National Aeronautics and
Space Administration

MSFC-SPEC-2028A
5/22/95

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

LIGHTNING IMAGING SENSOR (LIS) SYSTEMS REQUIREMENTS AND PERFORMANCE SPECIFICATION DOCUMENT FOR TROPICAL RAINFALL MEASURING MISSION (TRMM) SPACECRAFT

MSFC - Form 454 (Rev. October 1992)

Release Date	Marshall Space Flight Center SPECIFICATION/DOCUMENT CHANGE INSTRUCTIONS	Page 1 of 1
- -	Spec./Doc. No. MSFC-SPEC-2028	Copy No.:

Change No./Date	SCN/DCN No./Date	CCBD No./Date	Replacement Page Instructions
–		MA3-02-0010 12/15/92	Baseline Release
CHG 1 Rev A	SCN 001	MA3-02-0016 6/02/95	Revision A supersedes the baseline release in its entirety

12/16/92 RELEASE

6-6-95 RELEASE

MSFCForm 4140 (Revised September 1990)

NOTE: After revising the document, file this sheet in document preceeding Table of Contents

TABLE OF CONTENTS

SECTION PAGE

1.0 SCOPE 1
1.1 General Description of LIS Instrument 1
1.1.1 Lightning Signal Characteristics 1
1.1.2 Scientific Objectives 2
2.0 APPLICABLE DOCUMENTS 2
3.0 REQUIREMENTS 4
3.1 Mission Requirements 4
3.1.1 Launch 4
3.1.2 Orbit 4
3.1.3 Design Life 4
3.1.4 Safety 4
3.1.4.1 Safety Priority 4
3.1.4.2 Hazard Reduction 5
3.1.5 Design Assurance & Reliability 5
3.1.6 Maintainability 5
3.1.7 Quality 6
3.1.8 Coordinate Systems 6
3.2 Operational Requirements 6
3.2.1 Ground Operations 6
3.2.2 Integrated System Testing 6
3.2.3 Flight Operations 8
3.3 Performance Requirements 8
3.3.1 Field-of-View 8
3.3.2 Storm Spatial Resolution 8
3.3.3 Temporal Resolution 8
3.3.4 Detection Threshold/Wavelength 8
3.3.5 Detection Efficiency 8
3.3.6 Dynamic Range 9
3.3.7 Measurement Location Accuracy 9
3.3.8 Measurement Intensity Accuracy 9

3.3.9 Science Mode 9
3.4 Mechanical Interface Requirements 9
3.4.1 Mounting Envelope 9
3.4.2 Mass Properties 9
3.4.3 Alignment Requirements 12
3.4.3.1 Placement Accuracy 12
3.4.3.2 Placement Knowledge 12
3.4.3.3 Instrument Stability 12
3.5 Electrical System Interfaces Requirements 12
3.5.1 Electrical Harnessing 13
3.5.2 Power Interface Requirement 13
3.5.3 Signal Interface Requirement 13
3.5.4 Electromagnetics Compatibility 13
3.5.5 Electrostatic Discharge Control 13
3.5.6 Magnetic Requirements 13
3.6 Command and Data Handling Interfaces Requirements 13
3.6.1 Science Data 14
3.6.2 Housekeeping Data 14
3.7 Thermal Requirements 14
3.7.1 Thermal Interface Requirements 14
3.7.2 Instrument Thermal Design 14
3.7.3 Instrument Temperature Range 15
3.7.4 Instrument Temperature Monitoring 15
3.8 Ground Support Equipment (GSE) 15
3.8.1 Mechanical Ground Support Equipment 15
3.8.2 Electrical Ground Support Equipment 15
3.8.3 Software 16
3.9 Environmental Requirements 16
3.9.1 Launch Pressure Profile 16
3.9.2 Cosmic Rays 16
3.10 Design and Construction Standards 24
3.10.1 Specifications and Standards 24
3.10.2 Electronic, Electrical, and Electromechanical (EEE) Parts 24
3.10.2.1 EEE Parts Selection 24
3.10.2.2 Nonstandard EEE Parts 24
3.10.2.3 Parts Qualification 24

3.10.2.4 Approved EEE Parts Engineering List 25
3.10.2.5 EEE Parts Derating Criteria 25
3.10.3 General Structural/Mechanical Design Requirements 25
3.10.3.1 Equipment Integrity and Factors of Safety 26
3.10.3.2 Corrosion Prevention 26
3.10.3.3 Stress Corrosion Cracking 26
3.10.3.4 Fracture Control 26
3.10.4 Materials and Processes 27
3.10.5 Contamination Control Requirements 27
3.10.5.1 Surface Cleanliness 27
3.10.5.2 Outgassing 27
3.10.5.3 Flammability 27
3.10.6 Workmanship 27
3.11 Handling Requirements 28
3.12 Packaging, Preservation, and Transportation 28
3.13 LIS Verification Requirements Matrix 28
APPENDIX A A-1

1.0 SCOPE

This specification establishes the system level design and performance requirements for the Lightning Imaging Sensor (LIS) experiment for the Tropical Rainfall Measuring Mission (TRMM) and the general requirements for associated ground support equipment (GSE). The requirements specified herein must be met in order to successfully accomplish the LIS scientific objectives.

1.1 General Description of LIS Instrument

The Lightning Imaging Sensor consists of a small solid state optical sensor to detect and locate lightning over a large region of the Earth's surface along the orbital track of the spacecraft. In terms of measurement capabilities, the sensor will mark the time of occurrence of the lightning with 2 milliseconds (ms) resolution, and measure the radiant energy. The instrument will be designed to utilize existing technology to meet the performance requirements. It consists of a Sensor Head Assembly and an Electronics Assembly. The LIS is a staring instrument with a fixed field-of-view. Upon detection of a lightning event, the sensor will output the location and characteristics of the event on the spacecraft science data bus.

1.1.1 Lightning Signal Characteristics

The occurrence of lightning is accompanied by the sudden release of electrical energy which is converted into rapid heating in the vicinity of the lightning channel, the generation of a shock wave, and electromagnetic radiation. These optical emissions result from the dissociation, excitation, and subsequent recombination of atmospheric constituents as they respond to the sudden heating in the lightning channel. The strongest emissions in the optical spectra are produced by the neutral oxygen and neutral nitrogen lines in the near infrared (e.g., the OI(l) line at 777.4 nm and the NI(l) multiplex at 868.3 nm are the strongest features).

The lightning signal is comprised of a series of fast rise time, short duration pulses associated with the discharge processes within the cloud. The optical pulse widths and rise times are highly variable. The median pulse rise time and the full width at half maximum are 240μs and 370μs respectively.

1.1.2 Scientific Objectives

The overall scientific objectives of the LIS instrument are to acquire and investigate the distribution and variability of lightning on a global scale, and to increase the understanding of the underlying and interrelated processes in the Earth atmospheric system.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. In the event of conflict between these documents and this specification, this specification shall supersede.

MSFC-RQMT-2355	Lightning Imaging Sensor (LIS) Science Requirements Document
TRMM-490-022	Tropical Rainfall Measuring Mission(TRMM) to Lightning Imaging Sensor(LIS) Instrument Interface Control Description (ICD)
TRMM-303-006	Performance Assurance Requirements(PAR) for the Tropical Rainfall Measuring Mission (TRMM)
MSFC-DOC-2142	Thermal Requirements for Qualification and Acceptance Testing
MSFC-HDBK-505A	Structural Strength Design and Verification Requirements
MSFC-HDBK-1453	Fracture Control Program Requirements
MSFC-PLAN-2012	Lightning Imaging Sensor(LIS) Performance Assurance Implementation Plan (PAIP) for the Tropical Rainfall Measuring Mission
MSFC-PLAN-1857	Lightning Imaging Sensor(LIS) Performance Verification Plan
MSFC-PLAN-1973	LIS Contamination Control Plan
MSFC-SPEC-250	Protective Finishes for Space Vehicle Structures and Associated Flight Equipment General Specification
MSFC-SPEC-522	Design Criteria for Controlling Stress Corrosion Cracking
MSFC-SPEC-1198	Screening Requirements for Nonstandard Electrical, Electronic, Electromagnetic Parts
MSFC-SPEC-1238	Thermal Vacuum Bakeout Specifications for Contamination Sensitive Hardware

MSFC-SPEC-2026	LIS Software Requirements Specification
MSFC-STD-506	Standard Materials and Processes Control
MSFC-STD-1249	Standard NDE Guidelines and Requirements for Fracture Control Programs
MIL-STD-889	Military Standard Dissimilar Metals
MIL-STD-975H	NASA Standard Electrical, Electronic, and Electromechanical Parts List, Military Standard
MM 8070.2	MSFC Approved Baseline List of Specifications and Standards
ASTM-E-595	Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
JSC-SP-R-0022A	Vacuum Stability Requirements of Polymeric Materials for Spacecraft Application
NHB 6000.1	Packaging Handling and Transportation for Aeronautical and Space Systems Equipment and Associated Component Requirements
NHB 8060.1	Flammability, Odor, and Offgassing Requirements and Test Procedure for Materials in Environments that Support Combustion

3.0 REQUIREMENTS

The following paragraphs contain system level requirements to which the LIS instrument must be designed and fabricated as well as the operational performance the instrument must meet. In additional to the requirements specified in this document, the LIS design shall be in compliance with the requirements of TRMM-490-022.

