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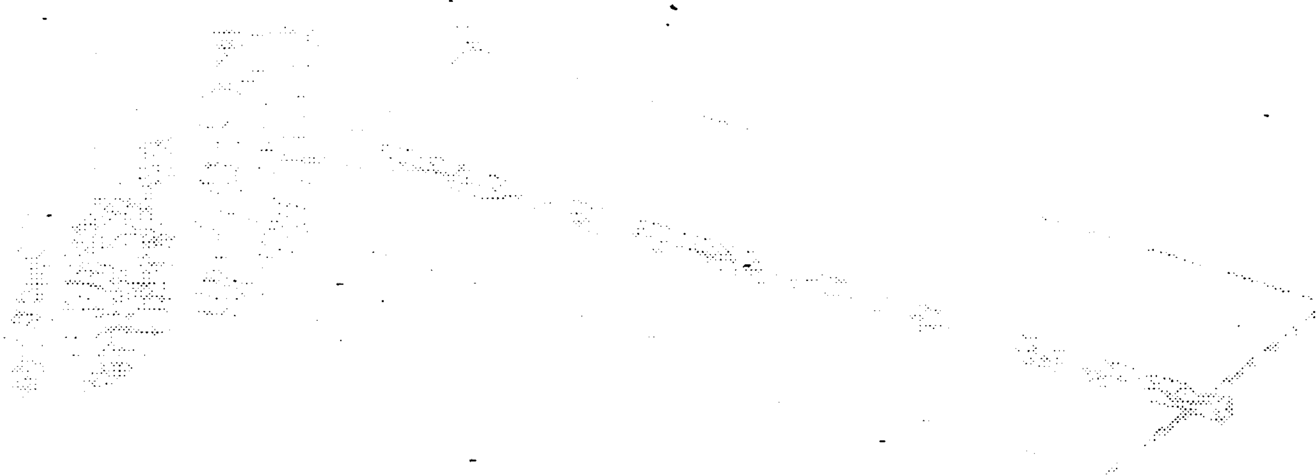
CONTRACT NAS5-32500

Earth Observing System

EOS–AM SPACECRAFT PDR DATA PACKAGE

Package 6



17 SEPTEMBER 1993

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EAST WINDSOR, NJ

EOS–AM SPACECRAFT CONTRACT DOCUMENT TRANSMITTAL

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☐ Type 1 requires approval of Technical Manager prior to implementation Approval Due Date ________	TITLE: (Draft) Electromagnetic Compatibility (EMC) Test Plan for EOS–AM Spacecraft Martin Marietta Document No.: PN20005868
☒ Type 2 time–limited right of disapproval (45 days after receipt) Approval Due Date ________	References: EOS–AM Spacecraft PDR Data Package 6, dated 17 September 1993 (EOSC–0993)
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REMARKS:

This document is one of two documents omitted from EOS–AM Spacecraft PDR Data Package 6, and should be placed in that package as indicated on the Table of Contents. Twelve copies of the revised last page of the Table of Contents are also enclosed for insertion into the Data Package.

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DR/DN	TYPE	TITLE	REV	DOCUMENT	DATE
Package No. 6				**Rev.: 18 October, 1993**	
SEP-104	2	GSE Requirements Document	-	20001430	9/1/93
VRD-105	2	EMC Test Plan for EOS-AM S/C	Draft	PN20005868	10/7/93
EOS-DN	-	EOS-AM Ku- Band H/W Distortion Impact Analysis by CLASS	-	COMM-022	9/7/93
-	-	EOS-AM S/C EMC Design Handbook	A	20005400	LATER **
UID-102	3	ICD, MISR, for EOS-AM S/C	C	20008830	8/23/93
		ICD, Integration & Test, MISR	Draft	20008836	7/15/93
UID-102	3	ICD, MODIS, for EOS-AM S/C	B	20008840	8/23/93
		ICD, Integration & Test, MODIS	Prelim	20008846	7/15/93
UID-102	3	ICD, MOPITT, for EOS-AM S/C	-	20008850	8/4/93
		ICD, Thermal Tables, MOPITT	Draft	20008853	9/7/93
-	-	EOS-AM S/C Equipment Planning Diagrams (In front cover pocket)	Prelim	20008541	9/7/93

** NOTE: THIS DOCUMENT WILL BE PROVIDED VIA A SEPARATE TRANSMITTAL AT A LATER DATE

Ground Support Equipment Requirements Document (GSERD) for EOS–AM Spacecraft (SEP–104)

20001430
CAGE No. 49671
01 September 1993

Ground Support Equipment Requirements Document (GSERD) for EOS–AM Spacecraft (SEP–104)

Prepared under
Contract NAS5–32500
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

Prepared by:
Martin Marietta Corporation
Astro Space
P.O. Box 800
Princeton, New Jersey 08543–0800

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REVISION LOG

This log identifies those portions of this document which have been revised since the original issue. Revised portions of each page, for the current revision only, are identified by marginal striping.

Revision	Paragraph Number(s) Affected	Rev. Date	Approval
Initial Issue		09/02/93	CM/GSR

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ITEM	SECTION	PAGE	SUBJECT	RESP.	DUE
TBD–1	3.2.1.7.11	32	Alarm Page Scroll Size	Rankin	EGSE CDR

TBR LOG

ITEM	SECTION	PAGE	SUBJECT	RESP.	DUE
TBR–1	3.2.1.7.3	16	Number of workstations in test system	Rankin	EGSE CDR
TBR–2	3.2.1.7.3	17	Time required to change master wkstn	Rankin	EGSE CDR
TBR–3	3.2.1.7.3	17	Time required to initiate abort proc.	Rankin	GSE SW PDR
TBR–4	3.2.1.7.4	18	Function key usage	Rankin	GSE SW PDR
TBR–5	3.2.1.7.7	26	Time to report limit violation	Rankin	GSE SW PDR
TBR–6	3.2.1.7.7	28	Number of test instrummt data sources	Rankin	EGSE CDR
TBR–7	3.2.1.7.7	28	Max data rate from each GSE source	Rankin	EGSE CDR
TBR–8	3.2.1.7.7	28	Max aggregate GSE data rate	Rankin	EGSE CDR
TBR–9	3.2.1.7.10	29	Time tag accuracy	Rankin	EGSE CDR
TBR–10	3.2.1.7.10	29	Time tag resolution	Rankin	EGSE CDR
TBR–11	3.2.1.7.10	29	Data file record duration	Rankin	EGSE CDR
TBR–12	3.2.1.7.10	31	Archive label length	Rankin	EGSE CDR
TBR–13	3.2.1.7.11	33	Data display latency	Rankin	EGSE CDR

1 SCOPE

1.1 Identification

This Ground Support Equipment Requirements Document (GSERD) identifies and describes common performance and functional requirements for all Ground Support Equipment (GSE) necessary to support the assembly, test, subsystems checkout, systems checkout, handling, transportation, launch–site activities, and overall integration and processing of the Equipment Modules, Solar Array Assembly, High Gain Antenna Assembly, Spacecraft Bus, and integrated EOS–AM Spacecraft. This document identifies GSE interfaces and describes the minimum equipment requirements to support Spacecraft Integration and Test (I&T).

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2 APPLICABLE DOCUMENTS

The following documents, of the issue or revision shown, form a part of this document to the extent referenced herein. In the event of conflict between any of the documents referenced herein and this document, the contents of this document shall be considered a superceding requirement, except for documents GSFC–421–10–01, GSFC–421–21–01, and Martin Marietta Astro Space (Astro Space) PS20005396 listed below which shall take precedence.

2.1 Government Documents

2.1.1 Specifications

Federal

None

Military

None

NASA

None

Other Government Agency

None

2.1.2 Standards

Federal

FED–STD–595 15 December 1989	Colors, Paints, Dopes, Varnishes, and Related Products

Military

MIL–STD–1472	Human Engineering Design Criteria for Military Systems, Equipment, and Facilities
MIL–STD–45662A	Calibration System Requirements

2.1.3 Drawings

None

2.1.4 Other Publications

Regulations

WSMCR 127–1 15 December 1989	Western Space and Missile Center Range Safety Requirements

Handbooks

MIL–H–25579E	Hose Assembly, Tetrafluoroethylene, High Temperature, Medium Pressure
MIL–H–38360B	Hose Assembly, Tetrafluoroethylene, High Temperature High Pressure, Hydraulic and Pneumatic
NHB 6000.1C June 1976	Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems Equipment and Associated Components
SP8077	Requirements for Shipping Containers

2.2 Non–Government Documents

2.2.1 Specifications

PS20001415	Performance Specification, Structures and Mechanisms Subsystem
PS20005396	Contract End Item Specification for the EOS–AM Spacecraft (SEP–101)
IS20008501	General Interface Specification for the EOS–AM Spacecraft (ICD–101)
PS20008567	Performance Specification for Command and Data Handling Subsystem for EOS–AM Spacecraft (SP–301)
IS20008658	EOS–AM Spacecraft Data Format Control Book Interface Control Document (ICD–106)
Source:	Martin Marietta Astro Space P. O. Box 800 Princeton, NJ 08543–0800

2.2.2 Standards

47A210105 Rev. L	Electrical AGE Fabrication and Workmanship Standard
Source:	Martin Marietta Astro Space P. O. Box 800 Princeton, NJ 08543–0800

2.2.3 Drawings

None

2.2.4 Other Publications

20004280	EOS Subcontractor Performance Assurance Requirements
20005397	Performance Assurance Implementation Plan (PA–100)
PN20005869	Electromagnetic Compatibility Control Plan for the EOS–AM Spacecraft (SEP–106)
23001146	Configuration Management Requirements for Subcontractors
AEP 6.04	Engineering Procedure, Red Line System
PAP A1.13	Ground Support Equipment Quality Plan
Source:	Martin Marietta Astro Space P. O. Box 800 Princeton, NJ 08543–0800
ANSI X3.4	American Standard Code for Information Interchange
Source:	ANSI, Inc. 1430 Broadway New York, NY 10018
NFPA 70–1990	National Electrical Code
Source:	National Fire Protection Association Batterymarch Park Quincy, MA 02269

2.3 Information Documents

PS20008509	Requirements Document for Spacecraft Checkout Station (SCS) (SEP–900)
PS20008510	Requirements Document for Spacecraft Interface Simulator (SIS) (SEP–910)
PS20008511	Requirements Document for Equipment Module Special Test Equipment (EM STE) (SEP–920)
PS20008512	Requirements Document for Launch Support Equipment (LSE) (SEP–950)
Source:	Martin Marietta Astro Space P. O. Box 800 Princeton, NJ 08543–0800

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3 REQUIREMENTS

3.1 General

This section includes a description of the functional, performance, and physical requirements for all Ground Support Equipment used to assemble, test, handle, and transport EOS–AM Spacecraft hardware.

This section also includes a description of the functional and performance requirements for Electrical Ground Support Equipment (EGSE) software to be used in the testing of Spacecraft hardware.

GSE for servicing and testing the Spacecraft and its components has been allocated to three major categories, Spacecraft GSE, Major Subassembly GSE, and Launch Support Equipment. Within each category, two further subcategories have been defined, Electrical Ground Support Equipment and Mechanical Ground Support Equipment (MGSE). This is illustrated in Figure 1.

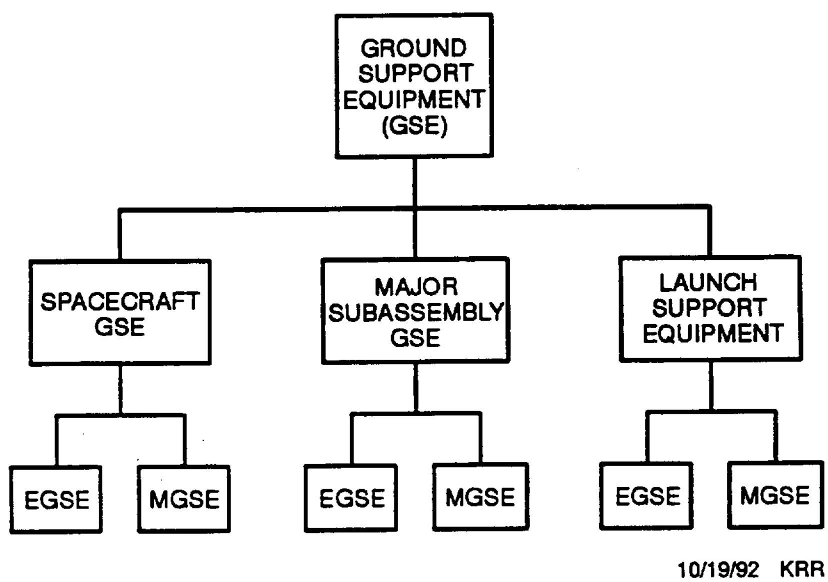

Figure 1. EOS–AM Spacecraft Ground Support Equipment

3.2 Functional Requirements

3.2.1 Spacecraft Electrical Ground Support Equipment

The EGSE for the Spacecraft will consist of the three major equipment systems and miscellaneous Special Test Equipment which are outlined in Figure 2 and described in the following subsections.

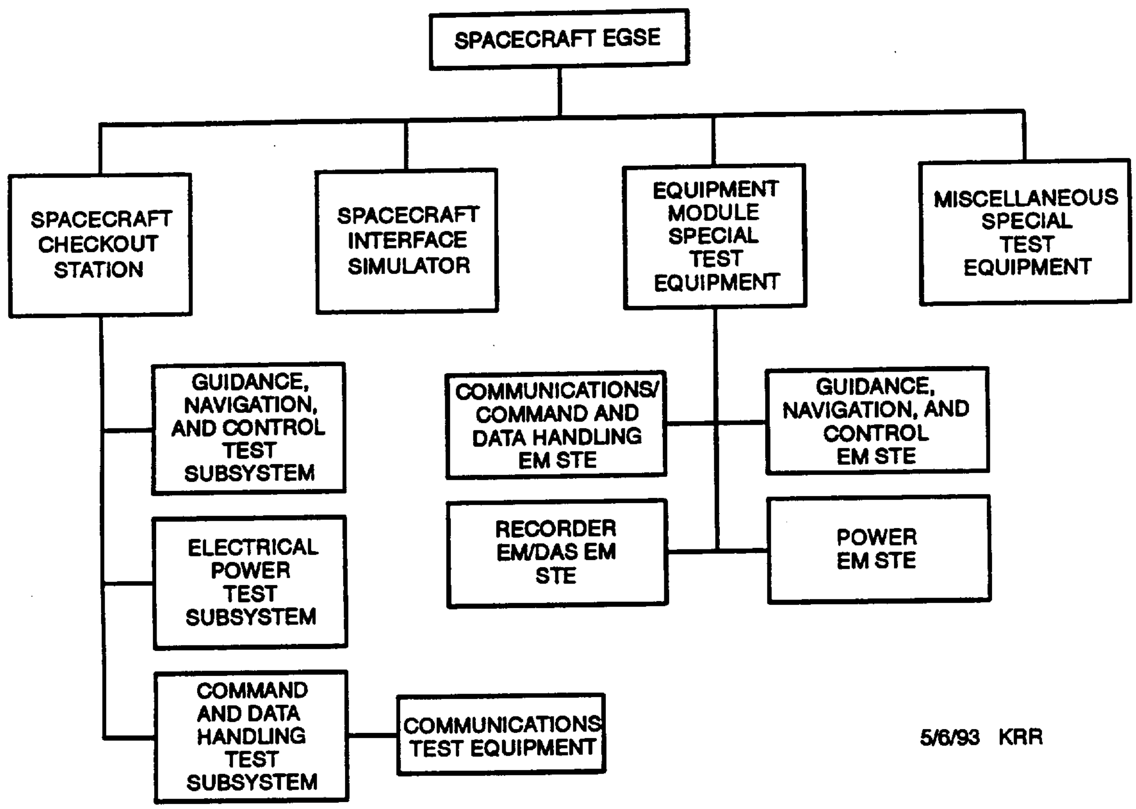

Figure 2. Spacecraft Electrical Ground Support Equipment

The three major EGSE systems (Spacecraft Checkout Station, Spacecraft Interface Simulator, and Equipment Module Special Test Equipment), which are computer based, will be designed to maximize automatic test procedure implementation and the commonality of software among them.

EGSE will be designed to maximize commonality of hardware, including custom in–house designed and fabricated units, among them to the extent possible. All EGSE will be designed with certain common requirements for basic electrical and mechanical design and construction.

The following subsections contain overall top–level requirements for EGSE, in addition to general and common requirements for EGSE software.

Later sections of this document contain general and common requirements for EGSE hardware.

3.2.1.1 Spacecraft Checkout Station

[1] The Spacecraft Checkout Station (SCS) shall constitute a test system for performance of electrical tests upon the EOS–AM Spacecraft.

[2] The SCS shall be designed and constructed to facilitate use for both factory and launch site testing.

[3] The SCS shall provide all of the test equipment, computer facilities, and software necessary to perform integration and verification testing of the Spacecraft.

[4] The SCS shall provide DC power supply equipment, command, telemetry, and data handling and processing equipment, r.f. communications equipment, and orbit and attitude control test support equipment as required to support operation and testing of the Spacecraft.

[5] The SCS shall include computer equipment and appropriate peripheral devices to provide test control and man–machine interface.

[6] The SCS shall be designed and constructed as a distributed system to provide flexibility of use with the Spacecraft and to accommodate the various test scenarios and locations within which the Spacecraft must be tested.

[7] The SCS shall include the following test subsystems and equipment:

a. Electrical Power Test Subsystem

b. Command and Data Handling Test Subsystem

c. Communications Test Equipment

d. Guidance, Navigation, and Control Test Subsystem

e. Test Port Interface

[8] Each of the SCS test subsystems, named for that portion of the Spacecraft it supports, shall be driven as required by one or more separate computers.

[9] These computers shall be networked with each other and with the test station main computer(s).

[10] Constituent elements and equipment comprising the test subsystems of the SCS shall be identical to and interchangeable with functionally similar equipment in the Spacecraft Interface Simulator and the Equipment Module Special Test Equipment, which are described in Subsections 3.2.1.2 and 3.2.1.3 respectively, to the maximum extent possible.

A block diagram of the SCS is shown in Figure 3. More detailed requirements for the SCS are set forth in PS20008509, Requirements Document for the Spacecraft Checkout Station.

3.2.1.2 Spacecraft Interface Simulator

[1] The Spacecraft Interface Simulator (SIS) shall simulate the Spacecraft–to–Instrument electrical interface to any EOS–AM Instrument.

[2] The SIS electrical interfaces shall include:

a. Spacecraft power bus

b. Low Rate Science Bus connections

c. High–rate science data link connections

d. Command & Telemetry Bus

e. Time Mark & Frequency Bus

f. discrete–line command and telemetry interfaces.

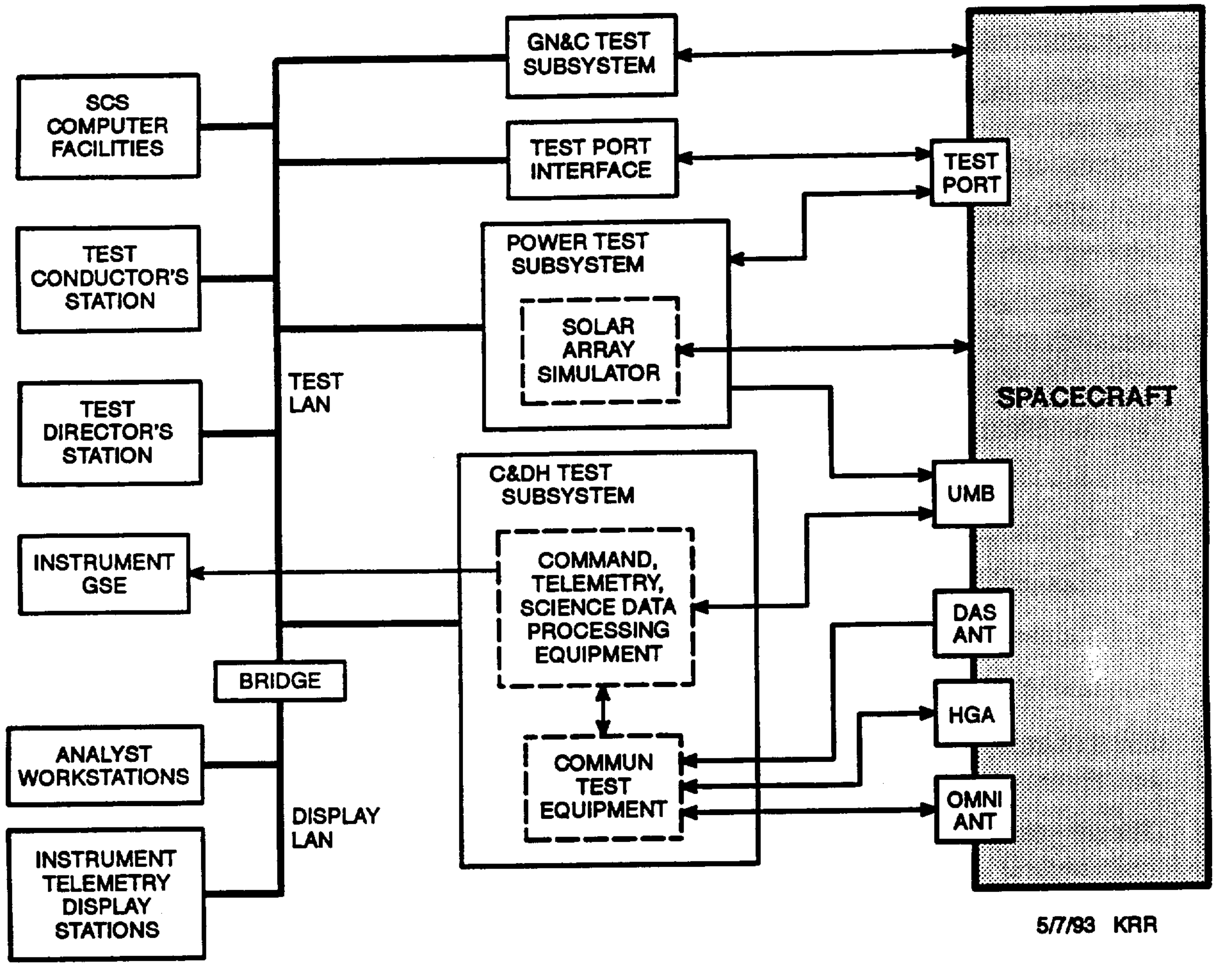

Figure 3. Spacecraft Checkout Station Block Diagram

[3] The SIS shall provide capabilities to verify Instrument compatibility with Command & Telemetry (C&T) Bus protocols.

[4] The SIS shall provide capabilities to verify Instrument compatibility with low and high rate science data interfaces.

[5] The SIS shall simulate the SCS – to – Instrument Science Ground Support Equipment (ISGSE) science data interfaces that will be used during Spacecraft–level testing.

[6] The SIS shall be capable of being transported between Astro Space and Instrument Developer locations.

A block diagram of the SIS is shown in Figure 4. More detailed requirements for the SIS are set forth in PS20008510, Requirements Document for the Spacecraft Interface Simulator.

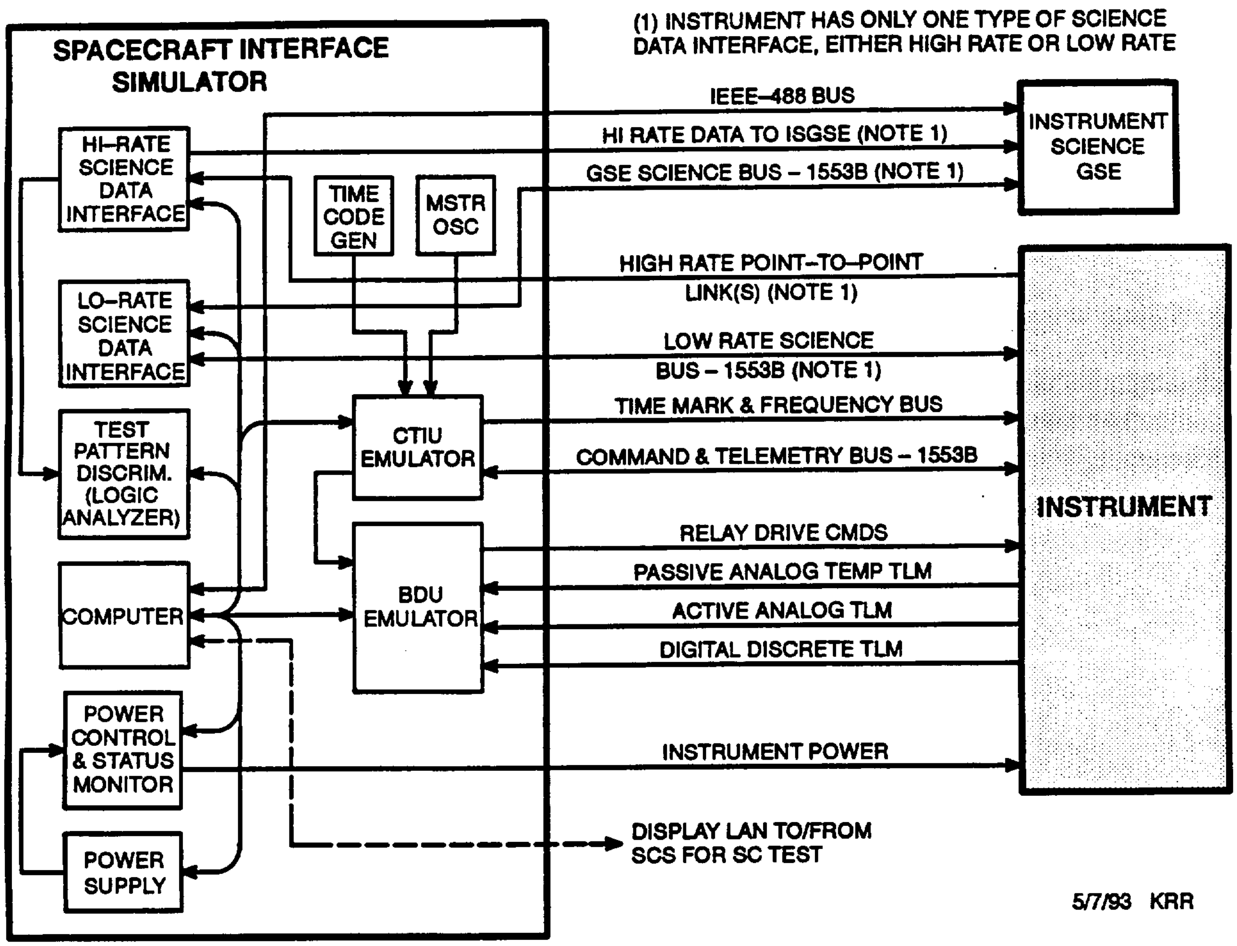

Figure 4. Spacecraft Interface Simulator Block Diagram

3.2.1.3 Equipment Module Special Test Equipment

[1] The Equipment Module Special Test Equipment (EM STE) shall constitute a group of test systems for performance of electrical tests upon the EOS–AM Spacecraft Equipment Modules.

[2] Each Equipment Module STE shall provide DC power supply equipment, command, telemetry, and data handling and processing equipment, and other test equipment as required to support operation and testing of the relevant Equipment Module(s).

[3] Each Equipment Module STE shall include computer equipment and appropriate peripheral devices to provide test station control and man–machine interface.

[4] Each test station shall provide capability within its computer equipment for test control, test procedure implementation, and test data management.

[5] The Equipment Module STE shall consist of the following four stand–alone test stations to be used for testing of Equipment Modules before they are installed on the Spacecraft:

a. Power Equipment Module STE

b. Communications/Command and Data Handling (C&DH) Equipment Module STE

c. Recorder/Direct Access Subsystem (DAS) Equipment Module STE

d. Guidance, Navigation, and Control (GN&C) Equipment Module STE.

Each of these test stations is named for the Equipment Module(s) being tested.

Block diagrams describing the four Equipment Module STE are shown in Figures 5 through 8 inclusive. More detailed requirements for the Equipment Module STE are set forth in PS20008511, Requirements Document for Equipment Module Special Test Equipment.

