrated attitude data and up to twenty selected-parameters from the A stored telemetry data. These data are then input to the pre-gridding module where AVCS shutter times are available. The output of the pre-gridding module is the Selected Engineering Data Tape (SEDT) which represents the source of all attitude and telemetry data used for further processing on the IBM 7094 computer.

Since the SEDT is originally written in CDC 924 format, it is necessary to perform an additional editing and formatting of these data for input to the IBM 7094 computer. The format of this final tape is described in detail in Appendix E.

4.4 Spacecraft Position

The spacecraft position as a function of time can be computed from the mean orbital elements distributed from the Goddard Space Flight Center, or calculated from the X, Y, Z position vectors contained on the Minute Vector Tape at one minute intervals. Normal operating procedure has been based on the Minute Vector Tape.

The position vectors obtained from the Minute Vector Tape are measured in a geocentric equatorial coordinate system in which the X axis is directed toward the vernal equinox and lies in the equatorial plane. The Y axis lies in the equatorial plane 90 degrees east of the X axis. The Z axis is perpendicular to the equatorial plane and directed to the north pole. The position vector (R_s) to the spacecraft is defined by

$$R_s = \sqrt{X^2 + Y^2 + Z^2}$$

The geocentric latitude (ϕ') of the subsatellite point is defined by

$$\phi' = \arcsin\left(\frac{Z}{R_s}\right)$$

The geodetic latitude (ϕ) of the subsatellite point and the altitude (h) above the computational ellipsoid are computed from the following equations.

$$\phi = \phi' + A_2 \sin(2\phi') + A_4 \sin(4\phi') + A_6 \sin(6\phi') + A_8 \sin(8\phi')$$

$$h = R_s \cos(\phi - \phi') - R_E \sqrt{1 - e^2 \sin^2 \phi}$$

A_2, A_4, A_6, A_8 are coefficients determined by Morrison and Pines (Ref. 3).

The geodetic longitude of the subsatellite point is determined by first computing the right ascension (φ) of the subsatellite point from the following equations.

$$\sin \varphi = \frac{Y}{\sqrt{X^2 + Y^2}}$$

$$\cos \varphi = \frac{X}{\sqrt{X^2 + Y^2}}$$

$$\varphi = \arctan \left(\frac{\sin \varphi}{\cos \varphi}\right) = \arctan \left(\frac{Y}{X}\right)$$

$$\text{Geodetic Longitude } (+\text{East}) = \varphi - \text{GHA}\,\Upsilon$$

4.5 HRIR Data Processing

The general flow of information during the processing and archiving of HRIR data on the IBM 7094 computer has been illustrated in Figure 7. The various data inputs have been described briefly in the previous sections. The various steps taking place in each of the computer programs will now be described.

Upon receipt of the HRIR raw data tape from the Nimbus Data Handling System, the first step is to conduct an initial examination of the raw data and prepare the intermediate data tape. Since HRIR data can be played back to the ground from the spacecraft in both forward and reverse modes with respect to time, two separate programs are employed at this point depending on the mode being processed.

The computer program employed in processing the reverse mode data was designed to accept reverse mode data as input and reorganize the data into forward mode with respect to time. The first step in this process is to recognize a particular pattern of bits representing the sync pulse. Once the sync pulse is located, the height of the spacecraft is computed, and then the size of each space viewed portion, the earth viewed portion, and the housing viewed portion of this scan revolution are determined. Each of these segments is then examined, and the maximum, minimum, and average response for each of the space portions and the housing portion are recorded on the intermediate tape along with the entire reordered earth scan. The remaining portions of the space and housing segments and the sync pulse are discarded at this point.

The computer program employed to process the forward mode data accepts forward mode data as input and outputs an intermediate tape with format identical to the intermediate tape prepared from reverse mode data. The primary difference in these two programs is that forward mode data does not have to be reorganized with respect to time. The first step in this process is to recognize a particular pattern of bits representing the sync pulse. Once the sync pulse is located, the height of the spacecraft is computed, and then the size of each space viewed portion, the earth viewed portion, and the housing viewed portion of this scan revolution are determined. Each of these segments is then examined, and the maximum, minimum, and average response for each of the two space portions and the housing portion are recorded on the intermediate tape along with the entire earth scan. The remaining portions of the space and housing portions, and the sync pulse are discarded at this point.

The NMRT-HRIR program was designed to accept HRIR data from the intermediate data tape and produce the Nimbus Meteorological Radiation Tape (NMRT). Additional inputs to this program are the Nimbus Minute Vector Tape, the Selected Engineering Data Tape, and the prelaunch calibration data. The minute vector tape provides position vectors at one minute intervals for computing subsatellite point and height of the spacecraft during the time interval on the intermediate data tape. The Selected Engineering Data Tape provides measurement of roll, pitch, and yaw, and the housekeeping functions for the HRIR subsystem for the same time interval.

The prelaunch calibration data for the HRIR radiometer are adjusted in this program by the in-flight calibration. Based on the original calibration data, the average radiometer response while viewing the housing is converted to degrees Kelvin (T_R), and then to effective radiance ($\overline{N}_R$). The average housing temperature, as measured through the telemetry system, (T_T) is also converted to effective radiance ($\overline{N}_T$). The ratio of $\overline{N}_T/\overline{N}_R$ provides the adjustment factor for correcting the prelaunch cablibration data. Each temperature in the prelaunch calibration data is adjusted by converting to effective radiance, multiplying the effective radiance by the factor $\overline{N}_T/\overline{N}_R$, and then converting back to degrees Kelvin. All digital values in the original calibration data which fall below the average space viewed response from the radiometer are replaced by the average space viewed response. A typical calibration curve is shown in Figure 8 along with the corrected curve.

Each earth viewed swath of HRIR data is next processed sequentially from the intermediate data tape. The time, roll, pitch, yaw, height, HRIR detector cell temperature, HRIR electronics temperature, 24 volt supply, 20 volt supply, reference housing temperature A, reference housing temperature B, and the anchor mirror angles are determined and formatted in the documentation of each output record.

If the maximum mirror angle produces no earth intersection, the angle is moved in from the horizon in one tenth of a degree increments until earth intersection is

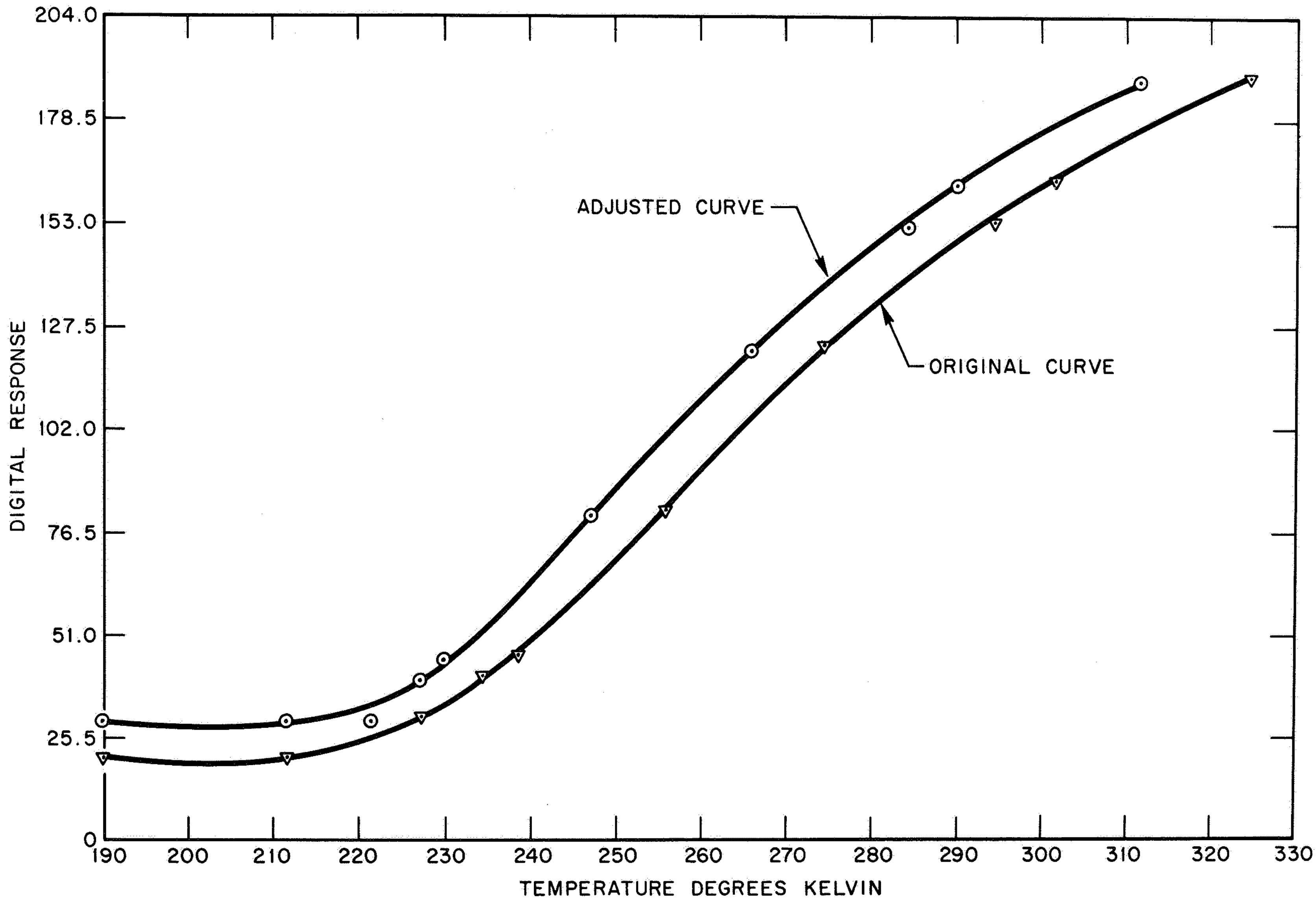

Figure 8–Typical Adjustment for In Flight Calibration (Orbit 66)

achieved. The angle is then moved out in increments of one hundredth of a degree until there is no earth intersection. If the initial nadir angle produced an earth intersection, the angle is moved out toward the horizon in increments of one tenth of a degree until no intersection is found. It is then moved in from the horizon in increments of one hundredth of a degree until earth intersection is found. This process locates the outermost mirror angle to within one hundredth of a degree. The family of mirror angles are selected such that they subtend equal distances on the surface of the earth.

The time, latitude and longitude of the substallite point, the number of data points in the swath, and the status flags are then output for the particular swath being processed. The latitude and longitude of the viewed point for each selected mirror angle is computed and output. All digital data are then converted to degrees Kelvin and formatted into the output record. This completes the processing of one individual swath, and other swaths are processed in the same manner until the output record is completed. The process continues until all data on the intermediate data tape are processed and archived on the Nimbus Meteorological Radiation Tape – HRIR.

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APPENDIX A

INDEX OF AVAILABLE NIMBUS METEOROLOGICAL RADIATION TAPES – HRIR (NMRT – HRIR)

The Index of Nimbus Meteorological Radiation Tapes tabulates the High Resolution Infrared data acquired during the active lifetime of the Nimbus I meteorological satellite, and processed through the digital data processing system. It has been pointed out in Section III that HRIR data can be played back to the ground from the spacecraft in both forward and reverse modes with respect to time. Furthermore, the same recorded data can be and often were read out several times. In order to identify particular segments of data, a sequential block number was assigned to each continuous, uninterrupted segment of data that was digitized and processed on the IBM 7094 computer.

During normal operating procedures, the HRIR subsystem recorded data only during the nighttime portion of the orbit. However, it was possible to command the system to record during the daylight portion of the orbit, and a few data blocks contain data recorded entirely during the daylight portion of an orbit. Usually the recording of HRIR data did not begin or end at exactly the time corresponding to a change between sunlight and darkness. Therefore, a data block representing the nighttime portion of an orbit often contains a small amount of daytime data at the beginning or end of the block. This explains why most data blocks are described in the Remarks column as "data partly in sunlight."

The Index contains two basic types of information. One type describes the orbit and time interval when the data were recorded on the spacecraft. The second type describes the readout of these data from the spacecraft to the ground. The nomenclature used in the Index is defined below.

1. Calendar Day—Calendar days are numbered consecutively from January 1, 1964.

2. Data Orbit Number—The data orbit number is the number of the orbit at the time the HRIR data were recorded on the spacecraft. The orbit number increases by one at each ascending node.

3. Longitude of Descending Node—The longitude on earth at which the spacecraft crossed the equatorial plane going from north to south. The longitude is measured from 0 to 180 degrees East or West.

4. Time of Descending Node—The Greenwich Mean Time of the occurrence of the descending node in hours, minutes, and seconds.

5. Data Block—A continuous and uninterrupted segment of data. These blocks of data are numbered sequentially for identification purposes.

6. HRIR Data Interval—The beginning and end of HRIR data are described in terms of latitude and time. The latitude defines the location of the subsatellite point corresponding to the time given for each data block. Latitude is measured in degrees north, N, or south, S. The "A" or "D" following "N" or "S" indicates that the data began or ended while the satellite was on the ascending or descending leg of the orbit, respectively.

7. Playback Mode—The playback mode indicates the playback direction of the tape recorder. Forward (FWD) means the data were played back from the tape recorder in the same direction as that in which they were recorded. Reverse (REV) means the data were played back in the opposite direction from the direction in which they were recorded.

8. Readout Orbit Number—The readout orbit number is the number of the orbit at the time the data were readout from the satellite.

9. Data Acquisition Facility—The Data Acquisition Facility which readout the data. "G" is the Gilmore Creek, Alaska station, and "R" is the Rosman, North Carolina station.

10. NMRT Reel Number—The reel number is a sequential number which identifies each Nimbus Meteorological Radiation Tape – HRIR.

To illustrate the use of the tabulated material, the entry in the row for data block 21 indicates that data were recorded on the spacecraft on August 30, 1964 (day 243) during orbit 36. The descending node of orbit 36 was over longitude 65.8E when Nimbus I crossed the equatorial plane going from north to south at 19:11:53 GMT. The data began to be recorded when the satellite was over 75.2 North latitude on the descending leg of orbit 36. The beginning time of the data was 18:52 GMT to the nearest minute. The data ended when the satellite was over 76.5 South latitude on the ascending portion of the orbit at 19:39 GMT. These data were readout in the reverse mode when the satellite passed within range of the Gilmore Creek, Alaska, Data Acquisition Facility on orbit 37. The archived data are stored on NMR Tape number 12.

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR		DATA ORBIT	DESCENDING NODE		DATA BLOCK	H R I R D A T A				PLAY BACK MODE	READ -OUT ORBIT	DAF	R E M A R K S	NMRT REEL NO.
						B E G I N		E N D						
D A T E	DAY		LONG. (DEG)	T I M E (GMT)		LAT. (DEG)	TIME (GMT)	LAT. (DEG)	TIME (GMT)					
08/28/64	241	7	59.2E	19-37-28	1	2.1SD	19-38	77.8SD	19-59	REV	8	G	DATA PARTLY IN SUNLIGHT.	1
08/29/64	242	23	25.6E	21-52-19	2	24.6ND	21-46	74.7SA	22-20	FWD	28	R	DATA PARTLY IN SUNLIGHT.	2
08/29/64	242	24	1.0E	23-30-45	3	80.0ND	23-09	77.6ND	23-10	FWD	28	R	ALL DATA IN SUNLIGHT.	2
08/29/64	242	24	1.0E	23-30-45	4	77.6ND	23-10	53.3ND	23-17	FWD	31	G	DATA PARTLY IN SUNLIGHT.	3
08/29/64	242	24	1.0E	23-30-45	5	53.3ND	23-17	30.2ND	23-23	REV	31	G	ALL DATA IN DARKNESS.	4
08/29/64	242	24	1.0E	23-30-45	6	26.3ND	23-24	75.9SA	23-58	REV	28	R	DATA PARTLY IN SUNLIGHT.	5
08/30/64	243	31	171.2W	10-59-45	7	41.8ND	10-49	76.0SA	11-27	FWD	36	G	DATA PARTLY IN SUNLIGHT.	6
08/30/64	243	31	171.2W	10-59-45	8	41.8ND	10-49	76.0SA	11-27	FWD	37	G	DATA PARTLY IN SUNLIGHT.	7
08/30/64	243	31	171.2W	10-59-45	9	41.8ND	10-49	76.0SA	11-27	FWD	38	G	DATA PARTLY IN SUNLIGHT.	8
08/30/64	243	31	171.2W	10-59-44	10	6.8ND	10-58	76.0SA	11-27	FWD	35	R	DATA PARTLY IN SUNLIGHT.	9
08/30/64	243	32	164.2E	12-38-10	11	78.8ND	12-17	78.8ND	12-17	FWD	35	R	ALL DATA IN SUNLIGHT. 28 SECONDS OF DATA.	9
08/30/64	243	32	164.2E	12-38-11	12	78.8ND	12-17	76.0ND	12-18	FWD	36	G	ALL DATA IN SUNLIGHT. 35 SECONDS OF DATA.	6
08/30/64	243	32	164.2E	12-38-11	13	78.8ND	12-17	76.0ND	12-18	FWD	37	G	ALL DATA IN SUNLIGHT. 27 SECONDS OF DATA.	7
08/30/64	243	32	164.2E	12-38-11	14	78.8ND	12-17	76.0ND	12-17	FWD	38	G	ALL DATA IN SUNLIGHT. 35 SECONDS OF DATA.	8
08/30/64	243	34	115.0E	15-55-02	15	80.5ND	15-33	46.8ND	15-43	FWD	35	R	DATA PARTLY IN SUNLIGHT.	9
08/30/64	243	34	115.0E	15-55-02	16	80.5ND	15-33	46.8ND	15-43	FWD	36	G	DATA PARTLY IN SUNLIGHT.	6
08/30/64	243	34	115.0E	15-55-02	17	80.5ND	15-33	54.3ND	15-41	FWD	37	G	DATA PARTLY IN SUNLIGHT.	7
08/30/64	243	34	115.0E	15-55-02	18	80.5ND	15-33	50.6ND	15-42	FWD	38	G	DATA PARTLY IN SUNLIGHT.	8
08/30/64	243	34	115.0E	15-55-02	19	46.8ND	15-43	76.8SA	16-22	REV	35	R	DATA PARTLY IN SUNLIGHT.	10
08/30/64	243	35	90.4E	17-33-28	20	79.4ND	17-12	77.9SA	18-00	REV	36	G	DATA PARTLY IN SUNLIGHT.	11
08/30/64	243	36	65.8E	19-11-53	21	75.2ND	18-52	76.5SA	19-39	REV	37	G	DATA PARTLY IN SUNLIGHT.	12
08/30/64	243	37	41.2E	20-50-19	22	79.1ND	20-29	77.6SA	21-17	REV	38	G	DATA PARTLY IN SUNLIGHT.	13
08/31/64	244	40	32.6W	01-45-36	23	24.6SD	01-52	74.2SD	02-06	FWD	43	R	DATA PARTLY IN SUNLIGHT.	14
08/31/64	244	42	81.9W	05-02-28	24	78.0SA	05-29	75.4SA	05-30	REV	43	R	ALL DATA IN SUNLIGHT.	15