3.1 Mission Requirements

The requirements in this section are imposed on the LIS design by the TRMM mission.

3.1.1 Launch

The LIS design shall be compatible with launch on the Japanese H-II expendable launch vehicle.

3.1.2 Orbit

The LIS design shall meet all performance requirements of Section 3.3 after insertion into a 35 degree inclination orbit with an operational altitude of 350 km (referenced to the equator).

3.1.3 Design Life

The LIS instrument shall be designed for an operational lifetime of 3 years plus 2 years of preflight ground operations. It shall also be designed for 5 years of storage life.

3.1.4 Safety

The LIS instrument shall be designed to minimize danger to ground personnel before launch, as well as to the launch vehicle during launch. The LIS design shall meet the safety requirements specified in Section 4.0 of MSFC-PLAN-2012, Performance Assurance Implementation Plan (PAIP) for LIS.

3.1.4.1 Safety Priority

Safety considerations for LIS shall be in the following order of priority:

a. Support Personnel

b. Japanese H-II Expendable Launch Vehicle
c. TRMM Spacecraft
d. LIS Instrument

3.1.4.2 Hazard Reduction

The LIS instrument shall be designed to minimize the likelihood and effects of hazardous conditions during all phases of operational use. The safety requirements of this subsection shall be regarded as minimum standards for design, and shall be exceeded where appropriate, within program constraints, to reduce the potential for personnel injury or equipment damage. The following actions, in the order of preference, shall be used to resolve identified hazards:

a. Design for Minimum Hazard - Design to eliminate hazards. If an identified hazard cannot be eliminated, control the hazard through design selection (e.g., safe/fail operational features, redundancy, safety factors, and isolation of energy sources).

b. Safety Devices - Known hazards that cannot be eliminated or adequately controlled by design selection shall be reduced to an acceptable level by the use of automatic safety design features or safety devices as part of the system, subsystem, or equipment.

3.1.5 Design Assurance & Reliability

The LIS instrument shall be designed to meet the design assurance and reliability requirements specified in Section 8.0 of MSFC-PLAN-2012. The design shall also assure that no single point failure will propagate across the interface to the spacecraft platform. The probability of success goal will be greater than 85% at the end of 3 years of orbital operations without regard to redundancy.

3.1.6 Maintainability

The LIS shall be designed for ease of maintenance during its preflight lifetime. The maintainability design guidelines presented below shall be considered during all design phases:

a. Component design should avoid projecting parts which could be easily damaged during handling.

b. Components should be designed so that form, size, and center-of-gravity location permit the unit to stand by itself in a stable manner.
c. All components or parts which may be inadvertently reversed or misaligned during installation or insertion must be keyed.
d. All components shall be designed so that adjustments, alignments, and calibrations are independent of other component adjustments to the extent possible.
e. All components should be designed so that only standard tools are needed for mounting or adjustment.

3.1.7 Quality

The LIS shall be designed, fabricated, assembled, and tested to meet the quality assurance requirements as described in Section 8.0 of MSFC-PLAN-2012.

3.1.8 Coordinate Systems

The TRMM observatory with its science instruments including the LIS is shown in Figure 1. The instrument coordinate system shall be oriented and aligned with the TRMM spacecraft reference coordinate system as specified in TRMM-490-022.

3.2 Operational Requirements

3.2.1 Ground Operations

The LIS hardware shall be shipped to the integration contractor site after all environmental tests are performed at MSFC facilities. Following shipment, it shall undergo post-shipment testing with MSFC supplied ground support equipment (GSE).

3.2.2 Integrated System Testing

The LIS interfaces with TRMM spacecraft shall be verified and essential tests shall be performed prior to and during TRMM spacecraft processing. This capability will be provided by MSFC supplied GSE that shall interface with Goddard Space Flight Center (GSFC) supplied GSE for sending commands and receiving instrument science data.

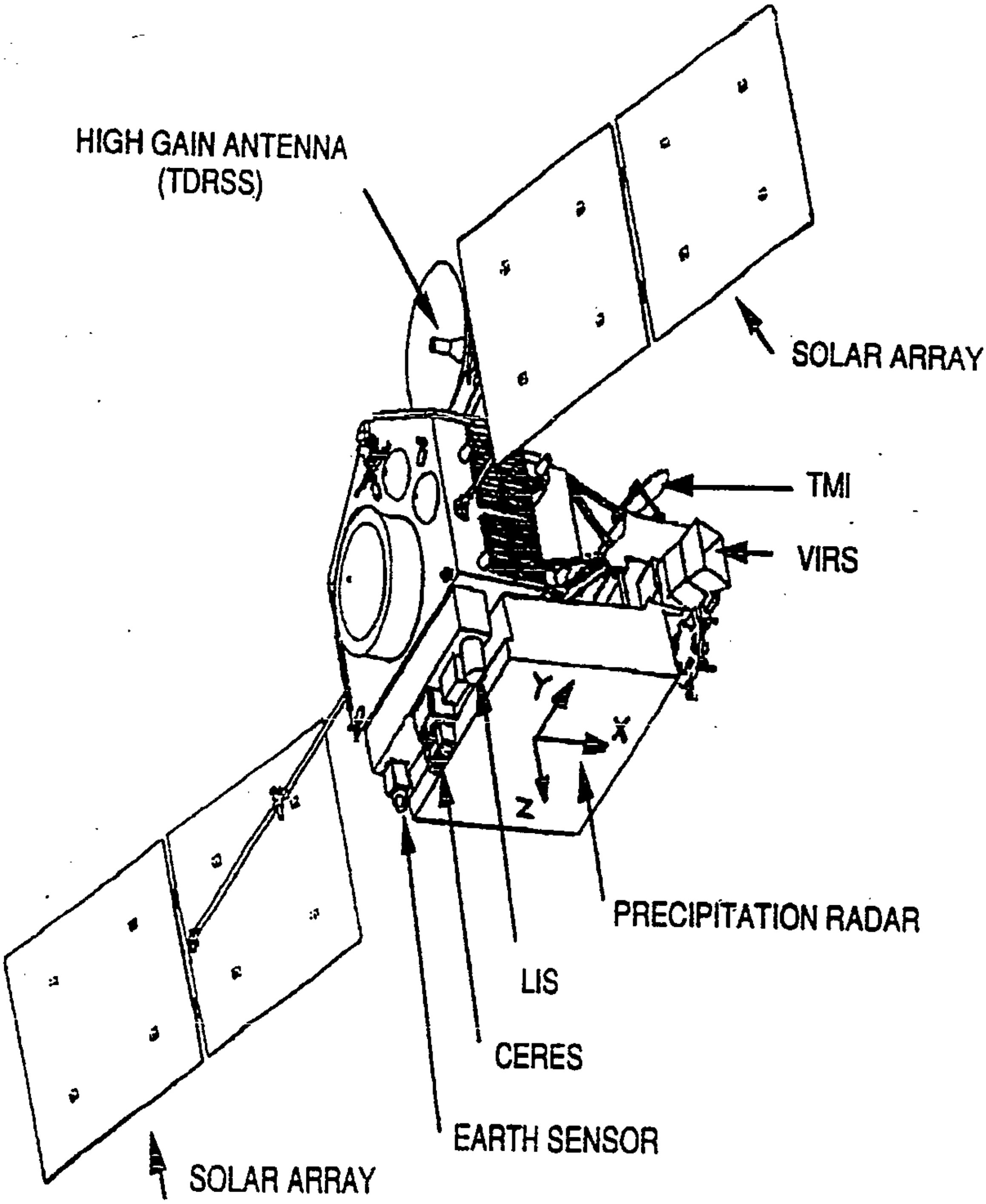

FIGURE 1. LIS INSTRUMENT ON TRMM SPACECRAFT

3.2.3 Flight Operations

The LIS instrument shall be designed to operate in a continuous nadir(+Z) staring mode. The LIS design shall require no mechanical movement for scanning.

3.3 Performance Requirements

The LIS instrument shall meet the performance requirements specified in the following paragraphs.

3.3.1 Field-of-View

The LIS instrument shall be designed to have a nominal field-of-view of 80° X 80°.

3.3.2 Storm Spatial Resolution

The LIS design shall provide a nominal storm spatial resolution of 4 km at nadir at an orbital altitude of 350 km.

3.3.3 Temporal Resolution

The LIS design shall provide a frame rate of 500 frames/second or greater.

3.3.4 Detection Threshold/Wavelength

The LIS design shall be capable of detecting lightning events with minimum energy as low as 4.7 $\mu J/m^2$-sr over the 0.3 nm wide 777.4 nm spectrum line triplet. The instrument shall be designed to make the measurement against a worst case background of 300 $Watt/m^2$-sr-μm.

