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FINAL TECHNICAL REPORT

AAFE MAN-MADE NOISE EXPERIMENT PROJECT

VOLUME I
INTRODUCTION; EXPERIMENT DEFINITION AND REQUIREMENTS

JUNE 1974

Prepared under

Contract NAS 1-11465

Prepared for

National Aeronautics and Space Administration
Langley Research Center
Hampton, Virginia 23365

National Scientific Laboratories, Inc.
Westgate Research Park, McLean, Virginia 22101

A Subsidiary of Systematics General Corporation

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TABLE OF CONTENTS

LIST OF TABLES

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1. INTRODUCTION

1.1 Purpose and Scope (of Report)

This technical report describes an experiment and associated hardware developed by the National Scientific Laboratories, Inc. (NSL) under the Advanced Applications Flight Experiment (AAFE) program, to measure and map radio interference phenomena at earth orbital altitudes. The report is intended to provide general information and overall concepts and also to constitute an archive record of the project.

1.2 Organization

This report is contained in three volumes, including fifteen sections and a number of appendices. The first two sections are contained in Volume 1 and provide introductory and summary material. The remaining thirteen sections of the report are in Volume 2; they discuss the project and its related studies and problem areas in detail. Volume 3 contains the appendices which support the report.

Volume 1 provides adequate material for individuals seeking an overview of the Man-Made Noise Experiment. Section 2 includes titled subsections which provide the overview and discuss the experiment from topical perspectives.

In Volume 2, there are thirteen sections which cover the project and its associated experiment:

- The background for the project is discussed in Section 3, and the course of the project is described in Section 4.

- Section 5 presents the objectives and limitations of the experiment.

- The following six sections (6 through 11) discuss problems associated with the design of such an experiment and their associated solutions or resolutions in this experiment. Such problems are intrinsic to any experiment with similar goals and objectives, and titled discussions of them may be of value to other experimenters.

- In Section 12, the data processing and simulation developed in connection with the project are described.

- Section 13 describes the hardware designed and fabricated in connection with the experiment; this hardware consists of a receiver and its associated digital control and interface unit. The design and performance of this feasibility hardware also are discussed in Section 13.

- Problem areas not fully resolved during the project, such as spacecraft selection or design, are discussed in Section 14.

- A number of feasible alternatives to the achievemen of some or all of the experiment's objectives are presented in the final section, Section 15.

In Volume 3, Appendices for the report are contained. Data which is not specifically used in the body of the report but which may be of value to report users is complied in the Appendices.

2. EXPERIMENT DEFINITION AND REQUIREMENTS

2.1 Overview

The Advanced Applications Flight Experiment Man-Made Noise (MMN) experiment was designed to provide a tool for the measurement of man-made radio frequency emanations which exist at earth orbital altitudes. The major objectives of the program are to develop a complete conceptual experiment and developmental hardware for the collection and processing of data required to produce meaningful statistics on man-made noise level variations as functions of time, frequency, and geographic location. The AAFE MMN experiment will provide:

- Maps of incident power flux density isopleths for required altitudes, frequency bands, and geographic coordinates;
- Parametric statistical graphs of incident peak power levels as functions of frequency, time (of day, year, etc.), geographic coordinates, etc.;
- Tabular listings of incident peak power levels based on frequency, time, geographical coordinates or angular of incidence.

A wide dispersion measurement receiver on a spacecraft operating in a specialized orbit will be required to meet the objectives of the experiment. The experiment output will consist of data describing MMN amplitude samples, each unique in frequency, time, and location. These data will be collected, processed and stored on the ground and will be subsequently processed at a central facility to generate the required outputs. The dedicated experiment spacecraft will be placed in a 63.4 degree, prograde, elliptical orbit with an average altitude of 1000 km. It will receive commands from participating ground stations, which will be stored and executed under control of an onboard clock. The digital bit stream from the receiver will either be transmitted in real time via a dedicated data transmitter or will be recorded by an onboard recorder. Pre-recorded and real time data streams will be similar except for the inclusion of a time signal in the recorded data stream.

The data from the satellite will be recorded at each participating ground station after preliminary processing by ADP equipment. Data tapes produced at the ground stations will be forwarded to a central processing facility. Receiver commands control all of the variable elements of the receiver including: fundamental operating mode (i.e., fixed frequency or scanning); frequency or dispersion range of operation; gain setting; calibration; antenna; and recorder mode. The time cycle for onboard clock is 1000 minutes, and the clock is resettable under ground command. A maximum of 64 commands may be stored sequentially in the receiver.