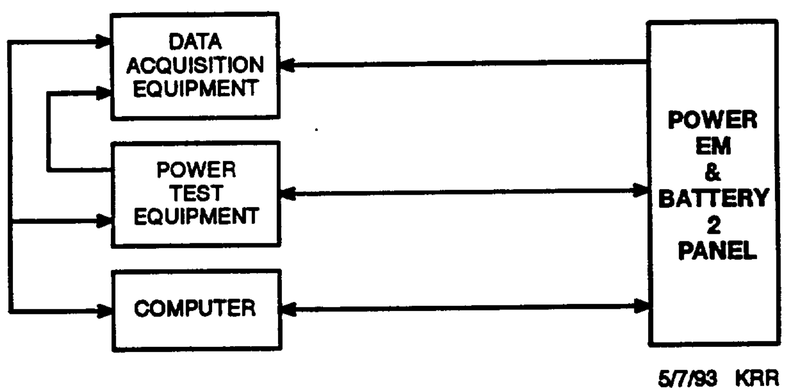

Figure 5. Power Equipment Module STE Block Diagram

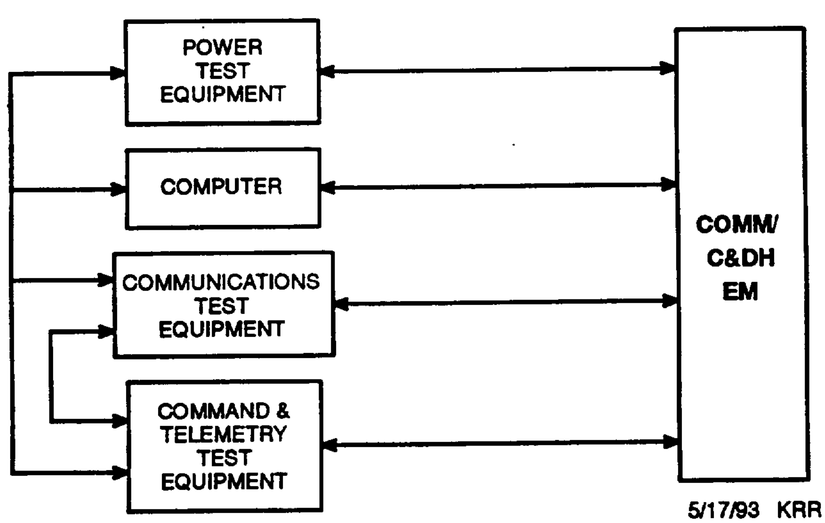

Figure 6. Communications/C&DH Equipment Module STE Block Diagram

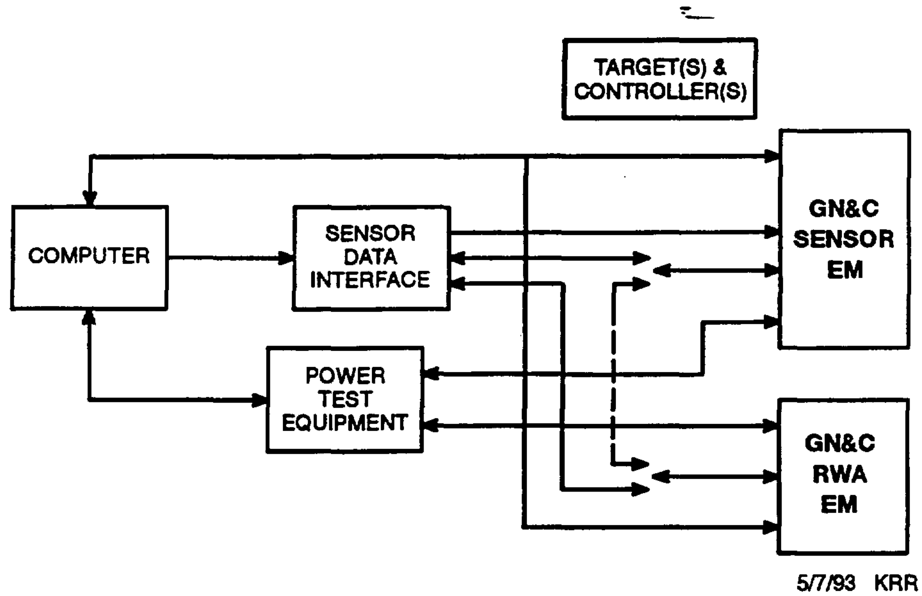

Figure 7. GN&C Equipment Module STE Block Diagram

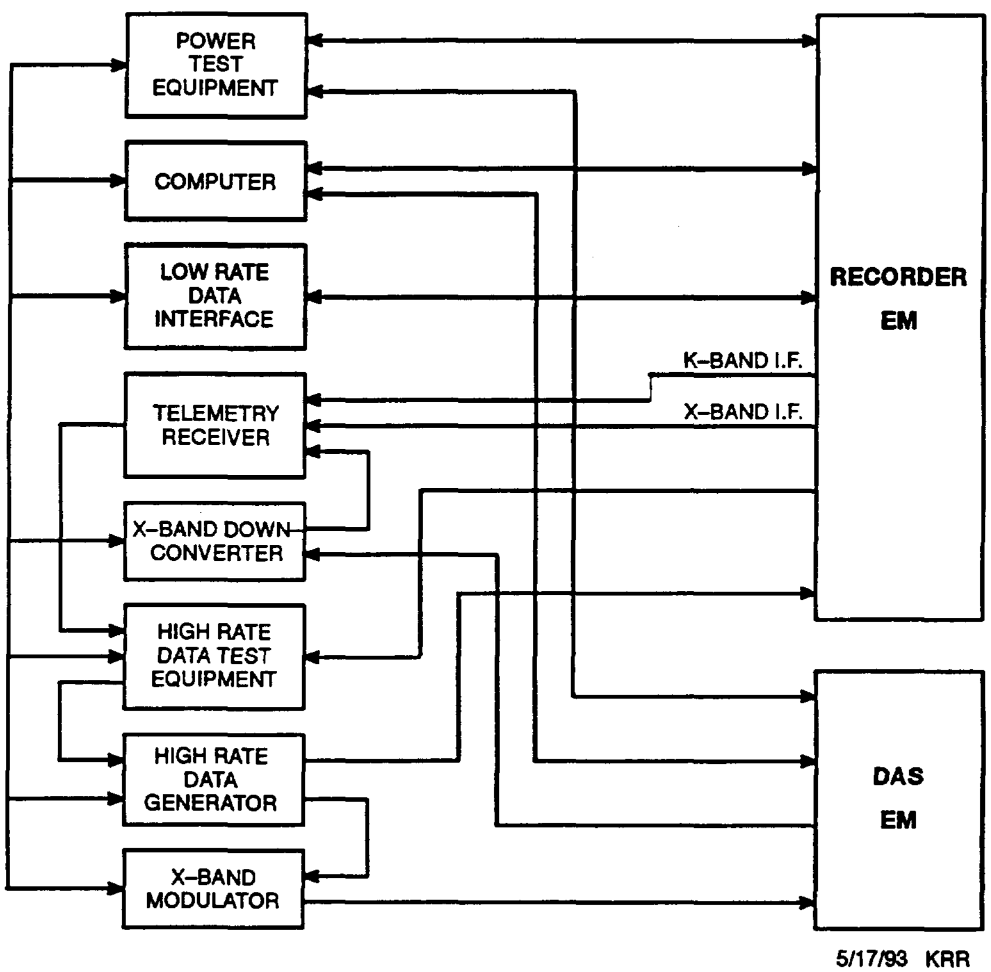

Figure 8. Recorder/DAS Equipment Module STE Block Diagram

3.2.1.4 Propulsion Module Special Test Equipment

[1] The Propulsion Module (PM) GSE shall support the electrical testing of the PM as a stand–alone unit prior to integration with the Spacecraft.

[2] The PM STE shall simulate the electrical interface between the PM and the Spacecraft.

[3] The PM STE shall permit full functional operation of the PM without a Spacecraft interface connection.

[4] The PM STE shall provide DC power for operation of the PM electronics units, pressure and temperature transducers, latch valves, thruster valves, and heaters.

[5] The PM STE shall provide capabilities to actuate any of the thruster and isolation valves and enable or disable any of the propellant pressure transducers.

[6] The PM STE shall provide monitoring for the open and closed status of all isolation valves and for tank pressure transducers and temperature sensors.

A block diagram describing the Propulsion Module STE is shown in Figure 9. More detailed requirements for the Propulsion Module STE are set forth in PS20008511, Requirements Document for Equipment Module Special Test Equipment.

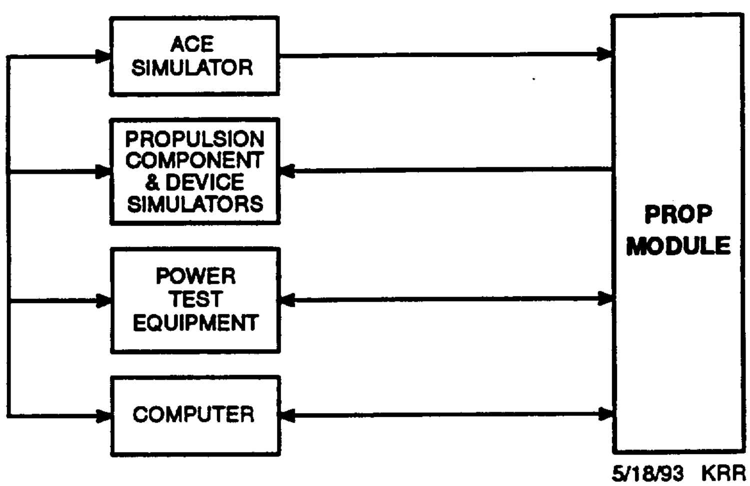

Figure 9. Propulsion Module STE Block Diagram

3.2.1.5 Miscellaneous Spacecraft EGSE

3.2.1.5.1 Pyro Special Test Equipment

[1] The Pyro STE shall electrically simulate all Spacecraft pyrotechnic devices for testing.

[2] The Pyro STE shall provide electrical interfaces with flight hardware and with a multichannel chart recorder.

3.2.1.5.2 Multichannel Chart Recorder

[1] A multichannel chart recorder shall be provided to generate hard copy records of pyro firing and duration.

[2] The multichannel chart recorder shall provide a minimum of eight signal channels.

[3] The chart recorder shall provide an electrical interface with the Pyro STE.

3.2.1.5.3 EGSE Connector Savers (Buffer Cables) and Fuse Buffers

[1] Connector savers shall be provided and used between flight connectors and EGSE connectors when numerous disconnections between the flight and EGSE connectors are anticipated.

[2] Fuse buffers shall be provided and used between flight power connectors during initial electrical integration and test of the Spacecraft.

[3] Buffer fuse current ratings shall be equal to or less than the derated values of the flight fuses being protected.

3.2.1.6 Launch Support Equipment

Launch Support Equipment (LSE) includes power, control, and communications equipment for support of the launch of the EOS–AM Spacecraft from the Western Test Range (Vandenburg AFB). LSE encompasses all electrical and electronic equipment at the launch pad associated with control and monitoring of the Spacecraft.

[1] The electrical LSE shall provide electrical interfacing between the launch site locations as described in Figure 10.

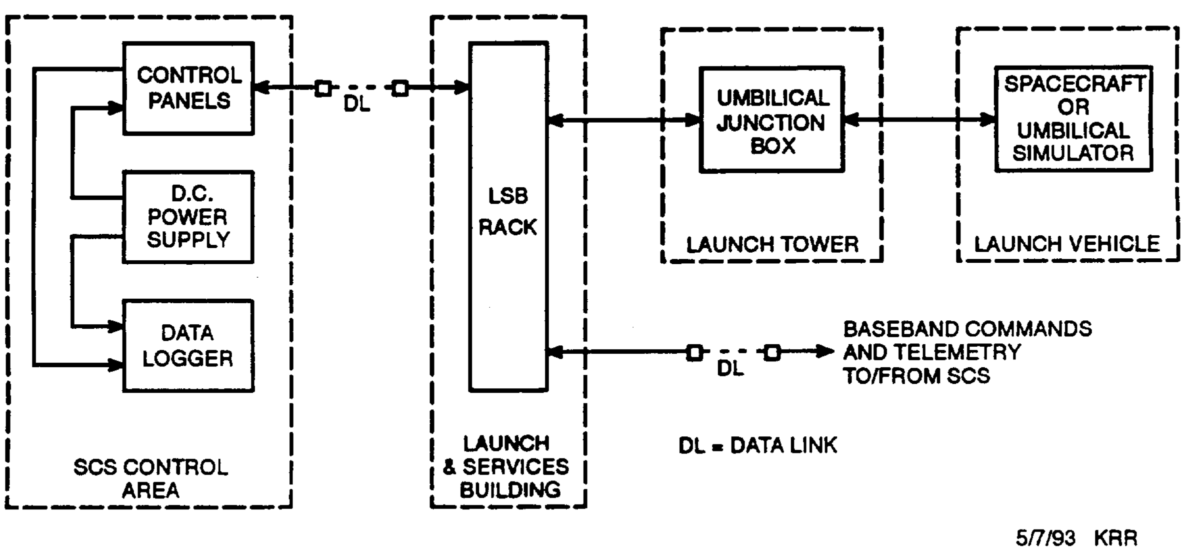

Figure 10. Launch Support Equipment

[2] The LSE shall provide external electrical power to the Spacecraft.

[3] The LSE shall provide independent charging of the Spacecraft batteries.

[4] The LSE shall provide command and telemetry communications with the Spacecraft mounted on the launch vehicle.

[5] LSE shall comply with the applicable requirements of Subsection 3.14 of U. S. Air Force document WSMCR 127–1, Western Space and Missile Center Range Safety Requirements.

More detailed requirements for the LSE are set forth in PS20008512, Requirements Document for Launch Support Equipment.

3.2.1.7 GSE Software

3.2.1.7.1 General

This section covers software architecture and the software requirements which are common to two or more of the SCS, SIS, and Equipment Module STE. These software functions will be provided and utilized as common elements among these GSE systems. Other test–system–specific software requirements may be found in Astro Space documents PS20008509, PS20008510, and PS20008511.

3.2.1.7.2 GSE Software Architecture

[1] The GSE computer software shall contain functions for test software procedure generation, providing the procedure author with the ability to create and modify test command procedures.

[2] The GSE computer software shall contain functions for execution of test language directives and procedures.

[3] Test execution software shall provide the Test Conductor with the ability to control all aspects of online testing including mode setting, system commanding, system monitoring, and display and data logging selections.

[4] The GSE computer software shall contain functions for off–line data analysis, providing the Test Analyst with test evaluation tools for report generation, data plotting, data trending, and general analysis.

[5] The GSE computer software shall contain functions for maintaining and updating the GSE databases.

[6] The GSE computer software shall provide capabilities for user file maintenance, operating system management, and user access class management.

3.2.1.7.3 GSE Computer System Management

[1] The GSE software shall support up to 18 **(TBR–1)** workstations in any specific test system, consisting of (as an example in the SCS configuration) a combination of master station, file server, test subsystem control computers, and analyst stations.

[2] The GSE software shall allow only one workstation to be designated as master.

[3] The GSE software shall allow only the master workstation to issue commands to the Spacecraft, Equipment Module, Instrument, or GSE.

[4] The designation of the master workstation shall be part of the system configuration.

[5] It shall be possible, with two levels of security provided in the software, for the operator at the master workstation to designate another workstation as master.

[6] It shall be possible, with two levels of security provided in the software, for the operator, using a workstation not the current master, to designate that workstation as master.

[7] When the designation of master workstation is changed, the change shall take less than 15 **(TBR–2)** minutes without requiring restarting or interruption of test flow continuity.

[8] The GSE software shall provide the master workstation with the capability to direct a page display to be displayed on any other workstation in the system.

[9] The GSE software shall provide file management utilities and operating system access to all users.

[10] The GSE software shall provide capabilities for storage of program and data files to removable non–volatile media.

[11] The GSE software shall provide capabilities for retrieval of program and data files from removable non–volatile media.

[12] The GSE software shall provide capabilities to define and control user classes, levels of authority, and privileges to provide operational and data security.

[13] The GSE software shall control system access by means of a formal system of user identification, authentication, and authorization.

[14] The GSE software shall provide a capability to log system accesses made by each user.

[15] The GSE software shall control data access by means of a formal system of user identification, authentication, and authorization.

[16] The GSE software shall provide a capability for a system administrator to bypass the user authorization procedures with appropriate authority levels.

[17] The GSE software shall provide capabilities for accepting input time data from a time code generator and incorporating it as the system time reference.

[18] The GSE computer hardware and software shall maintain the system time reference within 0.10 seconds of the input time code data by updating the system time reference as necessary.

[19] GSE software processing operations which result in abort actions shall initiate the abort process within 0.50 **(TBR–3)** seconds of the logical decision requiring the abort.

3.2.1.7.4 User Interface

[1] GSE computer hardware and software shall provide an operator interface for manually entering or viewing data, which will include or accommodate the use of:

a. windowing software

b. graphical user interface

c. an English–like test language.

[2] The GSE software user interface function shall support operator inputs which include the following, as a minimum:

a. standard keyboards which include function keys

b. programmable keys

c. "mouse" pointing devices.

[3] The GSE software user interface function shall validate user input, providing an error indication to the user if invalid entries are made.

[4] The GSE software user interface function shall halt upon error, display a message noting the error detected, and provide the capability to restart, correct the input and continue, or cancel the input and exit that operation.

[5] The GSE user interface software shall provide the capability to associate frequently used functions with the available function keys of the keyboard, allowing the function to be executed by pressing the proper function key.

[6] The GSE user interface software shall accommodate the following function key usages via hard or soft function keys (**TBR–4**):

a. GO to initiate or resume a procedure

b. HALT to suspend a procedure

c. KILL (terminate current directive and suspend procedure execution)

d. KILLPROC, with confirmation (terminate current procedure, return to previous level, and suspend execution)

e. print display

f. resend command.

[7] The GSE user interface software shall support communication with the operator using the following features, as needed:

a. color display monitors with alphanumeric and graphics capabilities

b. monochrome display monitors with alphanumeric and graphics capabilities

c. display window managers

d. text entry windows

e. pop–up windows

f. menu selection options

g. pull–down menus

h. function key selection

i. toggle items

j. audio alarm controls.

[8] The GSE software display interface shall support a minimum of 16 distinct colors.

[9] The GSE software display interface shall provide capabilities to define default colors as part of the startup configuration.

[10] The GSE software display interface shall provide for the simultaneous implementation of windows as follows:

a. up to seven permanently displayed windows of fixed size and location within the upper half of the display screen

b. two callable or "pop–up" windows of fixed size and location appearing at the right center of the display screen when active

c. two windows of fixed size in the bottom half of the display screen which will be predefined and may be called, moved, or dismissed at the discretion of the operator.

[11] If a newly–called or moved window occludes another window, either partially or fully, the occluded window shall reappear without loss of data when the occluding window is dismissed or moved to remove the occlusion.

[12] Data in an occluded window shall be updated as though the occlusion were not in effect.

[13] The GSE software display interface shall provide a standard set of information as part of a display, including, but not limited to, the following items:

a. date and time

b. telemetry acquisition status

c. Spacecraft telemetry mode

d. command verification status

e. limit checking status

f. out–of–limits flag

g. procedure status.

[14] The GSE user interface software shall provide the capability to initiate or perform any of the following activities based upon correct user entry or selection:

a. execution of a test directive (a single command element)

b. execution of a test script or procedure (a list of successive test directives)

c. transmission of commands and command lists

d. control of applicable elements of the GSE to which the computer(s) are interfaced, as shown in the EGSE block diagrams given in the SCS Requirements Document, 20008509, EM STE Requirements Document, 20008511, and SIS Requirements Document, 20008510

e. description of a test configuration, including the presence or absence of hardware, on/off status, any important mode information, etc

f. control of data displays

g. entering of comments and descriptive text

h. control of archival of flight hardware telemetry data

i. control of retrieval of flight hardware telemetry data

j. control of archival of GSE hardware status or measurement data

k. control of retrieval of GSE hardware status or measurement data

l. execution of any available data analysis functions

m. enabling or disabling of data monitoring

n. enabling or disabling of data logging, with confirmation

o. enabling or disabling of verification of command transmission

p. enabling or disabling of verification of command execution

q. enabling or disabling of command prerequisite checking

r. enabling or disabling of flight telemetry and GSE data limit checking

s. setting of flight telemetry and GSE data limits

t. control of message routing.

u. control of archival of test status messages

v. control of retrieval of test status messages

w. control of archival of alarm messages

x. control of retrieval of alarm messages

y. control of data printing or hardcopy generation

z. retrieval of data from any available database

3.2.1.7.5 Test Language

[1] The GSE software shall provide a test language which will facilitate the automation of testing and provide a standardization of the overall commanding and operation of the system under test and the GSE hardware.

[2] The Test Language shall exhibit the characteristics of a structured, English–like high–level language.

[3] The Test Language function shall provide control of all commandable functions of the system under test and the GSE.

[4] The Test Language function shall provide features which permit testing to be accomplished via manual step–by–step actions and by automatic procedures.

[5] The Test Language function shall permit test scripts (procedures) to be created with the use of an ASCII file text editor, compiled, and loaded for library storage.

[6] The Test Language function shall provide capabilities to modify, copy, and delete procedures.

[7] The Test Language function shall permit procedures to be referenced by name.

[8] The Test Language function shall provide the capability for procedures to accept parameter information up to a maximum of 8 parameters.

[9] The Test Language function shall provide the capability to single–step procedures.

[10] The GSE software shall provide capabilities for evaluating test directives against the state of the system under test, including GSE, such as for the presence or absence of specified hardware, to determine whether the directives are permissible.

[11] The Test Language function shall support the definition and use of both local and global variables.

[12] The Test Language function shall prohibit the redefinition of the characteristics of a global variable while a procedure is executing.

[13] The Test Language function shall perform syntax checking on entered input, report syntax errors, and upon error prohibit the execution of incorrect input.

[14] The Test Language function shall provide the capabilities to execute or accommodate the following activities and functions:

a. execution of a test directive (a single command element)

b. execution of a test script or procedure (a list of successive test directives)

c. transmission of commands and command lists

d. control of applicable elements of the EGSE to which the computer(s) are interfaced, as shown in the block diagrams given in Astro Space documents 20008509, 20008510, and 20008511

e. control of data displays

f. conditional instructions, including looping and branching, IF–THEN–ELSE, and LOOP–ENDLOOP constructs

g. nested instructions or procedures, to a minimum of five levels of nesting

h. arithmetic operations of addition, subtraction, multiplication, division, and exponentiation

i. logical and relational operations

j. support of labels and GOTO directives

k. procedure control directives, including as a minimum the following:

   1. WAIT unconditional
   2. WAIT conditional {time}
   3. WAIT conditional {expression}
   4. GO to initiate or resume a procedure
   5. GO at {line number or label} (resume at specified line number or label)
   6. KILL (terminate current directive and suspend procedure execution)
   7. KILLPROC, with confirmation (terminate current procedure, return to previous level, and suspend execution)

l. entering of comments and descriptive text

m. access to local variables

n. access to global variables

o. processing of data types as follows:

  1. integer

  2. long integer

  3. 1750 floating point

  4. character string

p. control of data printing and hardcopy generation

q. control of archival of flight hardware telemetry data

r. control of retrieval of flight hardware telemetry data

s. control of archival of GSE hardware status or measurement data

t. control of retrieval of GSE hardware status or measurement data

u. execution of any available data analysis functions

v. enabling or disabling of data monitoring

w. enabling or disabling of data logging, with confirmation

x. enabling or disabling of verification of command transmission

y. enabling or disabling of verification of command execution

z. enabling or disabling of command prerequisite checking

aa. enabling or disabling of flight telemetry and GSE data limit checking

ab. control of message routing.

ac. setting of flight telemetry and GSE data limits

ad. control of archival of test status messages

ae. control of retrieval of test status messages

af. control of archival of alarm messages

ag. control of retrieval of alarm messages

ah. control of data printing or hardcopy generation

ai. retrieval of data from any available database

[15] The Test Language function shall provide the capability to specify which language functions are permitted to be used in procedures.

[16] The Test Language function shall provide the capability to specify which language functions are permitted to be invoked from the workstation.

[17] The Test Language function shall provide the capability for generation of listings of software procedures, including line number information.

3.2.1.7.6 Command Operations

[1] The GSE software shall provide capabilities for transmission of commands to flight hardware using any of the specified command rates of 125 bps, 1 kbps, 2 kbps, and 10 kbps.

[2] The GSE software shall deliver command words to the GSE link layer hardware with the same format and data content as the flight command words as defined in Section 5 of Astro Space document IS20008658, Data Format Control Book.

[3] The GSE software shall provide the ability to set command parameters, including Spacecraft address.

[4] The GSE software shall provide capabilities for repeated transmission of the same command indefinitely, and for termination of the repetition of the command.

[5] The GSE software shall provide capabilities for causing the hardware command interface to generate erroneous command transmissions for the purpose of testing proper flight hardware response.

[6] The GSE software shall provide capabilities for hazardous or critical command checking.

[7] Hazardous or critical command checking shall always be active and may not be disabled.

[8] Any hazardous or critical command shall require operator confirmation by prompting the operator for either an "allow" or a "reject" response and then either transmitting the command or ignoring it as appropriate.

[9] An "allow" response to any hazardous or critical command shall require two keystrokes of physically separated keys or a positive response followed by a "Return" on the keyboard.

[10] If the operator does not respond to the "allow/reject" response request for a hazardous command, the GSE software shall cause the following actions to occur:

a. generation of a log message

b. termination of the procedure if the command is part of a procedure.

[11] The GSE software shall provide command prerequisite checking, using information associated with each command to determine, by examining telemetry or status data, whether or not the flight hardware or GSE is in the desired configuration for command transmission.

[12] The GSE software command prerequisite checking shall provide the capability to report a message indicating the result of the check.

[13] When the GSE software determines that a component for which an issued command is destined is missing or off, it shall display a message to that effect to the operator and shall ignore the transmission and verification of the command.

[14] The GSE software shall permit command prerequisite checking to be enabled or disabled.

[15] Command prerequisite checking shall function in the absence of active return telemetry, indicating that it is unable to check telemetry or finds telemetry indeterminate as appropriate.

[16] The GSE software shall provide capabilities for verification of command receipt by the flight hardware, where applicable, by examination of returning telemetry status messages for proper conditions.

[17] The GSE software shall permit verification of command receipt to be enabled or disabled.

[18] The GSE software shall provide capabilities for verification of command execution by the flight hardware by examination of returning telemetry for proper values as specified in the database.

[19] The GSE software shall permit specification of a time–out value for command execution verification, where expiration of the time–out period with the desired telemetry state(s) not being achieved indicates that the command did not execute.

[20] The GSE software shall provide capabilities to check the desired execution verification state prior to command transmission to determine if the command is redundant (i.e., the desired telemetry state is the same as the current telemetry state), display a message, and optionally request confirmation from the operator.

[21] The GSE software shall permit verification of command execution to be enabled or disabled for commands other than hazardous or critical commands, for which verification of command execution may not be disabled.

[22] Any hazardous or critical command shall require completion of command execution verification before the software will permit continuance of any procedure.

[23] If the appropriate command execution verification information is not present in the database, the GSE software shall cause the following actions to occur:

a. generation of a log message

b. suspension of the procedure pending operator action if the command is part of a procedure.

[24] Command execution verification shall function in the absence of active return telemetry, indicating that it is unable to check telemetry or finds telemetry indeterminate as appropriate.

[25] The GSE software shall maintain a cumulative status of all command execution categorized by subsystem and for all subsystems collectively since the last previous query of the corresponding execution status was performed.

[26] The GSE software shall provide capabilities for sending multiple commands and having the command verification results of those commands reflected collectively as a block in the execution status information.

[27] The GSE software shall permit examination of command execution status from the keyboard or from a procedure.

[28] The GSE software shall permit resetting or initializing command execution status associated with a specific subsystem and for all subsystems collectively.

[29] The GSE software shall provide the ability to suspend procedure execution until command execution has been verified for any of the following groups of commands:

a. all commands in a command block

b. all commands associated with a particular subsystem

c. the most recent command

[30] The GSE software shall provide capabilities for unexpected event detection, which will monitor all command execution verification status information for any unexpected change (i.e., a change that occurred when the associated command was not sent) and report it.

[31] In the event that command receipt or command execution cannot be properly verified for one or more commands, the GSE software shall provide capabilities for command retransmission under manual control.

[32] The GSE software shall provide capabilities for transmitting mode commands to elements of test equipment in the GSE.

[33] The GSE software shall provide capabilities for transmitting commands for setting parameter values to elements of test equipment in the GSE.

3.2.1.7.7 Telemetry Processing

[1] Telemetry processing software shall support non–simultaneous 1kbps and 16kbps Spacecraft telemetry data rates.

[2] Telemetry processing software shall indicate that no data is available for telemetry points in the 16 kbps telemetry stream which are not present in the 1 kbps telemetry stream when the latter is being processed.

[3] Telemetry processing software shall provide capabilities for synchronizing on minor frames of the Spacecraft telemetry data streams as defined in Subsection 3.2.1.6 of Astro Space document PS20008567.

[4] Telemetry processing software shall support simultaneous inputs of telemetry (1 or 16kbps) and diagnostic (1 or 16 kbps) Spacecraft data via separate data channels or ports. The same data rate will exist on both channels.

[5] Telemetry point values shall be accessible from the keyboard or from a procedure by mnemonic or location (i.e., position within a frame) reference.

[6] Telemetry processing software shall provide the capability to perform limit checking on Spacecraft telemetry or GSE measurement data.

[7] Limit checking, when performed, shall be performed only on raw data.

[8] Telemetry processing software shall permit limits to be specified in engineering units and shall process the limit information into the proper format for internal limit checking.

[9] Telemetry processing software shall provide the capability to examine every sample for any point being limit checked.

[10] Telemetry processing software shall provide the capability to enable and disable all telemetry limit checking.

[11] Telemetry processing software shall provide the capability to enable and disable limit checking for all telemetry points within a particular subsystem.

[12] Telemetry processing software shall provide the capability to enable and disable limit checking for individual telemetry points.