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA														
CALENDAR		DATA ORBIT	DESCENDING NODE		DATA BLOCK	H R I R D A T A				PLAY BACK MODE	READ -OUT ORBIT	DAF	R E M A R K S	NMRT REEL NO.
						B E G I N		E N D						
D A T E	DAY		LONG. (DEG)	T I M E (GMT)		LAT. (DEG)	TIME (GMT)	LAT. (DEG)	TIME (GMT)					
08/31/64	244	43	106.4W	06-40-54	25	80.3ND	06-19	38.5ND	06-31	REV	43	R	DATA PARTLY IN SUNLIGHT.	15
08/31/64	244	43	106.4W	06-40-54	26	38.5SD	06-51	76.6SA	07-08	FWD	46	G	DATA PARTLY IN SUNLIGHT.	16
08/31/64	244	44	131.0W	08-19-19	27	79.1ND	07-58	51.5SD	08-33	FWD	46	G	DATA PARTLY IN SUNLIGHT.	16
08/31/64	244	44	131.0W	08-19-19	28	70.0ND	08-01	18.0SD	08-24	FWD	45	G	DATA PARTLY IN SUNLIGHT.	17
08/31/64	245	44	131.0W	08-19-19	29	18.0SD	08-24	77.7SA	08-46	REV	45	G	DATA PARTLY IN SUNLIGHT.	18
08/31/64	244	45	155.6W	09-57-45	30	80.0ND	09-36	80.0ND	09-36	REV	45	G	ALL DATA IN SUNLIGHT. 1 SECOND OF DATA.	18
08/31/64	244	45	155.6W	09-57-45	31	60.8ND	09-42	73.4SA	10-26	REV	46	G	DATA PARTLY IN SUNLIGHT.	19
08/31/64	244	46	179.8E	11-36-11	32	78.8ND	11-15	72.9ND	11-16	REV	46	G	ALL DATA IN SUNLIGHT. 53 SECONDS OF DATA.	19
08/31/64	244	47	155.0E	13-14-37	33	35.8SD	13-24	75.9SA	13-42	FWD	49	R	DATA PARTLY IN SUNLIGHT.	20
08/31/64	244	48	130.6E	14-53-02	34	27.[illegible]ND	14-46	77.0SA	15-20	REV	49	R	DATA PARTLY IN SUNLIGHT.	21
08/31/64	244	49	105.9E	16-31-27	35	73.9ND	16-12	69.6SA	17-01	FWD	52	G	DATA PARTLY IN SUNLIGHT.	22
08/31/64	244	51	56.7E	19-48-19	36	80.9ND	19-26	80.0SA	20-14	REV	52	G	DATA PARTLY IN SUNLIGHT.	23
09/01/64	245	55	41.7W	02-22-02	37	62.9SD	02-39	74.4SA	02-50	FWD	57	R	DATA PARTLY IN SUNLIGHT.	24
09/01/64	245	56	66.3W	04-00-28	38	79.5ND	03-39	9.6ND	03-58	FWD	57	R	DATA PARTLY IN SUNLIGHT.	24
09/01/64	245	56	66.3W	04-00-28	39	39.9SD	04-11	75.7SA	04-28	REV	57	R	DATA PARTLY IN SUNLIGHT.	25
09/01/64	245	57	90.9W	05-38-54	40	80.3ND	05-17	42.4ND	05-28	REV	57	R	DATA PARTLY IN SUNLIGHT.	25
09/01/64	245	57	90.9W	05-38-54	41	34.6SD	05-48	76.8SA	06-06	FWD	64	R	DATA PARTLY IN SUNLIGHT.	26
09/01/64	245	57	90.9W	05-38-54	42	73.1SD	05-59	76.8SA	06-06	FWD	59	G	ALL DATA IN SUNLIGHT.	27
09/01/64	245	58	115.5W	07-17-19	43	79.2ND	06-56	32.4ND	07-09	FWD	59	G	DATA PARTLY IN SUNLIGHT.	27
09/01/64	245	58	115.5W	07-17-19	44	79.2ND	06-56	2.6SD	07-18	FWD	64	R	DATA PARTLY IN SUNLIGHT.	26
09/01/64	245	58	115.5W	07-17-19	45	40.4SD	07-28	75.3SA	07-45	REV	59	G	DATA PARTLY IN SUNLIGHT.	28
09/01/64	245	59	140.1W	08-55-45	46	77.7ND	08-35	68.0ND	08-38	REV	59	G	ALL DATA IN SUNLIGHT.	28
09/01/64	245	59	140.1W	08-55-45	47	49.5ND	08-43	49.8SD	09-09	REV	60	G	ALL DATA IN DARKNESS.	29
09/01/64	245	60	164.7W	10-34-11	48	51.1ND	10-21	77.6SA	11-01	REV	64	R	DATA PARTLY IN SUNLIGHT.	30
09/01/64	245	61	170.7E	12-12-37	49	79.8ND	11-51	77.4ND	11-52	REV	64	R	ALL DATA IN SUNLIGHT.	30

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR DATE	CALENDAR DAY	DATA ORBIT	DESCENDING NODE LONG. (DEG)	DESCENDING NODE TIME (GMT)	DATA BLOCK	HRIR DATA BEGIN LAT. (DEG)	HRIR DATA BEGIN TIME (GMT)	HRIR DATA END LAT. (DEG)	HRIR DATA END TIME (GMT)	PLAY BACK MODE	READ -OUT ORBIT	DAF	REMARKS	NMRT REFL NO.
09/01/64	245	64	97.0E	17-07-53	50	61.3ND	16-52	73.0SD	17-28	FWD	65	R	DATA PARTLY IN SUNLIGHT.	31
09/01/64	245	64	97.0E	17-07-53	51	73.0SD	17-28	19.3NA	18-04	REV	65	R	ALL DATA IN SUNLIGHT. DATA INCLUDE ORBIT 65.	32
09/01/64	245	65	72.3E	18-46-20	52	59.2ND	18-31	71.7SD	19-06	FWD	66	G	DATA PARTLY IN SUNLIGHT.	33
09/01/64	245	65	72.3E	18-46-20	53	71.7SD	19-06	14.4NA	19-41	REV	66	G	ALL DATA IN SUNLIGHT. DATA INCLUDES ORBIT 66.	34
09/01/64	245	66	47.7E	20-24-45	54	14.6ND	20-21	67.7SA	20-55	FWD	67	G	DATA PARTLY IN SUNLIGHT.	35
09/01/64	245	66	47.7E	20-24-45	55	0.9SA	21-15	47.9NA	21-29	REV	67	G	ALL DATA IN SUNLIGHT. DATA INCLUDES ORBIT 67.	36
09/02/64	246	69	26.1W	01-20-02	56	11.8ND	01-17	74.7SA	01-48	FWD	74	G	DATA PARTLY IN SUNLIGHT.	37
09/02/64	246	69	26.1W	01-20-02	57	7.9ND	01-18	77.4SA	01-47	REV	75	G	DATA PARTLY IN SUNLIGHT.	38
09/02/64	246	70	50.7W	02-58-28	58	79.5ND	02-37	56.0ND	02-40	FWD	74	G	DATA PARTLY IN SUNLIGHT.	37
09/02/64	246	70	50.7W	02-58-28	59	79.5ND	02-37	2.1SD	02-59	REV	75	G	DATA PARTLY IN SUNLIGHT.	38
09/02/64	246	71	75.3W	04-36-54	60	7.0ND	04-35	0.4SD	04-37	FWD	75	G	ALL DATA IN DARKNESS.	39
09/02/64	246	73	124.5W	07-53-45	61	77.8ND	07-33	76.7SA	08-21	FWD	75	G	DATA PARTLY IN SUNLIGHT.	39
09/02/64	246	73	124.5W	07-53-45	62	80.6SD	08-17	74.0SA	08-22	REV	74	G	ALL DATA IN SUNLIGHT.	40
09/02/64	246	75	173.7W	11-10-37	63	6.2ND	11-09	67.5SA	11-41	FWD	79	R	DATA PARTLY IN SUNLIGHT.	41
09/02/64	246	75	173.7W	11-10-37	64	42.9SD	11-22	64.3SA	11-42	REV	79	G	DATA PARTLY IN SUNLIGHT.	42
09/02/64	246	78	112.5E	16-05-54	65	75.3ND	15-46	79.5SA	16-32	REV	79	R	DATA PARTLY IN SUNLIGHT.	43
09/02/64	246	79	87.8E	17-44-20	66	29.2SD	17-52	53.7SA	18-19	FWD	80	G	DATA PARTLY IN SUNLIGHT.	44
09/02/64	246	79	87.8E	17-44-20	67	74.5SD	18-05	53.7SA	18-19	FWD	79	G	ALL DATA IN SUNLIGHT.	45
09/02/64	246	80	63.3E	19-22-45	68	10.7ND	19-20	71.1SA	19-52	FWD	81	G	DATA PARTLY IN SUNLIGHT.	46
09/02/64	246	80	63.3E	19-22-45	69	10.7ND	19-20	79.2SA	19-49	FWD	82	G	DATA PARTLY IN SUNLIGHT.	47
09/02/64	246	80	63.3E	19-22-45	70	71.1SA	19-52	51.3NA	20-28	REV	81	G	ALL DATA IN SUNLIGHT. DATA INCLUDES ORBIT 81.	48
09/02/64	246	81	38.7E	21-01-11	71	80.3NA	20-37	75.3SA	21-29	REV	82	G	DATA PARTLY IN SUNLIGHT.	49
09/03/64	247	84	35.1W	01-56-28	72	1.8ND	01-56	76.2SA	02-24	FWD	89	G	DATA PARTLY IN SUNLIGHT.	50
09/03/64	247	84	35.1W	01-56-28	73	13.5SD	02-00	76.2SA	02-24	FWD	90	G	DATA PARTLY IN SUNLIGHT.	51

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR		DATA ORBIT	DESCENDING NODE		DATA BLOCK	HRIR DATA BEGIN		HRIR DATA END		PLAY BACK MODE	READ -OUT ORBIT	DAF	REMARKS	NMRT REEL NO.
DATE	DAY		LONG. (DEG)	TIME (GMT)		LAT. (DEG)	TIME (GMT)	LAT. (DEG)	TIME (GMT)					
09/03/64	247	84	35.1W	01-56-28	74	36.0SD	02-06	76.2SA	02-24	FWD	86	R	DATA PARTLY IN SUNLIGHT.	52
09/03/64	247	85	59.7W	03-34-54	75	80.4ND	03-13	34.6ND	03-26	FWD	86	R	DATA PARTLY IN SUNLIGHT.	52
09/03/64	247	85	59.7W	03-34-54	76	80.4ND	03-13	26.8ND	03-28	FWD	89	G	DATA PARTLY IN SUNLIGHT.	50
09/03/64	247	85	59.7W	03-34-54	77	80.4ND	03-13	11.2ND	03-32	FWD	90	G	DATA PARTLY IN SUNLIGHT.	51
09/03/64	247	85	59.7W	03-34-54	78	15.7SD	03-39	77.3SA	04-02	REV	86	R	DATA PARTLY IN SUNLIGHT.	53
09/03/64	247	86	84.3W	05-13-20	79	79.2ND	04-52	55.4ND	04-59	REV	86	R	DATA PARTLY IN SUNLIGHT.	53
09/03/64	247	88	133.6W	08-30-11	80	51.1ND	08-17	78.0SA	08-57	REV	89	G	DATA PARTLY IN SUNLIGHT.	54
09/03/64	247	89	158.6W	10-08-37	81	52.7ND	09-55	76.6SA	10-36	REV	90	G	DATA PARTLY IN SUNLIGHT.	55
09/03/64	247	90	177.3E	11-46-57	82	80.6ND	11-25	78.6ND	11-26	REV	90	G	DATA PARTLY IN SUNLIGHT.	55
09/03/64	247	91	152.6E	13-25-28	83	5.9SD	13-27	76.3SA	13-53	FWD	105	G	DATA PARTLY IN SUNLIGHT.	56
09/03/64	247	91	152.6E	13-25-28	84	80.8SD	13-49	76.3SA	13-53	FWD	93	R	ALL DATA IN SUNLIGHT.	57
09/03/64	247	92	128.0E	15-03-54	85	78.2ND	14-43	4.2SD	15-05	FWD	93	R	DATA PARTLY IN SUNLIGHT.	57
09/03/64	247	92	128.0E	15-03-54	86	78.2ND	14-43	11.2ND	15-01	FWD	105	G	DATA PARTLY IN SUNLIGHT.	56
09/03/64	247	92	128.0E	15-03-54	87	4.2SD	15-05	77.4SA	15-31	REV	93	R	DATA PARTLY IN SUNLIGHT.	58
09/04/64	248	104	167.2W	10-45-03	88	58.1ND	10-30	78.0SA	11-12	REV	105	G	DATA PARTLY IN SUNLIGHT.	59
09/04/64	248	105	168.2E	12-23-28	89	81.1ND	12-01	77.0ND	12-03	REV	105	G	ALL DATA IN SUNLIGHT. 45 SECONDS OF DATA.	59
09/04/64	248	106	143.6E	14-01-54	90	4.2SD	14-03	77.6SA	14-29	FWD	109	G	DATA PARTLY IN SUNLIGHT.	60
09/04/64	248	106	143.6E	14-01-54	91	4.2SD	14-03	77.6SA	14-29	FWD	119	G	DATA PARTLY IN SUNLIGHT.	61
09/04/64	248	106	143.6E	14-01-54	92	8.0SD	14-04	77.6SA	14-29	FWD	110	G	DATA PARTLY IN SUNLIGHT.	62
09/04/64	248	106	143.6E	14-01-54	93	30.6SD	14-10	77.6SA	14-29	FWD	120	G	DATA PARTLY IN SUNLIGHT.	63
09/04/64	248	106	143.6E	14-01-54	94	79.8SA	14-28	77.6SA	14-29	FWD	108	R	ALL DATA IN SUNLIGHT.	64
09/04/64	248	107	119.0E	15-40-20	95	79.3ND	15-19	6.4SD	15-42	FWD	108	R	DATA PARTLY IN SUNLIGHT.	64
09/04/64	248	107	119.0E	15-40-20	96	79.3ND	15-19	9.0ND	15-38	FWD	109	G	DATA PARTLY IN SUNLIGHT.	60
09/04/64	248	107	119.0E	15-40-20	97	79.3ND	15-19	6.4SD	15-42	FWD	110	G	DATA PARTLY IN SUNLIGHT.	62
09/04/64	248	107	119.0E	15-40-20	98	79.3ND	15-19	6.4SD	15-42	FWD	119	G	DATA PARTLY IN SUNLIGHT.	61
09/04/64	248	107	119.0E	15-40-20	99	79.3ND	15-19	32.3ND	15-32	FWD	120	G	DATA PARTLY IN SUNLIGHT.	63

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR		DATA ORBIT	DESCENDING NODE		DATA BLOCK	H R I R D A T A				PLAY BACK MODE	READ -OUT ORBIT	DAF	R E M A R K S	NMRT REEL NO.
						BEGIN		END						
DATE	DAY		LONG. (DEG)	TIME (GMT)		LAT. (DEG)	TIME (GMT)	LAT. (DEG)	TIME (GMT)					
09/04/64	248	107	119.0E	15-40-20	100	20.6ND	15-35	6.4SD	15-42	FWD	125	G	ALL DATA IN DARKNESS.	64
09/04/64	248	107	119.0E	15-40-20	101	10.2SD	15-43	78.7SA	16-07	REV	108	R	DATA PARTLY IN SUNLIGHT.	65
09/04/64	248	108	94.4E	17-18-46	102	68.1ND	17-01	79.6SA	17-45	REV	109	G	DATA PARTLY IN SUNLIGHT.	66
09/04/64	248	109	69.8E	18-57-12	103	80.3NA	18-33	75.8SA	19-25	REV	110	G	DATA PARTLY IN SUNLIGHT.	67
09/04/64	248	110	45.2E	20-35-37	104	76.9NA	20-10	79.4NA	20-11	REV	119	G	ALL DATA IN SUNLIGHT. 25 SECONDS OF DATA.	68
09/05/64	249	118	151.6W	09-43-03	105	72.5ND	09-24	78.2SA	10-10	REV	119	G	DATA PARTLY IN SUNLIGHT.	68
09/05/64	249	119	176.2W	11-21-29	106	81.1ND	10-59	73.9ND	11-02	REV	119	G	ALL DATA IN SUNLIGHT.	68
09/05/64	249	119	176.2W	11-21-29	107	9.5ND	11-19	76.8SA	11-49	REV	120	G	DATA PARTLY IN SUNLIGHT.	69
09/05/64	249	120	159.2E	12-59-55	108	80.4ND	12-38	78.2ND	12-39	REV	120	G	ALL DATA IN SUNLIGHT.	69
09/05/64	249	120	159.2E	12-59-55	109	26.7ND	12-53	77.9SA	13-27	FWD	123	G	DATA PARTLY IN SUNLIGHT.	70
09/05/64	249	120	159.2E	12-59-55	110	30.5SD	13-08	77.9SA	13-27	FWD	122	R	DATA PARTLY IN SUNLIGHT.	71
09/05/64	249	120	159.2E	12-59-55	111	75.1SD	13-21	77.9SA	13-27	REV	123	G	ALL DATA IN SUNLIGHT.	72
09/05/64	249	121	134.6E	14-38-20	112	81.0ND	14-16	28.4ND	14-31	FWD	122	R	DATA PARTLY IN SUNLIGHT.	71
09/05/64	249	121	134.6E	14-38-20	113	81.0ND	14-16	28.4ND	14-31	FWD	123	G	DATA PARTLY IN SUNLIGHT.	70
09/05/64	249	121	134.6E	14-38-20	114	28.4ND	14-31	78.9SA	15-05	REV	122	R	DATA PARTLY IN SUNLIGHT.	73
09/05/64	249	122	110.0E	16-16-46	115	20.2NA	15-35	45.2NA	15-42	FWD	124	G	ALL DATA IN SUNLIGHT.	74
09/05/64	249	122	110.0E	16-16-46	116	80.2ND	15-55	79.7SA	16-43	REV	123	R	DATA PARTLY IN SUNLIGHT.	75
09/05/64	249	122	110.0E	16-16-46	117	64.4ND	16-00	77.5SA	16-44	FWD	125	G	DATA PARTLY IN SUNLIGHT.	64
09/05/64	249	122	110.0E	16-16-46	118	60.7ND	16-01	77.5SA	16-44	FWD	124	G	DATA PARTLY IN SUNLIGHT.	74
09/05/64	249	122	110.0E	16-16-46	119	53.2ND	16-03	52.9SA	16-52	FWD	134	G	DATA PARTLY IN SUNLIGHT.	76
09/05/64	249	123	85.4E	17-55-11	120	80.8ND	17-33	76.1SA	18-23	REV	124	G	DATA PARTLY IN SUNLIGHT.	77
09/05/64	249	124	60.8E	19-33-38	121	56.4NA	19-02	60.0NA	19-03	REV	124	G	ALL DATA IN SUNLIGHT. 3 SECONDS OF DATA.	77
09/05/64	249	124	60.8E	19-33-38	122	79.4NA	19-09	77.2SA	20-01	REV	125	G	DATA PARTLY IN SUNLIGHT.	78
09/05/64	249	125	36.2E	21-12-03	123	47.7NA	20-38	51.3NA	20-39	REV	125	G	ALL DATA IN SUNLIGHT. 1 SECOND OF DATA.	78
09/05/64	249	125	36.2E	21-12-03	124	72.4NA	20-45	75.6NA	20-46	REV	134	G	ALL DATA IN SUNLIGHT.	79