A number of major experiment design goals and constraints are summarized in Table 2-1. No redundancy has been specified for the experiment spaceborne components, and to the greatest

TABLE 2-1

SUMMARY OF EXPERIMENT DESIGN GOALS AND CONSTRAINTS

FREQUENCY COVERAGE	-	400 MHz - 12.4 GHz
RECEIVER	-	Single receiver for complete frequency coverage, Selectable: Dispersion - 10 MHz-12.4 GHz Dispersion Rate - 200 MHz/Sec. Max. Bandwidths - 20 kHz, 100 kHz
ANTENNA	-	o One earth coverage frequency independent (variable aperture) 400 MHz-3000 MHz o One earth coverage frequency independent (variable aperture) 3 GHz-12.4 GHz o One fixed aperture (parabolic, 1 m^2) selectable or broadband feed 3 GHz-12.4 GHz
GEOGRAPHIC COVERAGE	-	Initially, North America and Europe (defined by STDN visibility). Expandable to entire populated world
ORBIT	-	Medium Altitude - 1000 km Elliptical, Eccentricity 0.045 Inclination 63.5° Anti Sun-Synchronous Prograde Period, approximately 105 min.
SPACECRAFT CONSTRAINTS	-	Minimum Spacecraft Mass - 150 kg Launch Vehicle - Scout D or E Two Axis Stabilization, min. 5°

TABLE 2-1 (CONT)

SUMMARY OF EXPERIMENT DESIGN GOALS AND CONSTRAINTS

DATA HANDLING	-	Down-link Data Rate	
		Primary (Experiment Data)	
		Real-Time	70 kb/s
		Pre-recorded ("back-side")	80 kb/s
		Experiment Command Word	56 bits
		Command Storage	64 cmds.
		Tracking, Command & Data Acquisition Stations	Fairbanks Greenbelt Corpus Christi Quito Winkfield

extent possible, data processing and formatting is to be conducted on the ground rather than in the receiver. The "backside" data collection capability, achieved through use of the satellite data recorder, is an optional experiment requirement; weight and power considerations weigh heavily against its use.

2.2 Orbit

The orbit recommended for the experiment has a number of unusual characteristics which appear feasible and desirable for purposes of a MMN experiment. The inclination of the orbit will be nominally 63.4°; with this inclination, the apsidal precession rate will be 0. The line apsidees can be made coincident with the line of nodes; the orbit, with proper trimming, will maintain the same argument of perigee throughout the life of the experiment. Hence, the perigee and apogee will remain in the equatorial plane, and the altitude of the satellite at any given latitude will be one of two values, depending upon whether the satellite is ascending or descending. The mean altitude of the specified orbit is 1000 km; the apogee/perigee is 2:1; the eccentricity of this orbit is .045.

Under the conditions specified the satellite will remain within 110% of its perigee altitude through a central angle of approximately 75°; this corresponds to an excursion of 37° of latitude from the equator. The satellite will remain within 90% of its apogee altitude through a central angle of approximately 102° corresponding to a latitude excursion of approximately 49°.

Hence, the prescribed orbit will be able to collect data on 2 nominal orbit spheres over a 49° range of North and South latitude for the higher orbit and a 37° range of North and South latitude for the lower orbital sphere. Of course, significant data can be taken over the entire orbit of the spacecraft, but the two approximately concentric-sphere MMN maps would be best confined to the latitudes stated.

The maximum period of visibility for the prescribed orbit (assuming optical visibility and 0 degree elevation angle) will be less than 18 minutes. The duration of each orbit will be approximately 105 minutes, hence, successive orbit tracks will be separated by approximately 26.16°. Such an orbit can be maintained with relative ease for a two year operational period, and may be maintained over a considerably greater period should the need arise. Table 2-2 provides additional pertinent information concerning the launch and orbit parameters specified during the design experiment. (These values are based upon first order perturbations and spherical earth computations).

Additional information regarding the orbit selected and regarding other pertinent orbital selection criteria is given in Appendix A.