3.3.5 Detection Efficiency

The LIS shall be capable of detecting lightning events within its field-of-view with an efficiency greater than 90% and shall have a false alarm rate of not more than 10% of total events.

3.3.6 Dynamic Range

The dynamic range of the LIS shall be on the order of 100 or greater. The dynamic range is defined as the variation in event energy incident upon the LIS detector from minimum to maximum.

3.3.7 Measurement Location Accuracy

The LIS design shall provide the capability to locate each event in the field-of-view to an accuracy of 1 pixel.

3.3.8 Measurement Intensity Accuracy

The LIS design shall provide the capability to measure the relative intensity of each event to an accuracy of ± 10%.

3.3.9 Science Mode

In the science mode, the capability shall be provided to detect events which are equal to or stronger than the specified detection threshold. Background data shall supplement the event data to fill the allocated bandwidth.

3.4 Mechanical Interface Requirements

The LIS instrument shall be designed to meet the physical interfaces requirements specified in TRMM-490-022.

3.4.1 Mounting Envelope

The instrument shall be contained within the volume defined in TRMM-490-022. The sensor head assembly and electronics assembly envelope and dimension are shown in Figures 2 and 3.

3.4.2 Mass Properties

The LIS instrument shall meet the center of mass. mass allocation and moments of inertia requirements specified in the TRMM-490-022.

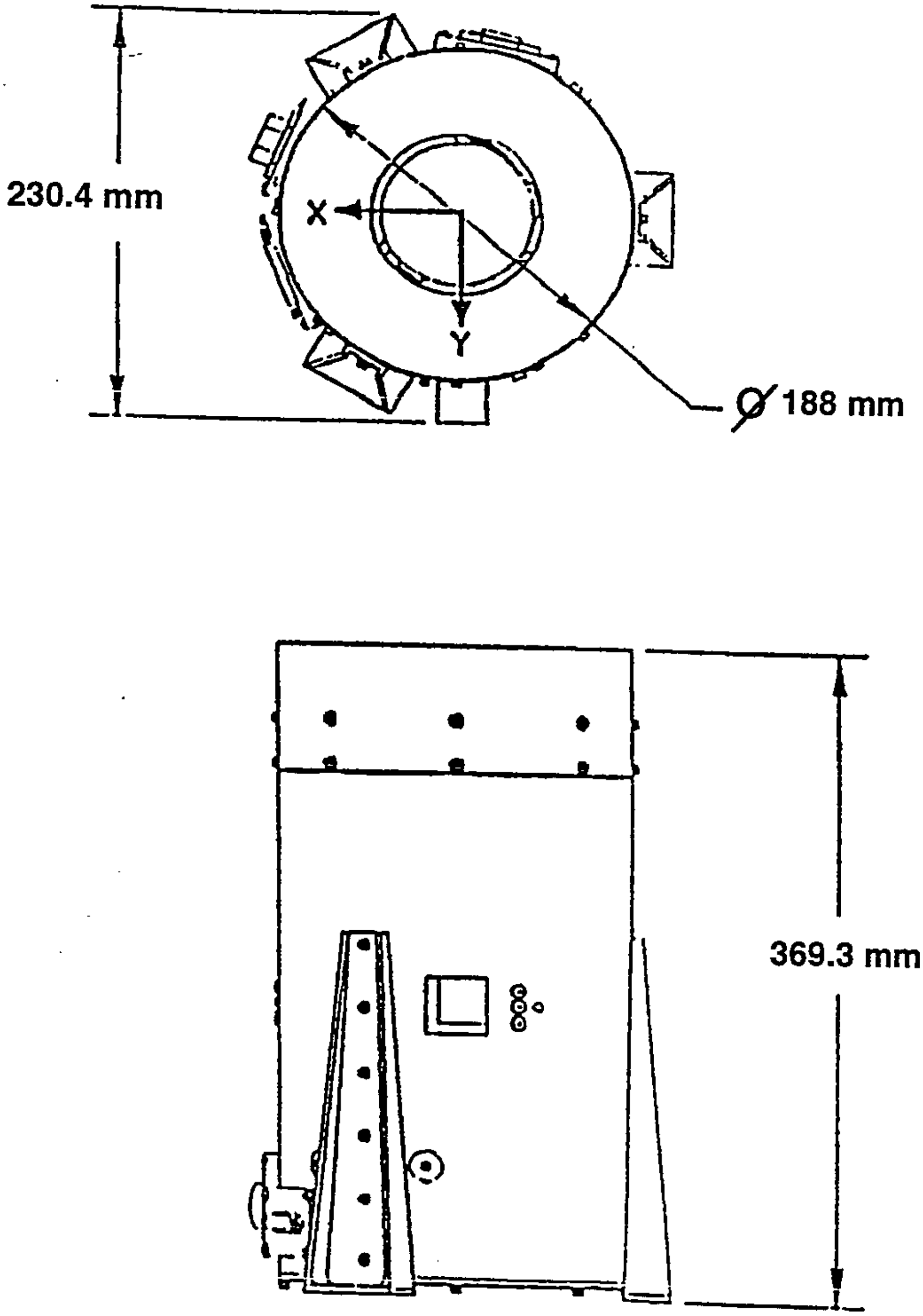

FIGURE 2. LIS SENSOR HEAD ASSEMBLY

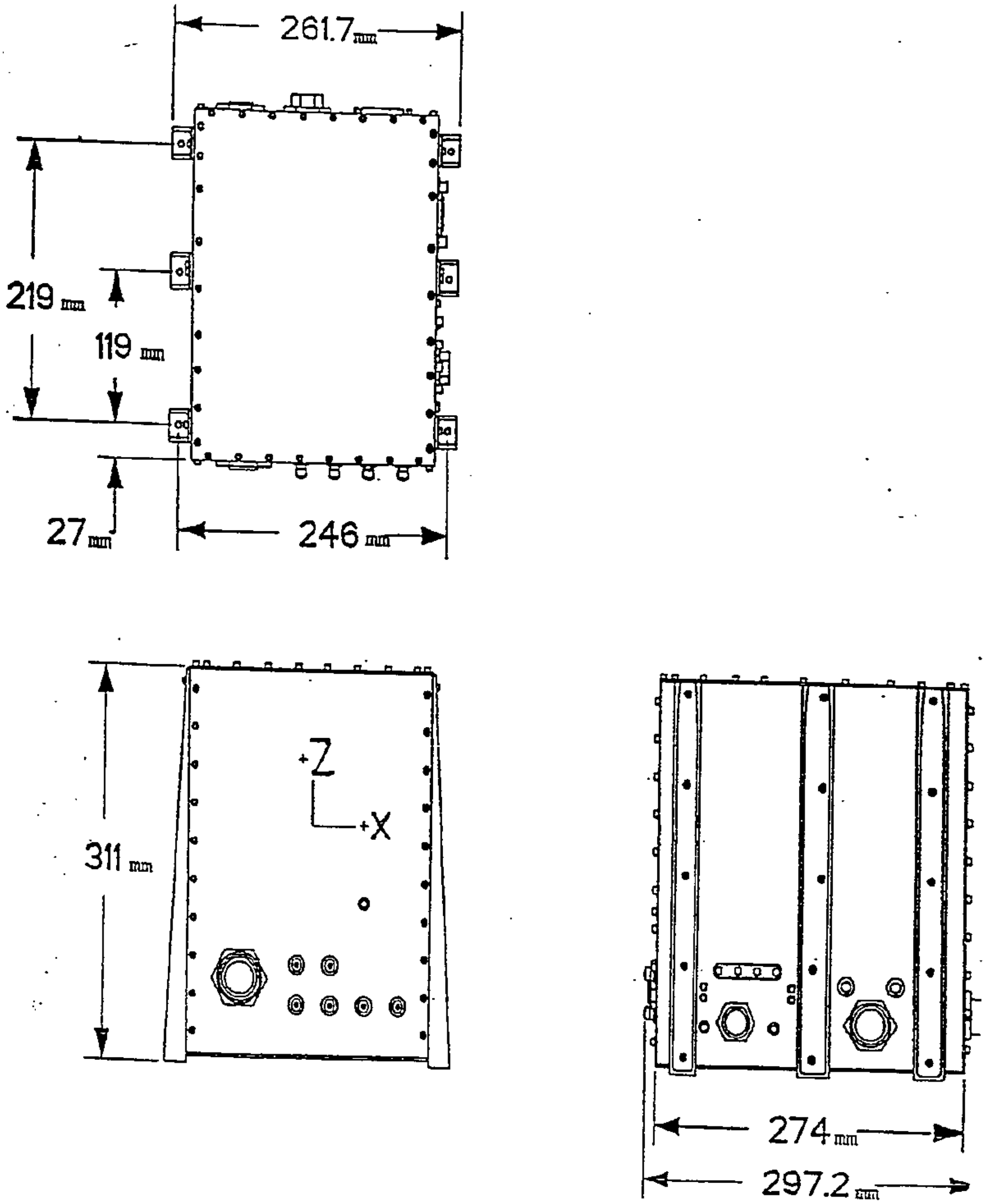

FIGURE 3. LIS ELECTRONICS ASSEMBLY

3.4.3 Alignment Requirements

The instrument design shall be compatible with the spacecraft provided mounting plane, and hole pattern. The instrument boresight and focal plane grid lines shall be nominally parallel or perpendicular to the TRMM spacecraft reference axes, and shall define the instrument reference axes. The instrument alignment requirements shall be compatible with the alignment requirements of TRMM-490-022.