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR DATE	CALENDAR DAY	DATA ORBIT	DESCENDING NODE LONG. (DEG)	DESCENDING NODE TIME (GMT)	DATA BLOCK	HRIR DATA BEGIN LAT. (DEG)	HRIR DATA BEGIN TIME (GMT)	HRIR DATA END LAT. (DEG)	HRIR DATA END TIME (GMT)	PLAY BACK MODE	READ -OUT ORBIT	DAF	REMARKS	NMRT REEL NO.
09/05/64	249	125	36.2E	21-12-03	124	72.4NA	20-45	75.6NA	20-46	REV	134	G	4 SECONDS OF DATA.	
09/06/64	250	133	160.7W	10-19-29	125	73.9ND	10-00	77.0SA	10-47	REV	134	G	DATA PARTLW IN SUNLIGHT.	79
09/06/64	250	134	174.8E	11-57-55	126	80.4ND	11-36	78.2ND	11-37	REV	134	G	ALL DATA IN SUNLIGHT. 5 SECONDS OF DATA.	79
09/06/64	250	135	150.1E	13-36-21	127	2.5SD	13-37	76.7SA	14-04	FWD	139	G	DATA PARTLY IN SUNLIGHT.	80
09/06/64	250	135	150.1E	13-36-21	128	2.5SD	13-37	79.1SA	14-03	FWD	140	G	DATA PARTLY IN SUNLIGHT.	81
09/06/64	250	135	150.1E	13-36-21	129	10.1SD	13-39	76.7SA	14-04	FWD	138	R	DATA PARTLY IN SUNLIGHT.	82
09/06/64	250	136	125.5E	15-14-46	130	80.2ND	14-53	2.9ND	15-14	FWD	138	R	DATA PARTLY IN SUNLIGHT.	82
09/06/64	250	136	125.5E	15-14-46	131	80.2ND	14-53	4.7SD	15-16	FWD	139	G	DATA PARTLY IN SUNLIGHT.	80
09/06/64	250	136	125.5E	15-14-46	132	80.2ND	14-53	4.7SD	15-16	FWD	140	G	DATA PARTLY IN SUNLIGHT.	81
09/06/64	250	136	125.5E	15-14-46	133	8.5SD	15-17	77.8SA	15-42	REV	137	R	DATA PARTLY IN SUNLIGHT.	83
09/06/64	250	137	100.9E	16-53-12	134	73.0ND	16-34	80.6SA	17-19	REV	138	R	DATA PARTLY IN SUNLIGHT.	84
09/06/64	250	138	76.3E	18-31-38	135	79.9ND	18-10	77.5SA	18-59	REV	139	G	DATA PARTLW IN SUNLIGHT.	85
09/06/64	250	139	51.7E	20-10-03	136	51.2NA	19-37	54.8NA	19-38	REV	139	G	ALL DATA IN SUNLIGHT. 1 SECOND OF DATA.	85
09/06/64	250	139	51.7E	20-10-03	137	78.4NA	19-45	81.3SA	20-35	REV	140	G	DATA PARTLY IN SUNLIGHT.	86
09/07/64	251	145	95.9W	06-00-38	138	19.4SA	06-46	78.6ND	07-18	FWD	162	G	ALL DATA IN SUNLIGHT. DATA INCLUDES ORBIT 146.	87
09-07/64	251	146	120.5W	07-39-04	139	11.8NA	06-55	75.7ND	07-19	FWD	164	G	ALL DATA IN SUNLIGHT.	88
09/07/64	251	146	120.5W	07-39-04	140	22.4NA	06-58	4.0ND	07-38	FWD	160	R	DATA PARTLY IN SUNLIGHT.	89
09/07/64	251	146	120.5W	07-39-04	141	31.1ND	07-31	7.9ND	07-37	FWD	153	G	ALL DATA IN DARKNESS.	90
09/08/64	252	159	80.3W	04-58-38	142	13.9ND	04-55	77.8SA	05-26	REV	160	R	DATA PARTLY IN SUNLIGHT.	91
09/08/64	252	160	104.9W	06-37-04	143	80.6ND	06-15	50.3ND	06-24	REV	160	R	DAT● PARTLW IN SUNLIGHT.	91
09/07/64	252	161	129.5W	08-15-30	144	1.9ND	08-15	77.5SA	08-43	REV	162	G	DATA PARTLW IN SUNLIGHT.	92
09/07/64	252	162	154.1W	09-53-55	145	80.4ND	09-32	68.4ND	09-36	REV	162	G	ALL DATA IN SUNLIGHT.	92
09/08/64	252	163	178.8W	11-32-20	146	17.5SD	11-37	79.●SA	11-59	REV	164	G	DATA PARTLY IN SUNLIGHT.	93
09/08/64	252	164	156.6E	13-10-47	147	81.3ND	12-48	74.8ND	12-51	REV	164	G	ALL DATA IN SUNLIGHT.	93
09/08/64	252	164	156.6E	13-10-47	148	26.0ND	13-04	80.2SA	13-37	FWD	168	G	DATA PARTLY IN SUNLIGHT.	94

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR		DATA ORBIT	DESCENDING NODE		DATA BLOCK	H R I R D A T A				PLAY BACK MODE	READ -OUT ORBIT	DAF	R E M A R K S	NMRT REEL NO.
D A T E	DAY		LONG. (DEG)	T I M E (GMT)		BEGIN LAT. (DEG)	BEGIN TIME (GMT)	END LAT. (DEG)	END TIME (GMT)					
09/08/64	252	164	156.6E	13-10-47	149	22.2ND	13-05	80.2SA	13-37	FWD	167	R	DATA PARTLY IN SUNLIGHT.	95
09/08/64	252	164	156.6E	13-10-47	150	37.9SD	13-21	80.2SA	13-37	FWD	166	R	DATA PARTLY IN SUNLIGHT.	96
09/08/64	252	165	132.0E	14-49-13	151	81.4ND	14-26	23.8ND	14-43	FWD	166	R	DATA PARTLY IN SUNLIGHT.	96
09/08/64	252	165	132.0E	14-49-13	152	81.4ND	14-26	50.8ND	14-36	FWD	168	G	DATA PARTLY IN SUNLIGHT.	94
09/08/64	252	165	132.0E	14-49-13	153	27.7ND	14-42	23.8ND	14-43	FWD	183	G	ALL DATA IN DARKNESS. 30 SECONDS OF DATA.	97
09/08/64	252	165	132.0E	14-49-13	154	23.8ND	14-43	79.2S●	15-16	REV	166	R	DATA PARTLY IN SUNLIGHT.	98
09/08/64	252	166	107.4E	16-27-38	155	79.8ND	16-06	80.0SA	16-54	REV	167	R	DATA PARTLY IN SUNLIGHT.	99
09/08/64	252	167	82.8E	18-06-04	156	57.9ND	17-51	78.9SA	18-33	REV	168	G	DAT● PARTLY IN SUNLIGHT.	100
09/08/64	252	168	58.2E	19-44-30	157	53.1NA	19-12	56.7NA	19-13	REV	168	G	ALL DATA IN SUNLIGHT. 38 SECONDS OF DATA.	100
09/08/64	252	168	58.2E	19-44-30	158	79.8SA	20-11	77.6SA	20-12	REV	169	G	ALL DATA IN SUNLIGHT. 31 SECONDS OF DATA.	101
09/09/64	253	174	89.4W	05-35-04	159	61.6ND	05-19	80.7SD	05-59	FWD	178	G	DATA PARTLY IN SUNLIGHT.	102
09/09/64	253	174	89.4W	05-35-04	160	11.1SD	05-38	67.9SA	06-06	REV	181	R	DATA PARTLY IN SUNLIGHT.	103
09/09/64	253	175	114.0W	07-13-30	161	79.5ND	06-52	66.8ND	06-56	REV	181	R	ALL DATA IN SUNLIGHT.	103
09/09/64	253	175	114.0W	07-13-30	162	66.8ND	06-56	52.8SD	07-28	FWD	181	R	DATA PARTLY IN SUNLIGHT.	104
09/09/64	253	175	114.0W	07-13-30	163	48.0ND	07-01	31.6SD	07-22	FWD	184	G	ALL DATA IN DARKNESS.	105
09/09/64	253	175	114.0W	07-13-30	164	36.5ND	07-04	43.2SA	07-52	FWD	183	G	DATA PARTLY IN SUNLIGHT.	97
09/09/64	253	175	114.0W	07-13-30	165	28.8ND	07-06	72.2SA	07-43	FWD	182	R	DATA PARTLY IN SUNLIGHT.	106
09/09/64	253	175	114.0W	07-13-30	166	24.9ND	07-07	43.2S●	07-52	REV	178	G	DATA PARTLY IN SUNLIGHT.	107
09/09/64	253	181	98.4E	17-04-04	167	50.2ND	16-51	80.7SD	17-28	REV	182	R	DATA PARTLY IN SUNLIGHT.	108
09/09/64	253	182	73.8E	18-42-30	168	81.1ND	18-20	79.9SA	19-09	REV	183	G	DATA PARTLY IN SUNLIGHT.	109
09/09/64	253	183	49.2E	20-20-56	169	22.7SD	20-27	78.8SA	20-48	REV	184	G	DATA PARTLY IN SUNLIGHT.	110
09/09/64	253	184	24.6E	21-59-22	170	49.9NA	21-26	53.5NA	21-27	REV	184	G	ALL DATA IN SUNLIGHT. 4 SECONDS OF DATA.	110
09/10/64	254	187	49.2W	02-54-39	171	37.0ND	02-45	5.1SD	02-56	FWD	192	G	ALL DATA IN DARKNESS.	111
09/10/64	254	188	73.8W	04-33-04	172	78.5ND	04-12	7.3SD	04-35	FWD	192	G	DATA PARTL● IN SUNLIGHT.	111

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR DATE	CALENDAR DAY	DATA ORBIT	DESCENDING NODE LONG. (DEG)	DESCENDING NODE TIME (GMT)	DATA BLOCK	HRIR DATA BEGIN LAT. (DEG)	HRIR DATA BEGIN TIME (GMT)	HRIR DATA END LAT. (DEG)	HRIR DATA END TIME (GMT)	PLAY BACK MODE	READ -OUT ORBIT	DAF	REMARKS	NMRT REEL NO.
09/10/64	254	188	73.8W	04-33-04	173	50.2ND	04-20	7.3SD	04-35	REV	193	G	ALL DATA IN DARKNESS.	112
09/10/64	254	188	73.8W	04-33-04	174	23.2ND	04-27	7.3SD	04-35	FWD	195	R	ALL DATA IN DARKNESS.	113
09/10/64	254	189	98.4W	06-11-30	175	79.5ND	05-50	28.7ND	06-04	FWD	192	G	DATA PARTLY IN SUNLIGHT.	111
09/10/64	254	189	98.4W	06-11-30	176	79.5ND	05-50	24.9ND	06-05	REV	193	G	DATA PARTLY IN SUNLIGHT.	112
09/10/64	254	189	98.4W	06-11-30	177	79.5ND	05-50	24.9ND	06-05	FWD	195	R	DATA PARTLY IN SUNLIGHT.	113
09/10/64	254	189	98.4W	06-11-30	178	24.9ND	06-05	5.6SD	06-13	FWD	193	G	ALL DATA IN DARKNESS.	115
09/10/64	254	189	98.4W	06-11-30	179	24.9ND	06-05	5.6SD	06-13	REV	195	R	ALL DATA IN DARKNESS.	114
09/10/64	254	189	98.4W	06-11-30	180	21.0ND	06-06	5.6SD	06-13	REV	192	G	ALL DATA IN DARKNESS.	116
09/10/64	254	190	123.0W	07-49-56	181	78.1ND	07-29	4.0SD	07-51	REV	192	G	DATA PARTLY IN SUNLIGHT.	116
09/10/64	254	190	123.0W	07-49-56	182	78.1ND	07-29	4.0SD	07-51	FWD	193	G	DATA PARTLY IN SUNLIGHT.	115
09/10/64	254	190	123.0W	07-49-56	183	78.1ND	07-29	15.0ND	07-46	REV	195	R	DATA PARTLY IN SUNLIGHT.	114
09/10/64	254	191	147.6W	09-28-22	184	73.3ND	09-09	2.4SD	09-29	REV	192	G	DATA PARTLY IN SUNLIGHT.	116
09/10/64	254	195	114.0E	16-02-05	185	50.9NA	15-29	32.9SD	16-11	FWD	197	G	DATA PARTLY IN SUNLIGHT.	117
09/10/64	254	195	114.0E	16-02-05	186	72.3NA	15-35	73.5SD	16-23	FWD	198	G	DATA PARTLY IN SUNLIGHT.	118
09/10/64	254	195	114.0E	16-02-05	187	76.3SD	16-24	62.0SA	16-35	REV	196	G	ALL DATA IN SUNLIGHT.	119
09/10/64	254	195	114.0E	16-02-05	188	62.0SA	16-35	27.4NA	17-01	REV	196	R	ALL DATA IN SUNLIGHT. DATA INCLUDES ORBIT 196.	120
09/10/64	254	196	89.4E	17-40-30	189	55.6ND	17-26	78.0SA	18-08	REV	197	G	DATA PARTLY IN SUNLIGHT.	121
09/10/64	254	197	64.8E	19-18-56	190	80.8NA	18-55	80.7SD	19-43	REV	198	G	DATA PARTLY IN SUNLIGHT.	122
09/11/64	255	201	33.7W	01-52-39	191	74.6SD	02-14	3.8NA	02-45	FWD	203	R	ALL DATA IN SUNLIGHT. DATA INCLUDES ORBIT 202.	123
09/11/64	255	202	58.3W	03-31-05	192	53.9ND	03-17	10.9SD	03-34	REV	204	R	ALL DATA IN DARKNESS.	124
09/11/64	255	202	58.3W	03-31-05	193	14.6SD	03-35	79.4SD	03-58	REV	203	R	DATA PARTLY IN SUNLIGHT.	125
09/11/64	255	202	58.1W	03-30-56	194	14.6SD	03-35	73.4SD	03-52	FWD	204	R	DATA PARTLY IN SUNLIGHT.	126
09/11/64	255	203	82.9W	05-09-31	195	81.1ND	04-47	40.2ND	04-59	REV	203	R	DATA PARTLY IN SUNLIGHT.	125
09/11/64	255	205	132.1W	08-26-22	196	76.4ND	08-06	17.3SD	08-31	FWD	206	G	DATA PARTLY IN SUNLIGHT.	127
09/11/64	255	205	132.1W	08-26-22	197	17.3SD	08-31	77.8SA	08-54	REV	206	G	DATA PARTLY IN SUNLIGHT.	128

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR DATE	CALENDAR DAY	DATA ORBIT	DESCENDING NODE LONG. (DEG)	DESCENDING NODE TIME (GMT)	DATA BLOCK	HRIR DATA BEGIN LAT. (DEG)	HRIR DATA BEGIN TIME (GMT)	HRIR DATA END LAT. (DEG)	HRIR DATA END TIME (GMT)	PLAY BACK MODE	READ -OUT ORBIT	DAF	REMARKS	NMRT REEL NO.
09/11/64	255	206	156.7W	10-04-48	198	80.1ND	09-43	74.6ND	09-45	REV	206	G	ALL DATA IN SUNLIGHT.	128
09/11/64	255	206	156.7W	10-04-48	199	10.6ND	10-02	71.2SD	10-25	FWD	208	G	DATA PARTLY IN SUNLIGHT.	129
09/11/64	255	206	156.7W	10-04-48	200	15.7SD	10-09	34.8SA	10-46	FWD	207	G	DATA PARTLY IN SUNLIGHT.	130
09/11/64	255	206	156.7W	10-04-48	201	34.8SA	10-46	76.0ND	11-23	REV	207	G	ALL DATA IN SUNLIGHT. DATA INCLUDES ORBIT 207.	131
09/11/64	255	207	178.7E	11-43-14	202	21.4SD	11-49	79.7SA	12-10	REV	208	G	DATA PARTLY IN SUNLIGHT.	132
09/11/64	255	208	154.1E	13-21-39	203	81.2ND	12-59	77.2ND	13-01	REV	208	G	ALL DATA IN SUNLIGHT.	132
09/11/64	255	208	154.1E	13-21-39	204	37.9SD	13-32	78.5SA	13-49	FWD	210	R	DATA PARTLY IN SUNLIGHT.	133
09/11/64	255	208	154.1E	13-21-39	205	81.0SD	13-46	78.5SA	13-49	FWD	212	G	ALL DATA IN SUNLIGHT.	134
09/11/64	255	209	129.5E	15-00-05	206	80.6ND	14-38	72.2ND	14-41	FWD	210	R	ALL DATA IN SUNLIGHT.	133
09/11/64	255	209	129.5E	15-00-05	207	80.6ND	14-38	50.1ND	14-47	FWD	212	G	DATA PARTLY IN SUNLIGHT.	134
09/11/64	255	210	129.5E	15-00-05	208	18.3SD	15-05	81.4SA	15-25	REV	210	R	DATA PARTLY IN SUNLIGHT.	135
09/11/64	255	210	104.9E	16-38-31	209	28.6ND	16-31	72.0SD	16-59	REV	211	G	DATA PARTLY IN SUNLIGHT.	136
09/11/64	255	210	104.9E	16-38-31	210	72.0SD	16-59	9.9SA	17-27	FWD	211	G	ALL DATA IN SUNLIGHT.	137
09/11/64	255	210	104.9E	16-38-31	211	75.7SA	17-07	25.7NA	17-37	FWD	212	G	ALL DATA IN SUNLIGHT. DATA INCLUDES ORBIT 211.	134
09/11/64	255	210	104.9E	16-38-31	212	69.9SA	17-09	76.0NA	17-51	FWD	213	G	ALL DATA IN SUNLIGHT. DATA INCLUDES ORBIT 211.	138
09/11/64	255	211	80.3E	18-16-57	213	57.1ND	18-02	80.8SA	18-43	REV	212	G	DATA PARTLY IN SUNLIGHT.	139
09/11/64	255	212	55.7E	19-55-22	214	73.2ND	19-36	80.0SA	20-22	REV	213	G	DATA PARTLY IN SUNLIGHT.	140
09/12/64	256	216	42.7W	02-29-05	215	57.1SD	02-45	77.3SA	02-57	FWD	218	R	DATA PARTLY IN SUNLIGHT.	141
09/12/64	256	217	67.3W	04-07-31	216	81.1ND	03-45	5.6SD	04-09	FWD	218	R	DATA PARTLY IN SUNLIGHT.	141
09/12/64	256	217	67.3W	04-07-31	217	9.3SD	04-10	78.4SA	04-35	REV	218	R	DATA PARTLY IN SUNLIGHT.	142
09/12/64	256	218	91.9W	05-45-57	218	80.3ND	05-24	45.6ND	05-34	REV	218	R	DATA PARTLY IN SUNLIGHT.	142
09/12/64	256	218	91.9W	05-45-57	219	0.2SD	05-46	79.3SA	06-13	FWD	222	G	DATA PARTLY IN SUNLIGHT.	143
09/12/64	256	218	91.9W	05-45-57	220	64.2SD	06-04	79.3SA	06-13	FWD	220	G	DATA PARTLY IN SUNLIGHT.	144
09/12/64	256	219	116.5W	07-24-23	221	80.9ND	07-02	28.1ND	07-17	FWD	220	G	DATA PARTLY IN SUNLIGHT.	144
09/12/64	256	219	116.5W	07-24-23	222	80.9ND	07-02	54.9ND	07-10	FWD	222	G	DATA PARTLY IN SUNLIGHT.	143