2.3 Space Segment Hardware

The specification and design of experiment hardware was limited to definition and construction of a prototype RF measurement receiver and the definition of other hardware items such

TABLE 2-2

FLIGHT CHARACTERISTICS

Orbit	
Inclination	63.43°
Altitude	
Apogee	1334 km
Perigee	667 km
Average	1000 km
Velocity	
Apogee	7.03 km/sec
Perigee	7.69 km/sec
Average	7.35 km/sec
Eccentricity	.045
Max. Period of Visibility	18 min.
Orbit Period	105 min.
Recession/Orbit	26° 16'
Decay	74 years
Apsidal Precession/Orbit	0°
Argument of Perigee	0°
Launch (planar)	
Location	Wallops Island
Vehicle	Scout "D" or "E"
Launch Azimuth	30° or 145°
Characteristic Velocity Requirement	8.45 km/sec.

as spacecraft, telemetry transmitter, and command receiver. As in any AAFE experiment, space-qualified hardware was not a requirement.

2.3.1 Launch Vehicle Considerations

The launch vehicle for the experiment was considered during the experiment design, and the Scout class vehicle was tentatively specified. The adequacy of this class vehicle, for this experiment, was not fully developed, and the possible necessity of using either a hitherto undeveloped launch vehicle or a Delta class vehicle was also considered. If the experiment were constrained to make use of the Scout class vehicle, an obvious and considerable saving in experiment cost would result. If uprated versions of the Scout continue to be developed, it may well be feasible for such a vehicle to be used. In addition, the spacecraft upon which the dedicated experiment hardware will be mounted and which will supply the oriented platform for the experiment hardware is not defined.

2.3.2 Antennas

The dedicated spaceborne components of the experiment will include 3 measurement antennas, an antenna select unit, the experiment receiver and controller/interface unit, a digital tape recorder, and a data transmitter. In addition to the normal operating elements of a spacecraft including a command receiver, a spacecraft controller and a telemetry transmitter.

The three measurement antennas consist of two conical logarithmic spiral types required to cover the entire receiver spectrum (400 MHz to 12.4 GHz); and a single parabolic antenna with conical log spiral feed covering the range from 3 GHz to 12.4 GHz. The parabolic antenna will be mounted such that, under ground command, it can be pointed either at the nadir or toward the horizon. The angle between the horizon pointing antenna and the satellite track has not been determined and when pointed at the horizon, is not critical.

One of the conical log spiral antennas will cover the frequency range of 400 MHz to 3 GHz, and the other from 3 GHz to 12.4 GHz. Both of these antennas will be permanently oriented toward the spacecraft nadir. The nominal gains of these two antennas will be 6 dB and their 6 dB beamwidths will be nominally 120°; hence their 6 dB field of view will encompass the entire earth segment visible from the satellite.

The parabolic antenna will have a diameter of approximately 1 meter. At the 12.4 GHz it will have a gain of approximately 38 dB and at 3 GHz, approximately 9 dB. The half power beamwidth of the parabolic antenna will vary from approximately 2 degrees at 12.4 GHz to 55° at 3 GHz.

Considerable effort will be required in the development of experiment antennas to constrain the mass to reasonable levels. It is also considered likely that the conical log spiral antennas may require deployment of some type.

The basis for this particular antenna selection is to provide "full field of view coverage" with the 2 conical log spiral antennas, to provide a basis for the development of scalar power flux density maps. These maps should indicate incident power flux density at each data point without respect to angle of arrival. The gain of these antennas, however, is such that in the higher regions of the spectrum, the minimum detectable e.i.r.p. from a terrestrial transmitter will be on the order of 40 dBW or greater. The need for data on lower level emitters has been established, and the parabolic antenna is provided to obtain such data. Because of the dimensional complications, data obtained through the use of the high gain parabolic antenna will not be used to develop PFD maps, but rather will be used to generate statistics concerning typical incident power levels from either of the antenna's two orientations at the spacecraft's orbit altitude and general geographic locale.

Commercial versions of the antennas proposed for this experiment currently exist and are manufactured for general use. The primary antenna development requirements will be in the areas of mass constraint, structural integrity/rigidity, and deployment. It is noteworthy that the three antennas will have to "look" from approximately the same plane in order to avoid unwarranted shielding each by the other.

2.3.3 The Receiver

The receiver has a number of unusual characteristics: its frequency range is from 400 MHz to 12.4 GHz (an effective dispersion range of 12 GHz); its effective bandwidth is 20 kHz; and its frequency stability is better than 1 part in 10^6 per day. The output of the receiver consists of a digital bit stream, which indicates either the peak or average levels of band constrained input phenomena. Salient requirements of the man-made noise data collection receiver are summarized in Table 2-3 and discussed below.