3.4.3.1 Placement Accuracy

The LIS instrument design shall facilitate placement of the boresight direction within 12 arcmin of nominal, and the focal plane grid lines within 24 arcmin of nominal, both with respect to the TRMM spacecraft reference axes.
The LIS instrument boresight shall be perpendicular to the instrument base plane within 12 arcmin. Rotation of instrument reference axes about the boresight shall be measured within 3 arcmin of nominal with respect to the instrument alignment cube.

3.4.3.2 Placement Knowledge

Normals to the optical reference (alignment cube) surfaces for LIS shall be determined with respect to the focal plane grid/boresight derived instrument reference axes. The accuracy of measurement shall be equivalent to 3 arcmin error in the direction of the line of sight of the instrument.

3.4.3.3 Instrument Stability

The instrument reference axes shall be stable to 3 arcmin with respect to the spacecraft mounting plane, including launch shifts, and on-orbit thermal-structural effects.

3.5 Electrical System Interfaces Requirements

The LIS instrument shall be designed to meet the flight electrical systems interfaces requirements as specified in TRMM-490-022. These interfaces include power and all signals and telemetry not being carried over the MIL-STD-1773 Bus.

3.5.1 Electrical Harnessing

The LIS instrument shall be designed to meet the electrical harnessing design criteria specified in TRMM-490-022.

3.5.2 Power Interface Requirement

The LIS instrument shall be designed to meet the power interface requirement specified in TRMM-490-022.

3.5.3 Signal Interface Requirement

The LIS instrument shall be designed to meet the signal interface requirements for clock interface and pulse analog telemetry interface as specified in the TRMM-490-022.

3.5.4 Electromagnetics Compatibility

The instrument shall be designed to meet electrical bonding, grounding and isolation, shielding, conducted susceptibility, conducted emissions, radiated susceptibility and radiated emissions requirements as specified in TRMM-490-022.

3.5.5 Electrostatic Discharge Control

The instrument shall be protected during shipping, handling, and testing as specified in TRMM-490-022.

3.5.6 Magnetic Requirements

The instrument shall be designed to meet the magnetic requirements as specified in TRMM-490-022.

3.6 Command and Data Handling Interfaces Requirements

The LIS instrument shall meet the command and data handling interfaces requirements between the TRMM spacecraft and the LIS instrument as specified in the TRMM-490-022.

3.6.1 Science Data

Instrument science data shall as a minimum consist of the following information:

a. Location of each lightning event by pixel location.
b. Intensity of each event detected.
c. Time tag for each frame of events detected.

The science data shall also contain information necessary for interpreting this data from engineering measurements made on the hardware.

3.6.2 Housekeeping Data

Housekeeping data shall be provided as required for determining the instrument state-of-health. This data shall consist of temperatures, currents, voltages, etc. Housekeeping data shall be transmitted over the MIL-STD-1773 bus.

3.7 Thermal Requirements

The LIS design shall employ passive methods of thermal control to the maximum extent possible. Thermal testing shall be in accordance with the requirements specification in MSFC-DOC-2142 and TRMM-490-022.

3.7.1 Thermal Interface Requirements

The instrument shall be designed to meet the thermal interface on heat transfer, absorbed environmental fluxes (solar, albedo, earth), and thermal analysis requirements as specified in TRMM-490-022.

3.7.2 Instrument Thermal Design

The LIS thermal design shall provide for:

a. Maintaining the LIS within its temperature limits
b. Attaining of the LIS minimum turn-on temperature via survival power
c. Achieving thermal isolation as specified in the TRMM-490-022.

3.7.3 Instrument Temperature Range

Temperature range for the LIS instrument during ground test is 21±7°C. The instrument shall be designed to meet the following temperature ranges during operational and survival modes of orbital operations.

	Survival Mode	Operational Mode
Lens/Filter	-15°C to 40°C	21°C to 36°C
CCD/Electronics	-30°C to 40°C	-30°C to 40°C
Electronics Assembly	-35°C to 70°C	-20°C to 50°C

3.7.4 Instrument Temperature Monitoring

All components temperatures for which temperature limits have been established shall be monitored via passive analog telemetry. Active and passive temperature measuring shall be provided on all temperature critical items.

3.8 Ground Support Equipment (GSE)

3.8.1 Mechanical Ground Support Equipment

Mechanical ground support equipment shall be provided as required to support LIS during fabrication, test, storage, handling, and transportation. Mechanical ground support equipment shall be in two general categories: that used only at MSFC and that required at the integration contractor's site to support integration.

3.8.2 Electrical Ground Support Equipment

Electrical ground support equipment shall be provided as required to support the LIS experiment apparatus during fabrication, test, calibration, integration, and operations. Electrical ground support equipment shall be in two general categories: that used only at the MSFC and that required to support integration and test at the spacecraft integration site.

3.8.3 Software

The LIS instrument shall meet the software requirements as specified per LIS Software Requirements Specification, MSFC-SPEC-2026.

3.9 Environmental Requirements

The LIS instrument shall be designed to meet the performance requirements following exposure to the environmental conditions such as pressure, radiation, atomic oxygen , and meteoroids as defined in TRMM-490-022 .

3.9.1 Launch Pressure Profile

The LIS instrument shall be designed to withstand a maximum atmospheric pressure decay rate of 1.0 kilopascal/second.

3.9.2 Cosmic Rays

The instrument design shall be capable of withstanding transients and single event upsets due to the effects of cosmic rays, solar flares, and trapped protons. Figure 5 and Table 1 show the levels of heavy ion flux at the given 370 km, 35° orbit. Figure 6 and Table 2 show the levels of redistributed heavy ion flux data for 370 km, 35° orbit.