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR		DATA ORBIT	DESCENDING NODE		DATA BLOCK	H R I R D A T A				PLAY BACK MODE	READ -OUT ORBIT	DAF	R E M A R K S	NMRT REEL NO.
D A T E	DAY		LONG. (DEG)	T I M E (GMT)		BEGIN LAT. (DEG)	BEGIN TIME (GMT)	END LAT. (DEG)	END TIME (GMT)					
09/12/64	256	219	116.5W	07-24-23	223	16.6ND	07-20	1.4ND	07-24	FWD	221	G	ALL DATA IN DARKNESS.	145
09/12/64	256	219	116.5W	07-24-23	224	24.5SD	07-31	78.1SA	07-52	REV	220	G	DATA PARTLY IN SUNLIGHT.	146
09/12/64	256	220	141.1W	09-02-48	225	81.3ND	08-40	67.6ND	08-45	REV	220	G	ALL DATA IN SUNLIGHT.	146
09/12/64	256	221	165.7W	10-41-14	226	81.4ND	10-18	75.9ND	10-21	REV	221	G	ALL DATA IN SUNLIGHT.	147
09/12/64	256	221	165.7W	10-41-14	227	16.0ND	10-37	77.8SA	11-09	REV	222	G	DATA PARTLY IN SUNLIGHT.	148
09/12/64	256	222	169.7E	12-19-40	228	81.1NA	11-56	74.1ND	12-00	REV	222	G	ALL DATA IN SUNLIGHT.	148
09/12/64	256	222	169.7E	12-19-40	229	51.7SD	12-34	78.7SA	12-47	FWD	236	G	ALL DATA IN DARKNESS.	149
09/12/64	256	222	169.7E	12-19-40	230	51.7SD	12-34	78.7SA	12-47	FWD	237	G	DATA PARTLY IN SUNLIGHT.	150
09/12/64	256	223	145.1E	13-58-06	231	81.4ND	13-35	30.8ND	13-50	FWD	236	G	DATA PARTLY IN SUNLIGHT.	149
09/12/64	256	223	145.1E	13-58-06	232	81.4ND	13-35	72.1ND	13-39	FWD	237	G	ALL DATA IN SUNLIGHT.	150
09/12/64	256	223	145.1E	13-58-06	233	80.3SD	14-22	79.6SA	14-25	FWD	225	R	ALL DATA IN SUNLIGHT.	151
09/12/64	256	224	120.5E	15-36-31	234	81.1ND	15-14	1.8SD	15-37	FWD	225	R	DATA PARTLY IN SUNLIGHT.	151
09/12/64	256	224	120.5E	15-36-31	235	9.2SD	15-39	80.4SA	16-03	REV	225	R	DATA PARTLY IN SUNLIGHT.	152
09/12/64	256	224	120.5E	15-36-31	236	23.9SD	15-43	78.5SA	16-04	FWD	227	G	DATA PARTLY IN SUNLIGHT.	153
09/12/64	256	224	120.5E	15-36-31	237	31.1SD	15-45	78.5SA	16-04	FWD	236	G	DATA PARTLY IN SUNLIGHT.	149
09/12/64	256	224	120.5E	15-36-31	238	55.5SD	15-52	78.5SA	16-04	FWD	237	G	DATA PARTLY IN SUNLIGHT.	150
09/12/64	256	225	95.9E	17-14-57	239	22.6ND	17-09	80.9SA	17-41	REV	226	G	DATA PARTLY IN SUNLIGHT.	154
09/12/64	256	226	71.3E	18-53-23	240	80.9ND	18-31	80.2SA	19-20	REV	227	G	DATA PARTLY IN SUNLIGHT.	155
09/12/64	256	229	2.5W	23-48-40	241	2.1SA	23-01	1.2SD	23-49	REV	236	G	DATA PARTLY IN SUNLIGHT. DATA INCLUDES ORBIT 228.	156
09/13/64	257	236	174.7W	11-17-40	242	2.5ND	11-17	78.9SA	11-45	REV	237	G	DATA PARTLY IN SUNLIGHT.	157
09/13/64	257	237	160.6E	12-56-06	243	80.5ND	12-34	75.4ND	12-36	REV	237	G	ALL DATA IN SUNLIGHT.	157
09/13/64	257	237	160.6E	12-56-06	244	23.1ND	12-50	79.8SA	13-23	FWD	240	R	DATA PARTLY IN SUNLIGHT.	158
09/13/64	257	237	160.6E	12-56-06	245	23.1ND	12-50	79.8SA	13-23	FWD	241	G	DATA PARTLY IN SUNLIGHT.	159
09/13/64	257	237	160.6E	12-56-06	246	28.9SD	13-04	56.4SA	13-31	FWD	239	R	DATA PARTLY IN SUNLIGHT.	160
09/13/64	257	238	136.0E	14-34-32	247	81.3ND	14-11	32.4ND	14-26	FWD	240	R	DATA PARTLY IN SUNLIGHT.	158
09/13/64	257	238	136.0E	14-34-32	248	81.3ND	14-11	66.5ND	14-17	FWD	241	G	ALL DATA IN SUNLIGHT.	159

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR		DATA ORBIT	DESCENDING NODE		DATA BLOCK	HRIR DATA BEGIN		HRIR DATA END		PLAY BACK MODE	READ -OUT ORBIT	DAF	REMARKS	NMRT REFL NO.
DATE	DAY		LONG. (DEG)	TIME (GMT)		LAT. (DEG)	TIME (GMT)	LAT. (DEG)	TIME (GMT)					
09/13/64	257	238	136.0E	14-34-32	249	81.4SA	15-00	80.5SA	15-01	REV	239	R	ALL DATA IN SUNLIGHT.	161
09/13/64	257	239	111.4E	16-12-58	250	11.3SD	16-16	60.5SD	16-30	REV	240	R	ALL DATA IN DARKNESS.	162
09/13/64	257	240	86.9E	17-51-23	251	51.0ND	17-38	80.3SA	18-18	REV	241	G	DATA PARTLY IN SUNLIGHT.	163
09/13/64	257	241	62.2E	19-29-49	252	79.9ND	19-08	78.8SD	19-57	REV	242	G	DATA PARTLY IN SUNLIGHT.	164
09/13/64	257	242	37.6E	21-08-15	253	46.6ND	20-56	81.2SD	21-33	REV	243	G	DATA PARTLY IN SUNLIGHT.	165
09/14/64	258	245	36.2W	02-03-32	254	27.3SD	02-11	78.8SA	02-31	FWD	247	R	DATA PARTLY IN SUNLIGHT.	166
09/14/64	258	246	60.8W	03-41-58	255	81.4ND	03-19	7.4ND	03-40	FWD	247	R	DATA PARTLY IN SUNLIGHT.	166
09/14/64	258	246	60.8W	03-41-58	256	3.6ND	03-41	79.6SA	04-09	REV	247	R	DATA PARTLY IN SUNLIGHT.	167
09/14/64	258	247	85.4W	05-20-24	257	81.3ND	04-57	43.3ND	05-09	REV	247	R	DATA PARTLY IN SUNLIGHT.	167
09/14/64	258	248	110.0W	06-58-49	258	50.8SD	07-13	81.4SA	07-24	FWD	251	G	DATA PARTLY IN SUNLIGHT.	168
09/14/64	258	249	134.6W	08-37-15	259	50.4ND	08-24	28.3SD	08-45	FWD	250	G	ALL DATA IN DARKNESS.	169
09/14/64	258	249	134.6W	08-37-15	260	69.1SD	08-57	80.2SA	09-04	REV	250	G	ALL DATA IN SUNLIGHT.	170
09/14/64	258	250	159.2W	10-15-41	261	81.2ND	09-53	77.0ND	09-55	REV	250	G	ALL DATA IN SUNLIGHT.	170
09/14/64	258	250	159.2W	10-15-41	262	61.3SD	10-33	79.1SA	10-43	REV	251	G	ALL DATA IN SUNLIGHT.	171
09/14/64	258	251	176.2E	11-54-07	263	81.4ND	11-31	78.2ND	11-33	REV	251	G	ALL DATA IN SUNLIGHT.	171
09/14/64	258	251	176.2E	11-54-07	264	49.8SD	12-08	80.0SA	12-21	FWD	256	G	DATA PARTLY IN SUNLIGHT.	172
09/14/64	258	251	176.2E	11-54-07	265	49.8SD	12-08	63.1SD	12-12	FWD	264	G	ALL DATA IN DARKNESS.	173
09/14/64	258	251	176.2E	11-54-07	266	49.8SD	12-08	77.9SA	12-22	FWD	266	G	DATA PARTLY IN SUNLIGHT.	174
09/14/64	258	251	176.2E	11-54-07	267	49.8SD	12-08	80.0SA	12-21	FWD	270	G	DATA PARTLY IN SUNLIGHT.	175
09/14/64	258	251	176.2E	11-54-07	268	49.8SD	12-08	80.0SA	12-21	FWD	271	G	DATA PARTLY IN SUNLIGHT.	176
09/14/64	258	251	176.2E	11-54-07	269	53.2SD	12-09	80.0SA	12-21	FWD	272	G	DATA PARTLY IN SUNLIGHT.	177
09/14/64	258	252	151.6E	13-32-32	270	81.0ND	13-10	70.0ND	13-14	FWD	256	G	ALL DATA IN SUNLIGHT.	172
09/14/64	258	252	151.6E	13-32-32	271	81.0ND	13-10	24.7ND	13-26	FWD	266	G	DATA PARTLY IN SUNLIGHT.	174
09/14/64	258	252	151.6E	13-32-32	272	81.0ND	13-10	32.3ND	13-24	FWD	270	G	DATA PARTLY IN SUNLIGHT.	175
09/14/64	258	252	151.6E	13-32-32	273	81.0ND	13-10	59.0ND	13-17	FWD	271	G	DATA PARTLY IN SUNLIGHT.	176
09/14/64	258	252	151.6E	13-32-32	274	81.0ND	13-10	55.2ND	13-18	FWD	272	G	DATA PARTLY IN SUNLIGHT.	177

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR DATE	CALENDAR DAY	DATA ORBIT	DESCENDING NODE LONG. (DEG)	DESCENDING NODE TIME (GMT)	DATA BLOCK	HRIR DATA BEGIN LAT. (DEG)	HRIR DATA BEGIN TIME (GMT)	HRIR DATA END LAT. (DEG)	HRIR DATA END TIME (GMT)	PLAY BACK MODE	READ -OUT ORBIT	DAF	REMARKS	NMRT REEL NO.
09/14/64	258	252	151.6E	13-32-32	275	16.4SD	13-37	78.9SA	14-00	REV	256	G	DATA PARTLY IN SUNLIGHT.	178
09/14/64	258	252	151.6E	13-32-32	276	79.2SD	13-56	78.9SA	14-00	FWD	255	G	ALL DATA IN SUNLIGHT.	179
09/14/64	258	253	127.0E	15-10-58	277	81.3ND	14-48	0.1SD	15-11	FWD	255	G	DATA PARTLY IN SUNLIGHT.	179
09/14/64	258	253	127.0E	15-10-58	278	81.3ND	14-48	3.6ND	15-10	REV	256	G	DATA PARTLY IN SUNLIGHT.	178
09/14/64	258	253	127.0E	15-10-58	279	0.1SD	15-11	81.1SA	15-37	REV	255	G	DATA PARTLY IN SUNLIGHT.	180
09/14/64	258	253	127.0E	15-10-58	280	3.8SD	15-12	79.7SA	15-38	FWD	256	G	DATA PARTLY IN SUNLIGHT.	172
09/14/64	258	253	127.0E	15-10-58	281	14.9SD	15-15	79.7SA	15-38	FWD	271	G	DATA PARTLY IN SUNLIGHT.	176
09/14/64	258	253	127.0E	15-10-58	282	25.7SD	15-18	79.7SA	15-38	FWD	264	G	DATA PARTLY IN SUNLIGHT.	173
09/14/64	258	253	127.0E	15-10-58	283	81.3SA	15-36	79.7SA	15-38	FWD	266	G	ALL DATA IN SUNLIGHT.	17[illegible]
09/14/64	258	258	4.0E	23-23-07	284	75.7NA	22-57	56.4SD	23-39	REV	262	R	DATA PARTLY IN SUNLIGHT.	181
09/15/64	259	262	94.4W	05-56-50	285	73.2SD	06-18	79.6SA	06-24	REV	264	G	ALL DATA IN SUNLIGHT.	182
09/15/64	259	263	119.0W	07-35-16	286	80.6ND	07-13	19.8ND	07-30	REV	264	G	DATA PARTLY IN SUNLIGHT.	182
09/15/64	259	264	143.6W	09-13-42	287	44.3ND	09-02	26.6SD	09-21	REV	265	G	ALL DATA IN DARKNESS.	183
09/15/64	259	265	168.2W	10-52-07	288	53.5ND	10-38	72.3SD	11-13	REV	266	G	DATA PARTLY IN SUNLIGHT.	184
09/15/64	259	269	93.4E	17-25-50	289	77.3ND	17-05	18.9SD	17-31	REV	270	G	DATA PARTLY IN SUNLIGHT.	185
09/15/64	259	270	68.8E	19-04-16	290	65.2ND	18-47	81.3SA	19-30	REV	271	G	DATA PARTLY IN SUNLIGHT.	186
09/15/64	259	271	44.2E	20-42-42	291	59.4ND	20-27	44.1SD	20-55	REV	272	G	ALL DATA IN DARKNESS.	187
09/16/64	260	274	29.7W	01-37-59	292	80.1ND	01-16	64.1ND	01-21	REV	277	R	DATA PARTLY IN SUNLIGHT.	188
09/16/64	260	276	78.9W	04-54-51	293	67.3ND	04-37	40.9ND	04-44	FWD	277	R	DATA PARTLY IN SUNLIGHT.	189
09/16/64	260	276	78.9W	04-54-51	294	40.9ND	04-44	37.1ND	04-45	REV	277	R	ALL DATA IN DARKNESS.	188
09/16/64	260	276	78.9W	04-54-51	295	25.7ND	04-48	18.1ND	04-50	REV	277	R	ALL DATA IN DARKNESS.	188
09/16/64	260	277	103.5W	06-33-16	296	28.0SD	06-41	81.3SA	06-59	FWD	280	G	DATA PARTLY IN SUNLIGHT.	190
09/16/64	260	277	103.5W	06-33-16	297	81.3SA	06-59	80.4SA	07-00	FWD	279	G	ALL DATA IN SUNLIGHT. 36 SECONDS OF DATA.	191
09/16/64	260	278	128.1W	08-11-[illegible]2	298	81.1ND	07-49	15.7SD	08-16	FWD	279	G	DATA PARTLY IN SUNLIGHT.	191
09/16/64	260	278	128.1W	08-11-42	299	81.1ND	07-49	44.2ND	08-00	FWD	280	G	DATA PARTLY IN SUNLIGHT.	190
09/16/64	260	278	128.1W	08-11-42	300	15.7SD	08-16	71.7SA	08-42	REV	279	G	DATA PARTLY IN SUNLIGHT.	192

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR		DATA ORBIT	DESCENDING NODE		DATA BLOCK	HRIR DATA BEGIN		HRIR DATA END		PLAY BACK MODE	READ -OUT ORBIT	DAF	REMARKS	NMRT REFL NO.
DATE	DAY		LONG. (DEG)	TIME (GMT)		LAT. (DEG)	TIME (GMT)	LAT. (DEG)	TIME (GMT)					
09/16/64	260	279	152.7W	09-50-08	301	81.4ND	09-27	71.8ND	09-31	REV	279	G	ALL DATA IN SUNLIGHT.	192
09/16/64	260	279	152.7W	09-50-08	302	42.5SD	10-02	73.0SA	10-20	REV	280	G	DATA PARTLY IN SUNLIGHT.	193
09/16/64	260	280	177.3W	11-28-34	303	81.3NA	11-05	76.4ND	11-08	REV	280	G	ALL DATA IN SUNLIGHT.	193
09/16/64	260	281	158.1E	13-07-00	304	49.1ND	12-54	53.2SD	13-22	FWD	284	R	ALL DATA IN DARKNESS.	194
09/16/64	260	281	158.1E	13-07-00	305	18.7ND	13-02	53.2SD	13-22	FWD	286	G	ALL DATA IN DARKNESS.	195
09/16/64	260	281	158.1E	13-07-00	306	11.0SD	13-10	53.2SD	13-22	FWD	285	G	ALL DATA IN DARKNESS.	196
09/16/64	260	282	133.6E	14-45-26	307	81.4ND	14-22	5.3ND	14-44	FWD	286	G	DATA PARTLY IN SUNLIGHT.	195
09/16/64	260	282	133.5E	14-45-25	308	80.8ND	14-23	16.5ND	14-41	FWD	284	R	DATA PARTLY IN SUNLIGHT.	194
09/16/64	260	282	133.5E	14-45-25	309	80.8ND	14-23	5.3ND	14-44	FWD	285	G	DATA PARTLY IN SUNLIGHT.	196
09/16/64	260	282	133.5E	14-45-25	310	80.8ND	14-23	5.3ND	14-44	FWD	287	G	DATA PARTLY IN SUNLIGHT.	197
09/16/64	260	282	133.5E	14-45-25	311	5.8SD	14-47	51.7SD	15-00	REV	284	R	ALL DATA IN DARKNESS.	198
09/16/64	260	283	108.9E	16-23-51	312	29.5NA	15-45	40.7NA	15-48	REV	28[illegible]	R	ALL DATA IN SUNLIGHT.	198
09/16/64	260	284	84.3E	18-02-17	313	80.6ND	17-40	41.9SD	18-14	REV	285	G	DATA PARTLY IN SUNLIGHT.	199
09/16/64	260	285	59.8E	19-40-42	314	77.2NA	19-15	54.1SD	19-56	REV	286	G	DATA PARTLY IN SUNLIGHT.	200
09/16/64	260	286	35.1E	21-19-08	315	80.3ND	20-57	4.2ND	21-18	REV	287	G	DATA PARTLY IN SUNLIGHT.	201
09/16/64	260	287	10.5E	22-57-34	316	79.1ND	22-36	80.9SA	23-24	FWD	291	R	DATA PARTLY IN SUNLIGHT.	202
09/16/64	260	287	10.5E	22-57-34	317	39.8ND	22-47	77.0SA	23-26	FWD	295	G	DATA PARTLY IN SUNLIGHT.	203
09/16/64	260	287	10.5E	22-57-34	318	17.1ND	22-53	79.3SA	23-25	FWD	294	G	DATA PARTLY IN SUNLIGHT.	204
09/17/64	261	288	14.1W	00-36-00	319	81.3ND	00-13	64.0ND	00-19	FWD	294	G	DATA PARTLY IN SUNLIGHT.	204
09/17/64	261	288	14.1W	00-36-00	320	80.1ND	00-14	64.0ND	00-19	FWD	295	G	DATA PARTLY IN SUNLIGHT.	203
09/17/64	261	289	38.7W	02-14-26	321	75.9ND	01-54	43.0ND	02-03	REV	291	R	DATA PARTLY IN SUNLIGHT.	205
09/17/64	261	293	137.1W	08-48-09	322	57.1ND	08-33	79.6SD	09-12	REV	294	G	DATA PARTLY IN SUNLIGHT.	206
09/17/64	261	294	161.7W	10-26-35	323	51.1ND	10-13	77.1SA	10-55	REV	295	G	DATA PARTLY IN SUNLIGHT.	207
09/17/64	261	295	173.7E	12-05-00	324	81.3ND	11-42	74.5ND	11-45	REV	295	G	ALL DATA IN SUNLIGHT.	207
09/17/64	261	295	173.7E	12-05-00	325	52.8ND	11-51	3.6SD	12-06	FWD	298	R	DATA PARTLY IN SUNLIGHT.	208
09/17/64	261	296	149.1E	13-43-26	326	80.7ND	13-21	51.5SD	13-58	FWD	298	R	DATA PARTLY IN SUNLIGHT.	208