[13] Telemetry processing software shall generate a display flag for each subsystem which indicates whether or not any relevant point being limit checked is out of limits and displays the number of points currently out of limits for that subsystem.

[14] Telemetry processing software shall provide the capability to clear any or all of the out–of–limits flags by keyboard command or by displaying the ALARMS display (either of these actions constitutes acknowledgment of out–of–limits conditions).

[15] Telemetry processing software shall provide the capability to modify limit set values based on telemetry state, including the capability to inhibit limit checking of the associated point for a particular state.

[16] A telemetry limit set definition for analog telemetry points shall consist of a yellow and a red region within high and low regions (RL < YL < YH < RH).

[17] A telemetry limit set definition for bi–level telemetry points shall consist of valid and not valid indications.

[18] Telemetry processing software shall provide the capability to call a specified directive or procedure based on the occurrence of a red out–of–limits condition or an invalid status condition as applicable.

[19] A telemetry limit set definition shall include the specification of a deadband which specifies the range within which a point value is permitted to deviate from the previous out–of–limits point value without an additional out–of–limits message being generated.

[20] The telemetry limit set deadband shall default to zero if a value is not specified.

[21] A telemetry limit set definition shall include the specification of a maximum delta value which specifies the range beyond which deviation of a new point value from the previous point value will generate a message, even though one or both values used to establish the delta may individually be within limits.

[22] Telemetry processing software shall provide the capability to enable and disable the telemetry limit set delta value.

[23] Telemetry processing software shall generate an out–of–limits message any time the value of a telemetry point enters the yellow region for the first time and any time the value of a telemetry point enters the red region for the first time, with subsequent out–of–limits messages being dependent on the specified deadband for that point.

[24] Each telemetry out–of–limits message shall report the current telemetry point value and the limits against which it was checked.

[25] Telemetry processing software shall prohibit specifying a value of less than one for the number of times to display an out–of–limits message.

[26] Telemetry processing software shall display out–of–limits messages within 0.50 **(TBR–5)** seconds of the limit violation being detected.

[27] Telemetry processing software shall provide a scrolling display of out–of–limits messages.

[28] Telemetry processing software shall provide a function to allow the user to display all telemetry points that are currently out–of–limits.

[29] Telemetry processing software shall provide the capability to temporarily modify limit values associated with any given telemetry point, without affecting permanent limit set values.

[30] Telemetry processing software shall provide the capability to temporarily define limit set information for a telemetry point which did not previously have limit set information defined.

[31] Telemetry processing software shall ensure that temporary limit value modifications or definitions are not retained beyond the end of the current test or session, and are replaced by the valid permanent limit set values or deleted as appropriate.

[32] Telemetry processing software shall specifically preclude the definition of new permanent limit set information for any telemetry point while a test or procedure is in process.

[33] Telemetry processing software shall provide capabilities for calibration of telemetry points by the following methods, as a minimum:

a. polynomials of orders up to fifth

b. exponential

c. piecewise linear.

[34] Telemetry processing software shall permit calibration information to be specified in engineering units and shall process the calibration information into the proper format for internal data manipulation.

[35] Telemetry processing software shall provide the capability to temporarily modify calibration information associated with any given telemetry point, without affecting permanent calibration information.

[36] Telemetry processing software shall provide the capability to temporarily define calibration information for a telemetry point which did not previously have calibration information defined.

[37] Telemetry processing software shall ensure that temporary calibration information modifications or definitions are not retained beyond the end of the current test or session, and are replaced by the valid permanent calibration information or deleted as appropriate.

[38] Telemetry processing software shall specifically preclude the definition of new permanent calibration information for any telemetry point while a test or procedure is in process.

[39] Telemetry processing software shall provide the capability to define pseudo telemetry points, which are derived from actual data contained in the telemetry datastream.

[40] Pseudo telemetry point definitions shall consist of telemetry or other pseudo telemetry mnemonics combined with arithmetic and/or logical operators to form a mathematical expression.

[41] Telemetry processing software shall provide capabilities to accept data quality information, based upon the presence or absence of frame sync, from the baseband telemetry processing hardware.

[42] Telemetry processing software shall provide capabilities to develop data quality information based upon packet error status and control further processing based upon that quality information.

[43] The GSE software shall provide capabilities to uniquely tag all packets identified as being in error by the packet data quality information, prior to further processing and logging, by writing the tag into an unused packet header bit.

[44] The GSE software shall provide capabilities to automatically inhibit further processing of packets which are identified as being in error.

[45] The GSE software shall provide capabilities to override the inhibit for processing of erroneous packets.

[46] Telemetry processing software shall provide a real–time data smoothing function.

[47] The data smoothing function shall not affect raw telemetry data or limit checking in any way.

[48] Telemetry processing software shall provide a data readback capability.

[49] Telemetry processing software shall provide capabilities for processing GSE measurement data from up to 30 (**TBR–6**) individual test instruments or data ports concurrently with Spacecraft telemetry.

[50] Telemetry processing software shall provide capabilities for processing GSE measurement data at maximum data rates from each source not to exceed 5 (**TBR–7**) kbps and total aggregate rate not to exceed 40 (**TBR–8**) kbps, not including any Spacecraft telemetry.

[51] Processing of telemetry data shall not be a prerequisite for the proper operation of other software elements which have no dependency upon telemetry data.

3.2.1.7.8 Telemetry Simulation

[1] The GSE software shall provide the capability for simulation of Spacecraft telemetry data streams.

[2] The GSE software shall provide the capability for specifying simulated telemetry data patterns according to location.

[3] The GSE software shall provide the ability to extract data from a telemetry simulation database based on subsystem identifier and either telemetry parameter name or mnemonic or command name or mnemonic (for command–response simulation) and place the data in the proper position in a simulated telemetry stream.

[4] The GSE software shall provide the ability to extract data from a telemetry simulation database based on 1553B C&T Bus Remote Terminal address, assemble data items in accordance with a prespecified table, and place the data on the C&T Bus.

[5] The GSE software shall provide the capability to perform two–state modifications to individual items in the telemetry simulation database based on 1553B Remote Terminal address, subsystem identifier, and command name or mnemonic.

3.2.1.7.9 Memory Load and Dump Operations

[1] The GSE software shall provide the capability for loading memory data, including table loads and stored command lists as applicable, to any Spacecraft processing element by transmitting a "load initiate" command followed by the load data file.

[2] The GSE software shall provide capabilities to generate bodies of memory load data for any Spacecraft processing element.

[3] GSE software memory load capability shall include capabilities for partial memory loads to Spacecraft processing elements.

[4] The GSE software shall provide the capability for uploading patches or modifications to SCC flight software.

[5] The GSE software shall maintain an image of the load data in an on–line file.

[6] The GSE software shall provide the capability for computing checksum or cyclic redundancy check (CRC) values on specified files and displaying the results to the operator.

[7] The GSE software shall be capable of properly managing load data transfer in the event of a transmission problem, identifying the last information received by the target, and, on request, restarting the transmission at that point.

[8] The GSE software shall provide the capability for dumping memory data from any Spacecraft processing element, including partial memory dumps, by transmitting a "dump initiate" command followed by a "dump" command.

[9] The GSE software shall provide capabilities for saving any dump image to a file.

[10] The GSE software shall provide the capability for generating a report for current load and/or dump data.

[11] The GSE software shall provide capabilities for comparing any dump image to the corresponding currently resident load image for that processing element and reporting the number of miscompares.

[12] The GSE software shall provide capabilities for accepting and applying masks (for dynamic memory data that may have changed since the original upload) against memory dump images to be compared against resident load images.

[13] The GSE software shall provide the capability for generating a miscompare report (location, expected value, mask value (if any), and actual value) for display or printing.

3.2.1.7.10 Data Recording and Archival Functions

[1] The GSE software shall provide capabilities to record all flight hardware commands and telemetry and GSE measurement data to on–line non–volatile storage.

[2] The GSE software shall record the raw data values for Spacecraft telemetry and GSE measurement data.

[3] The GSE software shall provide capabilities to record all messages entered at the operator's keyboard to on–line non–volatile storage.

[4] The GSE software shall provide capabilities to record all test software procedure statements to on–line non–volatile storage as the procedure executes.

[5] The GSE software shall provide the capability to time tag all data elements with a time accuracy within 0.10 **(TBR–9)** seconds of the system time reference and time resolution of 0.01 **(TBR–10)** seconds.

[6] The GSE software shall partition recorded data into files each of which contains no more than two **(TBR–11)** hours of data.

[7] The GSE software shall provide the capability to close a data file by command and open a new data file by command.

[8] All data files shall be uniquely identified using a date–time tag.

[9] The GSE software shall provide the capability to store and archive data files created as a result of standard off–line processing, e.g., out–of–limits summary.

[10] The GSE software shall include capability for determining at software startup if adequate on–line non–volatile storage space exists for telemetry processing and data archival.

[11] The GSE software shall provide automatic copying of data files from the GSE computer on–line non–volatile storage subsystem to an archival mass storage device (magnetic tape, optical disk, etc.) immediately after the data file is closed, for long–term storage and later retrieval of test data.

[12] The GSE software shall support archiving of data simultaneously with test execution.

[13] The GSE software shall ensure that all data recording and archival functions of opening, closing, copying, and archiving files are performed without loss of data.

[14] The GSE software shall support read–after–write data verification for copying of data files to the archival mass storage device.

[15] The GSE software shall provide capabilities to record all data quality information resulting from processing of telemetry data.

[16] The GSE software shall preclude the archival of GSE telemetry recorder playback data.

[17] The GSE software shall provide a data retrieval capability.

[18] The GSE software shall provide automatic management of the mass storage device to determine when to mount the device, when a new volume is required, and inform the operator that these actions are required or when automatic operations are prevented.

[19] The GSE software shall automatically delete, as on–line storage space is filled, the oldest data files currently in on–line storage which have been permanently archived.

[20] The GSE software shall provide a warning message when on–line non–volatile storage fills to 80% of capacity and a continuously updated percent–full message for storage fill between 80% and 100%.

[21] The GSE software shall prohibit automatic deletion of data files from on–line storage which have not been permanently archived, issue a warning message to the operator if the system attempts such deletion, and permit the operator to take manual action from that point.

[22] Access to archived data from mass storage shall include, but not be limited to, the following query methods:

a. date and time tag

b. date and time tag range

c. telemetry mnemonic

d. GSE data mnemonic.

[23] The GSE software shall include provisions for prefixing a directory of mass storage medium contents to archived data volumes to facilitate data identification and retrieval.

[24] The GSE software shall provide capabilities for generating and maintaining a separate on–line database file (the Archive Directory Database) containing directory information for active data files and for archival mass storage medium data files to facilitate data identification and retrieval.

[25] Each record in the Archive Directory Database shall contain the following data elements in its information set:

a. file name

b. sequential file number

c. record time tag (time of entry of record information set into database)

d. data beginning time (date and time of start of data in file)

e. data ending time (date and time of end of data in file)

f. multiple sets of ASCII label information

g. on–line status of file (whether or not file is currently on line)

h. archive status of file (whether or not file has been archived)

i. mass storage volume name for archived files (blank if file not yet archived)

j. mass storage volume number for archived files (blank if file not yet archived).

[26] Each Archive Directory Database record shall be capable of accepting and incorporating descriptive label information of up to 80 **(TBR–12)** characters which may be specified via either keyboard or procedure.

[27] The GSE software shall provide capabilities for automatically prompting the operator for descriptive label information for record entries into the Archive Directory Database.

[28] The default label information shall be the last previous label entered.

[29] The GSE software shall permit the operator to accept the default label information with a "Return" on the keyboard or type in a new label.

[30] All entries in the Archive Directory Database shall be time tagged with a resolution of one second.

[31] The contents of the Archive Directory Database shall be accessible on–line at all times the test system is powered and operating.

[32] The Archive Directory Database shall reflect the current status of data files, i.e., whether or not each of them has been copied to mass storage and whether or not each of them is currently on line.

[33] The GSE software shall provide the capability to search the Archive Directory Database by query methods which include, but are not limited to, the following:

a. keyword

b. data file name

c. mass storage volume name

d. mass storage volume identification number or label

e. test number

f. procedure name

g. ASCII label information

h. date and time tag

i. time start.

[34] The GSE software shall provide the capability to print all or any part of the Archive Directory Database.

3.2.1.7.11 Data Display

[1] The GSE software shall provide a data display function for formatting and presenting information to the user via displays.

[2] The information shall be displayed on pertinent computer terminal(s) or workstation monitor(s) in accordance with the display definitions contained within a Display Definitions database.

[3] The data display software shall provide the following displays, as a minimum:

a. EVENTS page which displays all information that has been generated by the software, specifically, messages, keyboard entries, and procedure statements that have been processed

b. OPERATIONS or OPS page which is a subset of the information displayed on the EVENTS page, specifically, command related information and limit messages

c. ALARMS page which is a scrolling display of the last **(TBD–1)** limit error messages including limit information

d. COMMAND VERIFICATION or CMDVER page which displays the status of commands that have been transmitted and their associated verification status

e. index of all available STOL procedures

f. index of all available display pages.

[4] The data display software shall provide a standard display format which includes the following items:

a. current procedure line

b. previous two procedure lines

c. next procedure line in the file (does not anticipate any branching)

d. procedure status (wait, halt, or active)

e. critical message

f. error information

g. operator keyboard entry

h. keyboard echo if accepted by software.

[5] The data display software shall provide the user with a means of defining page displays.

[6] A display definition shall include the following types of information:

a. window definitions (size, location, colors, permanent, pop–up, etc.)

b. field definitions (size, color)

c. locations in which fields are to be displayed

d. data type

e. display format and attributes

f. non–data definitions (e.g., titles, labels, mnemonics, text annotations, icons, etc.).

[7] Any icon created on the display shall reflect the acceptable limits of the associated value.

[8] The data display software shall support the following types of icons, as a minimum:

a. analog meter

b. vertical bar graph

c. horizontal bar graph

d. thermometer.

[9] The data display software shall provide the capability to suppress message displays based upon the message source.

[10] The data display software shall provide the capability to route display messages to specific display devices.

[11] The data display software shall provide the capability for temporary definition of a display, which will equate telemetry mnemonics with "wildcard" variables that appear on a "wildcard" page of predefined format, without affecting any permanent display definitions.

[12] The data display software shall ensure that temporary display definitions are not retained beyond the end of the current test or session, and are deleted appropriately.

[13] The data display software shall present the current limit status of any information that is displayed for which limit checking is currently enabled.

[14] The data display software shall provide the capability to display all data within 2.0 **(TBR–13)** seconds of its receipt.

[15] The data display software shall provide the capability to display data from any one or more of the following sources:

a. Spacecraft telemetry

b. Spacecraft pseudo telemetry

c. any applicable element of the EGSE to which the computer(s) are interfaced, as shown in the block diagrams given in Astro Space documents 20008509, 20008510, and 20008511

d. retrieval of telemetry, status, or measurement data from the current log in on–line storage

e. status or listing of a currently executing program

f. any memory load or dump file.

[16] The data display software shall provide the capability to display data in any of the following formats as applicable:

a. raw data in binary or hexadecimal
b. signed or unsigned numerical integer or decimal value
c. calibrated value in engineering units
d. ASCII text
e. colored numerical integer or decimal value to provide warning
f. colored calibrated value to provide warning
g. colored ASCII text for states to provide warning
h. graphics symbols
i. graphics plots, including "strip chart" type of display.

[17] The data display software shall provide the capability for plotting, in real time, of up to two selected telemetry points against time or against a third telemetry point.

[18] The data display software shall provide the capability for printing a hard copy of any page display, even if the page is not currently displayed.

3.2.1.7.12 Event Log

[1] The GSE software shall provide the capability to permanently record all system activity, including messages, requests not permitted or executed, as well as normal test execution activity, in Event Log files.

[2] The GSE software shall provide the capability to segment and archive Event Log files in the same manner as telemetry or other data files.

[3] The GSE software shall uniquely identify each Event Log file.

[4] The GSE software shall provide the capability to create Event Log files in a format that permits direct printing.

[5] Record entries in the Event Log shall be time–tagged with a maximum resolution of one second.

[6] Record entries in the Event Log shall include information identifying the source of the entry (i.e., procedure (with line number), keyboard, software function identifier, workstation address or identifier, etc.).

[7] The GSE software shall provide capabilities for browsing the current (i.e., open) Event Log file.

[8] The GSE software shall provide the ability to extract and display messages from the Event Log by type.

[9] The contents of Event Logs shall be accessible on–line at all times the test system is powered and operating.

3.2.1.7.13 Operating Time Summary

[1] The GSE software shall provide the capability for tracking operating time of components based on telemetry information, with operating time defined as the total elapsed time, within the Spacecraft or equipment power–on time, from the time telemetry indicates the component is "on" (or in the desired state) to the time the telemetry indicates the component is "off".

[2] Operating time record information shall include, as a minimum, component name, assembly number, group number, and serial number.

[3] The GSE software shall provide the capability for annotating the operating time record with a short, user–specified text description of the operating mode of the component.

[4] Operating time information for each component shall be cumulative.

[5] The GSE software shall provide the capability for generation of an operating time summary report at any time.

[6] The GSE software shall provide the capability for a user to insert additional operating time data associated with a component.

[7] The GSE software shall provide the capability for enabling or disabling the operating time tracking function for any component to prevent erroneous information from being accumulated in the event the component must be removed from its EM or the Spacecraft.

3.2.1.7.14 Analysis Functions

[1] The GSE software shall provide off–line analysis and data processing functions, using data retrieved from the same test database used by the real–time system, or from archival data files.

[2] The analysis software shall provide capabilities for generating both two–axis and three–axis plots.

[3] The analysis software shall provide the ability to represent multiple points as a single point on a plot using a variety of functions, including minimum, maximum, rms, rss, and average.

[4] The analysis software shall provide the capability for the user to specify analysis start and stop times.

[5] The analysis software shall provide capabilities for specifying analysis time periods that span multiple telemetry archival data sets.

[6] The analysis software shall provide capabilities for specifying scaling information and the presence or absence of calibration of data to be processed.

[7] The analysis software shall provide capabilities for routine scheduling of off–line data processing, such as immediately following the end of a data archival period, including as a minimum the following analysis or processing functions:

a. trend data extraction and combining

b. out–of–limits messages

c. operating time summary data extraction and combining

d. data quality.

[8] The analysis software shall provide capabilities for extraction of intermediate data from archival data sets for later (e.g., daily, monthly) processing.

[9] The analysis software shall provide capabilities for long term (up to three years) trending of selected data items.

3.2.1.7.15 Database Management

[1] The GSE software shall provide capabilities for generation, modification, and maintenance of the various databases upon which the testing operations depend, including Command, Telemetry, Limit, Calibration, Procedure, Display, and Archive Directory databases.

[2] The GSE software shall provide the capability to display any data element in any of the databases.

[3] Information required for the proper operation of the system shall be defined only once in the database.

[4] The GSE software shall prohibit the installation of new permanent database or library information while a procedure or test is executing.

3.2.1.7.16 Data Hard Copy Generation Requirements

[1] The GSE software shall support the use of graphics printers, including color and black–and–white.

[2] The GSE software shall provide capabilities for producing printout of test or analysis data.

[3] The GSE software shall provide capabilities for producing printout of test scripts or procedures.

[4] The GSE software shall provide capabilities for printing memory load and dump files.

[5] The GSE software shall provide capabilities for printing excerpts from Event Log files.

[6] The GSE software shall provide capabilities for generating a "snapshot" hard copy printout of any display screen and of any window of the display screen.

[7] The GSE software shall provide capabilities for printing test reports, summaries, and other common ASCII documentation as desired.

3.2.1.7.17 GSE Self–Monitoring Functions

[1] The SCS, SIS, and Equipment Module STE shall include hardware features and software functions for monitoring the internal elements of the GSE for calibration, health, status, or required measurement data.

[2] Software functions shall provide for warning actions or messages in the event of anomalous operation of any portion of the GSE which is interfaced to the computer equipment.

[3] Software functions shall provide for abort actions in the event of unsafe operation of the GSE.

3.2.1.7.18 GSE Built–In Test Function

[1] The SCS, SIS, and Equipment Module STE shall include software capabilities for system self–test prior to initiating any testing of flight hardware.

[2] This self–testing shall include examination of all GSE equipment for proper status and exercising of each basic test function or path to the maximum extent possible without requiring interaction with the flight hardware under test.

[3] Self–testing shall be capable of execution with flight hardware connected, but shall not exercise flight hardware.

3.2.2 Spacecraft Mechanical Ground Support Equipment

[1] The Spacecraft MGSE shall support all phases of integration and test of the EOS–AM Spacecraft at Astro Space and the Western Test Range.

[2] MGSE used in handling and transportation of flight hardware shall be designed and constructed to limit vibration and shock exposure of the flight hardware to levels not exceeding 50% of the protoflight test levels specified in the applicable major assembly performance specifications and Appendix I of Martin Marietta document PS20001415, Structures and Mechanisms Subsystem Performance Specification.

The major MGSE subsystems are identified in Figure 11.

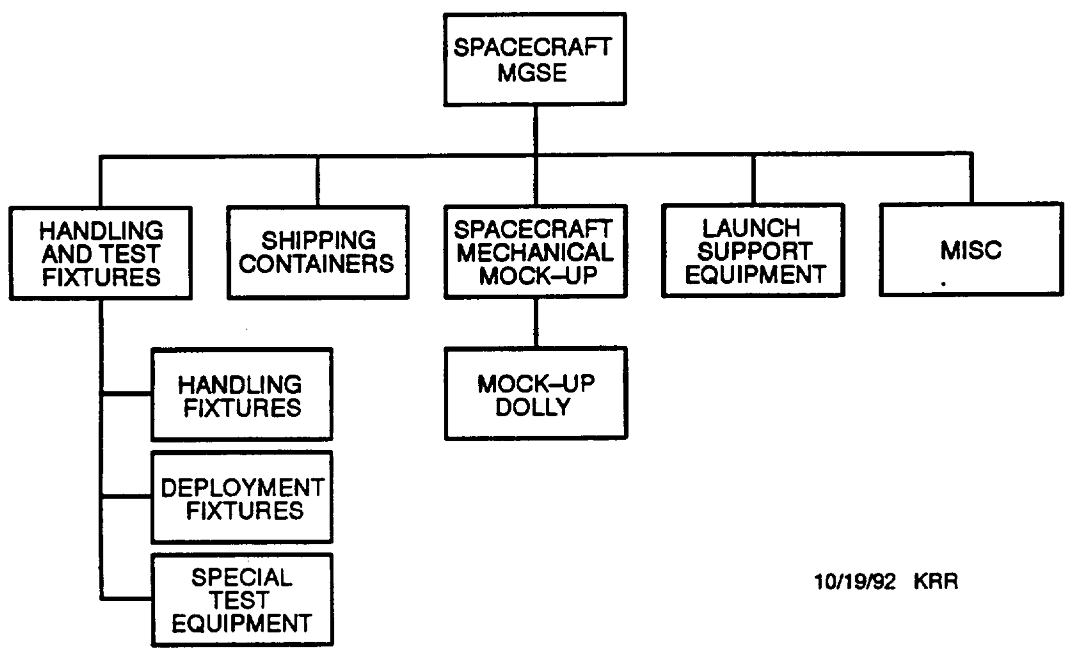

Figure 11. Spacecraft Mechanical Ground Support Equipment

3.2.2.1 Alignment Test Configuration

The Spacecraft alignment process will be implemented during two separate and distinct phases, i.e., alignment placement and alignment knowledge. The test fixturing for these phases is different as described below.

For the alignment placement phase, the test fixtures required include the Spacecraft Booster Adapter MGSE and the Three–Axis Positioner (TAP). The Spacecraft will be placed with the velocity ("+x","–x") axis horizontal during this phase. The Booster Adapter MGSE is designed to adapt the

Spacecraft primary structure to the TAP at the "–x" face of the Spacecraft. The TAP's extended base will also provide support for the Spacecraft at its "+x" end, from the Spacecraft's Zenith direction. Other support equipment required during the alignment placement phase includes a programmable computer–controlled triangulation alignment system, a General Alignment Prism (GAP) (stationary reference frame for use in checking alignment of theodolites), and a pair of theodolites located on vertical tool bars for sighting reference points on the Spacecraft.

For the alignment knowledge phase, the Spacecraft will be elevated to the "x"–axis vertical position and removed from the TAP using the vertical lifting sling and placed on the precision Rotary Table (the "+x" end of the Spacecraft is in the upward vertical direction). The Booster Adapter MGSE will support the Spacecraft on the Rotary Table. Other support equipment required during the alignment knowledge phase includes the triangulation alignment system, a GAP, and a theodolite located on a vertical tool bar.

3.2.2.2 Handling and Test Fixtures

[1] Mechanical, electro–mechanical, or pneumatic–mechanical fixtures and equipment shall be provided to support and manipulate the Spacecraft main structure, the Mechanical Test Model (MTM), and Spacecraft appendages throughout various stages of Spacecraft integration and environmental tests.

3.2.2.2.1 Handling Fixtures

Handling fixtures will be provided for manipulation of the large pieces of Spacecraft hardware (i.e., primary structure, Solar Array, Equipment Modules, etc.) and any items weighing greater than 35 pounds.

[1] Handling fixtures shall provide the capability for assembling, lifting, holding, positioning, aligning, protecting, and transporting the Spacecraft and its major components and subassemblies.

[2] Multiple–use features shall be incorporated in the designs of handling fixtures whenever possible.

[3] Designs for handling fixtures shall be functional and conservative, and will not be oriented toward advancement of the state of the art.

[4] All items shall be designed to allow for handling and servicing of the system with normal procedures and techniques.

[5] Clear, legible markings shall be used for identification, with special cautions and instructions to be clearly and legibly marked.

[6] Load factors shall be conservatively applied to encompass all phases of actual and inertial loading.

[7] The designs shall allow for installation of elements of flight hardware in their appropriate orientations in relation to adjacent hardware.

3.2.2.2.1.1 Spacecraft Three–Axis Positioner

The Three–Axis Positioner (TAP) will be used to support and orient the Spacecraft. The TAP will consist of the following subassemblies:

a. table top to which the Booster Adapter MGSE is mated to mount the hex bay structure of the Spacecraft

b. main body which contains the table top and main body drive mechanisms

c. cabinet which contains the electrical equipment and controls for the table top and main body

d. air bearing pallet base which supports the TAP

The Three–Axis Positioner is shown in the diagram of Figure 12.

[1] The TAP shall provide the capability to cantilever the Spacecraft horizontally from its mounting interface.

[2] The TAP shall be designed and manufactured to permit access to the Instruments and Equipment Modules mounted to the Nadir deck, Zenith deck, forward Spacecraft structure, and sides of the Spacecraft structure. Only access to the aft interior of the Spacecraft structure may be restricted.

[3] The TAP shall provide the capability to pitch the Spacecraft to the vertical position.

[4] The TAP shall provide the capability to rotate the Spacecraft ±180 degrees about the Spacecraft longitudinal axis.

[5] The TAP shall provide the capability to adjust the height of the longitudinal center line of the Spacecraft, when cantilevered in the horizontal position, within a total range of 4 feet minimum above the centerline minimum height above the floor on which the TAP rests, e.g., from 8.5 feet to 12.5 feet.

[6] The TAP shall provide the capability to adjust the height of its table top, when the Spacecraft is pitched to the vertical position, within a total range of 4 feet minimum above the tabletop minimum height above the floor on which the TAP rests, e.g., from 9 feet to 13 feet.

[7] The TAP shall be compatible with use in an explosive environment, e.g., at the launch site with the Spacecraft fueled.

3.2.2.2.1.2 Spacecraft Horizontal Lift Sling

A four–point "H" frame sling will be provided for all lifts with the Spacecraft in a horizontal orientation. The Horizontal Lift Sling will provide capability to level the Spacecraft pitch and roll axes to within $\pm 1^\circ$ simultaneously.

[1] The sling designed and used for the UARS Spacecraft shall be modified to interface with the designated horizontal attachment points on the EOS–AM Spacecraft primary structure and Booster Adapter MGSE.

3.2.2.2.1.3 Spacecraft Vertical Lift Sling

A three–point spreader sling will be provided for lifts with the Spacecraft in a vertical orientation.

[1] The Vertical Lift Sling shall be designed to interface with the designated vertical attachment points on the EOS–AM Spacecraft.

[2] The Vertical Lift Sling shall incorporate sling risers with turnbuckles to permit leveling of the Spacecraft during vertical lifting operations.