CREME HEAVY ION INTEGRAL FLUX
CREME M=4 FOR 370 KM, 35° ORBIT

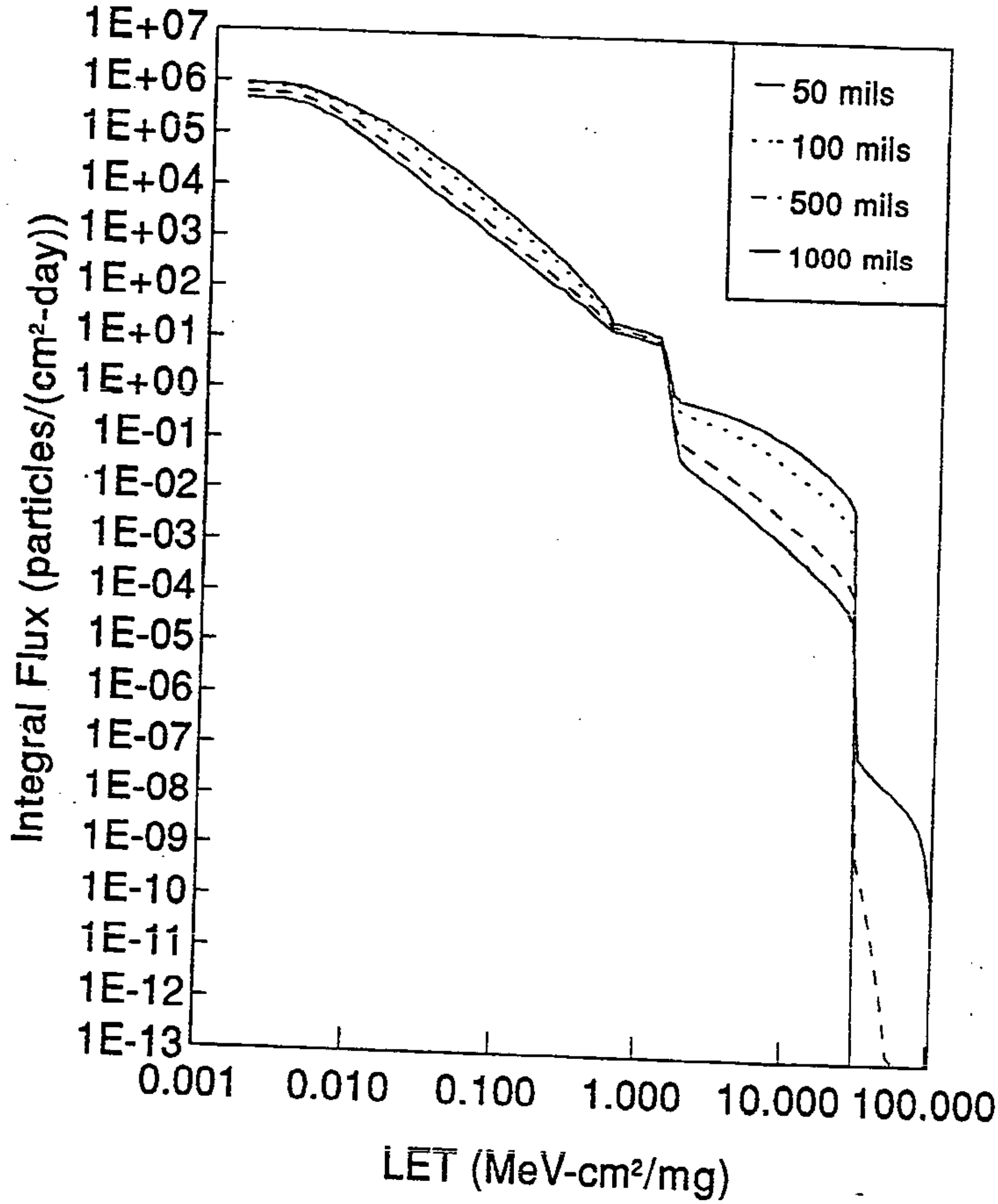

FIGURE 5

TABLE 1

HEAVY ION FLUX

SPHERICAL ALUMINUM SHELL THICKNESS

MILS	50	100	500	1000
G/CM^2	0.343	0.686	3.430	6.860
LET ($MEV-CM^2/MG$)	INTEGRAL FLUX ($PARTICLES/CM^2-DAY$)			
0.00169	9.164E+05	8.612E+05	6.462E+05	5.017E+05
0.00189	9.082E+05	8.530E+05	6.379E+05	4.935E+05
0.00212	8.895E+05	8.343E+05	6.193E+05	4.749E+05
0.00237	8.895E+05	8.343E+05	6.193E+05	4.749E+05
0.00265	8.886E+05	8.334E+05	6.193E+05	4.749E+05
0.00296	8.746E+05	8.195E+05	6.185E+05	4.742E+05
0.00331	8.447E+05	7.901E+05	6.057E+05	4.628E+05
0.00369	8.060E+05	7.520E+05	5.799E+05	4.414E+05
0.00413	7.582E+05	7.054E+05	5.459E+05	4.121E+05
0.00462	6.930E+05	6.416E+05	5.060E+05	3.783E+05
0.00516	6.290E+05	5.791E+05	4.529E+05	3.370E+05
0.00577	5.608E+05	5.123E+05	4.007E+05	2.949E+05
0.00645	4.991E+05	4.524E+05	3.451E+05	2.505E+05
0.00721	4.352E+05	3.907E+05	2.961E+05	2.115E+05
0.00806	3.771E+05	3.347E+05	2.474E+05	1.730E+05
0.00901	3.262E+05	2.863E+05	2.048E+05	1.403E+05
0.01007	2.791E+05	2.416E+05	1.692E+05	1.140E+05
0.01125	2.395E+05	2.045E+05	1.379E+05	9.173E+04
0.01258	2.013E+05	1.689E+05	1.130E+05	7.440E+04
0.01406	1.732E+05	1.430E+05	9.016E+04	5.871E+04
0.01572	1.442E+05	1.169E+05	7.423E+04	4.790E+04
0.01757	1.205E+05	9.583E+04	5.872E+04	3.756E+04
0.01964	1.004E+05	7.812E+04	4.677E+04	2.970E+04
0.02196	8.307E+04	6.346E+04	3.717E+04	2.345E+04
0.02454	6.848E+04	5.158E+04	2.948E+04	1.849E+04
0.02744	5.471E+04	4.069E+04	2.341E+04	1.462E+04
0.03067	4.457E+04	3.279E+04	1.809E+04	1.127E+04
0.03428	3.566E+04	2.598E+04	1.437E+04	8.940E+03
0.03832	2.873E+04	2.080E+04	1.124E+04	6.998E+03
0.04283	2.260E+04	1.629E+04	8.924E+03	5.564E+03
0.04788	1.787E+04	1.284E+04	6.948E+03	4.346E+03
0.05352	1.422E+04	1.021E+04	5.460E+03	3.425E+03
0.05983	1.122E+04	8.046E+03	4.346E+03	2.740E+03
0.06688	8.714E+03	6.237E+03	3.445E+03	2.189E+03
0.07476	6.660E+03	4.756E+03	2.669E+03	1.699E+03
0.08357	5.342E+03	3.817E+03	2.036E+03	1.298E+03
0.09341	4.143E+03	2.959E+03	1.653E+03	1.065E+03
0.10442	3.252E+03	2.325E+03	1.295E+03	8.412E+02
0.11672	2.514E+03	1.791E+03	1.035E+03	6.807E+02
0.13047	1.939E+03	1.372E+03	8.004E+02	5.280E+02
0.14584	1.474E+03	1.044E+03	6.047E+02	3.949E+02
0.16303	1.145E+03	8.144E+02	4.665E+02	3.074E+02
0.18224	8.718E+02	6.238E+02	3.737E+02	2.506E+02
0.20371	6.682E+02	4.811E+02	2.940E+02	2.003E+02
0.22771	5.041E+02	3.673E+02	2.323E+02	1.606E+02
0.25454	3.906E+02	2.891E+02	1.845E+02	1.303E+02
0.28453	2.840E+02	2.107E+02	1.524E+02	1.104E+02
0.31805	2.111E+02	1.587E+02	1.117E+02	8.107E+01
			8.715E+01	6.424E+01

TABLE 1 (CONT'D)

(CONTINUED)
SPHERICAL ALUMINUM SHELL THICKNESS

MILS	50	100	500	1000
G/CM2	0.343	0.686	3.430	6.860
LET (MEV-CM2/MG)	INTEGRAL FLUX (PARTICLES/CM2-DAY)			
0.35553	1.545E+02	1.184E+02	6.823E+01	5.136E+01
0.39741	1.083E+02	8.359E+01	4.897E+01	3.701E+01
0.44424	7.590E+01	6.044E+01	3.790E+01	2.938E+01
0.49658	4.878E+01	4.117E+01	2.889E+01	2.328E+01
0.55509	2.594E+01	2.511E+01	2.166E+01	1.848E+01
0.62049	2.457E+01	2.378E+01	2.050E+01	1.749E+01
0.69360	2.340E+01	2.264E+01	1.951E+01	1.664E+01
0.77532	2.135E+01	2.063E+01	1.775E+01	1.511E+01
0.86667	2.011E+01	1.942E+01	1.669E+01	1.420E+01
0.96878	1.833E+01	1.768E+01	1.518E+01	1.291E+01
1.08290	1.668E+01	1.607E+01	1.378E+01	1.171E+01
1.21050	1.501E+01	1.445E+01	1.237E+01	1.051E+01
1.35310	4.376E+00	3.988E+00	3.194E+00	2.713E+00
1.51260	1.109E+00	7.789E-01	3.627E-01	2.741E-01
1.69080	8.072E-01	4.925E-01	1.242E-01	6.154E-02
1.89000	7.468E-01	4.439E-01	9.993E-02	4.329E-02
2.11270	6.926E-01	4.013E-01	8.220E-02	3.341E-02
2.36160	6.418E-01	3.621E-01	6.772E-02	2.636E-02
2.63990	5.932E-01	3.257E-01	5.567E-02	2.092E-02
2.95090	5.470E-01	2.916E-01	4.555E-02	1.655E-02
3.29860	4.985E-01	2.568E-01	3.663E-02	1.294E-02
3.68720	4.508E-01	2.235E-01	2.919E-02	1.011E-02
4.12170	4.063E-01	1.943E-01	2.356E-02	8.037E-03
4.60730	3.620E-01	1.664E-01	1.882E-02	6.338E-03
5.15010	3.178E-01	1.402E-01	1.478E-02	4.894E-03
5.75690	2.768E-01	1.175E-01	1.166E-02	3.798E-03
6.43520	2.373E-01	9.702E-02	9.082E-03	2.904E-03
7.19340	2.013E-01	7.934E-02	7.063E-03	2.229E-03
8.04100	1.668E-01	6.347E-02	5.386E-03	1.677E-03
8.98840	1.386E-01	5.133E-02	4.205E-03	1.300E-03
10.04700	1.119E-01	4.031E-02	3.187E-03	9.757E-04
11.23100	9.032E-02	3.181E-02	2.451E-03	7.482E-04
12.55500	7.228E-02	2.496E-02	1.862E-03	5.625E-04
14.03400	5.706E-02	1.934E-02	1.395E-03	4.132E-04
15.68700	4.403E-02	1.468E-02	1.030E-03	3.022E-04
17.53600	3.364E-02	1.107E-02	7.690E-04	2.247E-04
19.60200	2.511E-02	8.160E-03	5.624E-04	1.640E-04
21.91100	1.798E-02	5.782E-03	3.960E-04	1.154E-04
24.49300	1.208E-02	3.862E-03	2.634E-04	7.669E-05
27.37900	6.784E-03	2.159E-03	1.468E-04	4.274E-05
30.60400	0.000E+00	0.000E+00	8.054E-10	9.473E-08
34.21000	0.000E+00	0.000E+00	2.803E-10	6.262E-08
38.24100	0.000E+00	0.000E+00	5.787E-11	4.509E-08
42.74700	0.000E+00	0.000E+00	9.986E-12	3.369E-08
47.78300	0.000E+00	0.000E+00	1.714E-12	2.557E-08
53.41300	0.000E+00	0.000E+00	1.412E-13	1.917E-08
59.70600	0.000E+00	0.000E+00	0.000E+00	1.410E-08
66.74100	0.000E+00	0.000E+00	0.000E+00	9.797E-09
74.60500	0.000E+00	0.000E+00	0.000E+00	6.480E-09