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR		DATA ORBIT	DESCENDING NODE		DATA BLOCK	H R I R D A T A				PLAY BACK MODE	READ -OUT ORBIT	DAF	R E M A R K S	NMRT REEL NO.
						B E G I N		E N D						
D A T E	DAY		LONG. (DEG)	T I M E (GMT)		LAT. (DEG)	TIME (GMT)	LAT. (DEG)	TIME (GMT)					
09/17/64	261	296	149.1E	13-43-26	327	46.8ND	13-31	6●.7SD	14-02	REV	299	G	DATA PARTLY IN SUNLIGHT.	209
09/17/6●	261	296	149.1E	13-43-26	328	76.6SD	14-06	80.8SA	14-10	REV	298	R	ALL DATA IN SUNLIGHT.	210
09/17/64	261	297	124.5E	15-21-52	329	81.2ND	14-59	81.2SD	15-●7	REV	298	R	DATA PARTLY IN SUNLIGHT.	210
09/17/64	261	297	124.5E	15-21-52	330	75.5SD	15-44	81.2SD	15-47	FWD	300	G	ALL DATA IN SUNLIGHT.	211
09/17/64	261	297	124.5E	15-21-52	331	75.5SD	15-44	81.2SD	15-47	FWD	301	G	ALL DATA IN SUNLIGHT.	212
09/17/6●	261	298	99.9E	17-00-18	332	80.5ND	16-38	31.3SD	17-09	FWD	299	G	DATA PARTLY IN SUNLIGHT.	213
09/17/6●	261	298	99.9E	17-00-18	333	38.7ND	16-50	70.8SA	17-31	FWD	301	G	DATA PARTLY IN SUNLIGHT.	212
09/17/6●	261	298	99.9E	17-00-18	334	19.7ND	16-55	70.8SA	17-31	FWD	300	G	DATA PARTLY IN SUNLIGHT.	211
09/17/6●	261	299	75.3E	18-38-43	335	81.1ND	18-16	57.2SD	18-55	REV	300	G	DATA PARTLY IN SUNLIGHT.	215
09/17/64	261	300	50.7E	20-17-09	336	78.8NA	19-52	65.5SD	20-36	REV	301	G	DATA PARTLY IN SUNLIGHT.	216
09/18/64	262	30●	47.7W	02-50-52	337	37.0ND	02-41	81.2SA	03-17	FWD	308	G	DATA PARTLY IN SUNLIGHT.	217
09/18/64	262	3●●	47.7W	02-50-52	338	81.2SA	03-17	80.0SA	03-18	FWD	309	G	ALL DATA IN SUNLIGHT.	218
09/18/64	262	305	72.3W	04-29-18	339	81.4ND	04-06	19.7ND	04-24	FWD	309	G	DATA PARTLY IN SUNLIGHT.	218
09/18/64	262	305	72.3W	04-29-18	3●0	19.7ND	04-24	45.1SD	04-42	REV	309	G	ALL DATA IN DARKNESS.	219
09/18/6●	262	305	72.3W	04-29-18	341	48.5SD	04-●3	80.7SA	04-56	REV	308	G	DATA PARTLY IN SUNLIGHT.	220
09/18/64	262	306	96.9W	06-07-●4	342	81.1ND	05-45	4.6SD	06-09	REV	308	G	DATA PARTL● IN SUNLIGHT.	220
09/18/64	262	309	170.8W	11-03-01	343	52.7ND	10-49	49.4SD	11-17	FWD	313	R	ALL DATA IN DARKNESS.	221
09/18/64	262	309	170.8W	11-03-01	3●4	11.2ND	11-00	49.4SD	11-17	FWD	315	G	ALL DATA IN DARKNESS.	222
09/18/64	262	309	170.8W	11-03-01	345	18.0SD	11-08	49.4SD	11-17	FWD	316	G	ALL DATA IN DARKNESS.	223
09/18/64	262	310	164.6E	12-41-27	346	81.4ND	12-18	12.9SD	12-45	FWD	313	R	DATA PARTLY IN SUNLIGHT.	221
09/18/64	262	310	164.6E	12-41-27	3●7	81.4ND	12-18	12.9SD	12-45	FWD	316	G	DATA PARTLY IN SUNLIGHT.	223
09/18/6●	262	310	164.6E	12-41-27	348	81.4ND	12-18	12.9SD	12-45	FWD	315	G	DATA PARTLY IN SUNLIGHT.	222
09/18/64	262	310	164.6E	12-41-27	349	12.9SD	12-45	18.4NA	13-38	REV	313	R	DATA PARTLY IN SUNLIGHT. DATA INCLUDES ORBIT 311.	224
09/18/6●	262	314	66.2E	19-15-10	350	76.1NA	18-49	58.8SD	19-32	REV	315	G	DATA PARTLY IN SUNLIGHT.	225
09/18/64	262	315	41.6E	20-53-36	351	77.7NA	20-28	30.1SD	21-02	REV	316	G	DATA PARTLY IN SUNLIGHT.	226
09/19/64	263	317	7.6W	00-10-27	352	9.2SD	00-13	79.4SA	00-38	FWD	323	G	DATA PARTLY IN SUNLIGHT.	227

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA														
CALENDAR		DATA ORBIT	DESCENDING NODE		DATA BLOCK	H R I R D A T A				PLAY BACK MODE	READ -OUT ORBIT	DAF	R E M A R K S	NMRT REEL NO.
						BEGIN		END						
DATE	DAY		LONG. (DEG)	TIME (GMT)		LAT. (DEG)	TIME (GMT)	LAT. (DEG)	TIME (GMT)					
09/19/64	263	318	32.2W	01-48-53	353	81.2ND	01-26	55.8ND	01-34	FWD	323	G	DATA PARTLY IN SUNLIGHT.	227
09/19/64	263	318	32.2W	01-48-54	354	70.5ND	01-30	55.8ND	01-34	FWD	320	R	DATA PARTLY IN SUNLIGHT.	228
09/19/64	263	318	32.2W	01-48-54	355	55.8ND	01-34	40.7ND	01-38	REV	320	R	ALL DATA IN DARKNESS.	229
09/19/64	263	318	32.2W	01-48-53	356	55.8ND	01-34	44.5ND	01-37	REV	323	G	ALL DATA IN DARKNESS.	230
09/19/64	263	321	106.0W	06-44-10	357	22.9ND	06-38	0.7ND	06-44	REV	323	G	ALL DATA IN DARKNESS.	230
09/19/64	263	322	130.6W	08-22-37	358	81.3ND	07-59	8.7SD	08-25	REV	323	G	DATA PARTLY IN SUNLIGHT.	230
09/19/64	263	323	155.2W	10-01-02	359	37.5ND	09-51	3.8ND	10-00	FWD	328	R	ALL DATA IN DARKNFSS.	231
09/19/64	263	324	179.8W	11-39-28	360	81.4ND	11-16	5.6SD	11-41	FWD	328	R	DATA PARTLY IN SUNLIGHT.	231
09/19/64	263	324	179.8W	11-39-28	361	65.3ND	11-22	5.6SD	11-41	FWD	330	G	ALL DATA IN DARKNESS.	232
09/19/64	263	324	179.8W	11-39-28	362	50.4ND	11-26	5.6SD	11-41	FWD	329	G	ALL DATA IN DARKNESS.	233
09/19/64	263	325	155.6E	13-17-54	363	81.2NA	12-54	48.2ND	13-05	FWD	328	R	DATA PARTLY IN SUNLIGHT.	231
09/19/64	263	325	155.6E	13-17-54	364	81.2NA	12-54	10.7ND	13-15	FWD	329	G	DATA PARTLY IN SUNLIGHT.	233
09/19/64	263	325	155.6E	13-17-54	365	81.2NA	12-54	7.0ND	13-16	FWD	330	G	DATA PARTLY IN SUNLIGHT.	232
09/19/64	263	325	155.6E	13-17-54	366	55.8ND	13-03	7.0ND	13-16	FWD	314	G	ALL DATA IN DARKNESS.	234
09/19/64	263	325	155.6E	13-17-54	367	40.7ND	13-07	7.0ND	13-16	FWD	337	G	ALL DATA IN DARKNESS.	235
09/19/64	263	326	131.0E	14-56-19	368	75.2ND	14-36	6.1SD	14-58	REV	328	R	DATA PARTLY IN SUNLIGHT.	236
09/19/64	263	327	106.4E	16-34-45	369	81.3ND	16-11	13.9ND	16-31	REV	328	R	DATA PARTLY IN SUNLIGHT.	236
09/19/64	263	328	81.8E	18-13-11	370	76.2NA	17-47	38.4SD	18-24	REV	329	G	DATA PARTLY IN SUNLIGHT.	237
09/19/64	263	329	57.2E	19-51-37	371	77.8NA	19-26	43.7SD	20-04	REV	330	G	DATA PARTLY IN SUNLIGHT.	238
09/19/64	263	330	32.6E	21-30-03	372	76.6NA	21-04	48.8ND	21-17	REV	337	G	DATA PARTLY IN SUNLIGHT.	239
09/20/64	264	333	41.2W	02-25-20	373	42.3ND	02-14	67.7SD	02-45	FWD	337	G	DATA PARTLY IN SUNLIGHT.	235
09/20/64	264	333	41.2W	02-25-20	374	38.5ND	02-15	54.7SD	02-41	REV	338	G	ALL DATA IN DARKNESS.	240
09/20/64	264	334	65.8W	04-03-46	375	72.4SD	04-25	80.1SA	04-31	FWD	338	G	ALL DATA IN SUNLIGHT.	241
09/20/64	264	335	90.4W	05-42-11	376	81.3ND	05-19	8.1ND	05-40	FWD	338	G	DATA PARTLY IN SUNLIGHT.	241
09/20/64	264	339	171.2E	12-15-55	377	79.5ND	11-54	3.4ND	12-15	FWD	344	G	DATA PARTLY IN SUNLIGHT.	242
09/20/64	264	339	171.2E	12-15-55	378	10.7ND	12-13	3.4ND	12-15	FWD	343	R	ALL DATA IN DARKNESS.	243

NIMBUS HIGH RESOLUTION INFRARED RADIATION DATA

CALENDAR DATE	CALENDAR DAY	DATA ORBIT	DESCENDING NODE LONG. (DEG)	DESCENDING NODE TIME (GMT)	DATA BLOCK	HRIR DATA BEGIN LAT. (DEG)	HRIR DATA BEGIN TIME (GMT)	HRIR DATA END LAT. (DEG)	HRIR DATA END TIME (GMT)	PLAY BACK MODE	READ -OUT ORBIT	DAF	REMARKS	NMRT REEL NO.
09/20/64	264	340	146.6E	13-54-20	379	81.4ND	13-31	27.2ND	13-47	FWD	343	R	DATA PARTLY IN SUNLIGHT.	243
09/20/6●	264	340	146.6E	13-54-20	380	81.4ND	13-31	12.3ND	13-51	FWD	344	G	DATA PARTLY IN SUNLIGHT.	2●2
09/20/64	264	342	97.3E	17-11-12	381	74.6ND	16-51	4.4ND	17-10	REV	343	R	DATA PARTLY IN SUNLIGHT.	244
09/20/6●	264	343	72.8E	18-●9-38	382	68.1NA	18-21	43.5SD	19-02	REV	344	G	DATA PARTLY IN SUNLIGHT.	245
09/20/64	264	345	23.5E	22-06-29	383	72.2ND	21-●7	57.4SD	22-23	FWD	349	R	DATA PARTLY IN SUNLIGHT.	246
09/20/64	264	3●5	23.5E	22-06-29	38●	81.1SA	22-33	79.7SA	22-3●	FWD	350	R	ALL DATA IN SUNLIGHT.	247
09/20/64	264	346	1.1W	23-44-55	385	81.2NA	23-21	59.3ND	23-29	FWD	350	R	DATA PARTLY IN SUNLIGHT.	247
09/20/64	264	346	1.1W	23-44-55	386	55.6ND	23-30	7.5SD	23-47	REV	350	R	ALL DATA IN DARKNESS.	2●8
09/20/64	264	346	1.1W	23-44-55	387	11.1SD	23-48	81.3SA	00-11	REV	349	R	DATA PARTLY IN SUNLIGHT.	249
09/21/64	265	347	25.7W	01-23-21	388	80.7NA	00-59	38.4ND	01-13	REV	349	R	DATA PARTLY IN SUNLIGHT.	249
09/21/6●	265	351	124.1W	07-57-04	389	79.2SD	08-21	80.6SA	08-24	REV	353	G	ALL DATA IN SUNLIGHT.	250
09/21/64	265	352	148.7W	09-35-30	390	81.●ND	09-12	75.8SD	09-58	REV	353	G	DATA PARTLY IN SUNLIGHT.	250
09/21/64	265	353	173.3W	11-13-56	391	48.1ND	11-01	3.8SD	11-15	REV	367	G	ALL DATA IN DARKNESS.	251
09/22/6●	266	367	157.7W	10-11-57	392	81.3ND	09-48	73.5ND	09-52	REV	368	G	ALL DATA IN SUNLIGHT.	252
09/22/64	266	367	157.7W	10-11-57	393	62.9ND	09-55	80.6SA	10-39	REV	368	G	DATA PARTLY IN SUNLIGHT.	252
09/22/6●	266	368	177.7E	11-50-23	394	78.9NA	11-25	74.9ND	11-30	REV	368	G	ALL DAT● IN SUNLIGHT.	252
09/22/64	266	368	177.7E	11-50-23	395	16.5SD	11-55	81.1SA	12-17	REV	369	G	DATA PARTLY IN SUNLIGHT.	253
09/22/64	266	369	153.0E	13-28-50	396	81.3ND	13-05	76.2ND	13-08	REV	369	G	ALL DATA IN SUNLIGHT.	253

APPENDIX B

RADIOMETER CALIBRATION

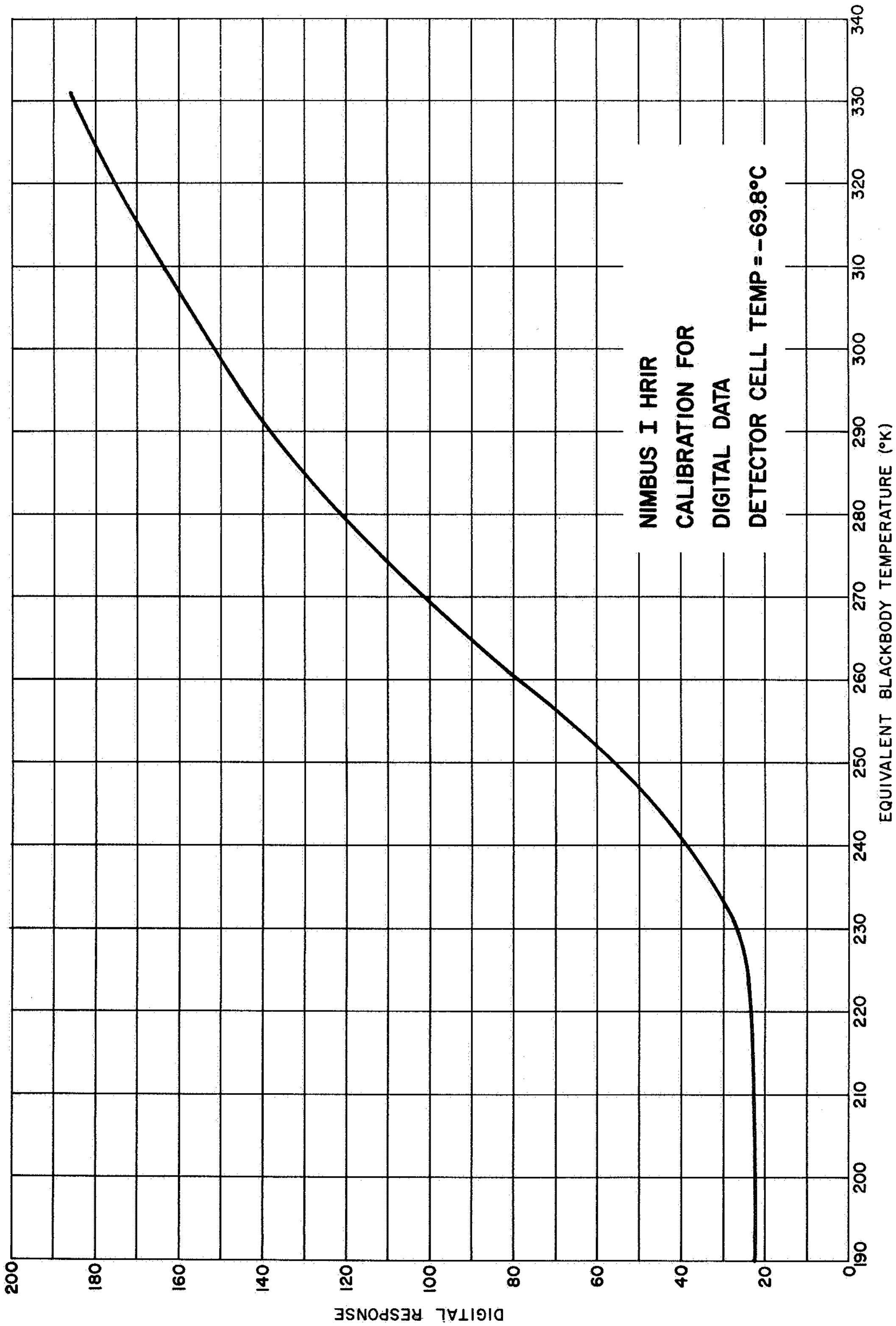

NIMBUS I HRIR
CALIBRATION FOR
DIGITAL DATA
DETECTOR CELL TEMP = -69.8°C
EQUIVALENT BLACKBODY TEMPERATURE (°K)
DIGITAL RESPONSE
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
0
20
40
60
80
100
120
140
160
180
200

Figure B1

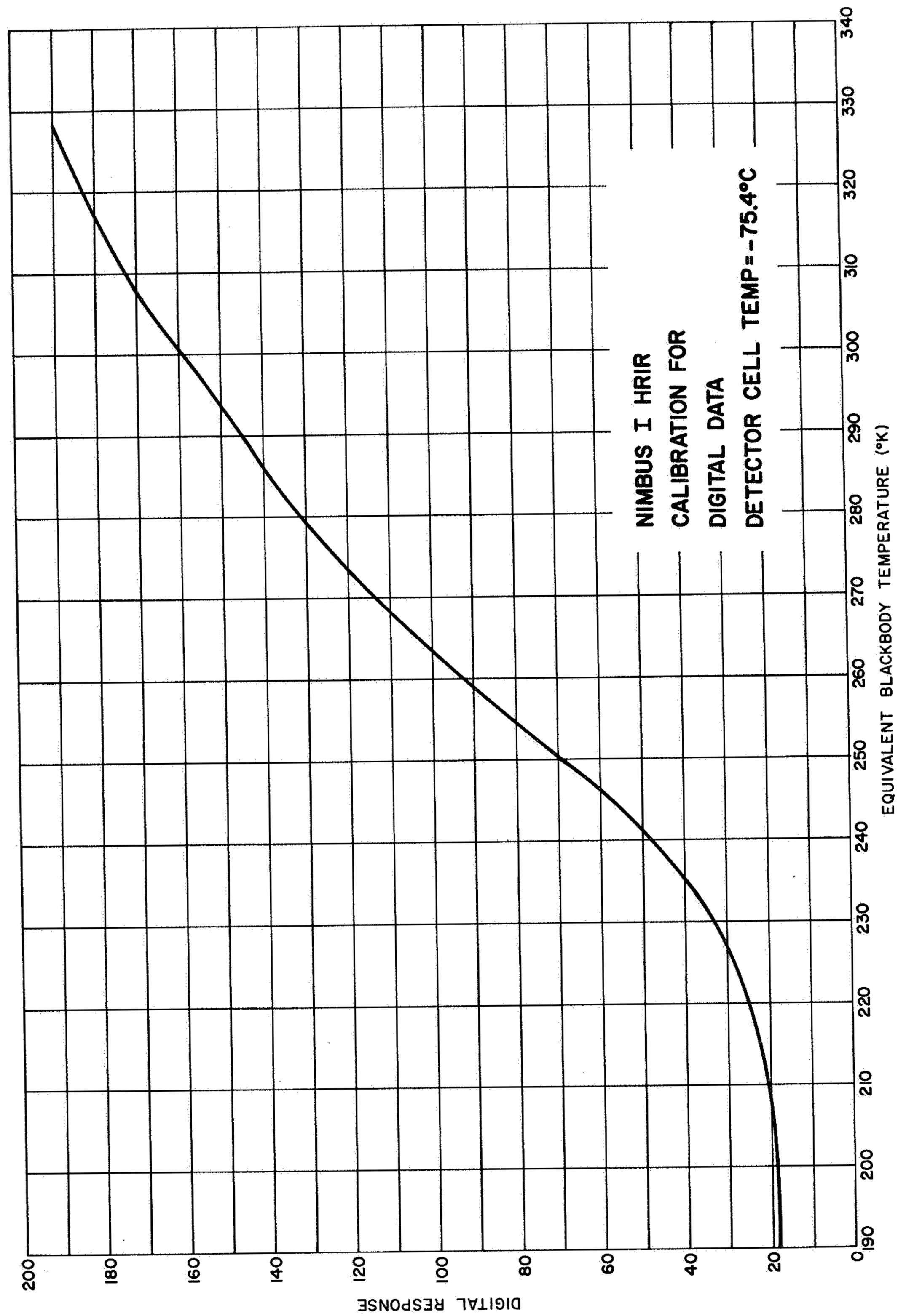

NIMBUS I HRIR
CALIBRATION FOR
DIGITAL DATA
DETECTOR CELL TEMP=-75.4°C
DIGITAL RESPONSE
EQUIVALENT BLACKBODY TEMPERATURE (°K)
0
20
40
60
80
100
120
140
160
180
200
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340