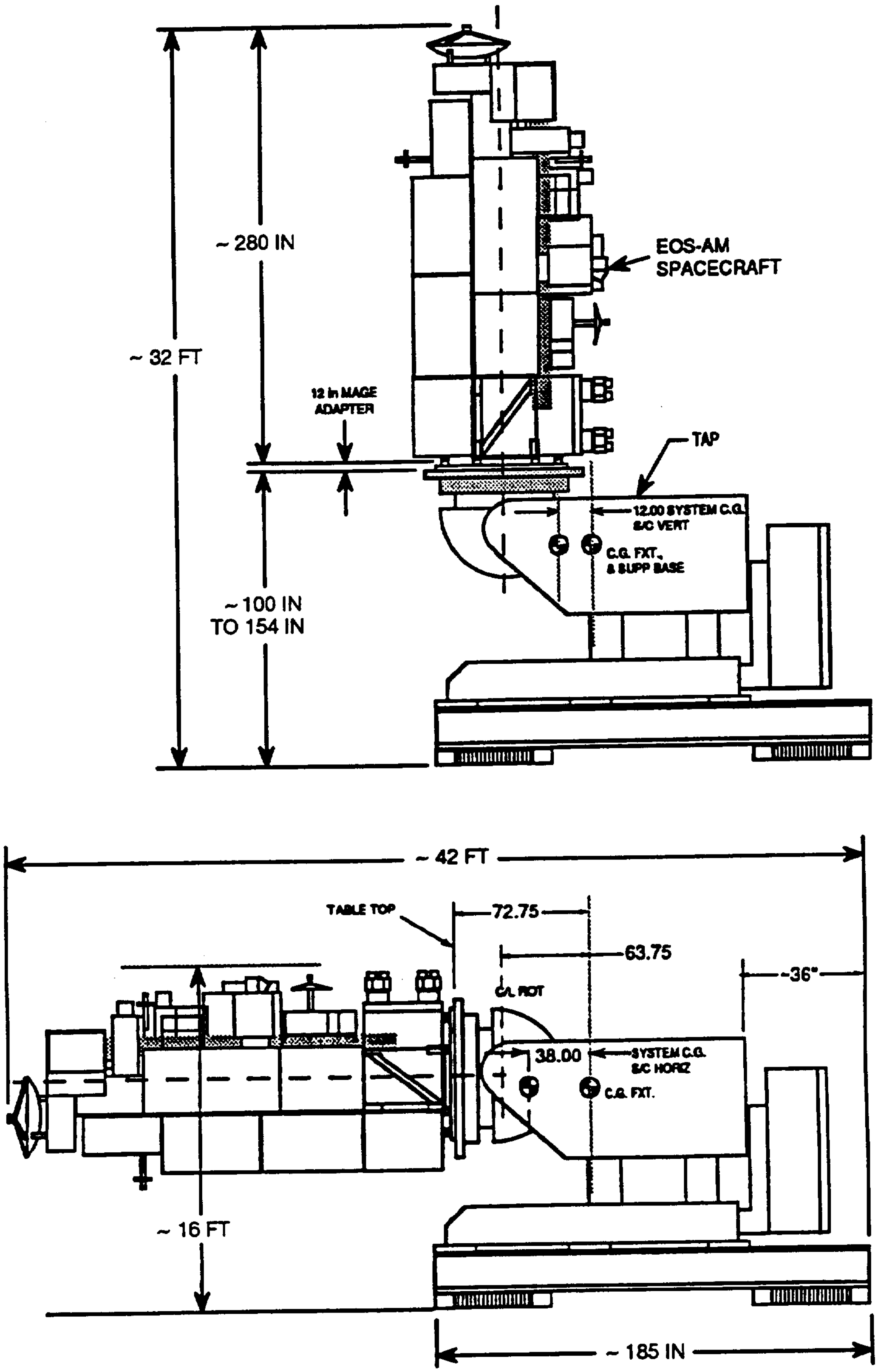

Figure 12. Three–Axis Positioner (TAP)

3.2.2.2.2 Deployment Fixtures

Mechanical equipment will be provided to give support to and/or counterbalance 1G effects on flight hardware during ground performance testing prior to or after mounting the item onto the Spacecraft. This will be accomplished through the use of counterweights, air bearings, adjustable pre–loaded springs, etc. provided for High Gain Antenna (HGA) deployment on the Spacecraft, HGA mass model and boom deployment off the Spacecraft, Solar Array Blanket Box (first stage) deployment, and Blanket "mini–excursion" on the Spacecraft.

3.2.2.2.3 Special Test Fixtures

Mechanical fixtures and equipment will be used to provide the required support to the Spacecraft and appendages during various environmental tests. This includes the mechanical equipment required to interface the Spacecraft or subassembly with the environmental facilities. These fixtures will be capable of being used to transfer loads to the Spacecraft structure or subassembly in the form of vibrations or steady state applied forces.

3.2.2.2.3.1 Thermal–Vacuum Test Fixture

The Mobile Environmental Transportation System (METS) Test Fixture originally designed for UARS will be used to support the EOS–AM Spacecraft within the Thermal–Vacuum Chamber. The METS will consist of the following subassemblies:

a. Spacecraft supporting structure made up of structural trusses designed to provide adequate support for the fully integrated Spacecraft

b. air bearings which fit into pockets on the METS base structure

The METS Test Fixture is shown in the diagram of Figure 13.

[1] The METS Test Fixture modifications shall be designed and manufactured to support the EOS–AM Spacecraft during thermal–vacuum testing in the Thermal–Vacuum Chamber.

[2] The METS Test Fixture shall be designed to permit positioning of the Spacecraft with the velocity axis ("+x","–x") parallel to the test chamber floor and the Nadir deck ("+z") facing the test chamber floor.

[3] The METS Test Fixture shall be designed to position the horizontal centerline of the Spacecraft 13 feet above the floor on which the METS rests.

[4] The METS Test Fixture shall provide mating devices to attach to supporting interface devices located at strategic positions on the Spacecraft primary structure.

[5] The METS Test Fixture shall be designed and manufactured to provide safe in–house transport of the mated METS/Spacecraft system.

[6] The METS Test Fixture shall support installation of the Propulsion Module into the Spacecraft.

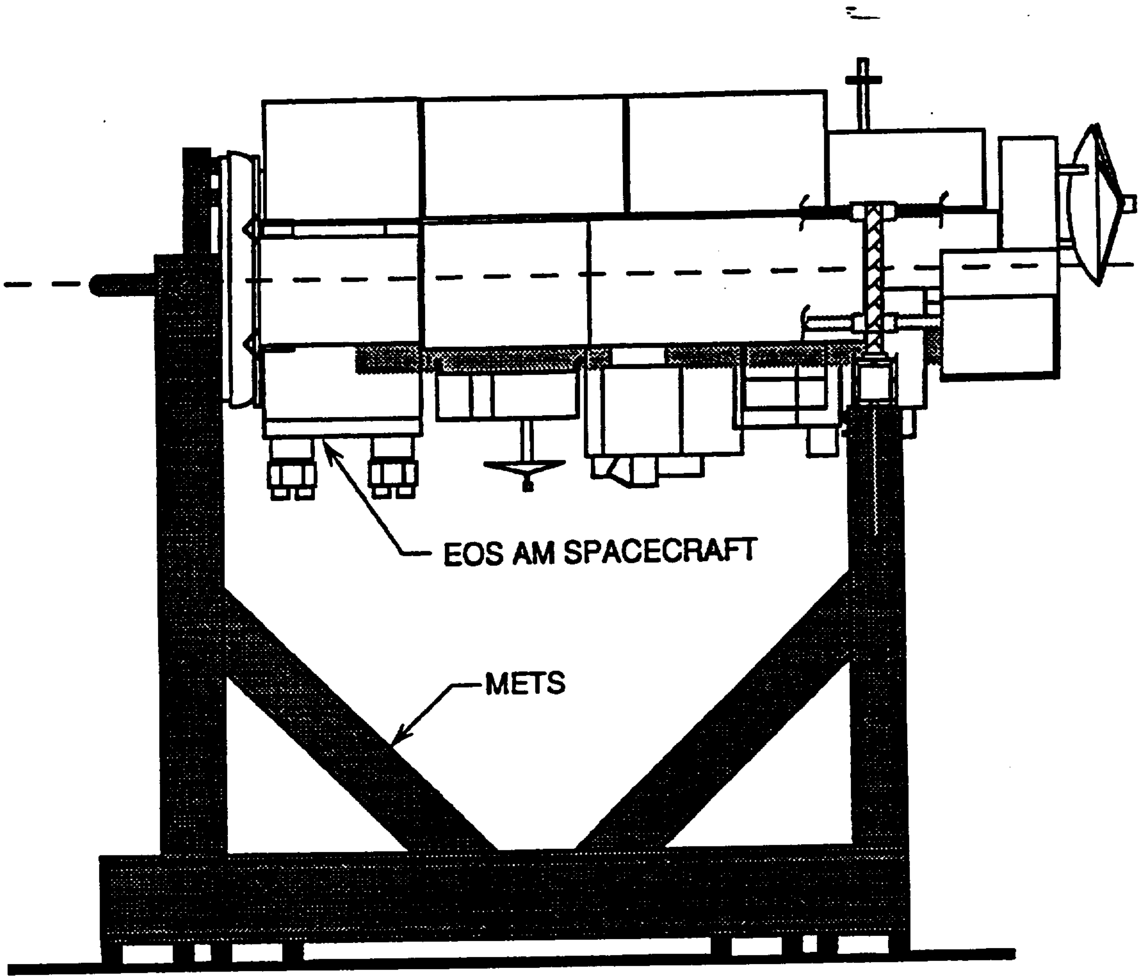

Figure 13. Mobile Environmental Transportation System Test Fixture

3.2.2.2.3.2 Acoustic Test Fixture

An Acoustic Test Fixture will be used to support the EOS–AM Spacecraft in the Acoustic Test Chamber. The fully integrated Spacecraft including the flight Booster Adapter will be supported vertically by this fixture. This fixture includes the following parts:

a. a baseplate which supports the weight of the Spacecraft, provides an attachment interface with the Spacecraft Booster Adapter, and provides stability to permit safe in–house transport

b. air bearing pads on the floor–facing side of the baseplate to facilitate maneuverability.

3.2.2.3 EMI/EMC Test Configuration

The EMI/EMC test will be conducted in the integration bay with the Spacecraft velocity ("x") axis parallel to the floor and the Nadir deck ("+z") pointing toward the floor. The Spacecraft will be cantilevered from the TAP providing clear lines of sight to all Instruments. Refer to Figure 12. Individual "r.f. hat" type absorbers will be strategically placed under and around the Spacecraft to absorb r.f. energy throughout EMI testing.

3.2.2.4 Spacecraft Mechanical Mock–Up

A full scale mechanical mock–up of the Spacecraft structure will be built as an aid in the design and routing of harness and plumbing lines as well as the placement of full scale models of Equipment Modules, equipment panels, and instruments to perform clearance studies, fit checks, etc.

[1] All mechanical models and mockups shall conform with the applicable GSE requirements given in Sections 3.5, 3.6, and 3.7 of this document.

3.2.2.5 Mock–Up Dolly

[1] The mobile mechanical structure provided to support and move the Spacecraft Mechanical Mock–up shall conform to the requirements of Sections 3.5, 3.6, and 3.7 of this document, as applicable.

3.2.2.6 Launch Support Equipment

Launch site mechanical equipment will be provided to transport and handle the Spacecraft and HGA reflector and will support the re–establishment of the launch configuration from the shipment configuration after transport from the initial I&T facility to the launch site. Mechanical launch support equipment will include items of MGSE used at Astro Space for initial integration of the Spacecraft (certain items listed in Table I) and will also include items specific to launch site operations.

[1] Launch site mechanical equipment shall comply with the applicable requirements of Subsections 3.5 and 3.6 of U. S. Air Force document WSMCR 127–1, Western Space and Missile Center Range Safety Requirements.

3.2.2.7 Shipping Containers

Environmentally controlled (shock, temperature, humidity, etc.) shipping containers will be provided as required for the Spacecraft, any shipped loose "flight" items, and support equipment.

[1] Shipping containers shall provide capabilities consistent with land, air, rail, and sea transportation loadings and combinations thereof (e.g., land and air "g" loading) as specified in NASA document SP8077.

[2] Shipping containers shall restrain environmental exposures of flight equipment to levels within those specified for prelaunch environments in Section 6.2 of Astro Space document IS20008501, General Interface Specification for the EOS–AM Spacecraft.

[3] Shipping containers shall conform to the requirements of Sections 3.5, 3.6, and 3.7 of this document, as applicable.

3.2.2.7.1 Spacecraft Shipping Container

The EOS–AM Spacecraft Shipping Container, illustrated in Figure 14, will be designed to transport the fully integrated Spacecraft from Astro Space to the launch site and from one facility to another at the launch site. The Gamma Ray Observatory (GRO) Spacecraft Shipping Container will be modified to accommodate the EOS–AM Spacecraft.

[1] The Spacecraft Shipping Container shall be designed to provide a transportation environment for the EOS–AM Spacecraft which restrains environmental exposure of the Spacecraft to levels within those specified for prelaunch environments in Section 6.2 of Astro Space document IS20008501.

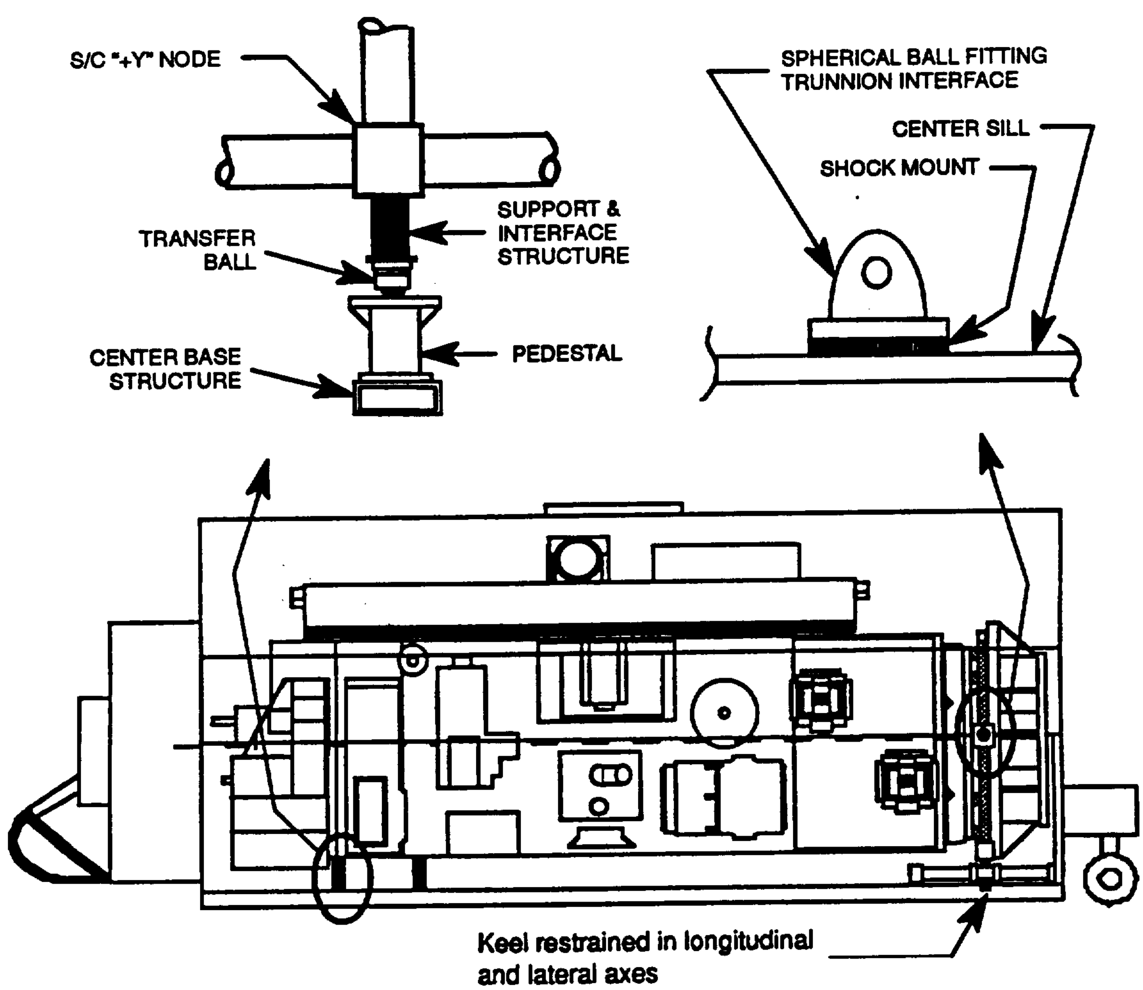

Figure 14. Spacecraft Shipping Container

3.2.2.8 Propulsion Module MGSE

The Propulsion Module will be aligned as required by adjusting its position on the various pieces of MGSE. With the PM suspended from the PM Sling, either the fixture beneath the PM can be adjusted, or the PM itself can be carefully turned until it is ready to be loaded.

[1] The PM MGSE shall support the transportation, handling, installation, and alignment of the Propulsion Module.

3.2.2.8.1 PM Dolly

[1] The PM Dolly shall provide vertical and lateral support for the Propulsion Module at predetermined MGSE pickup points on the "–x" side of the PM.

[2] The PM Dolly shall be mounted on shock–absorbing castors to allow for safe movement of the Propulsion Module within Astro Space facilities.

3.2.2.8.2 PM Sling

[1] The PM Sling shall provide capabilities for attachment to predetermined MGSE pickup points on the "+x" side of the Propulsion Module for lifting the PM to transfer from one MGSE fixture to another.

3.2.2.8.3 PM Propellant and Pressurant Loading Unit

[1] The PM Propellant and Pressurant Loading Unit (PPLU) shall provide liquid propellants and gaseous pressurants to the PM.

[2] The PPLU shall be capable of filling, draining, and purging PM propellant and pressurant tanks and lines.

3.2.2.9 Miscellaneous

Various items of mechanical equipment may be required which aid in the integration of the Spacecraft and fall outside the description of the other categories (e.g., contamination control). This equipment will be designed and fabricated or procured to ensure the program specified level of cleanliness over the Spacecraft and its instruments during "in–house" movements and transport between facilities.

3.2.2.10 Equipment Listing

Table I identifies the MGSE functions anticipated by Astro Space as necessary for supporting the I&T of the EOS–AM Spacecraft.

[1] All items supplying the functions identified in Table I shall meet the applicable requirements of this document.

3.3 Interface Requirements

Interface requirements will be defined, in addition to this document, in equipment Performance Specifications, Interface Control Documents (ICDs), or equipment drawings, as applicable.

Table I. EOS Spacecraft MGSE Functions Listing

HANDLING FIXTURE FUNCTIONS:	
1. Three–Axis Positioner	Spacecraft integration fixture "rolls" Spacecraft structure ±180 degrees along horizontal axis ("x") for installation of mass models, Instruments, Equipment Modules, etc. Also rotates Spacecraft about its "y" or "z" axis 0 through 90 degrees bring Spacecraft "x" axis from horizontal to vertical.
2. Spacecraft Horizontal Lift Sling	Counterweighted "H" beam sling used to transfer the Spacecraft horizontally ("±z" or "±y" up), in various c.g. configurations, between different fixtures, e.g., TAP to METS.
3. Spacecraft Vertical Lift Sling	"Y" shaped structural sling used to lift and transfer the Spacecraft vertically ("+x" up only), in various c.g. configurations, between different fixtures, e.g., TAP to Precision Rotary Table
4. Spacecraft Lift Fittings	High strength, small volume fittings which attach to specific Spacecraft primary structure nodes, providing the interface between the Spacecraft and its lifting slings and support structures
5. Spacecraft Aft MGSE Booster Adapter	Replaces, and interfaces with same Spacecraft "–x" nodes as, flight Booster Adapter. Serves as the Spacecraft's interface between its primary structure and the MGSE for handling (rotating, shipping, etc.) and testing (acoustic, t–v, etc.)
6. Spacecraft to Shipping Container Aft Adapter	Serves as the major structural support, in conjunction with the MGSE BA, for the assembled Spacecraft during shipping as well as providing the aft interface to the GRO shipping container
7. Spacecraft to Shipping Container Forward Adapter	Provides single axis structural support for the assembled Spacecraft during shipping as well as providing the forward interface to the GRO shipping container
8. Housekeeping Equipment Module Lift Fixture	Universal "H" beam sling with multiple configurations used for lifting and handling Equipment Module panels during EM assembly and completed Module lifting and handling during integration onto the Spacecraft
9. Equipment Module/Panel Holding & Assembly Fixture	Rotating stand used to position Equipment Modules and panels during Module or panel assembly
10. Housekeeping Equipment Panel Strongbacks	Structural support for individual EM panels used during population of panels with boxes and during integration of panels into EM assembly
11. Equipment Module Assembly Fixture	Static table used to support Equipment Modules during Module assembly
12. Solar Array Dolly	Fixture for in–house transport of the Solar Array

Table I. EOS Spacecraft MGSE Functions Listing (Continued)

HANDLING FIXTURE FUNCTIONS (Continued):	
13. Propulsion Module Installation Fixture	Positions, supports, and aligns the Propulsion Module to the Spacecraft mounting interface during installation of the PM into the Spacecraft primary structure
14. Propulsion Module Strongback Handling Ring	Interfaces with, and provides stiffness to, PM flight structure permitting safe lifting and handling of fully integrated PM in any horizontal or vertical orientation
15. Propulsion Module Turnover Fixture	Used in conjunction with the "strongback" to provide a rigid, rotating mounting bench providing access for PM I&T. Fixture will permit manual rotation of PM with locking positions every 45° allowing horizontal, vertical, or angular orientation.
16. Propulsion Module Handling Dolly	Rigid mobile platform which interfaces with, and attaches to, PM in the vertical ("+x" up) orientation for in–house transport. Used in conjunction with Vibration Mounts to make up the Acoustic Test Fixture. Also serves as the mounting platform for Leak Test Bag frame providing sealed mounting platform for the PM.
17. Propulsion Module Sling	Stable load spreading lifting device with 3–point interface to PM in vertical orientation, and 3–point interface to strongback when PM is in horizontal position. Used in conjunction with load cells and strongback to serve as 3–axis Mass Properties fixture. Also used in conjunction with strongback and counterweights to serve as PM Installation Fixture.
18. Propulsion Module Soft Cover/Leak Test Bag	"Poly" type material cover with frame which provides hermetic seal around PM during helium leak test of the PM. PM Handling Dolly will serve as mounting base for frame.
19. Thruster Protective Covers	Semi–hard cover (rigid foam) protecting thrusters from physical damage during PM and Spacecraft integration and testing
20. Propulsion Module Core Shipping Container	Rigid pallet which interfaces to the 6 mounting nodes of the PM base panel with the PM structure "+x" axis up. Pallet provides pockets for fork lift handling as well as means to tie down to enclosed trailer floor. System includes suitable poly material, e.g., Mylar, for wrapping core structure.
21. Spacecraft Protective Soft Cover	Protective bag made from a KSC–approved material (flammability, electrostatic, & hypergolic) which provides contamination protection for the Spacecraft during in–house and outside transportation
22. Primary Structure Shipping Container	Hard cover to protect the Spacecraft primary structure from physical elements during transport from Astro Space Valley Forge to Astro Space East Windsor

Table I. EOS Spacecraft MGSE Functions Listing (Continued)

HANDLING FIXTURE FUNCTIONS (Continued):	
23. Momentum Wheel Handling Fixture	Fixture for Momentum Wheel lifting and handling during installation into the RWA EM
24. Leak Test Bag	Airtight enclosure used to contain and detect gaseous leaks from the Spacecraft Thermal Control Subsystem and Propulsion Subsystem
25. Spacecraft Shipping Container	Environmentally controlled (temperature, humidity, and cleanliness levels) "hard" protective enclosure which houses and structurally supports the completely assembled Spacecraft and adapters for "over the road", air, and sea travel (modified GRO/UARS container)
DEPLOYMENT FIXTURE FUNCTIONS:	
1. HGA Boom Spacecraft Deployment Support System	Fixture used to offset "1G" effects during Spacecraft level deployment tests of the HGA hinge/boom assembly
2. HGA Hinge Subsystem Test Fixture	Fixture used to offset "1G" effects during component level deployment tests of the HGA hinge/boom assembly
3. Solar Array Assembly Spacecraft Deployment Test Fixture	Fixture used to offset "1G" effects during Spacecraft level deployment tests of the Solar Array Assembly (first stage full deployment and partial blanket excursion)
4. Solar Array Hinge Test Fixture	Fixture used to offset "1G" effects during component level deployment tests of the Solar Array hinge
5. Solar Array Blanket Pop & Catch Deployment Fixture	Fixture which supports testing of Solar Array blanket deployment first motion
SPACECRAFT LEVEL TEST FIXTURES:	
1. Vertical Test Stand (Acoustic)	Mobile structural frame which interfaces to the flight Booster Adapter and supports the full–up Spacecraft in a vertical ("+x" up) attitude during the acoustic test
2. EMI Test Fixture	Individual r.f. absorbers, hat shaped, strategically placed near Spacecraft to absorb r.f. energy throughout Spacecraft level EMI testing
3. Horizontal Test Stand (UARS METS)	Fixture used for Spacecraft environmental tests in a horizontal configuration not requiring r.f. transparency, e.g., thermal–vacuum. May also be used to position Spacecraft and provide access for certain I&T activities, e.g., Propulsion Module I&T
4. Static Load Test Fixture	Structural stand which supports the complete Spacecraft structure with mass models and reacts specified loads applied to the Spacecraft structure at specific points which simulate worst case load conditions incurred during launch

Table I. EOS Spacecraft MGSE Functions Listing (Continued)

SPACECRAFT LEVEL TEST FIXTURES (Continued):		
5.	Modal Test Fixture	Rigid plate designed for stiffness used to support the Spacecraft structure with mass models during "natural frequency" mode tests
6.	Pyro Shock Fixture	Add–on to the acoustic test fixture which will catch the fired pyro bolts and the flight Booster Adapter during separation tests
7.	Mass Properties Adapter	Interface adapter between payload and mass properties fixture
SUBASSEMBLY LEVEL TEST FIXTURES:		
1.	Proof Test Equipment	Test fixture for running proof tests on all Spacecraft handling and test fixtures, e.g., TAP, METS, Shipping Container
2.	Equipment Module Vibration Plate	Rigid fixture for interfacing and securing EM to test equipment
3.	Propulsion Module Acoustic Test Fixture	Rigid mounting platform which supports fully integrated PM in vertical ("+x" up) orientation while PM is subjected to acoustic vibration. PM Handling Dolly and 6 Vibration Mounts make up the Acoustic Test Fixture.
4.	Propulsion Module Vibration Fixture (sine sweep & sine burst)	Rigid, high frequency posts which interface the fully integrated PM to the vibration table via the 6 node points in the base plate of the PM. Used for sine sweep (0 thru 50 Hz) and sine burst (low frequency, high amplitude) tests. These fixtures will also be used with the PM Handling Dolly for acoustic tests.
5.	Propulsion Module Load Application Fixture/Dummy	Non–flight structure which approximates PM flight structure mass properties and PM structure specified stiffness and geometry. Provides exactly flight–like interfaces to Spacecraft and PM tank. Fixture will be used during Spacecraft prime structure static load test, and, in conjunction with PM tank mass model, for Spacecraft modal tests.
6.	Propulsion Module Tank Mass Model	Non–flight structure which approximates flight hydrazine tank mass properties when fueled. Mass model will be used as load application point for PM during Spacecraft static load test.
7.	Propulsion Module Thermal Vacuum Fixture	Static support stand for PM providing thermally–nonconductive interface between the thermal–vacuum chamber and the PM
8.	Propulsion Module Strut Test Fixture	Fixture to act as interface between end fittings of bonded strut/fitting assembly and existing "Compression–Tension Test Stand"

Table I. EOS Spacecraft MGSE Functions Listing (Continued)

THERMAL–VACUUM SUPPORT EQUIPMENT:		
1.	Thermal–Vacuum Baffles	Large curtains which zone off the thermal–vacuum chamber to present the required view factors to the various Instruments and Equipment Modules mounted on the Spacecraft.
2.	Thermal–Vacuum Coldplates	Individual plates used to simulate the space environment for those Instruments and Equipment Modules whose fields of view to the chamber walls or baffles are blocked by Spacecraft structure or other Instruments, etc.
3.	Thermal–Vacuum Target Pallet	Support structure which holds and positions simulated space targets for various Instruments inside the chamber during thermal–vacuum testing.
4.	Thermal–Vacuum Coldplate Supports	Support structures for portable cryopanels (coldplates).
5.	SSU Support	Support structure for Sequential Shunt Unit during room ambient and thermal–vacuum tests.
6.	Chamber Penetration Plates	Stainless steel plates with connectors or special fittings allowing electrical signals or purge tubes to pass through the thermal–vacuum chamber wall to the Spacecraft Instruments during thermal–vacuum tests.
MISCELLANEOUS EQUIPMENT:		
1.	Solar Array Installation & Handling Sling (Subcontractor furnished equip)	Sling fixture which interfaces to Solar Array used for lifting and positioning the Solar Array during integration to the Spacecraft.
2.	Flight Booster Adapter Lift Fixture (GFE)	Sling fixture which interfaces to the flight Booster Adapter used for lifting and positioning the BA during integration to the Spacecraft.
3.	Flight Booster Adapter Support Stand (GFE)	Fixture which holds Booster Adapter in correct position for integration to the Spacecraft structure.
4.	Mass Simulators	Mass models of Instruments, Equipment Modules, Propulsion Module, etc. used to simulate actual weights and centers of gravity of flight articles during mechanical environmental tests, e.g., static load and modal.
5.	Spacecraft Mechanical Mock–up	Full–scale mock–up of Spacecraft mechanical structure and major subassemblies for fit and clearance checks and harness design aid.
6.	Mock–up Dolly	Mobile mechanical structure to support and move the Spacecraft Mechancial Mock–up.