TABLE 1 (CONT'D)

(CONTINUED)
SPHERICAL ALUMINUM SHELL THICKNESS

MILS	50	100	500	1000
G/CM^2	0.343	0.686	3.430	6.860
LET ($MEV-CM^2/MG$)	INTEGRAL FLUX ($PARTICLES/CM^2-DAY$)			
83.39500	0.000E+00	0.000E+00	0.000E+00	3.751E-09
93.22000	0.000E+00	0.000E+00	0.000E+00	1.231E-09
104.20000	0.000E+00	0.000E+00	0.000E+00	1.036E-10

REDISTRIBUTED INTEGRAL FLUX AT 35° 370 km
CREME M=4, 80° cutoff

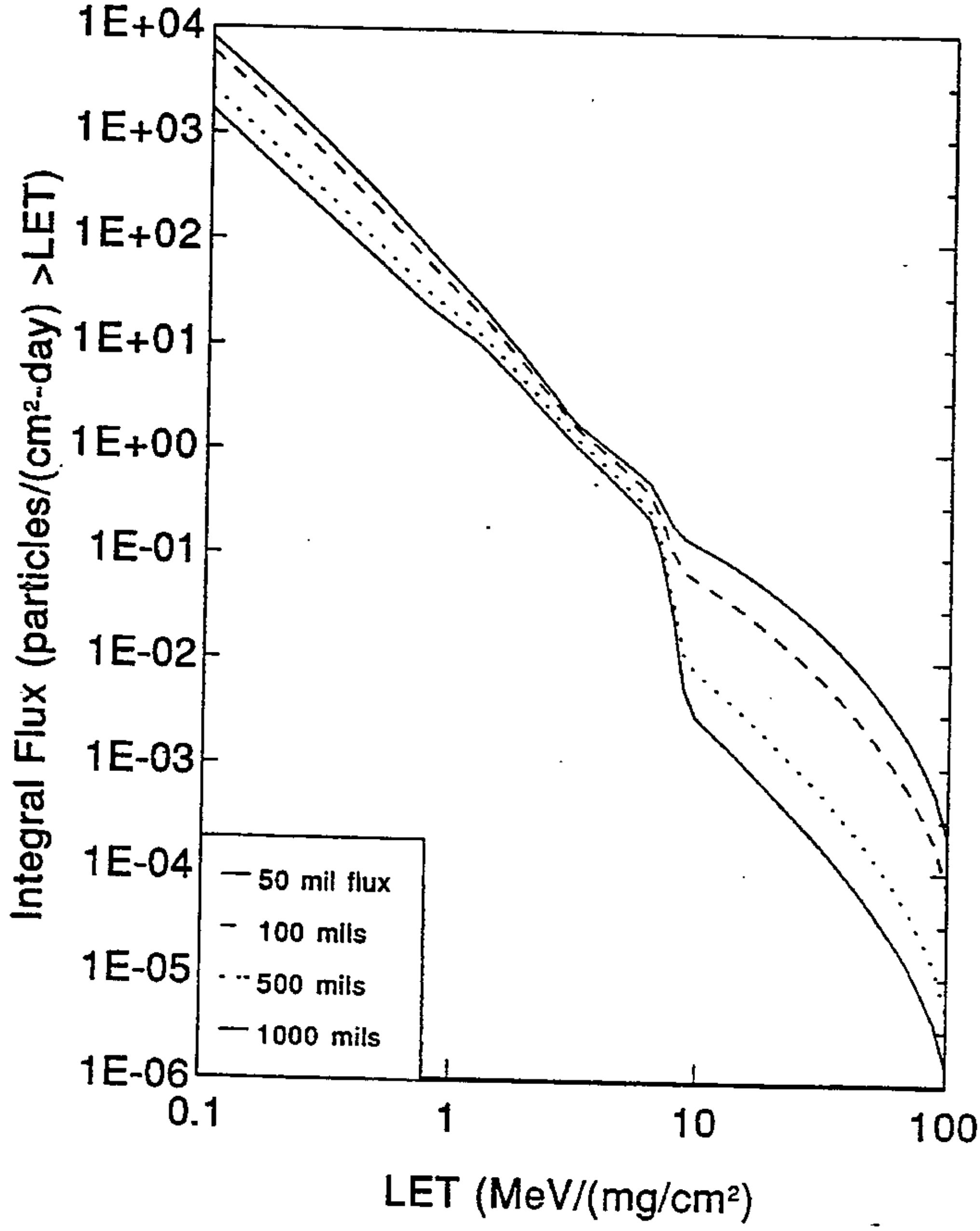

FIGURE 6

TABLE 2

REDISTRIBUTED HEAVY ION FLUX

CUTOFF ANGLE 80.0 DEGREES

SPHERICAL ALUMINUM SHELL THICKNESS

MILS G/CM^2	50 0.343	100 0.686	500 3.430	1000 6.860
LET (MEV-CM^2/MG)	REDISTRIBUTED INTEGRAL FLUX (PARTICLES/CM^2-DAY)			
0.10027	7.992E+03	5.938E+03	2.665E+03	1.684E+03
0.11209	6.426E+03	4.735E+03	2.107E+03	1.332E+03
0.12529	5.142E+03	3.762E+03	1.660E+03	1.050E+03
0.14005	4.084E+03	2.970E+03	1.301E+03	8.239E+02
0.15656	3.233E+03	2.339E+03	1.021E+03	6.479E+02
0.17500	2.549E+03	1.836E+03	8.000E+02	5.097E+02
0.19562	2.004E+03	1.439E+03	6.278E+02	4.019E+02
0.21867	1.575E+03	1.129E+03	4.946E+02	3.184E+02
0.24444	1.228E+03	8.806E+02	3.883E+02	2.518E+02
0.27324	9.571E+02	6.864E+02	3.052E+02	1.995E+02
0.30543	7.436E+02	5.338E+02	2.398E+02	1.581E+02
0.34142	5.737E+02	4.126E+02	1.880E+02	1.251E+02
0.38164	4.411E+02	3.177E+02	1.463E+02	9.808E+01
0.42661	3.387E+02	2.446E+02	1.143E+02	7.734E+01
0.47688	2.588E+02	1.876E+02	8.941E+01	6.122E+01
0.53306	1.961E+02	1.429E+02	6.966E+01	4.831E+01
0.59587	1.487E+02	1.092E+02	5.475E+01	3.856E+01
0.66608	1.120E+02	8.279E+01	4.254E+01	3.032E+01
0.74456	8.469E+01	6.323E+01	3.359E+01	2.431E+01
0.83229	6.436E+01	4.876E+01	2.704E+01	1.996E+01
0.93035	4.922E+01	3.795E+01	2.204E+01	1.659E+01
1.04000	3.782E+01	2.972E+01	1.807E+01	1.385E+01
1.16250	2.921E+01	2.347E+01	1.498E+01	1.169E+01
1.29950	2.225E+01	1.818E+01	1.202E+01	9.505E+00
1.45260	1.643E+01	1.359E+01	9.197E+00	7.332E+00
1.62370	1.204E+01	1.007E+01	6.971E+00	5.598E+00
1.81510	8.862E+00	7.506E+00	5.313E+00	4.299E+00
2.02890	6.386E+00	5.472E+00	3.953E+00	3.219E+00
2.26800	4.622E+00	4.007E+00	2.955E+00	2.422E+00
2.53520	3.381E+00	2.978E+00	2.257E+00	1.867E+00
2.83390	2.402E+00	2.159E+00	1.694E+00	1.418E+00
3.16780	1.805E+00	1.635E+00	1.305E+00	1.100E+00
3.54100	1.473E+00	1.314E+00	1.032E+00	8.673E-01
3.95820	1.199E+00	1.051E+00	8.102E-01	6.792E-01
4.42460	9.730E-01	8.348E-01	6.291E-01	5.258E-01
4.94590	7.914E-01	6.629E-01	4.876E-01	4.063E-01
5.52860	6.453E-01	5.263E-01	3.770E-01	3.132E-01
6.18000	5.169E-01	4.076E-01	2.818E-01	2.332E-01
6.90810	3.311E-01	2.327E-01	1.367E-01	1.106E-01
7.72200	2.030E-01	1.146E-01	4.097E-02	2.992E-02
8.63180	1.527E-01	7.312E-02	1.201E-02	5.654E-03
9.64880	1.317E-01	6.057E-02	8.123E-03	3.030E-03
10.78600	1.144E-01	5.135E-02	6.499E-03	2.334E-03
12.05600	9.869E-02	4.327E-02	5.190E-03	1.817E-03
13.47700	8.451E-02	3.624E-02	4.131E-03	1.417E-03
15.06500	7.176E-02	3.012E-02	3.265E-03	1.099E-03