Figure B2

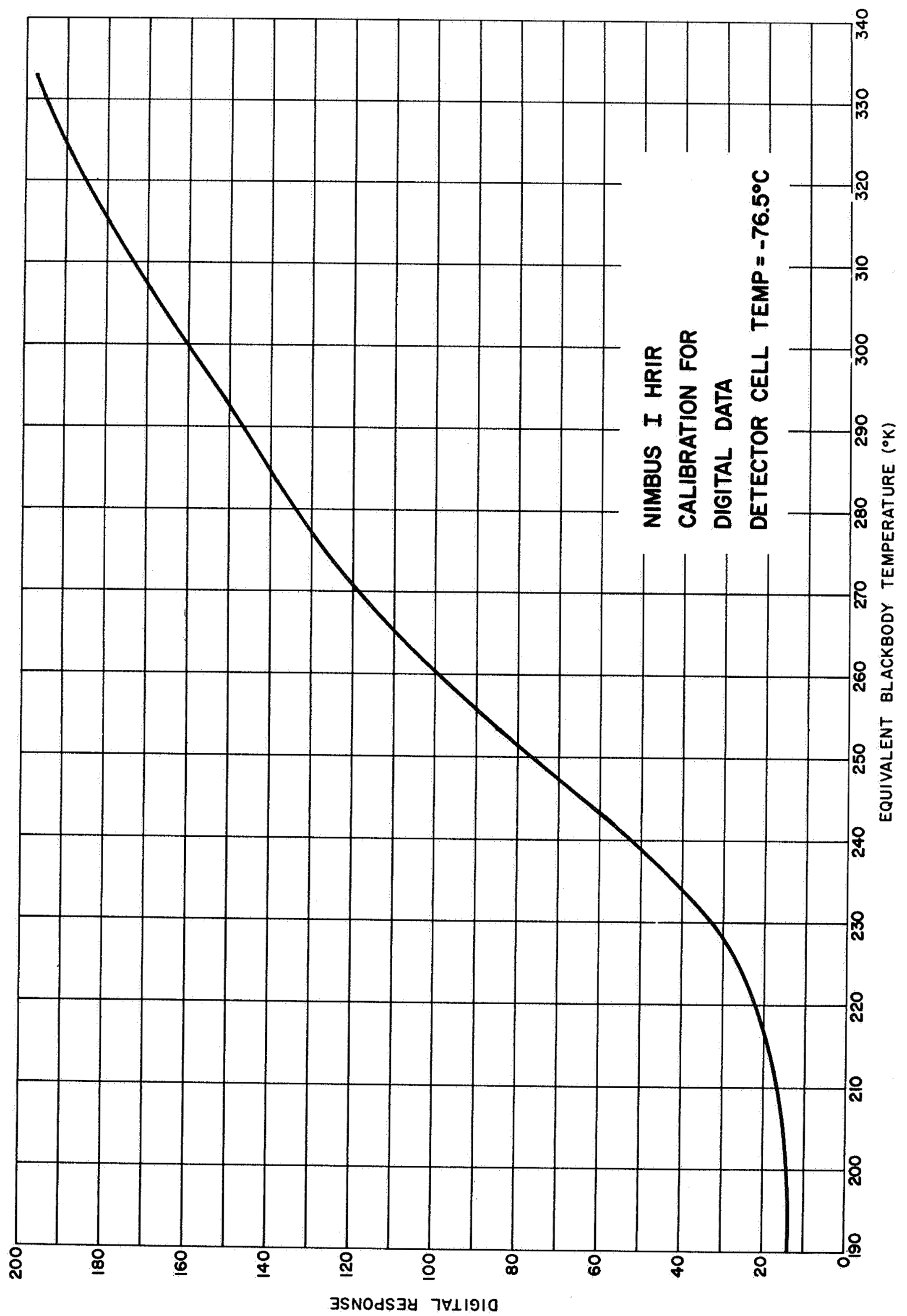

NIMBUS I HRIR
CALIBRATION FOR
DIGITAL DATA
DETECTOR CELL TEMP = -76.5°C
DIGITAL RESPONSE
EQUIVALENT BLACKBODY TEMPERATURE (°K)
0
20
40
60
80
100
120
140
160
180
200
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340

Figure B3

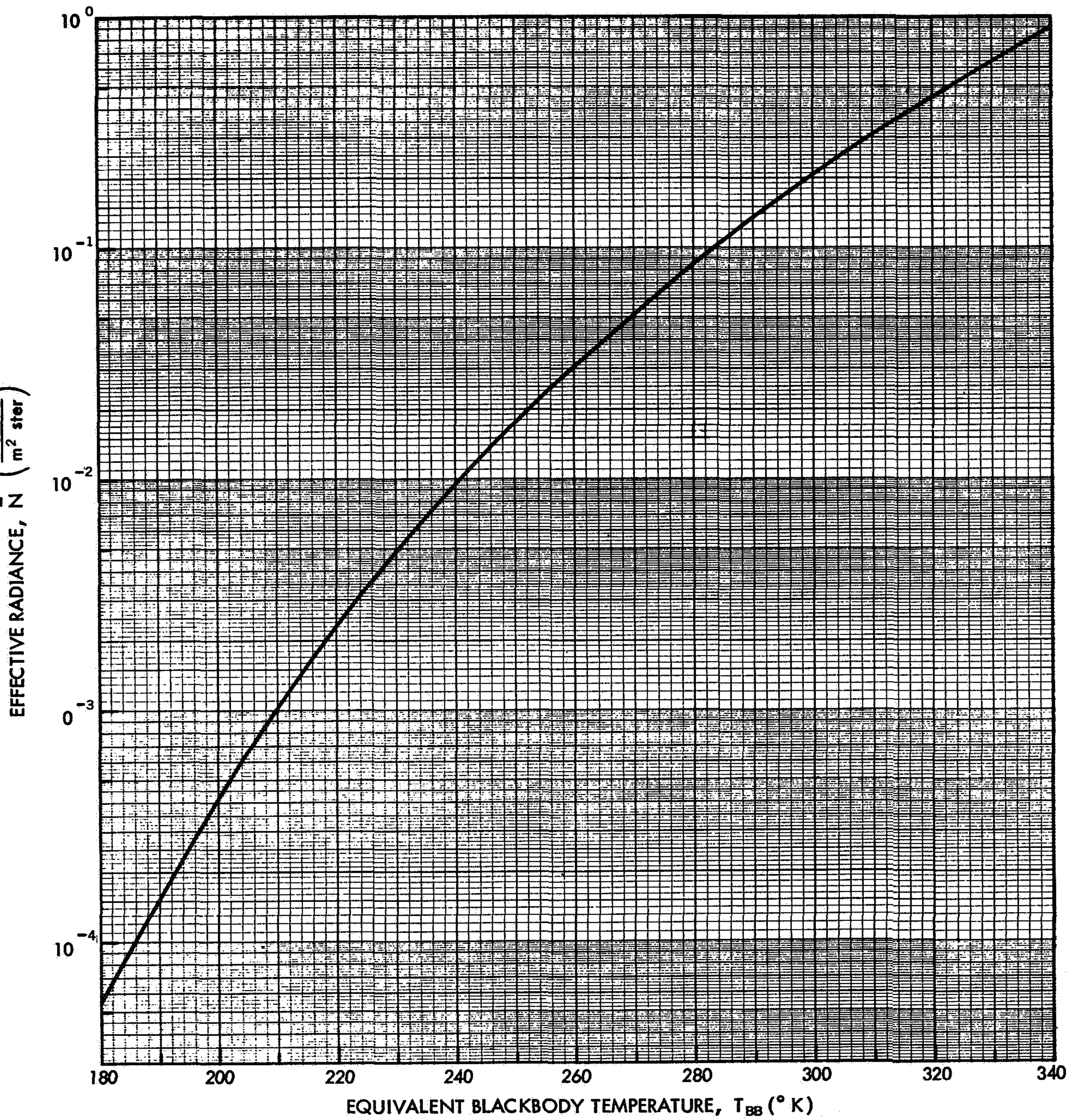


Figure B4–Effective Radiance versus Equilavent Blackbody Temperature

APPENDIX C

GEOGRAPHIC LOCATION OF HRIR DATA

LIST OF SYMBOLS FOR APPENDIX C

R,P,Y - Principal body axes of spacecraft (Figures 2 and 3)

X', Y', Z' - Earth oriented orbit constrained coordinates (Figure C2)

X'', Y'', Z'' - Geocentric orbit coordinates (Figure C2)

θ_R - Satellite roll error in radians (Figure C4)

θ_P - Satellite pitch error in radians (Figure C4)

θ_Y - Satellite yaw error in radians (Figure C4)

$\bar{L}$ - Vector from earth viewed point to origin of spacecraft axes (Figure C2)

ν - Mirror rotation angle (Figure C3)

ϕ_S - Latitude of subsatellite point (Figure C2)

λ_S - Longitude of subsatellite point (Figure C2)

ϕ_P - Latitude of earth viewed point (Figure C2)

λ_P - Longitude of earth viewed point (Figure C2)

$\bar{M}$ - Vector from center of earth to origin of spacecraft axes (Figure C2)

A - Angle between $\bar{M}$ and X'' axis (Figure C2)

i - Inclination of the orbit (Figure C2)

λ_{ANO} - Longitude of ascending node

α_{ANO} - Right ascension of ascending node

∞ - Right ascension

$\bar{R}_E$ - Radius vector of earth (Figure C2)

H - Satellite height, where $M = R_E + H$

$\bar{\ell}$ - Unit vector along $\bar{L}$

$\bar{m}$ - Unit vector along $\bar{M}$

$\bar{i}, \bar{j}, \bar{k}$ - Unit vectors along a set of coordinate axes in the order listed above, respectively. The number of superscripted prime marks indicate the corresponding coordinate set to which the unit vectors refer.

The mathematical procedure used in the NMRT-HRIR program to locate HRIR data on the earth's surface is described in this Appendix. An earth scan of radiation data is defined by a family of mirror nadir angles as illustrated in Figure C1. If the reader considers himself to be at the rear of the spacecraft, then the velocity vector points into the paper and the HRIR radiometer scans the earth in a clockwise direction from right to left.

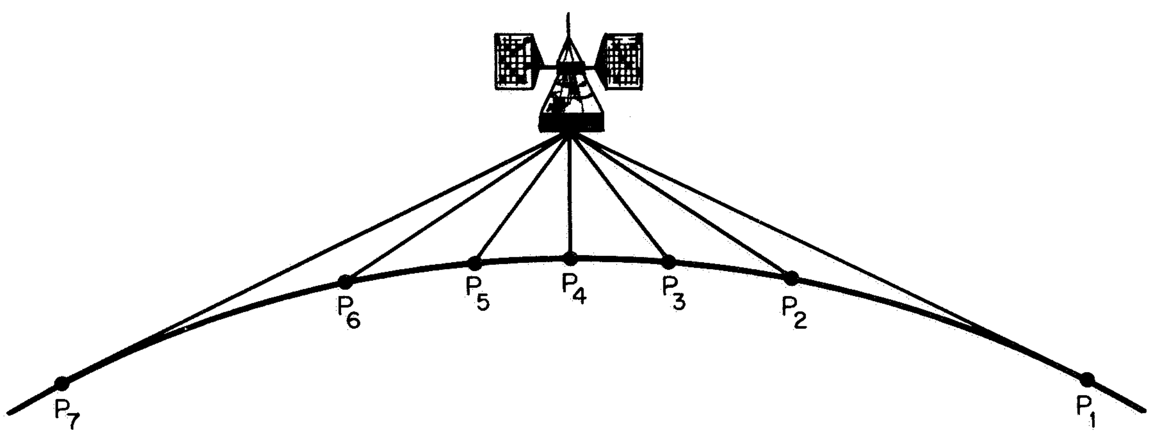


Figure C1

For each mirror angle, the latitude and longitude of the corresponding point on the earth's surface are computed and recorded on the NMRT. The position of individual data samples falling between two anchor points is determined by interpolation.

In order to compute the latitude and longitude of a point on earth corresponding to a particular mirror angle, consider the situation illustrated in Figure C2.

- From Figures 2 and 3, the principal body axes of the spacecraft are R, P, Y.
- From Figure C2, the earth oriented orbit constrained coordinates are X', Y', Z'.
- From Figure C2, the geocentric orbit coordinates are X'', Y'', Z''.

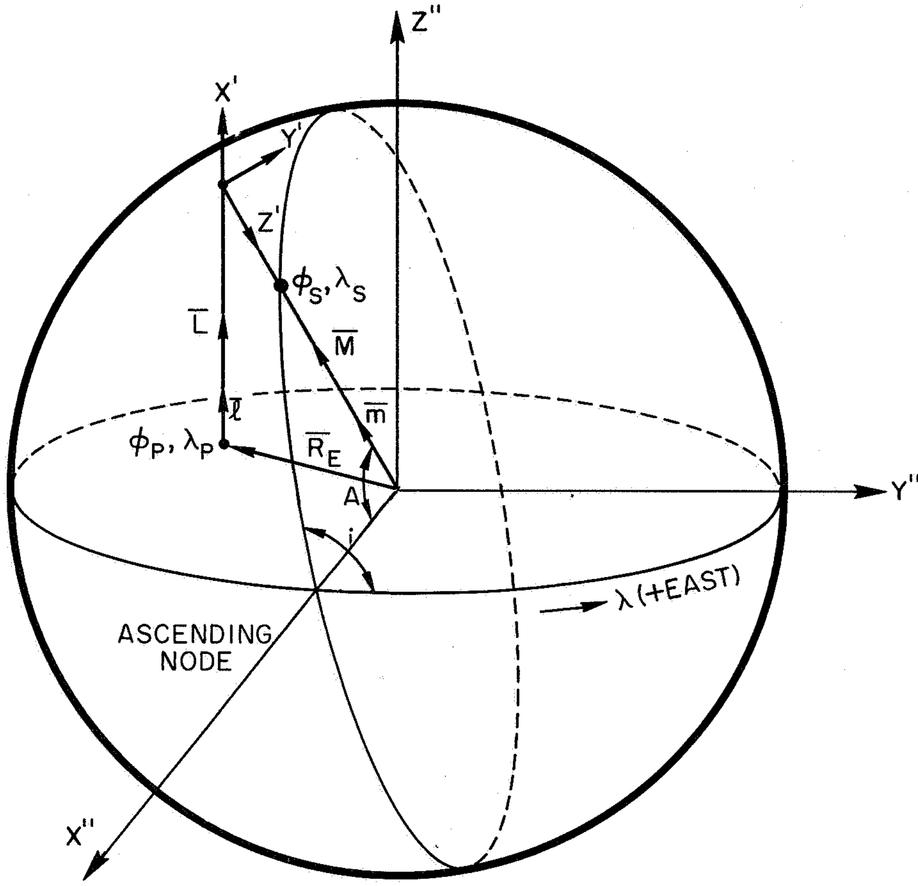


Figure C2

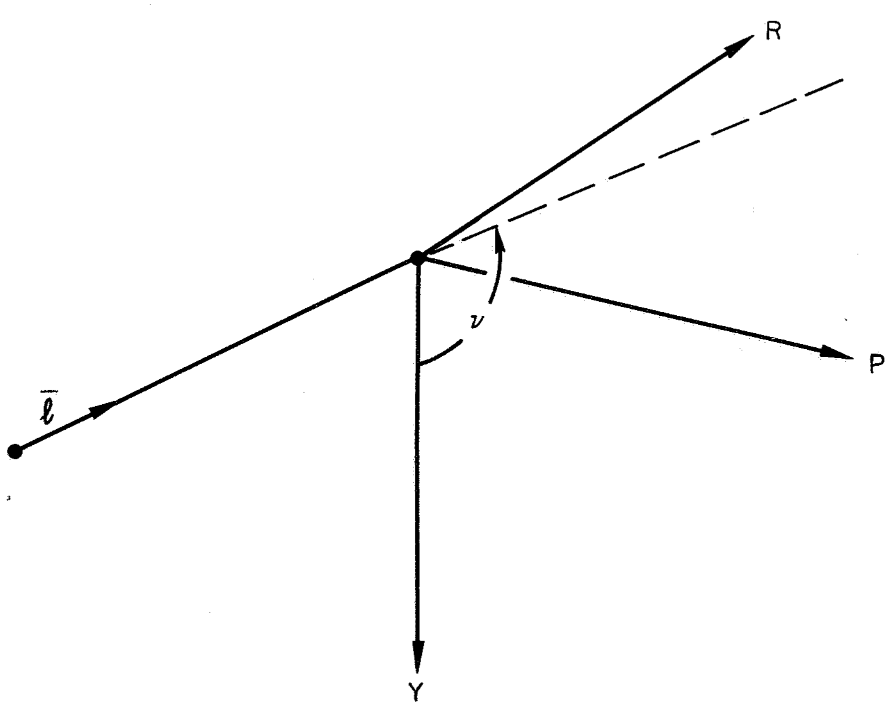


Figure C3

- From Figure C3,

$$\overline{\ell} = \overline{i}\,(0) + \overline{j}\,\sin \nu + \overline{k}\,\cos \nu$$

- From Figure C4, the order of attitude perturbations is

$$\theta_P = \text{satellite pitch error}$$
$$\theta_R = \text{satellite roll error}$$
$$\theta_Y = \text{satellite yaw error}$$

Assuming small angles for attitude errors, θ (radians) = $\sin \theta$.