Chief among the characteristics of interest in the demonstration receiver is the use of YIG tuned oscillators and phase lock loop techniques to provide precise and accurate local oscillator frequencies throughout the dispersion range of the receiver. The use of crystal filters in the final IF sections of the receiver also is noteworthy. At the present time, considerable advances are being made in the performance of RF amplifiers such as those used for preamp/preselector purposes in the demonstration hardware; the performance of such amplifiers may well improve by the time the man-made noise experiment can be (or will be) brought to operational status, so that considerably enhanced noise performance could be achieved.

The receiver's final output stage includes 5 contiguous 20 kHz final IF channels which operate effectively in parallel. The receiver tuned frequency actually connotes the center frequency of the center 20 kHz passband.

Sample bandwidth is the bandwidth of a single output data sample which results from the measurement made at the output of one of the contiguous 20 kHz IF data channels.

TABLE 2-3

MMN DATA COLLECTION RECEIVER REQUIREMENTS

REQUIREMENT	VALUE	UNITS
Tuned Frequency, Maximum	≥12.4	GHz
Minimum	≤400	MHz
Accuracy, absolute tuned frequency	± 10	kHz
Dispersion, maximum	≥12	GHz
minimum	10	MHz
Dispersion rate, effective, maximum	200	MHz/sec
Bandwidth, 3 dB, sample	20	kHz
increment	100	kHz
Noise temperature, maximum, 1 GHz	865	Kelvins
1 GHz	2610	Kelvins
Dynamic range, minimum	65	dB
Intermod. response: 3rd order intercept point	≥-60	dBW
Image rejection	65	dB
Input VSWR, maximum	3.0:1	
Primary input power, maximum	34	Watts
Mass, total	≤12	kg
Exterior dimension, maximum	≤55	cm
Volume, total	≤30,000	cm^3
Output resolution	1	dB
Gain variation (through max dispersion range), maximum	± 4	dB
Noise calibrator output level	≥-150	dBW/kHz
Noise calibrator level variation, (through max. dispersion range), maximum	± 1	dB

The increment bandwidth is the effective bandwidth of the 5 parallel operated contiguous 20 kHz channels.

Skirt selectivity, an important parameter for the actual receiver, was not specified, but information concerning the skirt selectivity and its effect on receiver responses under various conditions can be found in the feasibility hardware section of this report.

An internal excess noise calibrator is considered important for the generation of a reference baseline for receiver gain throughout the course of the experiment.

At each 100 kHz tuning increment of the receiver, each of 5 contiguous 20 kHz IF channels is simultaneously enabled, measured, disabled and reset. The five 20 kHz IF channels are essentially identical, and their output sections consist of a demodulator function which generates a single amplitude descriptor for each sample interval, in each 20 kHz channel. The detector function of the five IF channels is either of two as selected by ground control: one, a "peak hold and sample" function, and the other an average value generator function. The "peak hold and sample" function results in an output level at the end of each sample interval indicative of the peak value in that channel during that sample interval. The average generator function output results in a value indicative of the average value in that channel throughout the sample interval. At the completion of each sample interval, when the demodulator functions of the 5

IF channels are disabled, their outputs are stored and sequentially converted to digital signals and read during the tuning increment and the subsequent sample interval of the receiver (or during the sample interval alone, if the receiver is operating in its fixed frequency mode).

Two receiver operation modes are allowed: the fixed frequency mode causes the receiver to remain at a single frequency of operation throughout the period of the command and the scan mode of operation causes the frequency to which the receiver is tuned to be incremented in 100 kHz steps once each sample period through a range of frequencies determined by the command.

The output of the receiver is a digital bit stream which defines individual data samples to a precision of 1 decibel. The dynamic range of the receiver is at greater than 60 decibels. Because of the need to include data flags, seven bit output words are specified. These data flags are unique level values used to indicate conditions which change the effective code of the succeeding data stream or which indicate idle conditions wherein the receiver is not outputting valid data samples. Hence, a seven bit code is used to describe each data point, and the data rate based on the maximum dispersion rate of 200 MHz per second (corresponding to 2,000 frequency increments per second, or 10,000 data samples per second) is 70 kilobits per second.