3.4 Use of Commercial Equipment

Commercial items or components may be used when they satisfy the GSE requirement, will not degrade the safety or reliability of the ground or flight system, and as long as they are to be used in a manner consistent with their documented design intent. The cost savings should exceed possible cost increases due to unique maintenance or logistic requirements, modifications, or an increase in the complexity of the interfacing equipment or facilities. Requirements should be specified in terms of functions or performance rather than design.

3.5 Performance Requirements

3.5.1 Operability

[1] MGSE shall be designed and constructed to ensure that its operation and use do not overstress, degrade, or contaminate associated flight equipment during checkout, servicing, or handling.

3.5.2 Reliability

GSE design and fabrication will be consistent with full availability on demand for performance of an item's or system's intended functions during the operational lifetime of that item or system.

Redundant functions or components will not be required in GSE design or fabrication unless dictated by equipment or personnel physical safety.

[1] During the defined operational lifetime of a given GSE element, its performance, as defined in this document and any applicable performance specification, shall be maintained through normal preventive maintenance, repair, and/or calibration.

3.5.3 Maintainability

[1] GSE equipment designs shall permit ready access to interior parts for easy removal and replacement of major component parts.

[2] Components subject to normal replacement or servicing shall not be secured by rivets, welding, or other means that would prohibit easy removal.

[3] Provisions shall be made for the removal and replacement of all parts that are subject to wear, deterioration, or change.

[4] Electrical and mechanical equipment requiring in–place calibration capability shall interface with external calibration equipment or have built in calibration.

[5] Periodic maintenance programs shall be established, as applicable, to assure timely removal and replacement of all parts that are subject to wear, deterioration, or other detrimental change.

3.5.4 Limited Life

[1] GSE hardware items with limited life, if any, including Government Furnished Equipment (GFE), shall be identified.

[2] Time or cycle sensitive components and age–controlled items, if any, shall be identified.

[3] Requirements for inspection, maintenance, and replacement of time or cycle sensitive components and age–controlled items shall be identified.

[4] A limited–life item list shall be prepared containing each item part number and name, life limit, life limiting parameter, life limiting part or material and its function, any limitations on number of refurbishments, and any restriction related to operational use, test, handling, inspection, or maintenance.

[5] Provisions shall be made for connection of time and cycle indicators, if used, to automated data collection equipment when GSE hardware is to be controlled by automated test equipment.

3.5.5 Operational Lifetime

[1] All items of GSE shall be designed for an operational lifetime spanning the period beginning with the start of major subassembly integration through Spacecraft launch or any applicable subspan of that period if the supported function is of limited scope.

3.5.6 Human Performance/Human Engineering

3.5.6.1 Human Engineering

[1] Accepted principles of human engineering shall be incorporated into the design and operability of all GSE to ensure that all equipment can be operated and maintained efficiently, reliably, and safely.

[2] The human engineering design criteria of MIL–STD–1472 shall be applied as specifically referenced within this document.

[3] The front panels of all test equipment and power supplies shall be visible when equipment cabinets are viewed from the front.

[4] Unimpeded access shall be provided to all system input/output devices, recorders, and displays for the purpose of adjustment, viewing, and mounting or dismounting of tapes or other display or data recording consumables.

3.5.6.2 Equipment Operating Characteristics

3.5.6.2.1 Noise

[1] The noise level of the equipment when running at design capacity shall not be detrimental to the health or safety of the operator or other personnel in the immediate vicinity.

3.5.6.2.2 Light

[1] Lighting shall comply with the requirements of MIL–STD–1472, as applicable.

3.5.6.2.3 Smoke and Fumes

[1] GSE shall not produce smoke or fumes in its operation.

3.5.6.2.4 Heat/Cold

[1] Accessible areas of equipment which produce heating or cooling as a result of operation shall have touch temperatures not higher than 45 degrees Celsius (°C) (113 degrees Fahrenheit (°F)) or lower than 4°C (40°F).

[2] Visible warning or caution labels shall be provided indicating the presence of hot or cold areas.

3.5.6.2.5 Vibration

[1] Equipment which generates vibration shall not exceed the requirements of MIL–STD–1472, as applicable.

3.5.7 Safety

[1] GSE shall be designed to preclude or counteract failures and hazards that could jeopardize personnel safety or damage the flight hardware, facilities, or other GSE.

3.5.8 Environmental Design Criteria

Natural and induced environments to be considered for GSE design are described in the following paragraphs.

3.5.8.1 Natural Environments

[1] GSE for use in exterior environments shall be designed to function and survive storage without degradation at their respective geographical locations while exposed to the natural environments.

3.5.8.1.1 Temperature

[1] GSE for use in exterior environments shall be designed to function and survive storage at temperatures given in Table II, Temperatures for Environmental Design Criteria.

Table II. Temperatures for Environmental Design Criteria (Indoor and Outdoor)

		Area	Low Extreme	High Extreme
Nonoperating and Storage		All Areas	–40°C (–40°F)	+71°C (+160°F)
Operating	Outdoor	Cold Weather Area	–51°C (–60°F)	+52°C (+125°F)
		Temperate Area	–40°C (–40°F)	+52°C (+125°F)
		Desert And Tropical Areas	0°C (+32°F)	+68°C (+155°F)
	Indoor	All Areas	0°C (+32°F)	+49°C (120°F)

3.5.8.1.2 Altitude

[1] All GSE shall be designed to be operable without degradation in specified performance at altitudes up to 5,000 feet above sea level and to withstand air transportation (non–operating) at altitudes up to 50,000 feet above sea level.

3.5.8.1.3 Humidity

[1] GSE for use in exterior environments shall be designed to function and survive storage at the following humidity levels:

Minimum humidity: 20 percent from the minimum operating temperature to +16°C (+61°F); above +16°C (+61°F), the relative humidity shall be based on a dew point of –7°C (+19°F).

Maximum humidity: 100 percent including condensation from the minimum operating temperature to +27°C (+81°F); above +27°C (+81°F), the relative humidity shall be based on a dew point of –7°C (+19°F).

3.5.8.2 Interior Controlled Environment

3.5.8.2.1 Temperature

[1] GSE for use in interior environments shall be designed to function at temperatures given in Table II for indoor equipment.

3.5.8.2.2 Humidity

[1] GSE for use in interior environments shall be designed to function at humidity levels within the range of 30 percent to 70 percent at 21 ±5°C (70 ±10°F).

3.5.8.3 Induced Environment

[1] GSE used in the area of the launch pads at VAFB, to be subjected to the launch environment, shall be designed to sustain any induced launch vibration and any incidental exposure to products of launch combustion.

3.5.8.4 Controlled Clean Environment

[1] Any item of GSE specifically identified for use in a controlled clean environment shall be designed and constructed in a manner such that its use will not compromise the clean environment.

3.5.9 Transportability

[1] GSE shall be designed and constructed to facilitate movement from one building location to another, including between floors in a multi–story facility.

[2] GSE required for use during launch site operations shall be designed and constructed to permit its segmentation, if applicable, and transporting from the Astro Space East Windsor location to the Western Test Range (WTR).

3.5.10 Logistics

[1] Resources to be provided in support of items of GSE, where applicable, shall include technical data, operations and maintenance documentation, maintenance planning, spares (if any), maintenance training, transportation, packaging, handling, storage, maintenance support equipment, and any information required to ensure efficient and cost–effective operation.

3.6 Configuration Management Requirements

[1] Configuration control of GSE shall be maintained in accordance with Astro Space Engineering Procedure AEP 6.04, Red–Line System, and Astro Space document 23001146, Configuration Management Requirements for Subcontractors.

3.7 Design and Construction

3.7.1 General Design Requirements

3.7.1.1 Separation/Protection of Redundant Equipment

[1] Redundant systems, redundant subsystems, and redundant major elements of subsystems (such as assemblies, panels, power supplies, tanks, controls, or associated interconnecting wires or fluid lines), where used, shall be separated or otherwise protected to ensure that an unexpected event that damages one will not prevent the other from performing the function.

3.7.1.2 Ground Support Equipment Control and Monitoring

[1] EGSE used during Spacecraft systems tests or launch operations shall interface with ground communications or control stations as necessary to provide for control and status monitoring of normal operations and hazardous conditions.

3.7.1.3 Time Units

[1] Time units for GSE that support the launch countdown or mission shall, as a minimum, indicate time in military time (i.e., day, hour (24–hour format), minute, second).

3.7.2 Mechanical and Structural Design

[1] Mechanical and structural GSE that interfaces with WTR hardware and facilities shall comply with the requirements of U.S. Air Force document WSMCR 127–1.

[2] All attachment hardware for covers or other removable items shall be captive.

3.7.2.1 Ground Support Equipment Structures

[1] MGSE used to apply loads to flight hardware or to support or transport flight hardware shall comply with the requirements of Astro Space document PN20005397.

3.7.2.2 Equipment Tethers

[1] Any tools and test equipment to be used in areas where dropping of the tool could result in injury to personnel or damage to flight equipment shall be provided with a means to tether.

3.7.2.3 Control of Reassembly of Ground Support Equipment for Lifting

[1] All lifting or hoisting load bearing components which are normally disassembled, such as individual slings, cables, shackles, pins, bolts, and similar parts shall be tethered, serialized, tagged, or marked for positive identification to assure proper assembly of verified hardware after proof load testing.

3.7.2.4 EGSE Hardware

[1] All floor–standing cabinets shall be equipped with casters directly mounted to the cabinets.

[2] All floor–standing cabinets (other than commercially procured off–the–shelf enclosures housing standard assemblages of computer or other sensitive electronic equipment, if not so equipped) shall be equipped with lifting eyebolts either directly mounted to the cabinets or installed in ancillary equipment that is secured to the cabinets.

3.7.3 Fluid Systems Design

3.7.3.1 Design Criteria

[1] Only system–compatible lubricants shall be used on threaded connectors.

[2] All pressure system connectors shall be selected to make it physically impossible to mate wrong connections if a hazardous condition can be created. An example is the connections for fuel and oxidizer lines.

[3] Pressure system components shall not exceed the maximum allowable stress as defined by the requirements of American National Standards Institute/American Society of Mechanical Engineers (NASI/ASME) B31 code for pressure piping.

[4] Pressure system components which are not intended to be reversible shall be designed, marked, or provided with sufficient instructions to assure proper installation.

[5] Pressure systems shall be designed so that pressure cannot be trapped in any part of the system without bleed capability.

[6] GSE shall have shutoff valves located at all pressure supply entry and exit points.

[7] GSE that uses any fluid whose leakage could be detrimental to property, support equipment, personnel, or flight hardware shall have provisions for containing such leakage.

[8] Pressurized systems shall be capable of being vented without disassembly.

[9] All pressurized GSE shall have the capability to be depressurized prior to disconnections.

[10] The direction of fluid flow shall be clearly indicated with the permanent marking of fluid system components, parts, and mating lines.

[11] Where flow checks cannot be made, the design of fluid line components shall incorporate end fittings or connections whose dimensions or configurations will not permit incorrect installation.

[12] Protection devices (e.g., surge) shall be provided where there is a possibility of damage to system components or the total system.

[13] Control stations shall have adequate instrumentation to allow personnel to monitor pressure, temperature, or other critical parameters and confirm that initiated actions have occurred.

[14] Control stations shall be designed so that the operator does not have to leave the station to monitor hazard levels.

[15] GSE shall be designed to permit flushing and draining during ground operations.

[16] GSE shall be designed to preclude unnecessary liquid traps, and sloped to facilitate gravity drain.

[17] Drain and bleed ports shall be provided.

[18] A positive and readily accessible means of shutting off fluid flow from tanks shall be provided.

[19] All controls and adjustments shall be identified by a unique identifier using a permanent tag or label placed on, or in close proximity to, the component.

[20] GSE pressure system lines shall be identified with Maximum Operating Pressure (MOP), fluid content, and direction of flow.

[21] Sample valves or ports shall be provided at strategic locations in the system to permit sampling of the fluid.

[22] When interface filters are not used, liquid servicing GSE shall have sample ports downstream of all final filters.

[23] Fluid components such as gauges, regulators, valves, etc., shall be capable of being calibrated, adjusted, and tested without removal from the unit where practical.

[24] All reservoirs shall have a fluid level indicator.

[25] Sight gauges used for liquid level indicators shall be properly protected from physical damage.

[26] Regulator failure shall not create a hazard to personnel or equipment.

[27] GSE components downstream of a regulator shall be designed to operate safely under full upstream pressure, otherwise a relief system must be installed.

[28] Remotely controlled valves and actuators shall be capable of opening and closing under design flow and pressure.

[29] Remotely controlled valves shall provide for remote monitoring of open and closed positions.

[30] Remotely controlled normally open or closed valves shall have a spring on the actuator capable of operating the valve to the fail safe position without an external actuating force under system operating conditions.

[31] Manually operated valves shall be capable of being opened or closed under full system pressure.

[32] The relieving capacity of any relief device shall be equal to or greater than the maximum flow capacity of the upstream pressure regulator or pressure source.

[33] The relieving capacity of any relief device shall prevent the pressure from rising more than 10% above the design pressure.

[34] Relief devices shall be located so that other components such as shutoff valves cannot render them inoperative.

[35] Relief devices and their associated discharge plumbing shall be adequately supported such that their discharge impulse will not cause structural failure.

[36] Pressure relief for toxic fluids shall be designed and located so that gases, liquids, or vapors will not enter any inhabited areas.

[37] Pressure relief for inert gases shall not be discharged into a confined, occupied area where oxygen content could be lowered below acceptable limits for human occupancy.

[38] Pressure relief for high pressure gases and liquids shall be located such that the discharge will not endanger personnel.

[39] Pressure systems shall be equipped with gauges or sensors as follows:

a. downstream of each regulator

b. on any storage system

c. strategically located in a system to indicate pressure trapped between isolation devices and whenever pressure cannot be depleted and verified in a maintenance configuration.

[40] GSE flexible hoses shall be identified and marked, with each flexible hose assembly having a metal tag(s) attached which bears the following information:

a. date (month and year) of hydrostatic test

b. service fluid (only for dedicated system hoses)

c. maximum rated working pressure

d. identification number

e. manufacturer's identification.

[41] Hoses shall be used only when required for hookup of equipment or to provide for movement between interconnection fluid components when no other means is available.

[42] All flexible hoses pressurized to 150 psig or greater shall be designed with restraining devices securely attached across each union or splice.

[43] Flexible hoses shall be restrained at intervals not to exceed 183 cm (6 feet).

[44] Flexible hoses shall be secured at each end by a hose containment assembly or other approved restraint device.

[45] The hose containment assembly is to be securely attached to the end of the flexible hose with the other end of the device anchored to a substantial object of strength adequate to restrain the hose if the hose breaks.

[46] A restraint device (such as a split ring) clamped over an existing fitting shall be used for interfaces where no other restraint method can be used to attach to the hardware.

[47] Hoses and tubing shall be designed and/or specified to at least 4 times the maximum rated working pressure.

[48] Hoses shall be tested at 1–1/2 times the maximum rated working pressure by hydrostat or 1–1/4 times the maximum rated working pressure for pneumatic testing.

[49] Routing and installation of all fluid lines shall insure that the temperature extremes to which each line will be subjected are within limits acceptable for the fluid involved.

[50] GSE designs shall preclude venting GSE fluids back through a facility supply line (when facility line is vented).

[51] Design of cooling support GSE shall prevent power outage or cold shut down from causing hydraulic lock up of cold trapped coolant between valves in lines.

3.7.3.2 Hydraulic Systems

Hydraulic GSE which tests or services flight systems will be designed in accordance with the following requirements (these criteria are not applicable to tractors, trailers, fork lifts, etc.).

[1] Hoses shall conform to MIL–H–25579E, Class I; MIL–H–38360; or Society of Automotive Engineers (SAE) standards as applicable and shall be suitably protected against chafing to prevent damage to the hose or adjoining structure, tubing, wiring, and other equipment.

[2] Only system–compatible lubricant shall be used on threaded fluid line connections.

[3] Pressurized reservoirs having GN_2 as a pressurant, shall have the pressure controlled by a pressure regulator, and shall have an airspace relief valve to protect from excessive pressure.

[4] Reservoirs shall be provided with a direct reading fluid level indicator.

[5] The suction head of all pumps shall be maintained between the limits recommended by the pump manufacturer.

[6] Pump pulsations shall not adversely affect system tubing, components, and supports and shall not cause damage or improper operation of the equipment or flight system.

[7] The system shall not cause damage to critical systems due to reduced flow, such as that caused by single–pump operation of a multipump system, or increased flow such as that caused by accumulator operations.

3.7.3.3 Pneumatic Systems

The following criteria will be used for design of pneumatic GSE.

[1] Hoses shall conform to MIL–H–25579E, Class I, MIL–H–38360, or SAE standards as applicable.

[2] Shutoff valves that cannot be throttled to prevent rapid pressurization of downstream components shall be provided with a bypass metering valve.

3.7.4 Electrical Design Criteria

3.7.4.1 Primary Power

[1] All GSE shall be designed to operate and maintain specified performance from an AC power source having the following characteristics:

120/208 VAC rms ±10%, 60 Hz ±0.5 Hz, three phase, five wire, safety grounded
total harmonic content of less than 5%

[2] Individual equipment shall operate with 120 volt 1 phase, 208 volt 1 phase, or 208 volt 3 phase input.

[3] Each phase of the power source to a multiphase load shall be protected by a circuit breaker. These circuit breakers shall be ganged such that, if one phase causes a break, all phases will break.

[4] All AC power wiring shall conform to the following commercial color coding practice, consistent with document NFPA 70, National Electrical Code:

Wire color	Function
Green	Ground line
Black	Hot line
White	Neutral line

3.7.4.2 Electrical Equipment Design

[1] Electrical equipment and wiring of all voltages shall conform to the design standards of document NFPA 70, National Electrical Code, when installed or used in locations where fire or explosion may exist due to flammable gases, vapors, combustible dust, or ignitable fibers or flyers.

[2] Internal wiring of EGSE shall comply with the requirements of Astro Space document 47A210105, Electrical AGE Fabrication and Workmanship Standard.

[3] Electrical control systems shall operate from the nominal facility 120/208 volts, 60 Hz AC and/or 28 volt DC power.

[4] Malfunctions of GSE circuitry shall not induce overload into the flight hardware, GSE, or facilities.

[5] Electrical equipment shall be designed to provide personnel protection from accidental contact with AC voltages in excess of 30 volts rms or 30 volts DC or any lower voltage that could cause injury.

[6] GSE designs shall assure that all external parts and surfaces are at ground potential at all times.

[7] Switches which can create hazardous conditions if inadvertently operated shall be guarded, shielded, or otherwise protected against inadvertent operation.

[8] Electrical fuse and switch boxes for primary AC power located on electromechanical equipment shall be stenciled on the outside or inside cover to show the voltage present, rated fuse capacity, and equipment that the circuit controls.

[9] Procedures for tagging and lockout of control switches and circuit breakers located on or within electromechanical equipment shall be provided where appropriate to ensure personnel and equipment safety.

[10] If inadvertent reversal or connection to the wrong circuit could result in a hazardous condition, all connectors shall either be keyed, marked, or coded to clearly indicate the correct mating connection.

[11] Protection shall be provided by the GSE to the flight system to prevent improper electrical inputs, including overvoltages or overcurrents, or reverse polarity which could cause damage to the flight system.

[12] Electrical connectors and wire junctions to connectors that are exposed to moisture shall be sealed from moisture to prevent open and short circuits.

[13] Shrink boots shall not be acceptable as moisture barriers.

[14] Electrical circuits shall not be routed through adjacent pins of an electrical connector, unless mandated by flight equipment design, if a short circuit between them would constitute a single failure that would cause injury to personnel or damage to flight hardware.

[15] Electrical GSE shall be designed so that routine inspection and verification can be conducted before each connection to flight hardware is made to insure proper electrical and electronic inputs.

[16] GSE electrical systems shall be designed so that all necessary mating and demating of connectors can be accomplished without producing arcs that will damage connector pins or ignite surrounding materials or vapors.

[17] Shorting springs or shorting clips shall not be used in electrical/electronic connectors.

[18] Electrical plugs and receptacles of GSE cables which connect to flight equipment and/or are routinely mated and demated in normal operations shall be provided with protective covers or caps. The covers or caps shall be connected to the cable with a suitable lanyard, chain, or hinge.

[19] EGSE assembled as floor– or bench–standing rack cabinets shall provide connector panels at the bottom front or rear of the rack or rack group, as appropriate, for all interface cabling to external equipment not contained within the rack or rack group and to the flight equipment or system under test.

[20] Overload protection devices shall be designed, selected, and calibrated to protect all elements of major distribution and branch circuits.

[21] Branch circuit protection shall be designed so that the combination of the current and time to isolate the overloaded branch circuit will not be sufficient to allow upstream protection devices to act and remove power from other branches of the power system.

[22] Computers, radio equipment, other electronic equipment, controls, and wiring shall be designed and installed in such a way that operation of one unit or system of units will not corrupt wanted signals with radiated or conducted emissions during the simultaneous operation of any other unit or system of units.

[23] An initial dielectric test shall be performed on wire harnesses prior to use with flight hardware.

[24] GSE instrumentation and control cabling and harnesses shall be high pot tested to 500 volts minimum.

[25] Alarm and other emergency indicators shall be powered from different sources independent from the items being monitored.

[26] Electrical connectors shall be selected such that misalignment during normal connect/disconnect processes will not cause contact damage.

3.7.4.3 Electrical Grounding

[1] The design, construction,and installation of equipment shall be such that all external parts, surfaces, and shields are at ground potential at all times.

[2] Power cords on GSE shall provide a noncurrent carrying ground conductor unless the unit is double insulated.

[3] Grounding/bonding connections shall be designed to minimize the possibility of inadvertent disconnection.

[4] Solder shall not be used for external grounding or bonding connections.

[5] Threaded fasteners for grounding or bonding connections shall use lock washers.

[6] All GSE or major enclosures using or generating electrical energy shall have provisions for connecting the enclosure to the (facility) ground system.

[7] Ground buses shall be isolated by a DC resistance of at least 1.0 megohms from each other and from all chassis, ground surface, and GSE structure prior to making a connection to the intended grounding circuit.

[8] Alternating current power circuits located within GSE enclosures, cabinets, drawers, or modules shall be routed adjacent to structural members, chassis, or panels and as far away as possible from low–level signal leads.

[9] Where AC power is carried on single conductors, the conductors comprising a given circuit shall be twisted together with as many turns per unit length as possible to minimize magnetic coupling with other circuits.

[10] Shields used for the purpose of reducing reception or transmission of electrical interferences shall be free of signal and power currents.

3.7.4.4 Electromagnetic Compatibility/Interference (EMC/EMI)

[1] All EGSE which supplies 120 Volt DC power to the Spacecraft main power bus, or to the equivalent power inputs of Equipment Modules, the Propulsion Module, and Instruments, shall provide such power with source ripple and noise characteristics which satisfy the requirements of Subsection 6.2.1 of Astro Space document PN20005869, Electromagnetic Compatibility Control Plan, throughout their operating voltage and current ranges.

[2] Best commercial practices for EMC/EMI shall be employed in EGSE design and construction.

[3] Off–the–shelf commercial equipment shall be evaluated and selected for best Electromagnetic Interference compatibility.

[4] EGSE shall satisfy the requirements of Section 7 of Astro Space document PN20005869 as applicable for the location and condition of use of the specific element of EGSE as defined therein.

3.7.5 Materials, Parts, and Processes

3.7.5.1 Parts and Component Selection

[1] Mounting or attaching provisions for commercial equipment shall be designed to permit such mounting or attaching without requiring modification of any mounting or attaching hardware supplied with the equipment.

3.7.5.1.1 Electrical Connectors

[1] GSE electrical connectors that interface with the flight hardware shall be flight quality connectors.

3.7.6 Protective Coatings and Finishes

[1] Protective coatings and finishes for GSE shall be selected and applied in accordance with commonly used practices.

[2] Critical weldments requiring nondestructive testing may be coated with a strippable paint including an area 1/2 inch wide on each side of the weld bead.

[3] Commercial (off–the–shelf) hardware shall not require refinishing or repainting unless required for other design considerations.

[4] The following listed colors, in accordance with FED–STD–595, shall be used for GSE units:

Color	Code	Use
Yellow	13538	Handling equipment, hoisting equipment, internal and external platforms, stairs, access equipment, and transportation equipment
Gray	26440 or 26251	Electrical/electronic, hydraulic, pneumatic consoles, racks, and cabinets
White	17875 or 27875	Equipment located in white or clean rooms
Black	37038	Panel lettering on any of the above items
Red	11136	Safety, protective, and non–flight equipment

3.7.7 Corrosion Prevention and Control

[1] Prevention and control of corrosion, where applicable, shall follow commonly used practices.

3.7.8 Dissimilar Metals

[1] Dissimilar metals which in combination are prone to electrolytic corrosion shall not be used in contact unless suitably protected against such corrosion.

[2] If it is necessary that dissimilar metals, which in combination are prone to electrolytic corrosion, be assembled together, a material compatible with each shall be interposed between them.

[3] Dissimilar metals shall not be used in fluid systems in which electrolytic solutions are used.

3.7.9 Interchangeability

[1] GSE assemblies, components, and parts with the same part number shall be physically and functionally interchangeable.

3.7.10 Identification Markings and Labels

3.7.10.1 Equipment Markings

[1] GSE shall be identified and marked in accordance with Astro Space document 47A210105.

3.7.10.2 Instruction Plates

[1] Instruction plates shall be securely fastened to enclosures or instrument panels, and shall be placed in a position where they can be easily read.

3.7.10.3 Load Capacity Markings

[1] GSE used for hoisting, transportation, handling, and personnel access shall be conspicuously stenciled to indicate the maximum safe working load.

3.7.11 Traceability

[1] Configuration and revision traceability shall be maintained for all GSE subassemblies and subsystems.

[2] Serialization for the purposes of configuration management and logistics management of GSE shall be applied to the following as a minimum:

a. end items

b. assemblies which contain life limited components or parts

c. replacement units requiring maintenance, servicing, or calibration.

4 QUALITY ASSURANCE PROVISIONS

4.1 Quality Assurance Program Provisions

Quality assurance provisions for GSE shall comply with Astro Space documents PAP A1.13 for Astro Space in–house activities and PN20004280 for subcontract activities.

4.2 Acceptance Test of Ground Support Equipment

An acceptance test procedure shall be prepared and maintained for end items where quantitative data is a prerequisite to demonstrating compliance with design and/or procurement specifications. Test procedures and data sheets containing as–run quantitative data shall be retained on file and included in the acceptance data package.

4.3 Instrumentation Calibration

Calibration of measuring instruments shall be established and maintained in accordance with MIL–STD–45662A, as applicable.

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5 PREPARATION FOR DELIVERY

5.1 Preservation and Packaging

Ground Support Equipment end items shall be preserved and packaged, when necessary, in accordance with NHB 6000.1. The packing shall be adequate to protect the GSE during transportation and storage.

5.2 Shipping Containers

Shipping containers shall be compatible with operational site transportation, handling, and storage methods. For convenient handling and stacking of containers having a gross weight of more than 100 pounds, the use of integral skids or pallets shall be considered. Attach points shall be provided where applicable for crane hoist and tie–down.

5.3 Weight and Size

The weight and cubic displacement of packaging and packing shall be held to a minimum consistent with the requirements of the item and the method of transportation. GSE shall be designed so that the configuration (i.e., item) may be disassembled as required and packaged for shipment.

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6 NOTES

6.1 Acronyms and Abbreviations

A	Ampere
AC	Alternating Current
AFB	Air Force Base
AGE	Aerospace Ground Equipment
Ant	Antenna
ASCII	American Standard Code for Information Interchange
BA	Booster Adapter
BDU	Bus Data Unit
C	Celsius
C&DH	Command and Data Handling
CG	Center–of–gravity
COMM	Communications
C&T	Command and Telemetry
CTIU	Command and Telemetry Interface Unit
DAS	Direct Access Subsystem
DC	Direct Current
EGSE	Electrical Ground Support Equipment
EM	Equipment Module
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOS	Earth Observing System
F	Fahrenheit
GAP	General Alignment Prism
GFE	Government Furnished Equipment
GN&C	Guidance, Navigation, and Control
GRO	Gamma Ray Observatory
GSE	Ground Support Equipment
GSERD	Ground Support Equipment Requirements Document
GSFC	Goddard Space Flight Center
HGA	High Gain Antenna
Hz	Hertz

ICD	Interface Control Document
ISGSE	Instrument Science Ground Support Equipment
I&T	Integration and test
KSC	Kennedy Space Center
LSE	Launch Support Equipment
METS	Mobile Environmental Transportation System
MGSE	Mechanical Ground Support Equipment
MTM	Mechanical Test Model
NASA	National Aeronautics and Space Administration
NFPA	National Fire Protection Association
PCMU	Propulsion Command and Monitoring Unit
PM	Propulsion Module
PPLU	Propellant and Pressurant Loading Unit
psi	pounds per square inch
psig	pounds per square inch gauge
r.f.	radio frequency
rms	root mean square
rss	root sum square
RWA	Reaction Wheel Assembly
SCS	Spacecraft Checkout Station
SIS	Spacecraft Interface Simulator
SSU	Sequential Shunt Unit
STE	Special Test Equipment
TAP	Three–Axis Positioner
T–V	Thermal–vacuum
UARS	Upper Atmosphere Research Satellite
Umb	Umbilical
V	Volt
VAFB	Vandenburg Air Force Base
WSMCR	Western Space and Missile Center Regulation
WTR	Western Test Range

PN20005868
07 October 1993

(Draft)
Test Plan
Electromagnetic Compatibility (EMC)
for EOS–AM Spacecraft
(VRD–105)

Prepared under:
Contract NAS5–32500
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

Prepared by:
Martin Marietta Corporation
Astro Space
P.O. Box 800
Princeton, New Jersey 08543–0800

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REVISION LOG

This log identifies those portions of this document which have been revised since the original issue. Revised portions of each page, for the current revision only, are identified by marginal striping.