$$\ell_X' = +\ell_R(1) - \ell_P(\theta_Y) + \ell_Y(\theta_P) \tag{1}$$

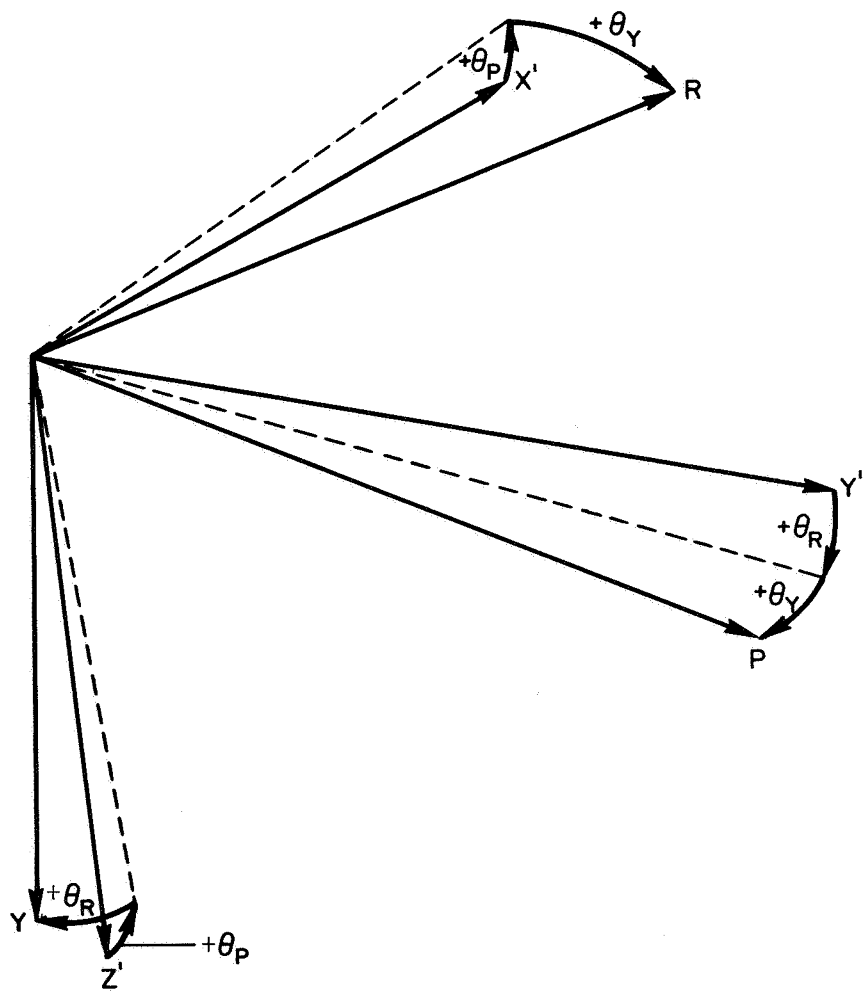


Figure C4

$$\ell_Y' = +\ell_R(\theta_Y) + \ell_P(1) - \ell_Y(\theta_R) \quad (2)$$

$$\ell_Z' = -\ell_R(\theta_P) + \ell_P(\theta_R) + \ell_Y(1) \quad (3)$$

$$\ell_X'' = -\ell_X' \sin A - \ell_Z' \cos A \quad (4)$$

$$\ell_Y'' = \ell_X' \cos A \cos i + \ell_y' \sin i - \ell_Z' \sin A \cos i \quad (5)$$

$$\ell_Z'' = \ell_X' \cos A \sin i - \ell_y' \cos i - \ell_Z' \sin A \sin i \quad (6)$$

Substituting the expressions for ℓ_X', ℓ_Y', and ℓ_Z' from equations 1, 2, and 3 into equations 4, 5, and 6 yields the following relationships

$$\ell_X'' = -[\ell_R - \ell_P\theta_Y + \ell_Y\theta_P] \sin A - [-\ell_R\theta_P + \ell_P\theta_R + \ell_Y] \cos A \quad (7)$$

$$\ell_Y'' = [\ell_R - \ell_P\theta_Y + \ell_Y\theta_P] \cos A \cos i + [\ell_R\theta_Y + \ell_P - \ell_Y \theta_R] \sin i$$

$$- [-\ell_R\theta_P + \ell_P\theta_R + \ell_Y] \sin A \cos i \quad (8)$$

$$\ell_Z'' = [\ell_R - \ell_P\theta_Y + \ell_Y\theta_P] \cos A \sin i - [\ell_R\theta_Y + \ell_P - \ell_Y \theta_R] \cos i$$

$$- [-\ell_R\theta_P + \ell_P\theta_R + \ell_Y] \sin A \sin i \quad (9)$$

Finally, equations 7, 8, and 9 can be expressed as follows:

$$\ell_X'' = (\theta_Y \sin \nu - \theta_P \cos \nu) \sin A$$

$$- (\theta_R \sin \nu + \cos \nu) \cos A \quad (10)$$

$$\ell_Y'' = (-\theta_Y \sin \nu + \theta_P \cos \nu) \cos A \cos i$$

$$+ (\sin \nu - \theta_R \cos \nu) \sin i$$

$$- (\theta_R \sin \nu + \cos \nu) \sin A \cos i \quad (11)$$

$$\ell_Z'' = (-\theta_Y \sin\nu + \theta_P \cos\nu)\cos A \sin i$$
$$-(\sin\nu - \theta_R \cos\nu)\cos i$$
$$-(\theta_R \sin\nu + \cos\nu)\sin A \sin i \tag{12}$$

From equations 10, 11, and 12 the following expression is derived for $\overline{\ell}$

$$\overline{\ell} = \overline{i}''[(\theta_Y \sin\nu - \theta_P \cos\nu)\sin A - (\theta_R \sin\nu + \cos\nu)\cos A]$$
$$+\overline{j}''[(-\theta_Y \sin\nu + \theta_P \cos\nu)\cos A \cos i + (\sin\nu - \theta_R \cos\nu)\sin i$$
$$-(\theta_R \sin\nu + \cos\nu)\sin A \cos i]$$
$$+\overline{k}''[(-\theta_Y \sin\nu + \theta_P \cos\nu)\cos A \sin i$$
$$-(\sin\nu - \theta_R \cos\nu)\cos i$$
$$-(\theta_R \sin\nu + \cos\nu)\sin A \sin i] \tag{13}$$

Also,

$$\overline{m} = \overline{i}''\cos A + \overline{j}''\sin A \cos i + \overline{k}''\sin A \sin i \tag{14}$$

and

$$M = R + H \tag{15}$$

From Figure C5,

$$\overline{L}\cdot\overline{M} = LM\cos N$$

where

$$N = 180° - \nu$$

$$\sin^2 N + \cos^2 N = 1$$

$$\sin N = \sqrt{1 - \cos^2 N}$$

$$\sin N = \sqrt{1 - (\ell_x'' m_x'' + \ell_y'' m_y'' + \ell_z'' m_z'')^2} \tag{16}$$

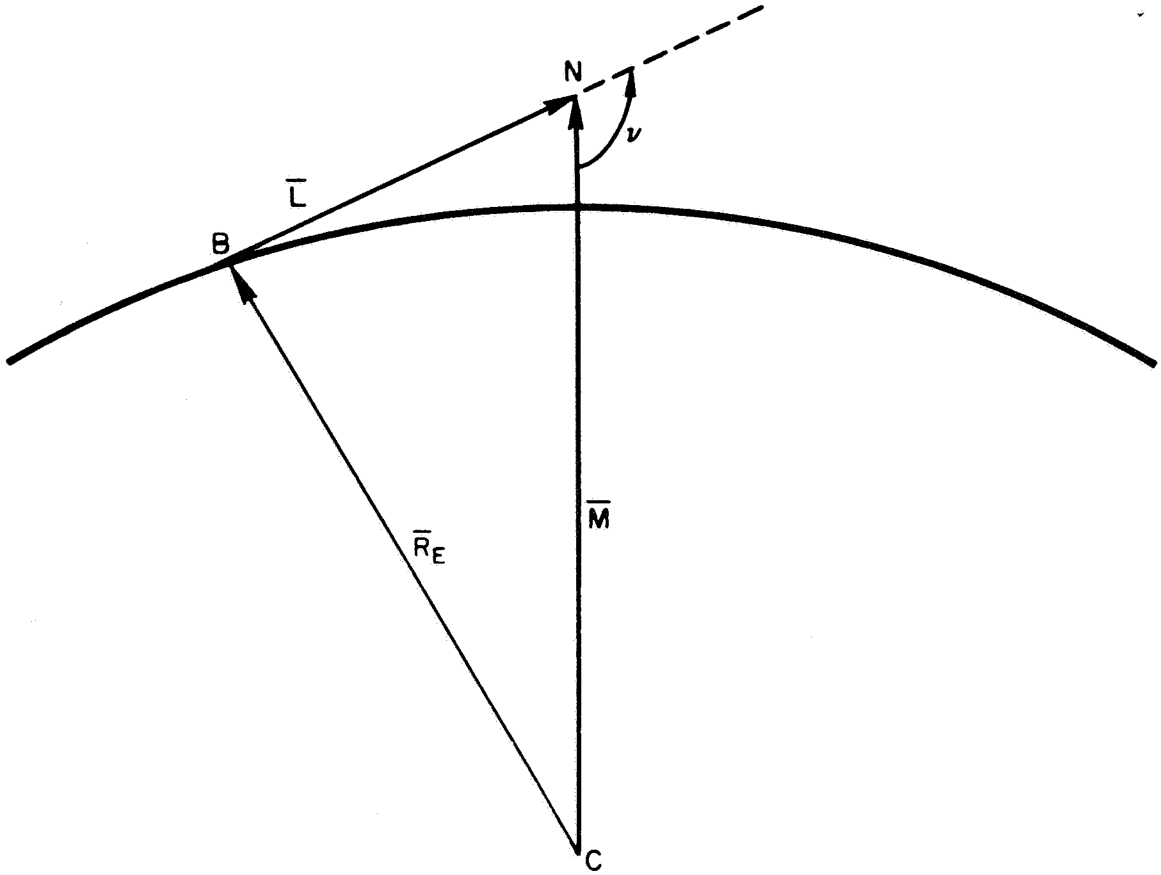


Figure C 5

$$\frac{R_E}{\sin N} = \frac{M}{\sin B}$$

$$\sin B = \frac{M}{R_E} \sin N$$

$$\sin B = \frac{M}{R_E} \sqrt{1 - (\ell''_x m''_x + \ell''_y m''_y + \ell''_z m''_z)^2} \tag{17}$$

$$\cos N = \sqrt{1 - \sin^2 N}$$

$$\cos N = \sqrt{(\ell''_x m''_x + \ell''_y m''_y + \ell''_z m''_z)^2} \tag{18}$$

$$\cos B = \sqrt{1 - \sin^2 B}$$

$$\cos B = \sqrt{1 - \frac{M^2}{R_E^2} \left[1 - (\ell''_x m''_x + \ell''_y m''_y + \ell''_z m''_z)^2\right]} \tag{19}$$

$$L = \frac{R_E}{\sin N} \sin (B + N)$$

$$\sin(B + N) = \sin B \cos N + \cos B \sin N$$

$$L = \frac{R_E}{\sin N} [\sin B \cos N + \cos B \sin N]$$

$$L = \frac{R_E}{\sin N} \left[\sin B \sqrt{1 - \sin^2 N} + \sin N \sqrt{1 - \sin^2 B}\right] \tag{20}$$

$$L = \frac{R_E}{\sin N} \left[\frac{M}{R_E} \sqrt{1 - (\ell''_x m''_x + \ell''_y m''_y + \ell''_z m''_z)^2} \cdot (\ell''_x m''_x + \ell''_y m''_y + \ell''_z m''_z) + \sqrt{1 - (\ell''_x m''_x + \ell''_y m''_y + \ell''_z m''_z)^2} \cdot \sqrt{1 - \frac{M^2}{R_E^2} [1 - (\ell''_x m''_x + \ell''_y m''_y + \ell''_z m''_z)^2]} \right] \tag{21}$$

$$L = M \left[(\ell''_x m''_x + \ell''_y m''_y + \ell''_z m''_z) \pm \sqrt{(\ell''_x m''_x + \ell''_y m''_y + \ell''_z m''_z)^2 + \frac{R_E^2}{M^2} - 1} \right] \tag{22}$$

If the expression under the radical in equation 22 is negative, there is no intersection with the earth. Furthermore,

$$\cos B = \pm \sqrt{1 - \sin^2 B} = \pm \sqrt{1 - \frac{M^2}{R_E^2} [1 - (\ell''_x m''_x + \ell''_y m''_y + \ell''_z m''_z)^2]} \tag{23}$$

From Figure C5 it can be seen that angle B is always equal to or greater than 90 degrees. Therefore cos B is always negative or zero. In equation 22 the second term is always subtracted from the first term. (The addition of the second term pertains to the intersection of the optical axis with the "other side" of the earth, a solution which is of no interest here.)

From Figure C2, it follows that

$$R_{Z''} = M_{Z''} - L_{Z''}$$

$$R_{Z''} = M_{Z''} - \ell_{Z''} L$$

$$\ell_{Z''} L = M_{Z''} - R_{Z''} \tag{24}$$

where for clarity $R_{Z''}$ is the Z component of the radius of the earth (R_E).

Now

$$M_z = M \sin \phi_s$$

$$R_z = R_E \sin \phi_P$$

Equation 24 can now be written as

$$\ell_Z'' L = M \sin \phi_s - R_E \sin \phi_P$$

$$R_E \sin \phi_p = M \sin \phi_s - \ell_Z'' L$$

Finally, the equation for determining the latitude of the viewed point, ϕ_P, becomes

$$\sin \phi_P = \frac{M \sin \phi_S - \ell_Z'' L}{R_E} \tag{25}$$

The projection of $\overline{R}_E$ in the $X'' Y''$ plane is

$$\overline{i}''(m_x'' M - \ell_x'' L) + \overline{j}''(m_y'' M - \ell_y'' L)$$

The projection of $\overline{M}$ in the $X'' Y''$ plane is

$$\overline{i}'' m_x'' M + \overline{j}'' m_y'' M$$

$$\sin \mu = \frac{m_y'' M}{M \cos \phi_S} = \frac{m_y''}{\cos \phi_S}$$

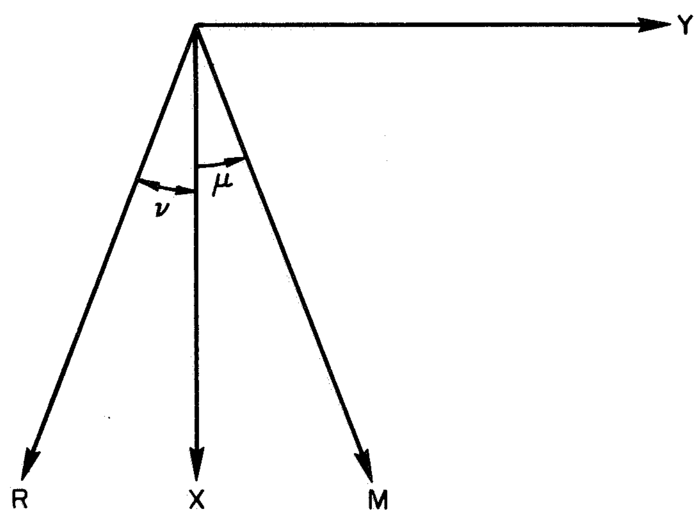


Figure C6

$$\cos \mu = \frac{m_x''}{\cos \phi_S}$$

$$\sin \nu = \frac{m_y'' M - \ell_y'' L}{R \cos \phi_P}$$

$$\cos \nu = \frac{m_x'' M - \ell_x'' L}{R \cos \phi_P}$$

$$\sin(\nu - \mu) = \sin \nu \cos \mu - \cos \nu \sin \mu$$

$$= \sin(\lambda_P - \lambda_S)$$

$$\sin(\lambda_P - \lambda_S) = \left(\frac{m_y'' M - \ell_y'' L}{R \cos \phi_P}\right)\left(\frac{m_x''}{\cos \phi_S}\right) - \left(\frac{m_x'' M - \ell_x'' L}{R \cos \phi_P}\right)\left(\frac{m_y''}{\cos \phi_S}\right) \tag{26}$$

$$\sin(\lambda_P - \lambda_S) = \frac{m_x'' m_y'' M - m_x'' \ell_y'' L - m_y'' m_x'' M + m_y'' \ell_x'' L}{R \cos \phi_P \cos \phi_S} \tag{27}$$

Finally, the equation for determining the longitude (positive east) of the viewed point, λ_p, becomes

$$\sin(\lambda_p - \lambda_S) = \frac{L(m_y'' \ell_x'' - m_x'' \ell_y'')}{R \cos \phi_P \cos \phi_S} \tag{28}$$

APPENDIX D

HRIR RAW DATA TAPE FORMAT

The format of the raw HRIR digitized data is described in detail in this section. This tape, produced on the CDC 924 computer in the Nimbus Data Handling System, has been described further in Section 4.2 of this Manual.

Documentation Record

IBM Word	CDC Word	Characters	Quantity
1	1	1-2	Satellite Identification
		3	File Number
		4	Total number of files obtained from this interrogation.
	2	5	Blank
		6	Zero = Backward Mode Data $(77)_8$ = Forward Mode Data
2		7-8	Blank
	3	9-12	Orbit Number
3	4	13-14	Year
		15-16	Blank
	5	17-18	Day of Interrogation (Day of year specified in characters 13-14)
4		19-20	CDA Station Identification
	6	21-24	Data sampling frequency
5	7	25	Sync pulse count
		26-27	Blank
		28	Month (Date data is digitized)
	8	29	Day (Date data is digitized)
		30	Year (Date data is digitized)

IBM Word	CDC Word	Characters	Quantity
6		31	Overflow Tape Flag—Normally this character will be binary zeroes. If the tape is an overflow tape, this character will be octal 77.
		32	This field indicates the setting of the hardware flywheel bandwidth in cycles per second. (0 = 100 cps, 1 = 500 cps, 2 = 1000 cps).
	9	33-36	The time correction factor in seconds to be added to the vehicle time.
7	10	37-39	The assigned digital tape number for each run.
	11	40-42	The number of the analog tape from which the data were obtained
		43-44	$(7777)_8$ (Code)
8	12	45-48	$(77777777)_8$ (Code)

Documentation Record Format

<table>
<tr><td>1</td><td>SAT.</td><td>I. D.</td><td>DATA DIRECTION THIS FILE</td><td>ANALOG DATA DIRECTION CODE</td><td>BLANK</td><td>ZERO OR $(77)_8$</td></tr>
<tr><td>2</td><td>BLANK</td><td>BLANK</td><td colspan="4">ORBIT NUMBER</td></tr>
<tr><td>3</td><td colspan="2">YEAR</td><td>BLANK</td><td>BLANK</td><td colspan="2">DAY OF YEAR</td></tr>
<tr><td>4</td><td colspan="2">STATION I. D.</td><td colspan="4">DATA SAMPLING FREQUENCY</td></tr>
<tr><td>5</td><td>SYNC PULSE COUNT</td><td>BLANK</td><td>BLANK</td><td>MM</td><td>DD</td><td>YY</td></tr>
<tr><td>6</td><td>OVERFLOW TAPE</td><td>BANDWIDTH</td><td colspan="4">TIME OFFSET</td></tr>
<tr><td>7</td><td colspan="3">DIGITAL TAPE NUMBER</td><td colspan="3">ANALOG TAPE NUMBER</td></tr>
<tr><td>8</td><td>77</td><td>77</td><td>77</td><td>77</td><td>77</td><td>77</td></tr>
</table>