The data concept developed during the man-made noise experiment project calls for the interruption of the scanning process at each 10 MHz cross-over point (when the receiver is in the scan mode) to permit the insertion of appropriate flag words and status data in the output data stream.

The receiver is controlled by stored commands, each containing 56 bits. The receiver can operate on a group of stored commands ranging from a single command to 64 commands. In addition to the stored command sequence, a ground override function is available which can enable a single command to be executed immediately, as the name of the function implies. The use of the override function does not defeat the ongoing cycle but merely replaces the "current" command with the override command. This function was determined necessary to permit real time system tests for possible failure mode analysis, and to facilitate a "quick look" capability. Data redundancy, addressing and error checking were not included in the feasibility hardware or defined in the project. Although such requirements exist and are of considerable import, the implementation and selection of such functions do not impose appreciable constraints on the feasibility of the experiment.

The receiver requirements expressed in Table 2-3 are based primarily on the effort performed in connection with the design and development of the feasibility and demonstration receiver constructed under this program. The technology used in development of this receiver was "near state-of-the-art", and through this receiver, the feasibility of performance requirements specified in Table 2-3 have been demonstrated. The design techniques and characteristics of the demonstration receiver will probably be applicable for use in the spaceborne receiver. All of the major component types used in the demonstration hardware have either been used successfully in space programs or are known to be space-qualifiable.

The demonstration receiver was built as a single, self contained unit, but as implemented for the experiment, it may be more desirable to relocate the preamps and front end elements of the receiver in proximity to the antennas with which they will be associated. The thermal control problems which may result from such relocation were not explored during the course of the project, nor was the performance degradation which will be induced by the use of interconnecting cables between the antennas and the receiver input explored to any appreciable degree.

The five contiguous-band parallel operation concept is a consequence of the desire to resolve 20 kHz bandwidths and scan at a 200 MHz per second rate while maintaining a $\pm$ 10 kHz frequency accuracy for each measurement point. In order to provide adequate data, sensitivity, and accuracy, the rates selected were considered to be those minimally acceptable for such an experiment, and the 5 band approach provided a readily attainable means of implementing these requirements. It is probable that this approach will be the most logical to be followed for the flight hardware; no alternative approach to achieve the same speed, accuracy, etc., has been noted or conceived during the course of the project.

The down-link data scheme developed during the course of the project was not optimized vis a vis other possible schemes. It would be entirely feasible to send the down-link data in parallel as well as in serial format. The approach selected, provides the minimum down-link requirements considered suitable for such an experiment. Table 2-4 summarizes the command and data requirements to and from the experiment receiver. For each input/output requirement stated, the range or number of levels or states is specified, together with the precision required and the number of bits used to attain that precision through that range.

2.4 Ground Support

Ground support requirements for the man-made noise experiment have been defined only to a first approximation. Of course, fabrication, prelaunch testing, launch, and post-launch tracking, command, data acquisition, processing and archiving are ground support functions which will have to be determined in minute detail for this, as for any other, experiment. For purposes of this feasibility demonstration, the only elements of this ground support activity included in the experiment design have been the ones relating to the active command tracking, and data acquisition processing and archiving. Some consideration was given to the launch facility which would be used for such an experiment, but no final decisions or requirements were reached in this regard during the AAFE experiment design.

TABLE 2-4

MMN DATA COLLECTION HARDWARE COMMAND AND OUTPUT REQUIREMENTS

REQUIREMENTS	RANGE/LEVELS	PRECISION	BITS
COMMAND INPUT			
Store/Override	2		1
Execute Time	1000 min.	1 min.	14
Receiver Mode	2		1
Receiver Low Frequency (Scan Mode)	12 GHz	10 MHz	12
Dispersion (Scan Mode)	12 GHz	10 MHz	12
Tuned Frequency (Fixed Mode)	12 GHz	100 kHz	20
Input Attenuator	3		2
Calibrator on/Off	2		1
Input (& Antenna Position) Select	5		3
Recorder Control	3		2
DATA OUTPUT			
Sample Amplitude	65 dB	1 dB	7
Reset Flag	1		7
Start Freq. plus (N x 10 MHz) Flag	1		7
Idle Flag	1		7
Tuned Frequency	12 GHz	10 MHz	14
Command	1×10^{16}		56
Acquisition Time	1000 min.	1 min.	14