Revision	Paragraph Number(s) Affected	Rev. Date	Approval
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1 INTRODUCTION

1.1 Scope

This EOS–AM Spacecraft Test Plan describes test concepts and outlines Electromagnetic Compatibility (EMC) tests required of components, major assemblies, and the Spacecraft system to ensure compliance with the EMC Control Plan for the EOS–AM Spacecraft (PN20005869). A more specific Individual Test Procedure will be issued 4 weeks prior to performing each test. The Spacecraft System Level Test Plan will be issued at least 4 weeks prior to system level EMC testing.

1.2 Description

This test plan shall assure compliance with section 3.5 of the Performance Assurance Requirements (GSFC 420–05–02) for the EOS–AM Spacecraft. It is generated following the requirements of the Verification Specification for the EOS–AM Spacecraft (PS20005404), and the Verification Plan for the EOS–AM Spacecraft (PN20005404). All tests described herein will be conducted in accordance with the Performance Assurance Implementation Plan (PN20005397). Test items may consist of the EOS–AM Spacecraft components, subassemblies, instruments, and/or the integrated Spacecraft.

1.3 Objective

The objective of this plan is to describe the tests required to verify the EMC/EMI performance of the EOS–AM Spacecraft along with proper test configuration, instrumentation, limits, methods, and procedures. The tests identified herein verify that the equipment: meets the established EMI limits, does not cause other equipment to malfunction, is not susceptible to external EMI sources and does not interfere with other systems such as the launch vehicle and other spacecraft.

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2 SOURCE DOCUMENTS

2.1 Applicable Documents

The following documents of the exact issue shown, form a part of this test plan to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this test plan, the contents of this test plan shall be considered the superceding document.

GSFC–420–05–02 08 November 1991	EOS Performance Assurance Requirements for the EOS–AM Spacecraft.
PN20005869	EOS–AM Spacecraft Electromagnetic Compatibility Control Plan (SEP–106)
PN20005404	Verification Plan for the EOS–AM Spacecraft (VRD–100)
PS20005404	Verification Specification for the EOS–AM Spacecraft (VRD–100)
PN20005397	Performance Assurance Implementation Plan (PA–100)
PN20004280	Subcontractor Performance Assurance Requirements
Source:	Martin Marietta Astro Space P. O. Box 800 Princeton, NJ 08543–0800

2.2 Reference Documents

GEVS–SE January 1990	General Environmental Verification Specification for STS and ELV, GSFC
MIL–STD–462 Notice 1	Electromagnetic Interference Characteristics, Measurement of Notice 1
MIL–C–45662 10 June 1980	Calibration System Requirements

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3 EMC TEST PROGRAM

The EOS–AM EMC Test Program will consist of testing in support of design and analysis activities as well as in support of design verification for compliance to the EOS–AM EMC requirements. The test program is structured to demonstrate that the component and system design satisfy the requirements of PN20005869, "EMC Control Plan for the EOS–AM Spacecraft". System level testing will be performed to verify that the EOS–AM Spacecraft is electromagnetically compatible with itself and with its intended electromagnetic environment. The EOS–AM Spacecraft EMC test matrix is listed in Table I. Table II describes the EMC test methods planned for EOS–AM Spacecraft equipment. The following test activities will be performed over the life of the program.

Engineering development tests are performed to support the development of EMC requirements and to substantiate and characterize EMC design features in support of hardware design. The test articles are, in general, non–flight and the test documentation is under engineering control. Data from engineering development tests may not be substituted for qualification or acceptance test data without formal customer approval.

Component qualification testing will be performed on specified unique component designs utilized on the EOS–AM Spacecraft. This testing will demonstrate compliance to the requirements of PN20005869. An individual EMC Test Procedure identifying operating modes, unique test set–ups and equipment limits will be prepared, reviewed and approved per the requirements of GSFC–420–05–02, EOS–AM Performance Assurance Requirements for the "EOS–AM Spacecraft". The EMC test set for these tests is given in Table II.

Component acceptance testing will be performed on all flight hardware to verify that EMC design features are consistently incorporated into the hardware. The EMC tests performed will be a subset of the qualification test set as described in Table II. The qualification EMC Test Procedure may be used for acceptance testing and should incorporate the acceptance test criteria at initial issue to avoid repeated approval cycles for multiple documents.

Spacecraft–level testing will be performed to demonstrate system compatibility with anticipated external environments as well as self–compatibility in all system operating modes. Spacecraft bus and instrument verification to the EOS–AM EMC requirements will have been demonstrated prior to Spacecraft system–level testing.

Martin Marietta Astro Space (Astro Space) subcontractors shall submit an EMC Test Plan and the Test Data resulting from EMC verification testing to Astro Space for review and approval.

EMC Test Plans for Instruments will be reviewed to insure that the intent of this document is met and that the data obtained from subsequent EMC testing will be directly applicable to overall Spacecraft Level EMC verification. EMC Test Data for the instruments will be submitted as a part of the Instrument Interface Control documents (ICDs). This data will be reviewed to ensure that there are no spacecraft level incompatibilities (instrument to instrument, or Spacecraft bus to instrument).

3.1 Test Application

The EMC tests will be performed in compliance with the methods and conditions required by the EOS–AM PAR (GSFC 420–05–02). The PAR calls out the GEVS and MIL–STD–462 which may be tailored according to the GEVS. This test plan clarifies the methods of MIL–STD–462 and defines program unique measurement methods needed to verify compliance with PN20005869.

Table I. EOS–AM EMC Test Matrix

EQUIPMENT	CE01	CE03	CE Common Mode	CE06	RE02	RE04	CS01	CS02	CS06	RS01	RS03	DC Magnetics	Magnetic Properties	Ripple	CS03/CS04/CS05	Abnormal Bus Transient
EPC	X	X	X		X	X	X	X	X	X	X	X	X			X
ADE	X	X	X		X	X	X	X	X	X	X	X	X			X
SSU	X	X	X		X	X			X	X	X			X		X
DEU	X	X	X		X	X	X	X	X	X	X	X	X			X
PRA					X	X	X	X	X	X	X					X
HCE/HTRS	X	X	X		X	X	X	X	X	X	X	X	X			X
PMEA	X	X	X		X	X	X	X	X	X	X	X	X	(1)		X
THRUSTERS										X	X					
PXDUCER							X	X	X	X	X					X
MTR										(6)	(6)					
RWA	X	X	X		X	X	X	X	X	X	X	X	X			X
FSS					X	X	X	X	X	X	X	X	X			X
ESA					X	X	X	X	X	X	X	X	X			X
ESE					X	X	X	X	X	X	X	X	X			X
CSS																
TAM					X	X	X	X	X	X	X	X	X	(1)		
IRU	X	X	X		X	X	X	X	X	X	X	X	X			
ACE	X	X	X		X	X	X	X	X	X	X	X	X	(1)		X
PSU	X	X	X		X	X	X	X	X	X	X	X	X			X
STAR TRKR					X	X	X	X	X	X	X	X	X	(1)		X

Note 1: Test Secondary Ripple
Note 2: Not used
Note 3: Not used
Note 4: Test with Diplexer
Note 5: Test in subsystem configuration
Note 6: Test or analysis
Note 7: Test with DAS transmitter

Table I. EOS–AM EMC Test Matrix (Continued)

EQUIPMENT	CE01	CE03	CE Common Mode	CE06	RE02	RE04	CS01	CS02	CS06	RS01	RS03	DC Magnetics	Magnetic Properties	Ripple	CS03/CS04/CS05	Abnormal Bus Transient
SCC	X	X	X		X	X	X	X	X	X	X	X	X			X
CTIU	X	X	X		X	X	X	X	X	X	X	X	X			X
BDU	X	X	X		X	X	X	X	X	X	X	X	X			X
SFE	X	X	X		X	X	X	X	X	X	X	X	X			X
SSR	X	X	X		X	X	X	X	X	X	X	X	X			X
SBT	X	X	X	(4)	X	X	X	X	X	X	(4)	X	X		(4)	X
SBIU/S–FILTER				X	X	X				X	X	X	X		X	
OMNI											X	X	X			
HGA	X	X		X	X	X	X	X	X	X	X	X	X		X	X
MO	X	X		X	X	X	X	X	X	X	X	X	X			X
KSAM	X	X		X	X	X	X	X	X	X	X	X	X		X	X
DAS ANT				(5)								X	X		(5)	
DAS TX	X	X	X	(5)	X	X	X	X	X	X	X	X	X		(5)	X
UC	X	X	X	(5)	X	X	X	X	X	X	X	X	X		(5)	X
DASM	X	X	X	(5)	X	X	X	X	X	X	X	X	X		(5)	X
WG SW				(5)						X	X	X	X		(5)	
DAS FILTER				(5)	(6)	(6)				X	(7)	X	X		(5)	

Note 1: Test Secondary Ripple
Note 2: Not used
Note 3: Not used
Note 4: Test with Diplexer
Note 5: Test in subsystem configuration
Note 6: Test or analysis
Note 7: Test with DAS transmitter

Table II. Test Methods

Requirement	Description	Frequency Range
CE01 †	Conducted Emissions, Powerlines, NB,CM	30 Hz to 15 kHz
CE03 †	Conducted Emissions, Powerlines, NB, BB, CM	15 kHz to 50 MHz
CE06 †	Conducted Emissions, Antenna Terminals	15 kHz to 18 GHz
CECM †	Conducted Emissions Common Mode	30 Hz to 50 MHz
RE02 † *	Radiated Emissions	14 kHz to 50 GHZ
RE04 †	Radiated Emissions, Magnetic Field	30 Hz to 200 kHz
CS01	Conducted Susceptibility, Powerlines	30 Hz to 50 kHz
CS02	Conducted Susceptibility, Powerlines	50 kHz to 400 MHz
CS06	Conducted Susceptibility, Powerlines	10 µs Spike, 60 pps
RS01	Radiated Susceptibility, Magnetic Field	30Hz to 30 kHz
RS03	Radiated Susceptibility	14 kHz to 18 GHz
CS03	Intermodulation	10 kHz to 18 GHz
CS04	Rejection of Undesired Signals	10 kHz to 18 GHz
CS05	Cross–Modulation	10 kHz to 18 GHz
DC Magnetic Field Dipole Moment		
DC Magnetic Susceptibility		
Ripple	Power Conducted Emissions Voltage Envelope	30 Hz – 400 MHz
Abnormal Bus Transient	Abnormal Transient Survival	10µs, 1 time per equipment or operating mode

* Denotes System Level Test also † Denotes Acceptance Test also

3.1.1 Operating Modes

Testing shall be performed in the most emissive mode normally used during operation. Units to be tested for susceptibility shall be done in their most susceptible mode. Individual component operational modes will be detailed in each individual component test procedure.

3.1.2 Acceptance Criteria

The acceptance criteria for emissions shall be determined for each test article based upon the requirements of the EOS–AM EMC Control Plan (PN20005869).

3.2 Quality Assurance Provisions

3.2.1 Measurements

All emission measurements will be made with the receiver/analyzer in the peak detector mode with bandwidth selector set to the appropriate bandwidth. In all cases, proper current probe transfer impedance, antenna factors, and cable attenuation factors will have been entered into the computer for automatic measurements, or will be added to manually obtained meter readings to obtain the correct units of measure to be compared to specification limits. Calibrated voltmeters, oscilloscope, and other general lab equipment will be used.

3.2.2 Calibration

Measurements required during all testing will be accomplished with instrumentation calibrated in the Martin Marietta Astro Space (Astro Space) Calibration and Standards Laboratory. Standards used in calibration are directly traceable to the National Bureau of Standards. The Astro Space measurement system is in compliance with MIL–C–45662, "Calibration System Requirements". All instrumentation will be used only during the normal calibration cycle.

3.2.3 EMISM

Electromagnetic Interference Safety Margin (EMISM) for safety critical circuits (such as EEDs) shall be 20dB, verified by analysis or test. EMISM for other EMC elements shall be 6dB, verified by comparison of emissions and susceptibility test data.

3.2.4 Test Discrepancies and Failures

Test discrepancies will be documented and resolved following the procedures given in the Performance Assurance Implementation Plan (PN20005397, Section 8.13) and the Subcontractor Performance Assurance Plan (PN20004280, Section 8.13). These requirements call for reporting test failures to the Failure Review Board (FRB) via the automated deficiency reporting system or approved method. The EMC engineer will participate in the disposition process as needed. In addition, the EMC engineer will provide analysis support requirements to satisfy the FRB.

3.2.5 Test Documentation

Test documentation shall be prepared in accordance with the Verification Specification (PS20005404) Section 3.4. A test report shall be generated by the EMC engineer detailing all tests performed and the results.

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4 TEST FACILITY

4.1 Description of Shielded Enclosure

EMC/EMI testing will be performed in a shielded enclosure. The shielded enclosure will provide a minimum shielding effectiveness of 100 dB to electric fields from 14 kHz to 18 GHz, and will be equipped with powerline filtration with an attenuation of 100 dB from 14 kHz to 18 GHz.

The shielded enclosure will be kept free of unnecessary equipment, racks and desks. Only essential equipment will be in the enclosure. Care will be taken to insure that accessory equipment does not affect measurement integrity.

Free field testing is acceptable if ambient levels can be shown to meet the measurement accuracies required by the detailed test procedure.

4.2 Ground Plane

A copper ground plane with a minimum thickness of 0.25 mm, and 2.25 square meters or larger in area with the smaller side no less than 76 cm will be used for equipment testing. The ground plane will be bonded to the shielded room such that the DC bond resistance does not exceed 2.5 milliohms. The bonds will be placed at distances no greater than 90 cm apart. If equipment is mounted on a metal test stand, the test stand will be considered a part of the ground plane for testing purposes and is bonded accordingly.

4.3 Grounding and Bonding

The equipment under test (EUT) will be bonded to a copper ground plane bench. The method of bonding will simulate the mounting of the equipment in the flight system to the greatest extent practical. Direct bonding to the ground plane by bolting or a low impedance bond strap bolted to the ground plane is recommended. A bond resistance less than 2.5 milliohms will be verified by measurement before EMI testing starts. Deviations from this bonding technique will be specifically defined in the approved detailed individual EMC test procedure.

4.4 Ambient Measurement

Prior to beginning EMC/EMI testing, the facility and test setup will be measured as described below to determine whether the ambient environment is suitable for testing.

4.4.1 Radiated

Prior to the commencement of radiated testing (with the item under test inoperative), a complete emissions scan will be made per test requirements. This scan will be done to ensure that a 6 dB margin below the imposed test limit exists across the measured frequency band. This data will become part of the test report.

4.4.2 Conducted

With the item under test inoperative, a complete emissions scan will be conducted, first with the current probe on the positive input lead and then on the return lead. This is to demonstrate that no coupling due to outside interference exists and that a 6 dB margin below the imposed test limit is present across the measured frequency band. This data will become part of the test report.

4.5 Test Conditions

The unit under test will be tested under normal laboratory ambient conditions of temperature, pressure, and humidity.

5 TEST EQUIPMENT

This section is devoted to listing the instrumentation used for EMI/EMC testing. Test equipment that requires correction factors, dB versus frequency, to obtain corrected units of measure are to be added to the recorded data.

5.1 EMC Test Equipment Accuracy and Calibration

Emissions measurement equipment shall be accurate to ±2 dB in amplitude and ±2% of the frequency upper limit of the receiver measurement band. Susceptibility equipment shall be controlled for amplitudes ±2 dB and frequency or time ±1%.

5.2 Test Equipment List

Table III contains a list of planned EMC test instrumentation. Additional specialized instruments will be acquired as needed.

Table III. Partial EOS–AM Test Equipment List

ITEM #	DESCRIPTION	MANUFACTURER	MODEL #	USE
1	EMI FIELD INTENSITY METER	EATON/AILTECH	NM–7A	CE,RE
2	EMI FIELD INTENSITY METER	EATON/AILTECH	NM–17/27A	CE, RE
3	EMI FIELD INTENSITY METER	EATON/AILTECH	NM–37/57A	CE, RE
4	CNTRL COUNTER INTERFACE	EATON/AILTECH	CCI–7	CE, RE
5	CONTROL INTERFACE UNIT A	EATON/AILTECH	CIU–7	CE, RE
6	CONTROL INTERFACE UNIT B	EATON/AILTECH	CIU–7	CE, RE
7	INTERFERENCE ANALYZER	ELECTROMETRICS	EMC–25	CE, RE
8	SPECTRUM ANALYZER	HEWLETT PACKARD	HP–8566B	CE, RE
9	RF PRESELECTOR 20HZ–2GHZ	HEWLETT PACKARD	HP–85685A	CE, RE
10	COMPUTER	HEWLETT PACKARD	HP–9836	CE, RE
11	PLOTTER	HEWLETT PACKARD	HP–7550A	CE, RE
12	PRINTER	HEWLETT PACKARD	HP–2671G	CE, RE
13	POWER ISOLATION XFMR	SOLAR	7032–1	CE, RE
14	LO FILTER (50kHz LPF)	MARTIN MARIETTA	N/A	RIPPLE
15	HI FILTER (50kHz HPF)	MARTIN MARIETTA	N/A	RIPPLE
16	LINE STABILIZATION CAP	SOLAR	7113–106R	CE
17	DIGITIZING SCOPE 250MHz BW	HEWLETT PACKARD	HP–54510A	CE, CS
18	OSCILLOSCOPE	TEKTRONIX	7844	CE, CS
19	VERTICLE PLUG–IN	TEKTRONIX	7A26	CE, CS
20	TIME BASE PLUG–IN	TEKTRONIX	7B15	CE, CS
21	SCOPE CAMERA	HEWLETT PACKARD	HP–197B	CE, CS
22	SCOPE PROBE	TEKTRONIX	P6156	CE, CS
23	SCOPE PROBE	TEKTRONIX	P6156	CE, CS
24	CURRENT PROBE AMPLIFIER	TEK	AM–503	CE
25	CURRENT AMPLIFIER PROBE DC–50MHZ	TEKTRONIX	P6302	CE

Table III. Partial EOS–AM Test Equipment List (Continued)

ITEM #	DESCRIPTION	MANUFACTURER	MODEL #	USE
26	CURRENT AMPLIFIER PROBE DC–50MHZ	TEKTRONIX	CT–5	CE
27	CURRENT PROBE	EMPIRE DEVICES	CP–105	CE
28	FUNCTION GENERATOR	TEKTRONIX	FG–504	CS
29	SPIKE GENERATOR	SOLAR	6254–5S	CS
30	SPIKE GENERATOR	SOLAR	7054–1	CS
31	AUDIO AMPLIFIER	McIntosh	MC–75	CS
32	AUDIO AMPLIFIER	SOLAR	6552–1A	CS
33	DC Coupled Audio Power Amp	TECRON (Crown)	7560	CS
34	ARBITRARY/FUNC GENERATOR	WAVETEK	FG–504	CS
35	TRANSIENT PULSE GENERATOR	SOLAR	8282–1	CS
36	AUDIO ISOLATION XFMR	SOLAR	6220–1A	CS1
37	RF COUPLER	SOLAR	7515–1	CS2
38	INJECTION CURRENT PROBE .01–100MHZ	TEGAM (.1–100µS pulses)	95236–1	CSSIG
39	INJECTION CURRENT PROBE 2–400MHZ	TEGAM	95236–1	CSSIG
40	ESD GENERATOR	GENERAL ELECTRIC	N/A	ESD
41	STATIC DISCHARGE SIMULATOR	SCHAFFNER	NSG431	ESD
42	VECTOR IMPEDANCE METER	HEWLETT PACKARD	HP–4815A	GND
43	DIGITAL OHMMETER	VALHALLA	4150	Gnd
44	HIGH RESISTANCE METER	HEWLETT PACKARD	HP–4329A	Gnd
45	MAGNETOMETER	EMCO	6701	RE–DC
46	H–FIELD ANTENNA 100HZ–100MHZ	ANTENNA RESEARCH	BBH–500/B	RE
47	E–FIELD ANTENNA –1k–1GHz	ANTENNA RESEARCH	SAS–1/D	RE
48	PARABOLIC ANTENNA 36Ó– 1–12GHz	AEL	ASN1242AA	RE
49	LOOP ANTENNA 24 IN 20HZ–150KHZ	FAIRCHILD	ALP–10	RE
50	LOOP ANTENNA 12 IN .1–30MHZ	EMPIRE DEVICES	LP–105	RE
51	H–FIELD ANTENNA	FAIRCHILD	ELS–10	RS
52	PARALLEL PLATE ANTENNA	IFI	EFG–3	RS
53	50 OHM LOAD f/EFG–3	BIRD TERMALINE	8230	RS
54	Double Ridged Waveguide ANTENNA	EMCO –1–18GHZ	EMCO–3115	RE, RS
55	LOG CONICAL ANTENNA .2–1GHZ	FAIRCHILD	LCA–25	RS
56	"PARABOLIC ANTENNA18"" 12–18GHz"	SINGER	1050/1001	RS
57	TWTA (1–2GHz)	KELTEC	LR 625–20	RS
58	TWTA (2–4GHz)	HUGHES	1277HS	RS
59	TWTA (4–8GHz)	HUGHES	1277HC	RS
60	TWTA (12–18GHz)	HUGHES	1277HKU	RS
61	TWTA (8–12GHz)	VARIAN	VZX6981K1	RS
62	POWER AMPLIFIER (.02–10MHz)	ENI	240L	RS
63	POWER AMPLIFIER (.15–250MHz)	ENI	420L	RS
64	POWER AMPLIFIER (1–1000MHz)	AMPLIFIER RESEARCH	50W1000	RS
65	LEVELING AMPLIFIER	AMPLIFIER RESEARCH	777	RS
66	LEVELING AMPLIFIER	AMPLIFIER RESEARCH	999	RS

Table III. Partial EOS–AM Test Equipment List (Continued)

ITEM #	DESCRIPTION	MANUFACTURER	MODEL #	USE
67	POWER AMPLIFIER 10KHz–220MHz	IFI –1000W	406	RS
68	RF AMPLIFIER	HEWLETT PACKARD	HP–8447F	RS
69	50 OHM LOAD	BIRD	81B	RS
70	ISOTROPIC PROBE	NARDA	8621B	RS
71	ISOTROPIC PROBE	NARDA	8631	RS
72	RADIATION MONITOR	GENERAL MICROWAVE	RAHAM 4C	RS
73	RADIATION MONITOR	GENERAL MICROWAVE	RAHAM 495	RS
74	FIELD STRENGTH METER	IFI	EFS–1	RS
75	REMOTE F.S. MONITOR	IFI	LDI	RS
76	RADIATION MONITOR	NARDA	8316	RS
77	E&H FIELD SENSOR	AERITALIA	TE307	RS
78	E&H FIELD SENSOR REPEATER	AERITALIA	TE308	RS
79	ISOTROPIC E–FIELD SENSOR	AERITALIA	13RV1001–1	RS
80	ISOTROPIC E–FIELD SENSOR	AERITALIA	19RV1001–1	RS
81	FUNCTION GENERATOR 1Hz–15MHz	HEWLETT PACKARD	HP–3325	RS, CS
82	SIGNAL GENERATOR 10MHz–26.5GHz	HEWLETT PACKARD	HP–8340A	RS, CS
83	IMPULSE GENERATOR	ELECTROMETRIX	CIG25	RS, CS
84	POWER AMPLIFIER 10KHz–220MHz	IFI –10W	5100	RS, CS
85	SWEEP OSCILLATOR	HEWLETT PACKARD	HP–8350B	RS, CS345
86	POWER METER	HEWLETT PACKARD	HP–436A	RF
87	POWER SENSOR	HEWLETT PACKARD	HP–8482A	RF
88	POWER SENSOR	HEWLETT PACKARD	HP–8483A	RF
89	WATT METER	BIRD	43	RF
90	COAXIAL ATTENUATOR	BIRD	8329–300	RF
91	DUAL DIRECTIONAL COUPLER0.2–.4GHz	HEWLETT PACKARD	HP–774D	RF
92	DUAL DIRECTIONAL COUPLER 0.4–1GHz	HEWLETT PACKARD	HP–775D	RF
93	DUAL DIRECTIONAL COUPLER 1–2GHz	HEWLETT PACKARD	HP–776D	RF
94	DUAL DIRECTIONAL COUPLER 2–18GHz	HEWLETT PACKARD	HP–11692D	RF
95	50 OHM STEP ATTENUATOR	TEKTRONIX	2701	RF
96	CLOSE FIELD PROBE .009–30MHz	HEWLETT PACKARD	HP–11941A	RE
97	CLOSE FIELD PROBE .030–1GHz	HEWLETT PACKARD	HP–11940A	RE
98	"CURRENT PROBE 1MHz–1GHz, 1–10 Zt"	TEGAM	94111–1	CE
99	"CURRENT PROBE 1MHz–1GHz, ~1 Zt"	TEGAM	94111–2	CE
100	PREAMPLIFIER 1–500MHZ 62dB 1.2DB NF	MITEQ	AV–4A–0150	RE, CE
101	PREAMPLIFIER .02–2.6GHZ 60dB 1.2DB NF	MITEQ	AFS32–001	RE, CE
102	PREAMPLIFIER .1–10GHZ 30dB 2.6DB NF	MITEQ	AFS4–001	RE, CE
103	PREAMPLIFIER 8–12GHZ 31dB 1.4DB NF	MITEQ	AFS4–080	RE, CE
104	PREAMPLIFIER 12–18GHZ 31dB 1.9DB NF	MITEQ	AFS4–120	RE, CE

5.3 Current Probe Correction Factors

Current probe correction factors (see Figure 1 for example) will be included in the EMC Test Report. Data will be adjusted to include these factors.

5.4 Antenna Correction Factors

Figure 2 illustrates a representative antenna correction factor curve. Broadband correction factors will be listed with the individual receiver used for test or added automatically to the test data. Antenna correction factors will be included in data reduction. All antennas in radiated tests will be calibrated.

5.5 EMC Test Support Equipment

Test support equipment will not effect the EMI measurement of the Equipment Under Test (EUT). Test support equipment will be checked for interference to the measurements during the tests. If an out–of–spec condition occurs due to the test support equipment, then modification of the setup or test support equipment will be allowed to remove the out–of–spec condition.