TABLE 2 (CONT'D)

(CONTINUED)
REDISTRIBUTED HEAVY ION FLUX

CUTOFF ANGLE 80.0 DEGREES

SPHERICAL ALUMINUM SHELL THICKNESS

MILS	50	100	500	1000
G/CM^2	0.343	0.686	3.430	6.860
LET (MEV-CM^2/MG)	REDISTRIBUTED INTEGRAL FLUX (PARTICLES/CM^2-DAY)			
16.84000	6.043E-02	2.484E-02	2.562E-03	8.473E-04
18.82400	5.047E-02	2.033E-02	2.005E-03	6.542E-04
21.04100	4.171E-02	1.647E-02	1.557E-03	5.020E-04
23.52000	3.412E-02	1.322E-02	1.203E-03	3.841E-04
26.29200	2.747E-02	1.045E-02	9.176E-04	2.900E-04
29.38900	2.158E-02	8.083E-03	6.894E-04	2.159E-04
32.85200	1.661E-02	6.138E-03	5.098E-04	1.583E-04
36.72200	1.265E-02	4.604E-03	3.726E-04	1.147E-04
41.04900	9.548E-03	3.427E-03	2.712E-04	8.296E-05
45.88500	7.107E-03	2.516E-03	1.951E-04	5.931E-05
51.29200	5.180E-03	1.810E-03	1.377E-04	4.168E-05
57.33500	3.706E-03	1.280E-03	9.573E-05	2.882E-05
64.09000	2.580E-03	8.818E-04	6.509E-05	1.957E-05
71.64101	1.722E-03	5.832E-04	4.223E-05	1.260E-05
80.08100	1.062E-03	3.561E-04	2.522E-05	7.409E-06
89.51701	5.818E-04	1.937E-04	1.358E-05	3.986E-06
100.06001	2.209E-04	7.319E-05	5.103E-06	1.492E-06

3.10 Design and Construction Standards

3.10.1 Specifications and Standards

Specifications and standards with which the LIS must comply are delineated throughout this document. Specifications and standards shall also be selected from MM 8070.2.

3.10.2 Electronic, Electrical, and Electromechanical (EEE) Parts

3.10.2.1 EEE Parts Selection

Maximum use shall be made of NASA standard parts in the design, modification, and fabrication of the LIS. The parts, selection, and screening shall conform to the requirements and guidelines contained in Section 5 of MSFC-PLAN-2012. The program objectives shall be to minimize part types, to utilize standard part types to the maximum extent feasible, and to assure that appropriate minimum quality levels are maintained.

3.10.2.2 Nonstandard EEE Parts

Nonstandard parts (not listed in MIL-STD-975H) may be used when there is no standard part with a performance capability to satisfy the application requirements or a standard part is not available. The minimum screening requirements shall be as specified in Sections 3 and 4 of MSFC-SPEC-1198. Nonstandard parts shall be selected with first consideration given to the inherent capability of the parts to withstand the space, terrestrial, and mission environments to which the parts will be subjected. When making nonstandard part selection, previous parts experience and known failure mechanisms which have been documented in the Government-Industry Data Exchange Program (GIDEP) "Failure Experience Data Bank Summary," shall be reviewed to assure that the selected parts do not have the same or similar design deficiencies or failure mechanisms.

3.10.2.3 Parts Qualification

All EEE parts shall be qualified for the application and procured only from manufacturers that are qualified or their authorized distributors. Parts shall be qualified by one of the following methods:

a. Qualification based on existing data that is applicable to the part design and manufacturer to be used in this project.
b. Qualification based on similarity, provided the design is similar, manufactured by the same manufacturer and process, and the design differences are not great enough to invalidate the data.
c. Qualification through higher levels of assembly testing.
d. Parts of unusual design, materials, or construction techniques shall be qualified by complete part-level qualification test.

3.10.2.4 Approved EEE Parts Engineering List

An Approved EEE Parts Engineering List shall be maintained. This list shall include all NASA standard parts and all approved nonstandard parts that are used in the equipment. This list shall be divided into flight and GSE component sections and shall include the following information:

a. Part name (resistor, capacitor, etc.)
b. Common/similar part number
c. Procurement specification number
d. Name of component(s) used in
e. Quantity used per component
f. Manufacturers name (when known; i.e., QPL, etc.)

3.10.2.5 EEE Parts Derating Criteria

The EEE parts derating shall comply with the derating criteria of Appendix A in MIL-STD-975H.

3.10.3 General Structural/Mechanical Design Requirements

This section defines the structural/mechanical requirements which apply to such design aspects as structural integrity, materials selection, and surface finishing. The LIS design shall conform to the general structural strength program requirements as prescribed in all sections of MSFC-HDBK-505A.

3.10.3.1 Equipment Integrity and Factors of Safety

The LIS shall be designed to withstand the normal launch and operational environments without failures, releasing equipment, loose debris, or particles which could damage the H-II launch vehicle or the TRMM spacecraft. In addition, the LIS equipment shall be able to withstand the environments resulting from ground handling and transportation defined in this specification. Experiment equipment shall be designed such that the equipment integrity and load carrying capability of structural mounting provisions fulfill the corrosion prevention, stress corrosion cracking and fracture control requirements.

The minimum design factors of safety for test verified components shall be 1.25 for yield and 1.40 for ultimate. Components which use analysis only for structural verification shall use a minimum design factor of safety 2.0 for yield and 2.6 for ultimate. Detailed stress analysis shall be performed to show that adequate margins of safety exist for all components of LIS instrument. The margin of safety shall be greater than or equal to zero.

3.10.3.2 Corrosion Prevention

In as much as possible, corrosion resistant type metals shall be used rather than putting total dependence on coatings for corrosion protection. Protective finishes, when required, shall conform to all sections of MSFC-SPEC-250. Dissimilar metals, defined by paragraph 3.6.2.2 of MSFC-SPEC-250 or Section 3 of MIL-STD-889, shall not be used in combination unless they are suitably coated.

3.10.3.3 Stress Corrosion Cracking

All metallic materials shall meet the stress corrosion cracking requirements of MSFC-SPEC-522.

3.10.3.4 Fracture Control

Fracture control for the LIS instrument shall be implemented in accordance with all sections of MSFC-HDBK-1453. All sections of MSFC-STD-1249 shall provide guidelines for selections and applications of Nondestructive Evaluation (NDE) Techniques required to implement a fracture control program.

3.10.4 Materials and Processes

All materials and processes used in the construction of LIS hardware shall meet the requirements of all sections of MSFC-STD-506.

3.10.5 Contamination Control Requirements

The LIS instrument shall be designed to meet the general contamination requirements, plume impingement, parts and subassemblies bake-out, instrument certification requirements, fabrication, assembly, and integration requirements, and cleaning requirement as specified in TRMM-490-022.

3.10.5.1 Surface Cleanliness

The cleanliness levels of the LIS instrument external surfaces shall meet requirements of paragraph 3.2 of MSFC-PLAN-1973. Prior to integration with the TRMM spacecraft, the cleanliness levels of all external surfaces shall be verified by testing as specified in the LIS Performance Verification Plan, MSFC-PLAN-1857.

3.10.5.2 Outgassing

LIS material shall meet the requirements defined in all sections of JSC-SP-R-0022A. New materials shall be subjected to testing per all sections of ASTM-E-595.

3.10.5.3 Flammability

All materials shall meet the flammability requirements per NHB 8060.1.

3.10.6 Workmanship

The equipment designed and manufactured under this specification shall conform to accepted standards of spacecraft design and shall be constructed and finished in a manner indicative of good workmanship. Particular attention shall be paid to neatness, cleanliness, and thoroughness of all processes and operations involving assembly and finishing of all items. Workmanship standards shall be consistent with the requirements of paragraphs 8.10.2 and 8.10.3 of MSFC-PLAN-2012.

3.11 Handling Requirements

Handling of the LIS experiment shall be done manually. Handling procedure shall be prepared to support during ground processing.

3.12 Packaging, Preservation, and Transportation

The LIS shall be packaged for protection against the induced handling, storage, and transportation environment per Appendix A of NHB 6000.1. The LIS design shall provide for the use of shipping containers to prevent damage during shipping and handling.