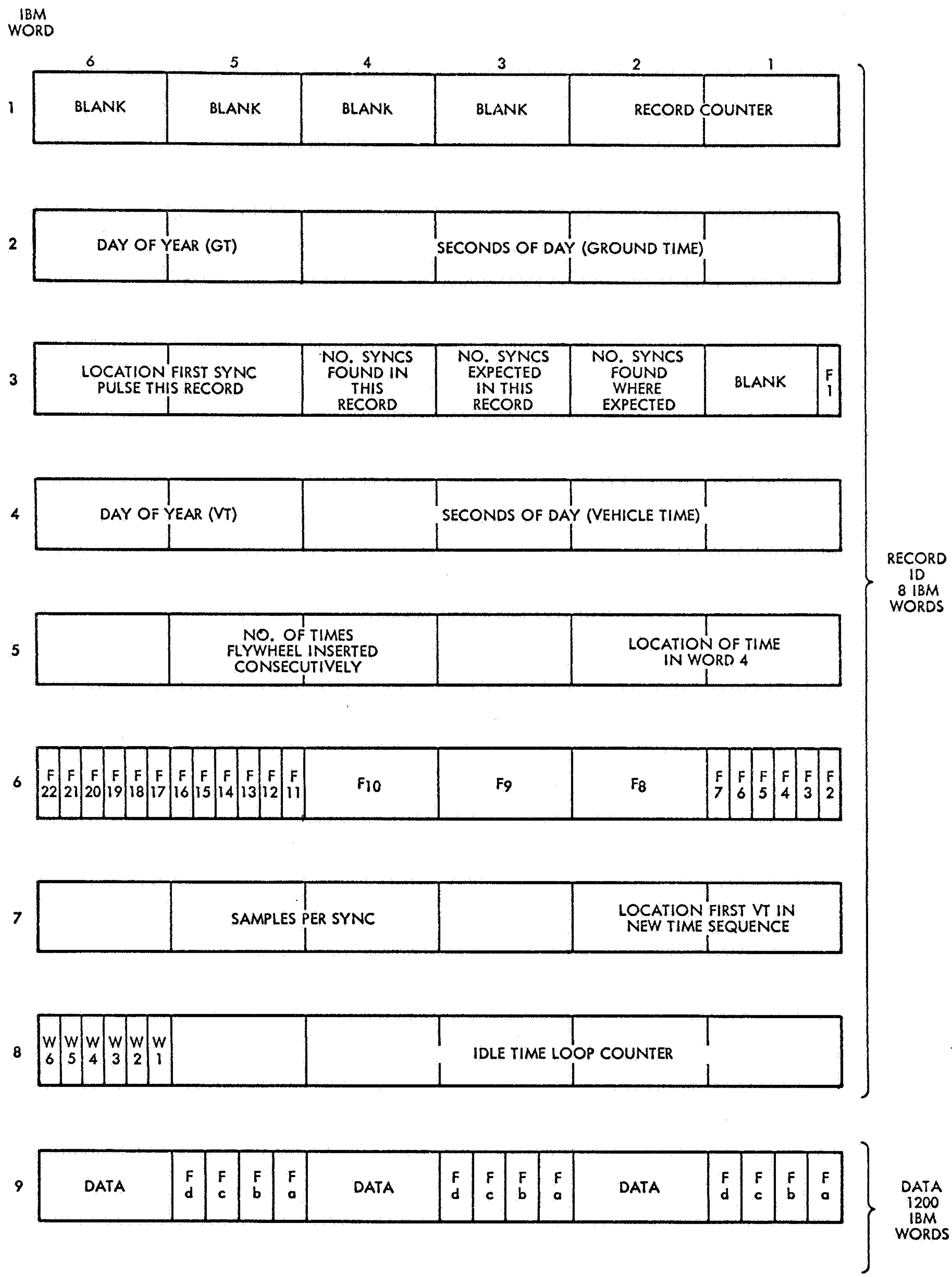
Data Records

IBM Word	CDC Word	Character	Quantity
1	1	1-4	Blank
	2	5-6	Record Sequence counter
2		7-8	Day of Year (Ground Time)
	3	9-12	Seconds of day (Ground Time)
3	4	13-14	Location of first Sync pulse in this record
		15	Number of Sync pulses found in this record
		16	Number of Sync pulses expected in this record
	5	17	Number of Sync pulses which occurred where expected
		18	F_1 = 0, sync pulse is satisfactory F_1 = 1, sync pulse is not satisfactory
4		19-20	Day of year (Vehicle Time)
	6	21-24	Seconds of day (Vehicle Time)
5	7	25-28	Number times flywheel inserted consecutively in this record for vehicle time
	8	29-30	Location in this record of the time specified in characters 21-24
6		31-32	F_{22} = 1 Summary bit. Vehicle time, ground time, sync and/or record continuity not okay. F_{22} = 0 Summary bit. Vehicle time, ground time, sync okay. F_{21} = 0 Vehicle time sampling rate consistent. F_{21} = 1 Vehicle time sampling rate not consistent.

IBM Word	CDC Word	Character	Quantity
			F_{20} = 0 FM data carrier always present F_{20} = 1 FM data carrier dropout occurred.
			F_{19} = 0 Ground time is noisy F_{19} = 1 Ground time has skipped
			F_{18} = 0 Ground time as decoded F_{18} = 1 Ground time is discontinuous (noisy or skipped)
			F_{17} = 0 Not end of satellite tape F_{17} = 1 End of satellite tape (tape track change)
			$\left.\begin{array}{l}F_{16}\\F_{15}\\F_{14}\\F_{13}\\F_{12}\end{array}\right\}$ not assigned at present time
			F_{11} = 0 Jump in vehicle time is not 58 minutes F_{11} = 1 Approximately 58 minutes jump in vehicle time
	9	33	F_{10} = number of words in which at least one invalid character detected in decoding time word
		34	F_9 = Number of words in which character sync was not found for at least one character in time word
		35	F_8 = Number of words in which frame sync interrupt occurred, but not when expected
		36	F_7 = unassigned F_6 = unassigned
			F_5 = 0, normal data F_5 = 1, no frame sync interrupt by hardward occurred in this record (if F_2 = 1)

IBM Word	CDC Word	Character	Quantity
			F_4 = 0, carrier present F_4 = 1, carrier absent somewhere in this record (if F_2 = 1) F_3 = 0, vehicle time is continuous F_3 = 1, vehicle time has skipped in this record F_2 = 0, vehicle time is good throughout this record F_2 = 1, vehicle time is questionable in this record (Error has been detected 3 times)
7	10	37-40	Assigned for hardware testing
	11	41-42	Assigned for hardware testing
8		43-44	Assigned for hardware testing
	9	45-48	Assigned for hardware testing
9	10	49-50	HRIR Data
		51-52	HRIR Data
	11	53-54	HRIR Data

Data Record Format



APPENDIX E

SELECTED ENGINEERING DATA TAPE (SEDT)
IBM 7094 FORMAT

The Nimbus Selected Engineering Data Tape (IBM 7094 Format) will contain between 100 and 150 orbits of selected engineering data on each reel of magnetic tape. A detailed description of the format of this tape follows.

1. The tape will be high density, 556 bpi.

2. The first file contains one 453 word record which documents the contents of the entire reel of tape.

3. Each file after the first file contains the selected engineering data obtained upon interrogation of the spacecraft. The following three types of records are found within this file.

   a. Type I records contain 27 words and are identified by the code word $(010101010101)_8$. This record is the first record of each file and documents the contents of that data file.

   b. Type II rcords contain 281 words and are identified by the code word $(020202020202)_8$. These records contain the selected engineering data specified in the Type I record. Each record contains data from 9 major frames of telemetry data.

   c. Type III records contain 281 words and are identified by the code word $(030303030303)_8$. These records contain roll, pitch, and yaw errors corresponding to shutter times.

4. In the event of bad data or poor transmission, the bad data will be omitted from this tape. In these cases, time will not be continuous in Type II records.

5. When the telemetry data is not a multiple of 9 frames, the last Type II record will contain zeros to maintain a constant record size of 281 words.

6. Type III records contain attitude errors associated with a maximum of 70 shutter times. Since the number of pictures per orbit will normally be less than 70, the unused words will contain zeroes. The attitude errors will begin with word number 72 for the first shutter time.

File I – Tape Documentation File

Word No.	Quantity	Units	Scaling	Remarks
1D	Satellite Identification	---	B = 17	---
1A	Number of data files	---	B = 35	Total number of data files recorded on a particular reel of tape.
2D	Orbit Number	---	B = 17	Orbit number corresponding to first data file on this tape.
2A	Date	MMDDYY	B = 35	Date of interrogation for this orbit, i.e., February 5, 1964 would be $(020564)_{10}$ or $(020504)_8$. Only the last digit of the year is retained.
3D	Orbit Number	---	B = 17	Orbit number corresponding to last data file on this tape.
3A	Date	MMDDYY	B = 35	Date of interrogation for this orbit, only the last digit of the year is retained.
4D	Blank	---	---	---
4A	Orbit Number	---	B = 35	Readout orbit number for the first file of data
5D	Date of Interrogation	---	B = 17	Day of year for interrogation of this orbit
5A	Hour	Z Hour	B = 35	Time of interrogation for this orbit
6D	Minute	Z Minute	B = 17	
6A	Seconds	Z Seconds	B = 35	
451D	Blank	---	---	---
451A	Orbit Number	---	B = 35	Readout orbit number for a particular file of data

Word No.	Quantity	Units	Scaling	Remarks
452D	Date of Interrogation	---	B = 17	Day of Year for interrogation of this orbit
452A	Hour	Z Hour	B = 35	Time of interrogation for this orbit
453D	Minute	Z Minute	B = 17	
453A	Seconds	Z Seconds	B = 35	

File I – Tape Documentation File

1	SAT. I.D. NO. DATA FILES
2	ORBIT NUMBER MM DD YY
3	ORBIT NUMBER MM DD YY
4	ORBIT NUMBER
5	DAY OF YEAR HOUR
6	MINUTE SECONDS
⋮	
451	ORBIT NUMBER
452	DAY OF YEAR HOUR
453	MINUTE SECONDS

Selected Engineering Data File – Documentation Record

Word No.	Quantity	Units	Scaling	Remarks
1	Code	---	---	$(010101010101)_8$. Code indicating this record is a documentation record for this file
2	Date	MMDDYY	B = 35	Date of interrogation for this orbit. Only the last digit of the year is retained
3	Day of year	---	B = 35	Actual day of playback
4	Orbit number	---	B = 35	Orbit number at time of interrogation
5	Hour	Z Hour	B = 35	Interrogation time
6	Minute	Z Minute	B = 35	Interrogation time
7	Seconds	Z Seconds	B = 35	Interrogation time
8	Function number	F_1	B = 35	Selected function numbers for this orbit in the order they appear in the following data records
.				
.				
.				
.				
.				
.				
.				
.				
27	Function number	F_{20}	B = 35	

Selected Engineering Data File – Documentation Record

1	01	01	01	01	01	01
2				MM	DD	YY
3			DAY	OF		YEAR
4				ORBIT	NUMBER	
5					HOUR	
6					MINUTE	
7					SECONDS	
8					FUNCTION NO.	
⋮						
27					FUNCTION NO.	

Selected Engineering Data File – Data Records (Type II)

Word No.	Quantity	Units	Scaling	Remarks
1	Code	---	---	$(020202020202)_8$. Code indicating this record contains selected engineering data
2	Day	---	B = 35	Actual day of year
3	Hour	Z Hour	B = 35	Time of day, i.e. first time slot in this major frame
4	Minute	Z Minute	B = 35	
5	Seconds	Z Seconds	B = 35	
6	Offset	---	Fl. Pt.	Yaw Offset
7	Roll error	---	Fl. Pt.	Attitude errors from minor frames 1 - 8
8	Pitch error	---	Fl. Pt.	
9	Yaw error	---	Fl. Pt.	
10	Roll error	---	Fl. Pt.	Attitude errors from minor frames 9 - 16
11	Pitch error	---	Fl. Pt.	
12	Yaw error	---	Fl. Pt.	
13	Function 1	---	Fl. Pt.	Value of functions
14	Function 2	---	Fl. Pt.	Value of functions
. . . .			. . . .	
32	Function 20	---	Fl. Pt.	
33-63	---	---	---	Repeat of words 2-32 for next major frame
64-94	---	---	---	Repeat of words 2-32 for next major frame

Word No.	Quantity	Units	Scaling	Remarks
95-125	---	---	---	Repeat of words 2-32 for next major frame
126-156	---	---	---	Repeat of words 2-32 for next major frame
157-187	---	---	---	Repeat of words 2-32 for next major frame
188-218	---	---	---	Repeat of words 2-32 for next major frame
219-249	---	---	---	Repeat of words 2-32 for next major frame
250-280	---	---	---	Repeat of words 2-32 for next major frame
281	Code word	---	---	$(252525252525)_8$. Code word indicating end of record

Selected Engineering Data File – Data Records (Type II)

1	02 02 02 02 02 02
2	DAY OF YEAR
3	HOUR
4	MINUTE
5	SECONDS
6	OFFSET (FL. PT.)
7	ROLL ERROR (FL. PT.)
8	PITCH ERROR (FL. PT.)
9	YAW ERROR (FL. PT.)

Selected Engineering Data File – Data Records (Type II) (Cont'd)

10	ROLL ERROR (FL. PT.)					
11	PITCH ERROR (FL. P T.)					
12	YAW ERROR (FL. P T.)					
13	1 st FUNCTION					
¦						
32	20 th FUNCTION					
¦						
281	25	25	25	25	25	25

Selected Engineering Data File – Data Records (Type III)

Word No.	Quantity	Units	Scaling	Remarks
1	Code	---	---	$(030303030303)_8$. Code word indicating this is a type 3 record
2	Hour	Z Hour	B = 23	Shutter time
2	Minute	Z Minute	B = 29	
2	Seconds	Z Seconds	B = 35	
.				
.				
.				
.				
71	Hour	Z Hour	B = 23	Shutter time
71	Minute	Z Minute	B = 29	
71	Seconds	Z Seconds	B = 35	
72	Roll error	---	Fl. Pt.	Attitude errors for first shutter time
73	Pitch error	---	Fl. Pt.	
74	Yaw error	---	Fl. Pt.	
75	Roll error	---	Fl. Pt.	Attitude errors for second shutter time
76	Pitch error	---	Fl. Pt.	
77	Yaw error	---	Fl. Pt.	
.				
.				
.				
.				
279	Roll error	---	Fl. Pt.	Attitude errors for 70th shutter time
280	Pitch error	---	Fl. Pt.	
281	Yaw error	---	Fl. Pt.	

Selected Engineering Data File – Data Records (Type III)

Record						
1	03	03	03	03	03	03
2				HH	MM	SS
⋮						
71				HH	MM	SS
72	ROLL ERROR (FL. PT.)					
73	PITCH ERROR (FL. PT.)					
74	YAW ERROR (FL. PT.)					
⋮						
279	ROLL ERROR (FL. PT.)					
280	PITCH ERROR (FL. PT.)					
281	YAW ERROR (FL. PT.)					

APPENDIX F

NIMBUS METEOROLOGICAL RADIATION TAPE – HRIR (NMRT-HRIR) FORMAT

The Nimbus Meteorological Radiation Tape – HRIR will be the basic repository for radiation data from the Nimbus High Resolution Infrared Radiometer. This tape will contain data in binary mode at a density of 800 bits per inch.

The first file on this tape contains a BCD label. The label consists of fourteen words of BCD information followed by an end of file.

The remaining files on this tape contain HRIR data in the format described on the following pages. The first record in this data file is a documentation record which describes the data to be found in the succeeding records. This record contains seventeen words. The remaining records in the file will be of variable length, but this length will be consistent within the file. The length (L) of a data record can be computed as follows:

$$L = (\text{SWATHS PER RECORD}) \times (\text{WORDS PER SWATH}) + (\text{NUMBER OF NADIR ANGLES}) + 7$$

Ninety degrees are added to all latitudes and attitude data to eliminate negative signs.

NMRT-HRIR Documentation Record Format

Word No.	Quantity	Units	Scaling	Remarks
1	Dref	---	B = 35	Number of days between 0 hour on 9/1/57 and zero hour on day of launch.
2	Date	MMDDYY	B = 35	Date of interrogation for this orbit, i.e., 2/5/64 would be $(020504)_8$. Only the last digit of year is used.
3	Nimbus Day	---	B = 35	Start time for this file of data
4	Hour	Z Hour	B = 35	
5	Minute	Z Minute	B = 35	
6	Seconds	Z Seconds	B = 35	
7	Nimbus Day	---	B = 35	End time for this file of data
8	Hour	Z Hour	B = 35	
9	Minute	Z Minute	B = 35	
10	Seconds	Z Seconds	B = 35	
11	Mirror Rotation Rate	Deg/Sec	B = 26	Rotation rate of radiometer mirror
12	Sampling Frequency	Samples/Sec	B = 35	Digital sampling frequency per second of vehicle time
13	Orbit Number	---	B = 35	Orbit Number
14	Station Code	---	B = 35	CDA Station identification code
15	Swath Block Size	---	B = 35	Number of 35 bit words per swath
16	Swaths/Record	---	B = 35	Number of swaths per record
17	Number of Locator Points	---	B = 35	Number of anchor points per swath for which latitudes and longitudes are computed

NMRT-HRIR Data Record Format

Word No.	Quantity	Units	Scaling	Remarks
1D	Nimbus Day	---	B = 17	Start time for this record of data
1A	Hour	Z Hour	B = 35	
2D	Minutes	Z Minute	B = 17	
2A	Seconds	Z Seconds	B = 35	
3D	Roll Error	Degrees	B = 14	Roll error at time specified in words one and two.
3A	Pitch Error	Degrees	B = 32	Pitch error at time specified in words one and two
4D	Yaw Error	Degrees	B = 14	Yaw error at time specified in words one and two
4A	Height	Kilometers	B = 35	Height of spacecraft at time specified in words one and two
5D	Detector Cell Temperature	Degrees K	B = 17	Measured temperature of detector cell at time specified in words one and two
5A	Electronics Temperature	Degrees K	B = 35	Measured temperature of electronics at time specified in words one and two
6D	24 V Supply	Volts	B = 14	Measured voltage at time specified in words one and two
6A	20 V Supply	Volts	B = 32	Measured voltage at time specified in words one and two
7D	Reference Temperature A	Degrees K	B = 17	Measured temperature of housing at time specified in words one and two
7A	Reference Temperature B	Degrees K	B = 35	
8	Nadir Angle	Degrees	B = 29	Nadir angles corresponding to each locator point, and measured in the plane of the radiometer
.				
.				
N	Nadir Angle	Degrees	B = 29	

The above data constitutes what is essentially the documentation portion of a data record. This data will be followed by several blocks of data with each block representing a swath. The number of these blocks in a record as well as the size of each block is specified in the documentation record represented on the previous page.

NMRT-HRIR Data Record Format (Continued)

Word No.	Quantity	Units	Scaling	Remarks
(N + 1) D	Seconds	Z Seconds	B = 8	Seconds past time in words 1A & 2D for beginning of this swath
(N + 1) A	Data Population	---	B = 35	Number of data points in this swath
(N + 2) D	Latitude	Degrees	B = 11	Latitude of subsatellite point for this swath
(N + 2) A	Longitude	Degrees	B = 29	Longitude of subsatellite point for this swath, positive westward 0 to 360°
(N + 3)	Flags	---	---	Reserved for flags describing this swath
(N + 4) D	Latitude	Degrees	B = 11	Latitude of viewed point for the first anchor spot
(N + 4) A	Longitude	Degrees	B = 29	Longitude of viewed point for first anchor spot, positive westward 0 to 360°
. . .				
MD	Latitude	Degrees	B = 11	Latitude and longitude for
MA	Longitude	Degrees	B = 29	Mth anchor spot
(M + 1) D	HRIR Data	---	B = 14	HRIR measurements. Tag
(M + 1) A	HRIR Data	---	B = 32	and prefix reserved for flags
. . .				
K(A or D)	HRIR Data	---	B = 32-14	Last HRIR data measurement

All remaining or unused portions of a swath data block are set to zero, giving swath block size as specified in the documentation record. The above data on this page is repeated for the number of swaths in each record.

Definition of Flags Describing Each HRIR Swath

Flag	Bit	Definition	Yes	No
1	35	Summary flag. All checks defined by flags 2 thru 12 are satisfactory. (Each flag is zero)	0	1
2	34	Consistency check between sampling rate, vehicle time, and ground time is satisfactory	0	1
3	33	Vehicle time is satisfactory	0	1
4	32	Vehicle time has been inserted by flywheel	1	0
5	31	Vehicle time carrier is present	0	1
6	30	Vehicle time has skipped	1	0
7	29	Vehicle time frame sync interrupt by hardware did not occur	1	0
8	28	Sync pulse recognition was satisfactory	0	1
9	27	Dropout of data signal was detected	1	0
10	26	Ground time has a new pattern	1	0
11	25	Ground time is discontinuous	1	0
12	24	Swath size is satisfactory when compared with the theoretical swath size	0	1
13	23	End of tape was detected on the spacecraft	1	0

Flags for Individual Measurements

Prefix	Tag	Definition	Yes	No
S	18	The particular measurement is below the earth-space threshold	1	0
1	19	Unassigned		
2	20	Unassigned		