TEST EQUIPMENT UTILIZATION AND CORRECTION FACTORS

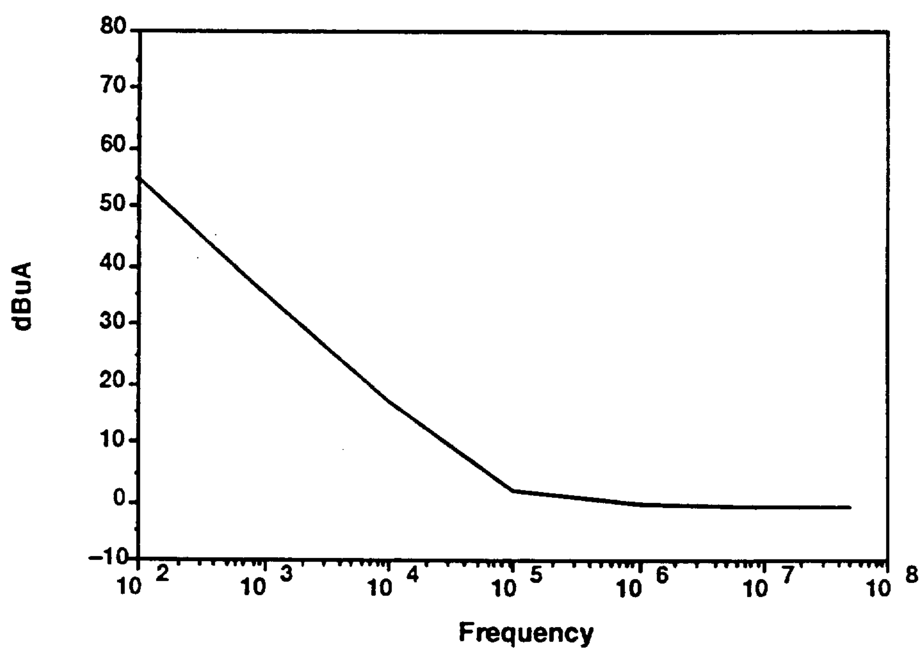

Figure 1. Singer CP–105 Current Probe Factor

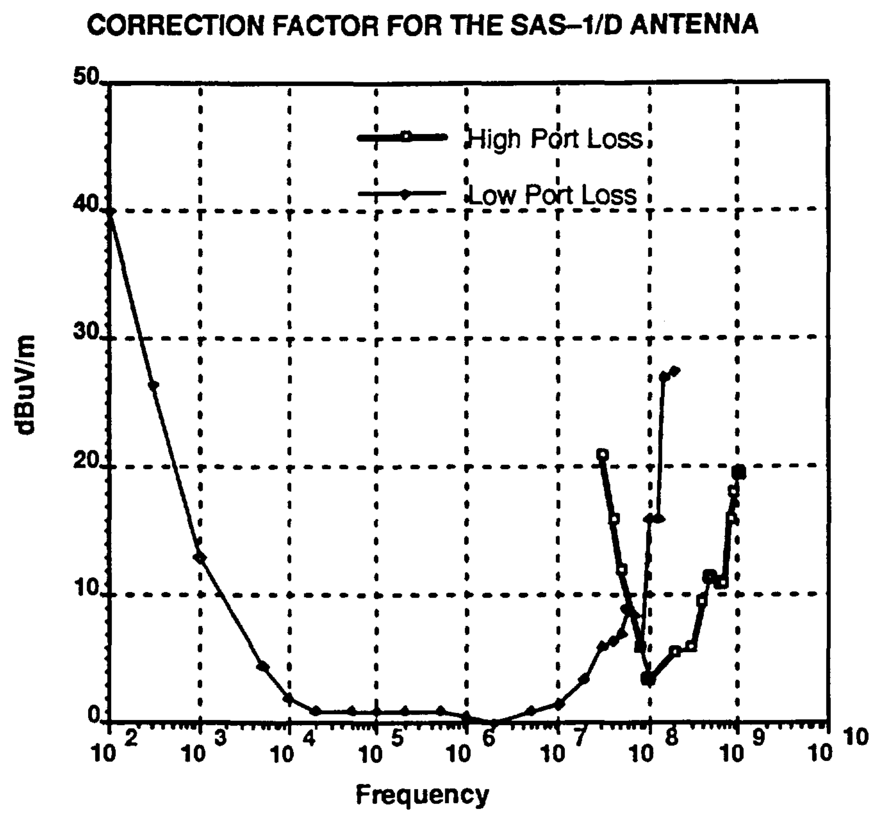

Figure 2. Representative Antenna Correction Factor

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6 EMC TEST METHODS

EOS–AM EMC tests will be performed in accordance with the following general test methods which are based on standard tests found in MIL–STD–462, Notice 1. EMC procedures will be prepared for each equipment tested. Each procedure will detail the set–up and measurement techniques will be defined along with the equipment operating modes for each test.

6.1 Component EMC Tests

6.1.1 Conducted Emissions (CE01), Powerline Conducted Ripple, 30 Hz to 15 kHz

a. Install the equipment under test (EUT) on a copper ground plane bench. Bond the EUT per paragraph 4.2 to the ground plane. See Figure 3, CE01 Test Setup.

b. Perform testing on both the +voltage and return leads individually.

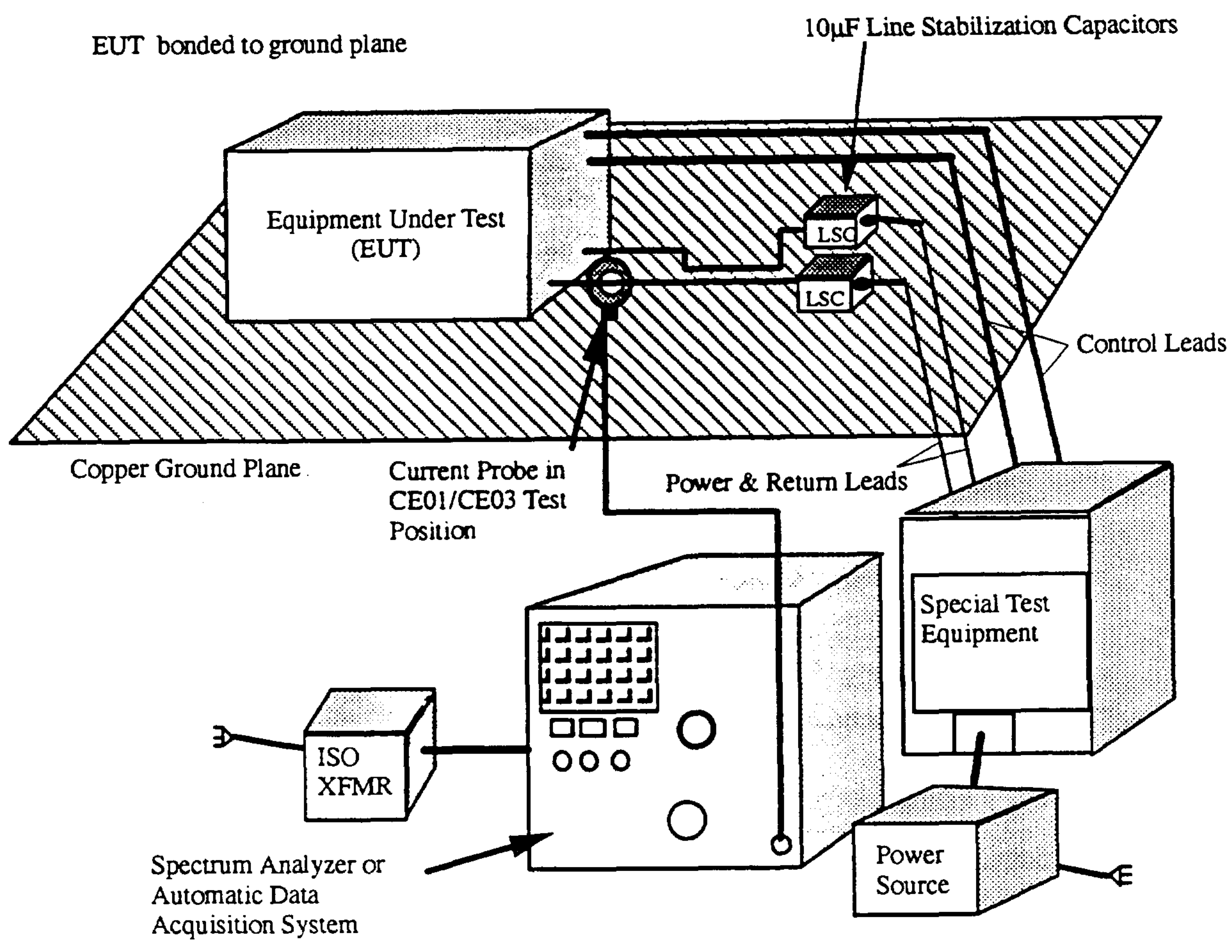


Figure 3. CE01, CE03 Test Setup

c. Clamp a current probe (section 5.3) on the power line under test.

d. Automatically, or manually, scan the frequency range of 30Hz to 15 kHz. Use an automated Data Acquisition System, automatically record and graphically plot data versus the CE01 test limit.

e. Test limits and required measurement bandwiths are shown in PN20005869 (EMC Control Plan, sections 5.2 and 6.2 for instruments and Spacecraft equipment, respectively).

6.1.2 Conducted Emissions (CE03), Powerline Conducted Ripple 15 kHz to 50 MHz

a. With the equipment under test (EUT) installed on a copper ground plane bench as in CE01, clamp a current probe around the +voltage powerline. See Figure 3, CE03 Test Setup.

b. Automatically, or manually, scan the frequency range of 15 kHz to 50 MHz. Record data and graphically plot data versus the test limit.

c. Broadband signals require that a broadband correction factor be added to the dBμV and probe factor to obtain dBμA/MHz. Current probe correction factors are also added. Test limits and required measurement bandwiths are shown in PN20005869 (EMC Control Plan, sections 5.2 and 6.2 for instruments and Spacecraft equipment, respectively).

d. Repeat test for power return lines.

6.1.3 Conducted Emissions Common Mode, Powerline Conducted Ripple – 30 Hz to 50 MHz

a. With the equipment under test (EUT) installed on a copper ground plane bench as in CE01, clamp a current probe around the +voltage powerline, return, and fault ground leads together. See Figure 4, CE Common Mode Test Setup.

b. Automatically, or manually, scan the frequency range of 30 Hz to 50 MHz. Record data and graphically plot versus the test limit.

c. Add current probe correction factors. Test limits and required measurement bandwidths are shown in PN20005869 (EMC Control Plan, sections 5.2 and 6.2 for instruments and Spacecraft equipment, respectively).

6.1.4 Conducted Emissions (CE06), Antenna Terminals – 15 kHz to 50 GHz

This test is for receivers and transmitters. The lower frequency limit is 15 kHz or 80% of waveguide cuttoff or 100 MHz, whichever is higher. The upper limit is 18 GHz.

a. Set up the equipment under test (EUT) on the ground plane per CEO1 and as shown in Figure 5 without the asterisk blocks for key–up or transmitter–standby modes and with them for key–down or transmitter–on modes.

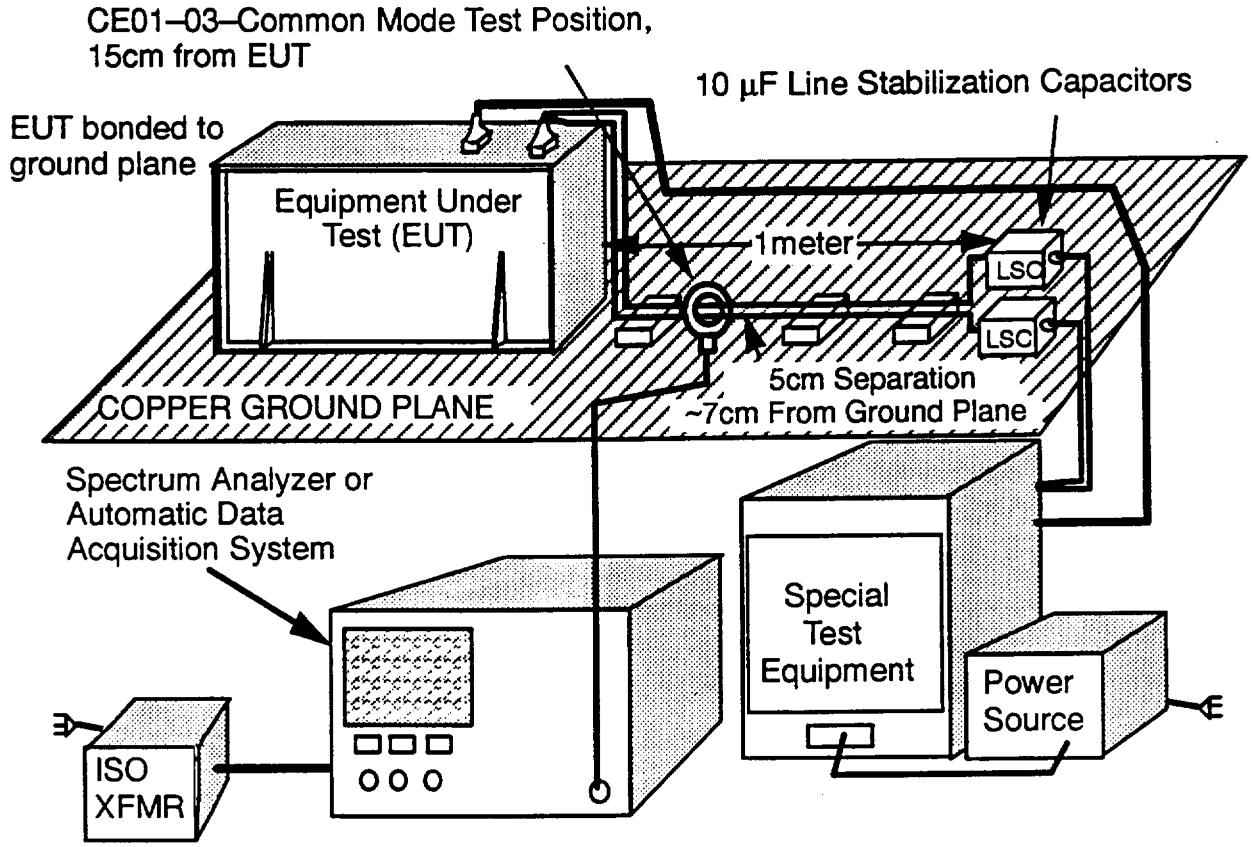


Figure 4. Common Mode Test Setup

b. Automatically, or manually, scan the frequency range for the component based upon the table above. Record data and graphically plot for narrowband emissions.

c. Scan the frequency range again with broadband measurement bandwidth and automatically record and graph the broadband emissions.

d. Add factors for cable loss, bandwidth correction for broadband measurements and record and graph emissions along with the test limits.

e. Repeat the test for other test sample frequencies and other modes of operation. Perform the test at high, lower, and mid frequencies for tunable receiver / transmitters. Key–up and key–down modes as a minimum for Transmitter / Receiver Equipment.

6.1.5 Radiated Emissions (RE02), E – Field 14 kHz to 18 GHz

a. Configure the EOS equipment under test (EUT) bonded to the ground plane per paragraph 4.2 and as shown in Figure 6.

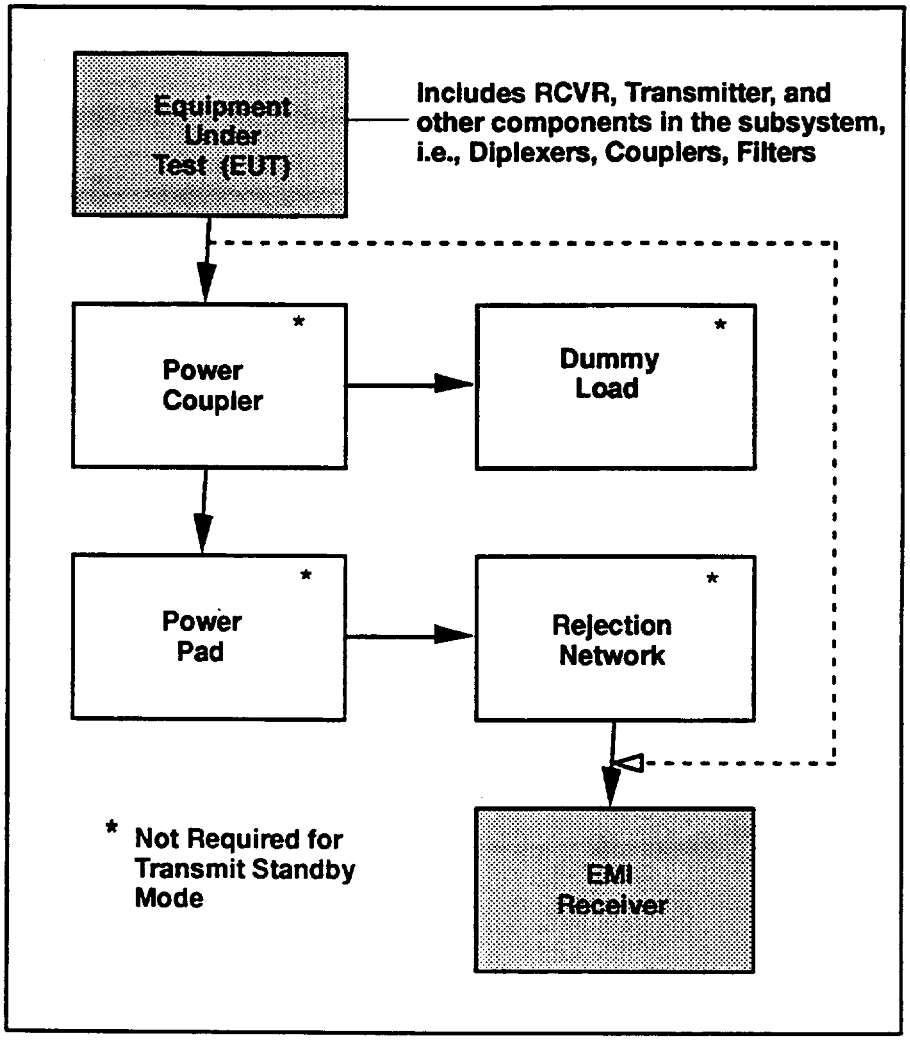


Figure 5. CE06 Test Setup

b. Probe the EUT with an RF probe and spectrum analyzer to determine which face exhibits maximum radiation. Set up the test antenna one meter from this face of the EUT.

c. Scan the frequency range of 14 kHz to 18 GHz. When using Linear Polarized antennas, repeat the range in both the horizontal and vertical positions.

d. Record emissions and graphically plot versus the test limit for narrowband emissions. Test limits and required measuremt bandwidths for narrowband emissions is shown in PN20005869 (EMC Control Plan, sections 5.1 and 6.1 for instruments and Spacecraft equipment, respectively).

e. Plot the broadband emissions levels.

f. To manually determine NB/BB signals by changing bandwidth, select switch from NB to BB; if signal level variation is greater than 6 dB, it is considered a broadband signal.

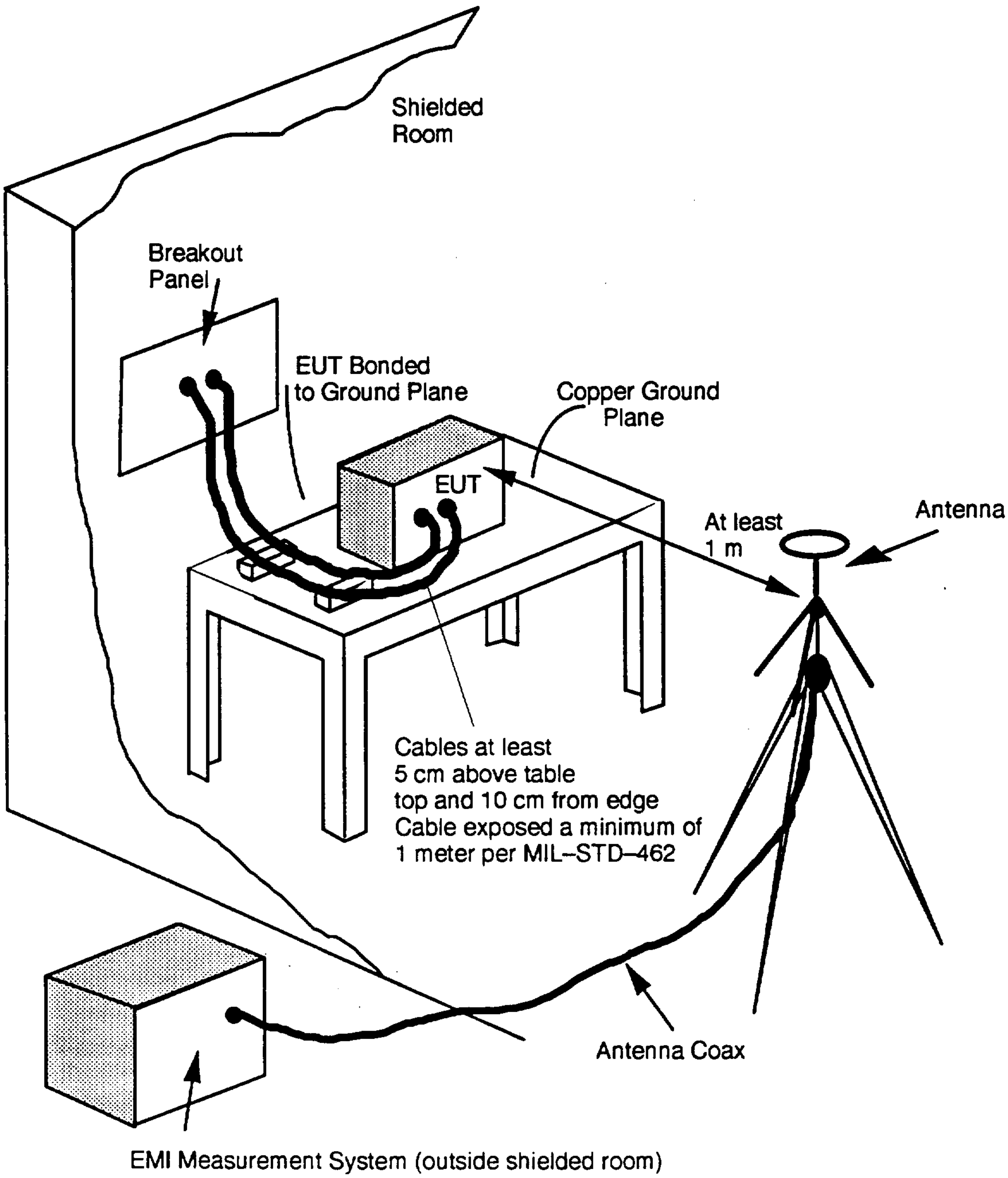


Figure 6. RE02 Broadband, Narrowband Test Setup

The test method RE03 is applicable when CE06 cannot be applied.

6.1.6 Radiated Emissions (RE04), AC Magnetic Field

a. Configure the equipment under test (EUT) bonded to the ground plane per paragraph 4.2 and as shown in Figure 7. Instrument and equipment test limits and required measurement bandwidths are showns in PN20005869 (EMC Control Plan, sections 5.1 and 6.1 for instruments and Spacecraft equipment, respectively).

b. Probe the EUT with a spectrum analyzer to determine which face exhibits maximum magnetic field radiation. Set up the test antenna one meter from this face of the EUT.

c. Using an automatic Data Acquisition System, scan the frequency range of 30 Hz to 200 kHz.

d. Record emissions and graphically plot versus the test limit.

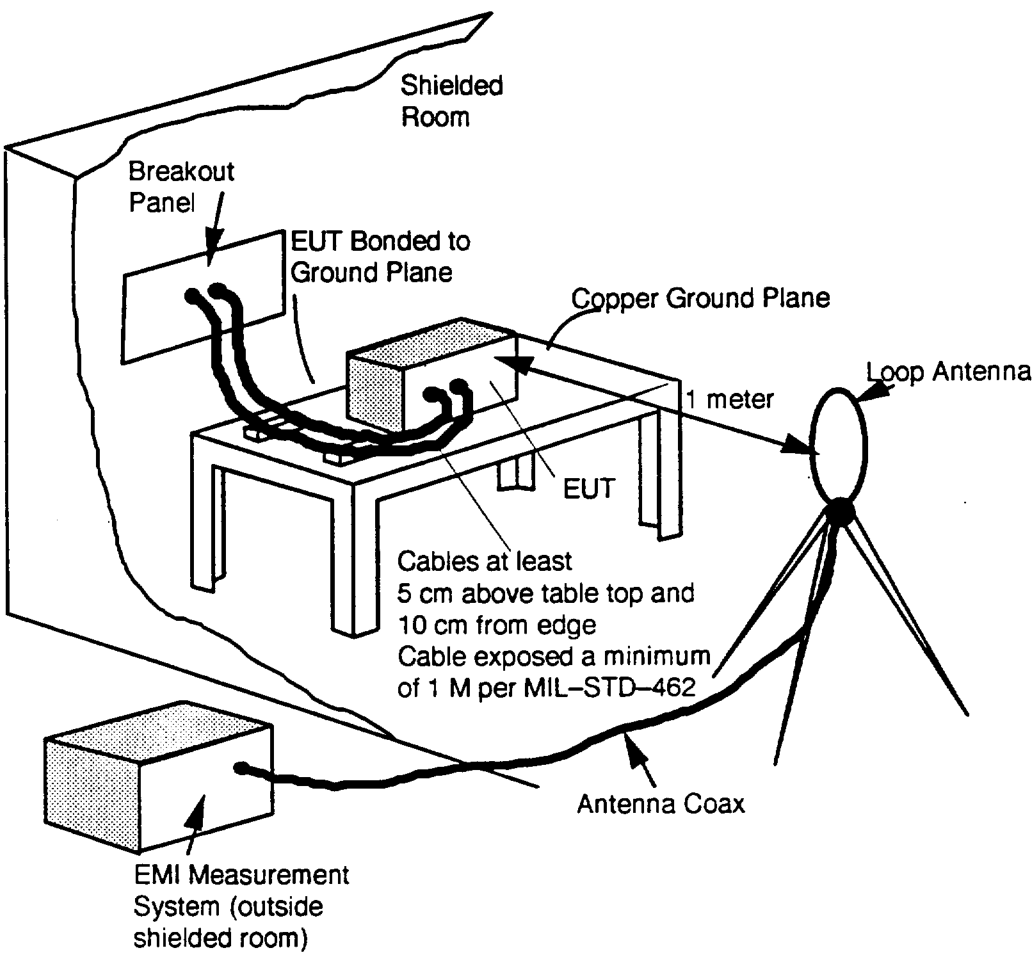


Figure 7. RE04 Test Setup

6.1.7 Conducted Susceptibility, Method CS01, Powerline 30 Hz to 50 kHz

a. Configure the equipment under test (EUT) per paragraph 4.2 and as shown in Figure 8.

b. Perform susceptibility testing on 120 V and return leads individually. Test units powered by 28 V on the 28 V and return leads.

c. The susceptibility CW signal is coupled onto the DC line under test at the level required in the EMC Control Plan (PN20005869) Maximum Power to be used for the test is limited to 50 Watts.

d. Slowly sweep the CW source generator over the frequency range of 30 Hz to 50 kHz, observing that normal operation of the unit under test is maintained throughout signal application.

e. Monitor the EUT for any malfunction or degradation as outlined in the performance specifications. Should susceptibility occur, establish the threshold levels and frequencies. Record this level(s) on the appropriate data sheet, as shown in Figure 22 (see Section 7). Record evidence of EUT susceptibility such as photographs of out–of–spec conditions or oscillographs of out–of–spec signals.

6.1.8 Conducted Susceptibility, Method CS02, Powerline 50 kHz to 400 MHz

a. Configure the equipment under test (EUT) per paragraph 4.2 and as shown in Figure 9.

b. Perform susceptibility testing on 120 V and return direct current leads individually. Test units powered by 28 V on the 28 V and return leads.

c. Ensure that the susceptibility CW signal is capacitively coupled onto the powerline under test, with an impedance of 50 ohms or less at all test frequencies. Set the susceptibility signal at the level required in the EMC Control Plan. Limit power to 10 Watts.

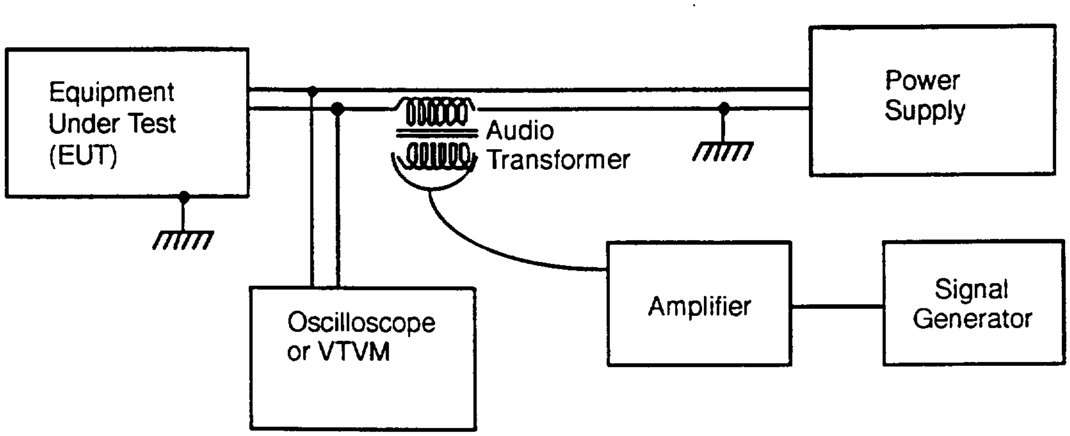


Figure 8. CS01 Test Setup

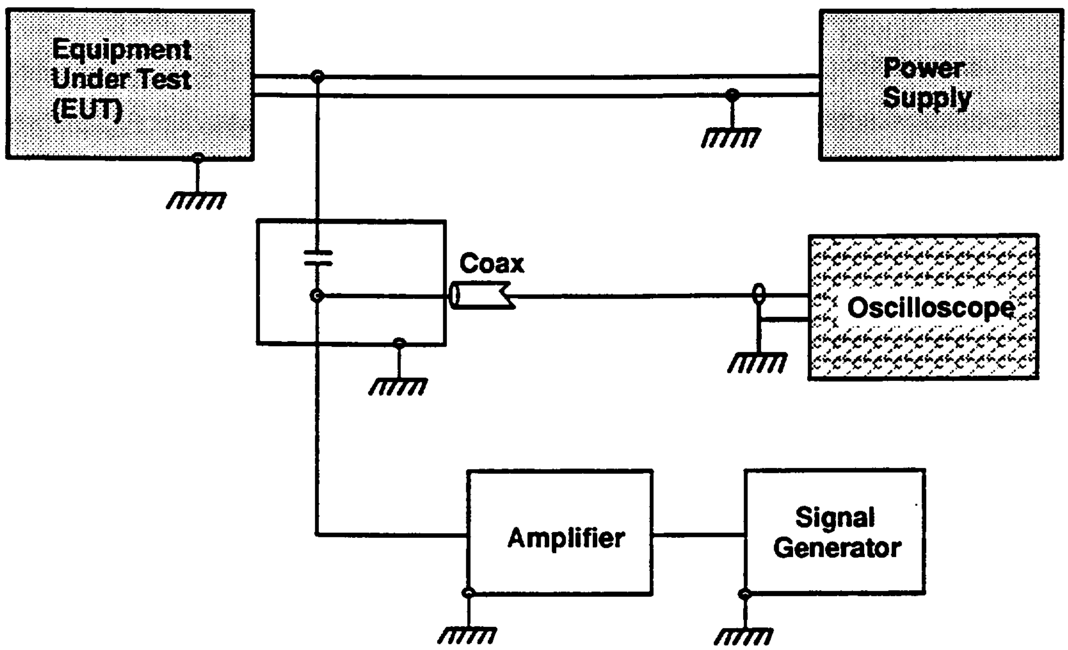


Figure 9. CS02 Test Setup

d. Slowly sweep the CW source generator over the frequency range of 50 kHz to 400 MHz, observing that normal operation of the unit under test is maintained throughout signal application.

e. Monitor the EUT for any malfunction or degradation as outlined in the performance specifications. Should susceptibility occur, establish the threshold levels and frequencies. Record the threshold data on the appropriate data sheet, as shown in Figure 22 (see Section 7). Record evidence of EUT susceptibility as necessary.