With regard to satellite launch on a Scout class vehicle it is understood that the Wallops Island launch facility could be employed and might provide some economy to the system if this were possible. The operating launch constraints with regard to launch angles were not investigated in depth, but it was felt on the basis of available information that a planar injection and orbit trim could be achieved with reasonable range limit waivers using the Wallops site. Five STDN stations were selected as providing a feasible basis of tracking and data acquisition ground support for the experiment. Each of these stations currently has a 30 foot USB antenna system installed. These stations are those located at Fairbanks, Alaska; Goldstone, California; Corpus Christi, Texas; Greenbelt, Maryland; and Madrid, Spain. Of course, the STDN network includes other stations which, if used, would place a far greater percentage of the earth under real-time coverage. For example, the addition of Hawaii, Santiago, Madagasgar and Guam would increase the real time coverage to a great portion of the Pacific, South America, Indian Ocean and Africa, and the Far East. However, real time coverage of the North American continent and the western portion of Europe were considered to be the primary requirements and objectives for purposes of experiment baseline definition.

It is anticipated that initial data processing will be performed by the ground station upon data acquisition and prior to initial recording. This processing will include translation, formatting, and selection and compression. It appears entirely feasible that, if general purpose machines are not available, dedicated small scientific computers could be placed at each facility participating in the acquisition of experiment data for the purpose of providing the initial processing functions as- sociated with each data acquisition pass.

The major function to be performed by the ground station automatic data processing equipment will be that of compression. The primary acquisition hardware has been designed to collect data points with extremely fine frequency and spatial resolution. The majority of the experiment objectives will, in all probability, not require resolution of such as is initially provided from the down-link data stream and the use of such high resolution would result in an unnecessarily large volume of output data from the participating ground stations if it were used. Hence, the experi- ment has been designed such that either the frequency or geographic resolution element may be decreased through data compression at the ground station. Those applications which require full resolu- tion requirements may, of course, be achieved.

2.5 Data Handling

An extensive discussion of the data handling requirements and concepts associated with the man-made noise experiment are presented in the Appendix entitled "Data Handling". In this subsection a brief overview of the data handling concepts for the experiment are presented to provide the fundamental require- ments of the data processing scheme. Additional and detailed information on the programs and procedures developed for data processing are covered in Section 12 of this report.

The essential concept in the central data processing required for this experiment is the creation, prior to the commencement of each specific mission associated with the experiment, of a fixed size magnetic tape library for archive storage of reduced data. Such a library will contain accumulated statistics indicative of the levels encountered by the spacecraft in addressable records identified by their spatial, spectral and temporal characteristics. The statistics in this library will be updated throughout the course of the experiment mission as new data is acquired. The primary data tapes provided to the central processing facility by the participating ground stations will not be retained but will be used only in the process of updating the statistical library at the central processing facility. Within the central data storage library, the lowest individually addressable element will be a frequency record. Each frequency record will contain a number of amplitude cells, a maximum and a minimum amplitude byte, and a flag. Each amplitude in each frequency record contains the count of amplitude bytes or samples received falling within the amplitude boundaries of the cell. The sample count for each amplitude cell will be a fixed number of bits; if the sample count is exceeded, the flag will be set, and an output indication will be given to the experiment operator; manual intervention then will be required befor further data is taken in that specific frequency record. Each frequency record is bounded in time, and space, by a location or address hierarchy to facilitate its acquisition use and identity.

A practical library organization will provide for storage, retrieval, and updating of the archive data with a minimum number of nonsequential storage area acquisitions. A typical library might store by annual season, nominal altitude, geographic resolution element, diurnal phase and frequency. Hence, each of four seasonal sublibraries might contain two altitude sectors, each of which could contain a large number of geographic "bins" and each geographic bin, in turn might contain a number of diurnal blocks, within which a set of frequency records is contained in each. The specific experiment mission associated with the development of the library will determine the practical boundaries in each of these dimensions, and the incoming data can be buffered, indexed, smoothed, and accumulated in the appropriate locations within the library.

The geographic bin, or "geo-bin" provides the geographic resolution element of the experiment. It was conceived to define an area which will be specified in terms of equatorial longitude boundaries and latitude boundaries. Its shape will depend upon its latitude boundaries. The purpose of such a structure is to facilitate the data storage and acquisition in the most sequential manner for the tape library.