3.13 LIS Verification Requirements Matrix

The Verification Requirements Matrix is attached as Appendix A. It specifies the method used to verify each of the system level requirement for the LIS instrument defined herein. The following key is provided for the "verification method" columns:

"T" -- Verification by test
Verification by test is the actual operation of equipment during ambient conditions or when subjected to specified environments to evaluate the performance.

"A" -- Verification by Analysis
Verification by analysis is a process used in lieu of or in addition to testing to verify compliance to the specification requirements. The selected techniques may include systems engineering analysis, statistics and qualitative analysis, computer and hardware simulations, and computer modeling.

"I" -- Verification by Inspection
Verification by inspection is the physical evaluation of equipment and/or documentation to verify design features. Inspection is used to verify construction features, workmanship, dimensions and physical condition, such as cleanliness, surface finish, and locking hardware.

APPENDIX A

VERIFICATION REQUIREMENTS MATRIX

VERIFICATION REQUIREMENTS MATRIX

REF. No.	PARA. NO.	REQUIREMENT STATEMENT	RESP. ORG.	VERIF. METH.	PHASE	REMARKS
	3.1	Mission Requirements				N/A
1	3.1.1	Launch	ED	R, A, T, I	Accep	
2	3.1.2	Orbit		T,R		See Section 3.3
3	3.1.3	Design Life	ED	A, I	Prel, Qual	
4	3.1.4	Safety	CT	R, A	Prel, Dev	
5	3.1.4.1	Safety Priority	CT	R, A	Dev	
6	3.1.4.2	Hazard Reduction	CT	A	Dev	
7	3.1.5	Design Assurance & Reliability	CT	R, A, T	Dev, Accep	
8	3.1.6	Maintainability	CQ	A	Dev, Prel	
9	3.1.7	Quality	CQ	R, I, A, T	Dev, Accep	
10	3.1.8	Coordinate Systems	ED	A	Dev	
	3.2	Operational Requirements				N/A
11	3.2.1	Ground Operations	EB	T	Accep, Prel	
12	3.2.2	Integrated Systems Testing	EB	T, A	Dev, Accep	
13	3.2.3	Flight Operations	EB	A, T	Dev, Accep	
	3.3	Performance Requirements				N/A
14	3.3.1	Field-of-View	ES	T	Qual	
15	3.3.2	Storm Spatial Resolution	ES	T	Qual	

VERIFICATION REQUIREMENTS MATRIX

REF. No.	PARA. NO.	REQUIREMENT STATEMENT	RESP. ORG.	VERIF. METH.	PHASE	REMARKS
16	3.3.3	Temporal Resolution	ES	T	Qual	
17	3.3.4	Detection Threshold/Wavelength	ES	T	Qual	
18	3.3.5	Detection Efficiency	ES	T	Qual	
19	3.3.6	Dynamic Range	ES	T	Qual	
20	3.3.7	Measurement Location Accuracy	ES	T	Qual	
21	3.3.8	Measurement Intensity Accuracy	ES	T	Qual	
22	3.3.9	Science Mode	ES	T	Qual	
	3.4	Mechanical Interface Requirements				N/A
23	3.4.1	Mounting Envelope	ED	A, I	Dev, Accep	
24	3.4.2	Mass Properties	ED	A, T	Dev, Qual	
25	3.4.3	Alignment Requirements	ED	A, T	Dev, Accep	
26	3.4.3.1	Placement Accuracy	EB	T, A	Dev, Qual	
27	3.4.3.2	Placement Knowledge	EB	T	Qual	
28	3.4.3.3	Instrument Stability	ES, ED	T, A	Dev, Qual	
	3.5	Electrical System Interfaces Requirements				N/A
29	3.5.1	Electrical Harnessing	EB	R, T	Qual,	
30	3.5.2	Power Interface Requirement	EB	T, A	Qual, Dev	
31	3.5.3	Signal Interface Requirement	EB	A	Dev	

VERIFICATION REQUIREMENTS MATRIX

REF. No.	PARA. NO.	REQUIREMENT STATEMENT	RESP. ORG.	VERIF. METH.	PHASE	REMARKS
32	3.5.4	Electromagnetics Compatibility	EL	T, R	Qual	
33	3.5.5	Electrostatic Discharge Control	EB	T	Qual	
34	3.5.6	Magnetic Requirements	EB	T	Qual	
	3.6	Command and Data Handling Interfaces Requirement				N/A
35	3.6.1	Science Data	EB	T, R	Qual	
36	3.6.2	Housekeeping Data	EB	T, R	Qual	
	3.7	Thermal Requirements				N/A
37	3.7.1	Thermal Interface Requirements	ED	A	Dev	
38	3.7.2	Instrument Thermal Design	ED	A	Dev	
39	3.7.3	Instrument Temperature Range	ED, EL	T, A	Dev, Accep	
40	3.7.4	Instrument Temperature Monitoring	ED, EL	T	Accep	
	3.8	Ground Support Equipment (GSE)				N/A
41	3.8.1	Mechanical Ground Support Equipment	EH	R, A	Dev	
42	3.8.2	Electrical Ground Support Equipment	EH	R, T	Accep	
43	3.8.3	Software	EB	R, A	Dev	
44	3.9	Environmental Requirements	ED, EL, EH	T, A, I	Dev, Accep	

VERIFICATION REQUIREMENTS MATRIX

REF. No.	PARA. NO.	REQUIREMENT STATEMENT	RESP. ORG.	VERIF. METH.	PHASE	REMARKS
45	3.9.1	Launch Pressure Profile	ED	A	Dev	
46	3.9.2	Cosmic Rays	EL	A	Dev	
	3.10	Design and Construction Standards				N/A
47	3.10.1	Specifications and Standards	EB, ED	R	Dev	
	3.10.2	Electronic, Electrical, and Electromechanical (EEE) Parts				N/A
48	3.10.2.1	EEE Parts Selection	EB	R	Dev	
49	3.10.2.2	Nonstandard EEE Parts	EB	R	Dev	
50	3.10.2.3	Parts Qualification	EB	R	Dev	
51	3.10.2.4	Approved EEE Parts Engineering List	EB	R	Dev	
52	3.10.2.5	EEE Parts Derating Criteria	EB	R	Dev	
53	3.10.3	General Structural/Mechanical Design Requirements	ED	R, A	Dev	
54	3.10.3.1	Equipment Integrity and Factors of Safety	ED	T, A	Dev, Qual	
55	3.10.3.2	Corrosion Prevention	EH	R	Dev	
56	3.10.3.3	Stress Corrosion Cracking	EH	R	Dev	
57	3.10.3.4	Fracture Control	EH	R	Dev	
58	3.10.4	Material and Processes	EH	R	Dev	

VERIFICATION REQUIREMENTS MATRIX

REF. No.	PARA. NO.	REQUIREMENT STATEMENT	RESP. ORG.	VERIF. METH.	PHASE	REMARKS
59	3.10.5	Contamination Control Requirements	EH	R, I	Dev, Qual	
60	3.10.5.1	Surface Cleanliness	EH	R, I, T	Dev, Qual	
61	3.10.5.2	Outgassing	EH	T, A	Qual, Dev	
62	3.10.5.3	Flammability	EH	R	Dev	
63	3.10.6	Workmanship	ED, EB	R, I	Dev, Qual	
64	3.11	Handling Requirements	EH	R, A	Dev	
65	3.12	Packaging, Preservation, and Transportation	EH	R, A, I	Dev, Qual	

Verification Method Code Key: R - Review of Design Documentation; A- Analysis; T- Test; I - Inspection

May 22, 1995

TO: CN22D/MSFC Repository

FROM: FA31/R. Chassay

SUBJECT: Document Distribution List

Please make distribution of MSFC-SPEC-2028A, LIS Systems Requirements and Performance Specification Document for Tropical Rainfall Measuring Mission Spacecraft, in accordance with the following list for Revision A and all updates:

CR32/J. Collins	1
CR75/M. Giuntini	1
EB73/D. O Dell	1
EB23/R. McIntosh	1
EB33/R. Rehage/M. Frankford/D. Wilkerson/ L. Kemp/D. Trice/K. Biel/L. Coe	7
EB42/L. Simeone	1
EB52/R. Eng	1
EB73/R. Doreswamy	1
EB75/J. Brown	1
ED25/K. Swaim	1
ED23/B. Perkins	1
ED26/K. Oliver	1
ED65/F. Lopez	1
EH44/M. Mitchell	1
EH52/R. Akins/J. Wright	2
EJ23/P. Hassler/D. Ellsworth	2
EL62/T. Phillips/A. Lee	2
ES41/H. Christian	1
ES43/R. Blakeslee/W. Koshak	2
FA31/R. Chassay/R. Beranek	2
FA62/L. Prendergast	1
GSFC/Code 490/B. Brown	1
PRC/P. Brown	1
PWI/L. Traylor	2
CN31D MSFC REPOSITORY	2
CN31D B. LAND	1