6.1.9 Conducted Susceptibility, Method CS06, Powerline Transient Spike (Operate and Perform)

a. Connect the equipment under test (EUT) as shown in Figure 10.

b. Perform susceptibility testing on power, return and fault ground leads.

c. Prior to the application of the transient spike, calibrate the transient pulse amplitude 5Ω load. The amplitude calibrated to the 5 Ω load has led to the concern that the energy and or voltage could be excessive and cause equipment damage. Figure 11 shows the typical circuit and transient energy calculation for CS06. The circuit generally has a blocking capacitor in the path from the high voltage charging supply, the discharge capacitor to the output. This results in a very high impedance at the output and when the load resistance varies from 5 to 1000Ω the output voltage does not exceed the level set at 5Ω.

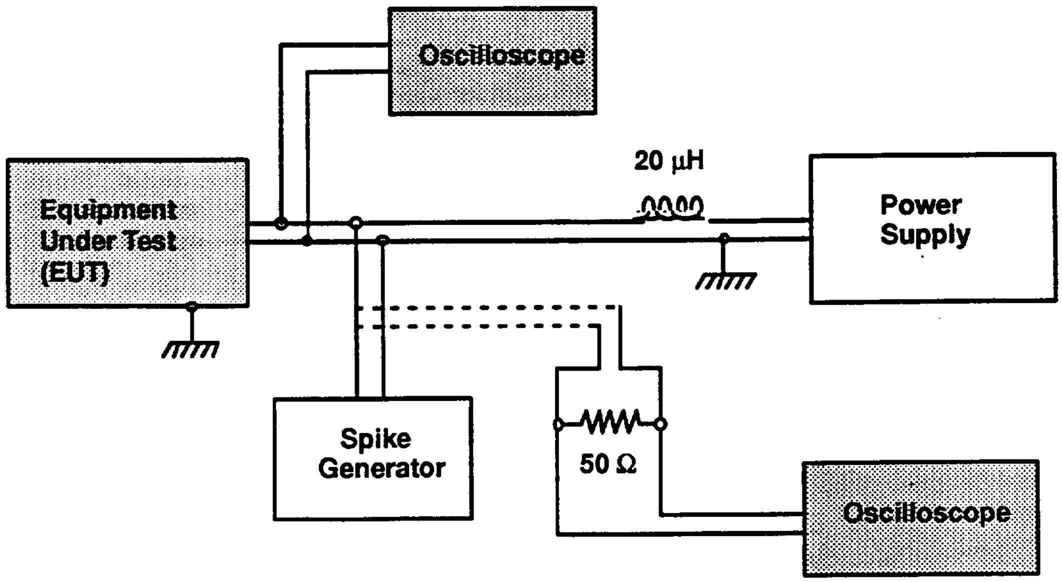


Figure 10. CS06 Test Setup

The equipment under test may have a lower impedance than the 5Ω in which case the peak voltage is less than the level set with 5Ω. This is allowed because low input impedance, such as when a zener diode is used, would mean increasing the source level to an extreme amount of energy that is not available on the real power system. Record the calibrated transient on an oscillograph.

d. Apply the transient pulse at both positive and negative polarity respectively onto the power line under test. Transient pulse rate will be 10 pps for a duration of one minute at each applied polarity. Record the applied transient on an oscillograph.

e. If susceptibility should occur, lower the transient pulse level to restore normal component operation thus establishing the threshold level. Record this level on an oscillograph when injecting into the 5 ohm calibration resistor and in the actual test setup. Record evidence of the susceptibility of the EUT, also.

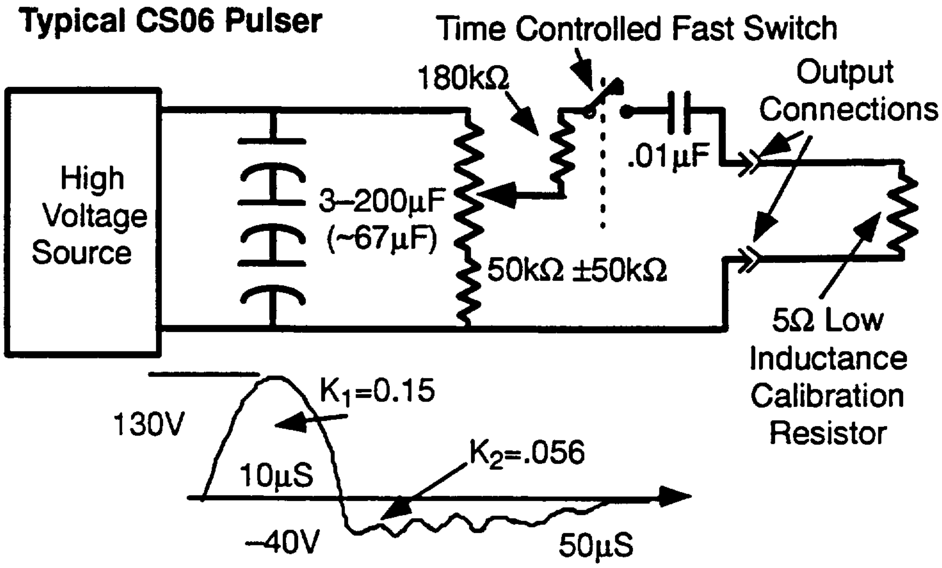
6.1.10 Conducted Susceptibility, Abnormal Bus Transient

a. To prevent possible damage to flight units, perform test on ETM or breadboard units.

b. Configure the equipment under test (EUT) per paragraph 4.2 and as shown in Figure 12.

c. Susceptibility testing is to be performed on 120 V+ direct current lead.

d. Prior to the application of the transient spike limits, as shown in PN20005869 (EMC Control Plan sections 5.4 and 6.4 for instruments and spacecraft, respectively), calibrate the transient pulse amplitude by developing the required transient voltage and wave form across a 5 ohm resistor. Record the calibrated transient on an oscillograph.



Energy = $K \bullet V_p \bullet I_p \bullet T_{Duration}$ where K= factor for waveform type

V_{p1} = 130 [V]
I_{p1} = 130/5[Ω] = 26 [A]
V_{p2} = 40 [V]
I_{p2} = 40/5[Ω] =8 [A]
E_{total} = $K_1 \bullet V_{p1} \bullet I_{p1} \bullet T_{Duration1} + K_2 \bullet V_{p2} \bullet I_{p2} \bullet T_{Duration2}$
(0.15)•130•26•10[µS] + (.056)•40•8•50[µS] =
5.07 [mJ] + 0.896 [mJ] ≃ 6 [mJ]

When Z_{load} changes:
Z_{load} = 50[Ω] then V_{p1}=130[V], I_{p1}=130/50=2.6A, T_1=10[µS]
so E≃0.6 [mJ] Energy is lower, but V_{p1} is same.
or if
Z_{load} = 0.5[Ω] then V_{p1}=30[V], I_{p1}=30/0.5=60[A], T_1=50[µS]
so E≃15 [mJ] Energy is higher, V_{p1} is not increased because realistic sources cannot produce higher voltage and exponentially growing energy

Figure 11. CS06 Spike Generator Circuit

e. Apply the transient pulse at positive polarity only on to the power line under test. Record the applied transient on an oscillograph.

f. A single transient pulse will be applied. Record any changes and anomalies of the EUT for future reference.

6.1.11 Intermodulation (CS03)

This test applies to receivers. The test is performed to measure input terminal susceptibility to two out–of–band simultaneous signals. This is done to ensure the signals do not mix and generate a frequency or frequencies that lie within the passband of the receiver.

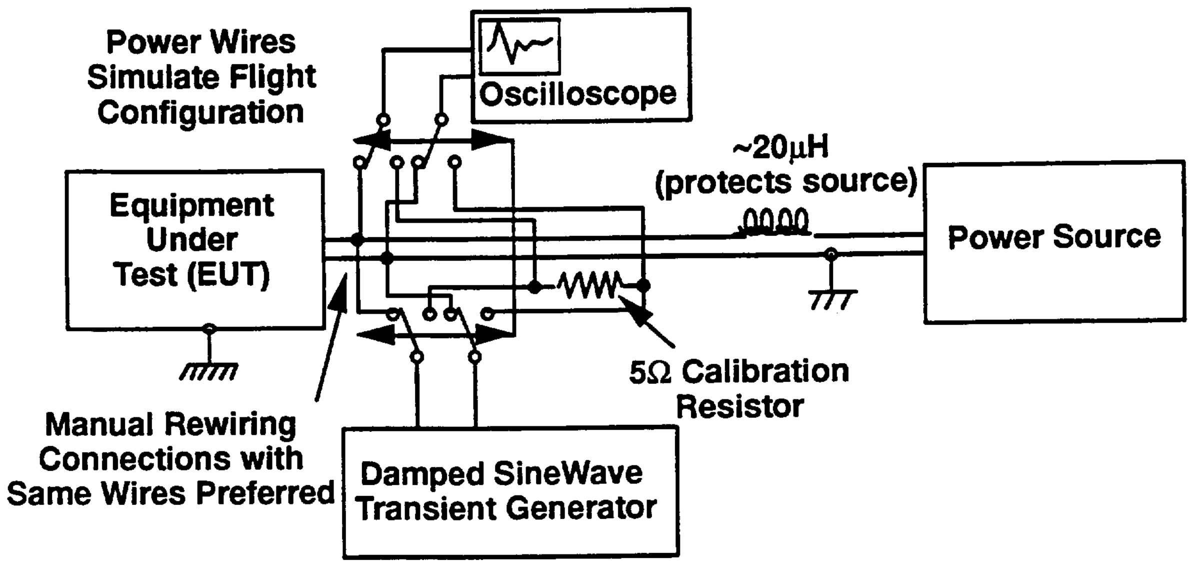


Figure 12. Bus Transient Test Setup

a. Configure the equipment under test (EUT) per paragraph 4.2 and as shown in Figure 13. Tune the receiver to f_0.

b. Test for intermodulation in the test setup. Set the signal generator outputs at 66 dB above the receiver standard response level. Tune one signal generator to the test sample frequency (f_0) and the other to 1.3 f_0. Second order intermodulation products exist at 0.3 f_0 and 2.3 f_0 and third order products exist at 0.7 f_0, 1.6 f_0, 3.3 f_0, and 3.6 f_0. No harmonics from the signal generators should exist at these frequencies.

c. Tune the receiver to f_0. Turn off signal generator 2 (SG2) by using the output attenuator to a maximum, and tune signal generator 1 (SG1) to f_0. Adjust the level to produce a standard reference output. Record the level.

d. Repeat step c. with SG1 turned off and SG2 tuned to f_0. Record the level.

e. For the remainder of the test, turn both signal generators on with SG1 unmodulated, but SG2 modulated. Turn down SG2.

f. Increase the level of SG1 by 66 dB above the level recorded in step c. Slowly tune SG1 above f_0 until there is no longer a response. Measure this frequency (f_1). (Note: $f_1 - f_0 = \Delta f$). Leave SG1 at f_1 (see Figure 14 for reference).

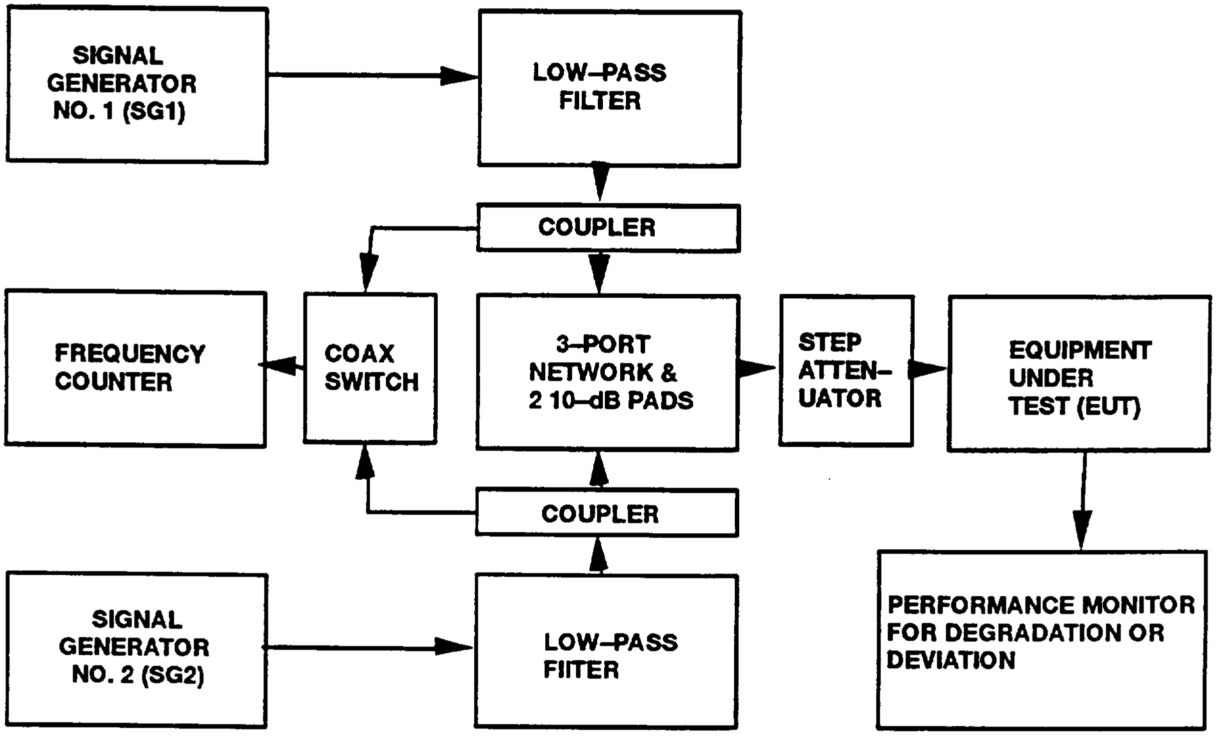


Figure 13. CS03, CS04, CS05 Test Setup

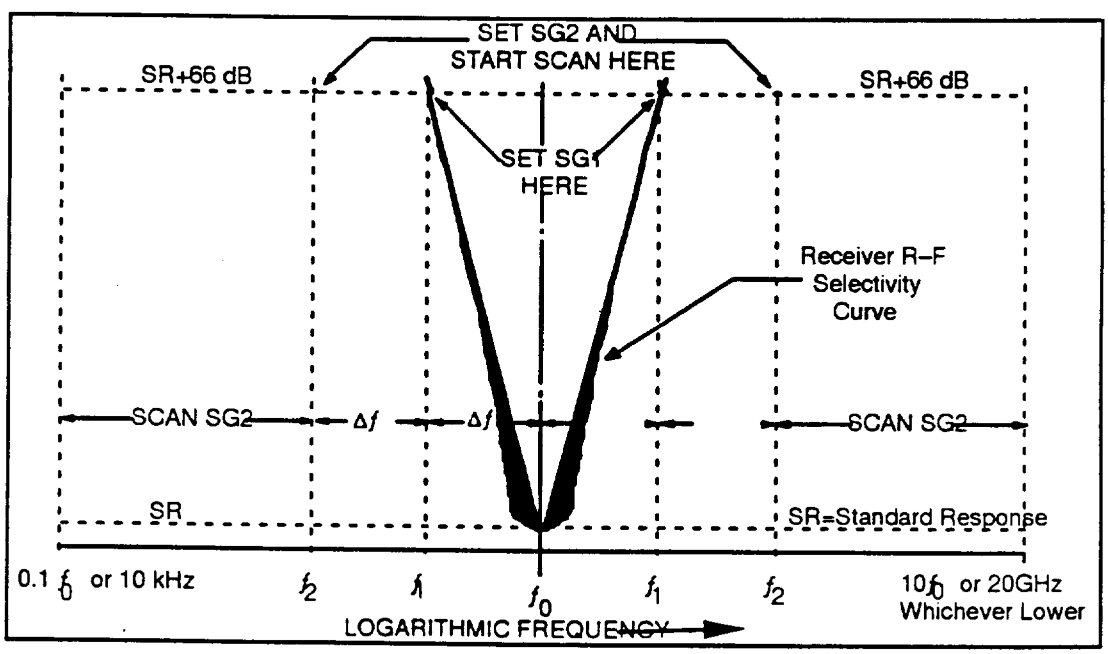


Figure 14. CS03 Signal Generator Tuning Instructions

g. Set SG2, modulated, to Δf above f_1. This is $2\Delta f$ above f_0 and corresponds to the closest–in third order intermodulation product. Adjust SG2 to CS04 requirement levels. Record if any response. Slowly scan the frequency of SG2, maintaining a constant output level, until a frequency of $10\ f_0$ or 26 GHz, whichever is less. Note all responses.

h. Test each response found in step 7 by removing the modulation on SG2. If the response is still present, it is not an intermodulation product and can be neglected for the test.

i. If an intermodulation response is confirmed, reduce the levels of both signal generators equally until the standard response is obtained. Record the threshold levels and frequencies. The difference between the new signal generator levels and the level in step 6 is the intermodulation rejection.

j. Repeat steps f. through i. with SG1 now set at $f_1 = f_0 - \Delta f$ and scanning of SG2 down from $f_0 - 2\Delta f$ to $0.1\ f_0$ or 10 kHz whichever is higher.

k. Repeat the test for other required receiver frequencies when a tunable receiver is under test.

6.1.12 Rejection of Undesired Signals (CS04)

This test is conducted on the input terminals of receivers or tuned amplifiers to ensure out–of–band rejection of undesired signals. The response may be due to increasing the receiver noise floor rather than direct processing of the out–of–band signal. In other words, the signal–to–noise ratio is reduced rather than the receiver locking on to an out–of–band signal

a. Follow the same procedure as in Section 6.1.11, steps a. through g. See, for reference, Figures 15 and PN20005869 (EMC Control Plan), section 6.14.

b. Test each response found in Section 6.1.11, step g. by removing the modulation on SG2. If the response is still present, then it is a receiver spurious response.

c. When a spurious response is found, reduce the level of SG2 until the standard response of Section 6.1.11, step h. is found. Record threshold levels and frequencies on the standard data sheet.

d. Repeat steps f. and g. of Section 6.1.11 except tune SG1 below f_0 until no response and record f1 and $f_0 - f_1 = \Delta f$. Then scan SG1 from $f_0 - 2\Delta f$ to the lowest required frequency, checking for responses.

e. Repeat steps b. and c. above to complete the test.

f. Repeat for other required tunable frequencies.

6.1.13 Cross–Modulation (CS05)

This test is applied to receivers. The test is to ensure the component is not susceptible an adjacent channel signal modulated upon the intended signal. The adjacent channel signal is defined as a signal between the receiver selectivity window and the image frequency. The selectivity window is the frequency span of normal receiver operation and the image frequency is the operations frequency added to the receivers first intermediate frequency.

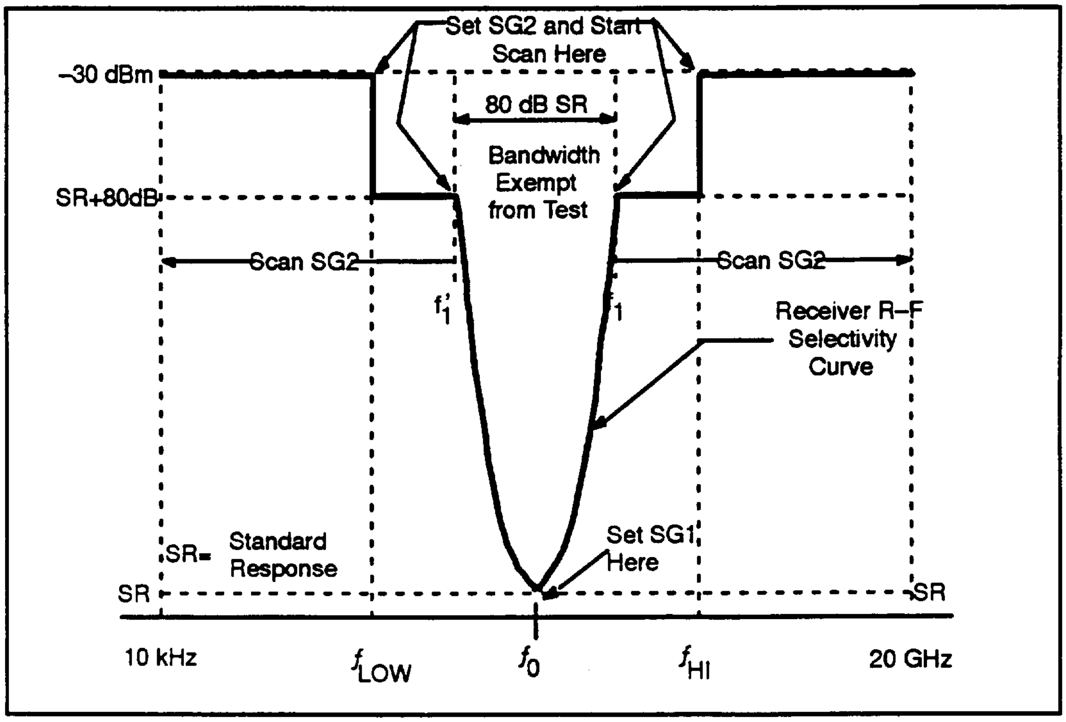


Figure 15. CS04 Signal Generator Tuning Instructions

a. Configure the equipment under test (EUT) per paragraph 4.2 and as shown in Figure 13.

b. Ensure that the receiver is operating at the required operating frequency (f_0). Turn off signal generator 2 (SG2) by using the output attenuator to a maximum, and tune signal generator 1 (SG1) to f_0 and adjust the level to produce a standard reference output. Record the level.

c. Repeat step b. with SG1 turned off and SG2 tuned to f_0 . Record the level.

d. For the remainder of the test, turn both signal generators on with SG1 unmodulated and SG2 modulated. Turn down SG2.

e. Set SG1 at 10 dB above the level obtained in step b. without modulation. Set SG2 at 66 dB above that of step c. or the CS04 levels whichever is less with the proper modulation. Slowly tune SG2 above f_0 until the original condition of SG1 alone exists. In reference Figure 16, this corresponds to the point where f_1 is reached. Record f_1.

f. Slowly increase the frequency of SG2 from f_1 to $f_0 + f_{IF}$. f_{IF} is the first intermediate frequency of the receiver. Note any receiver responses. Test any responses by removing the modulation from SG2. If the response disappears, it is due to cross modulation.

g. When a cross modulation response is found, reduce the level of SG2 until the standard response of SG1 is 10 dB above the standard reference is found. Record the response threshold and frequencies on the standard data sheet.

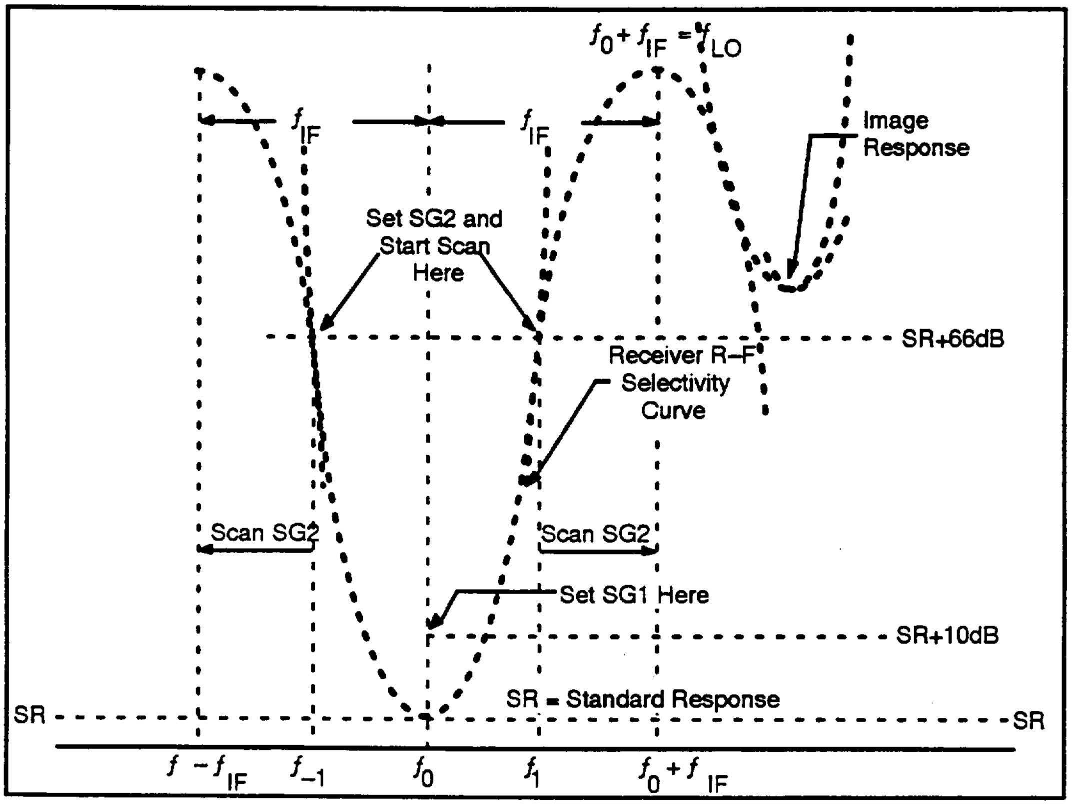


Figure 16. CS05 Signal Generator Tuning Instructions

h. Repeat steps e. through g., except SG2 will be tuned down in frequency until the SG1 only response, at f_{-1}, is found and then scan down in frequency monitoring for a response to $f_0 - f_{IF}$..

6.1.14 Radiated Susceptibility (RS01), Magnetic Induction Field

a. Configure the equipment under test (EUT) per paragraph 4.2 and as shown in Figure 17. Position the field radiating loop 5 cm from the surface of the test sample face with the plane of the loop parallel to the plane of surface.

b. Supply the loop with sufficient current to produce magnetic–flux densities approximately equal to than the applicable specification limit at the test frequencies by adjusting the oscillator drive to the test loop. Scan the oscillator from 30 Hz to 200 kHz, monitoring for proper operation of the EUT.

c. Move the loop over each of the test sample exposed faces and signal input and output cables and connectors to determine the location(s) at which the applied field produces maximum susceptibility. This search is done at frequencies that are multiples of 3, 6, and 10 starting with 30 Hz and adding 200 kHz at the end.

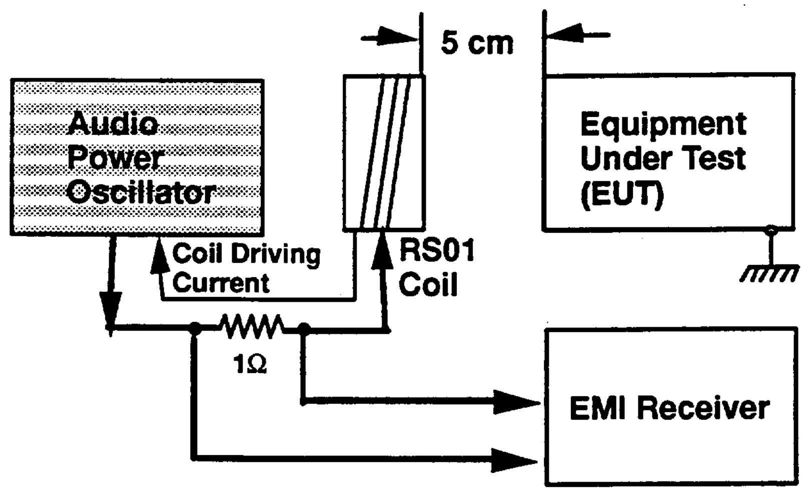


Figure 17. RS01 Test Setup

d. If susceptibility is found during the scan or during the location search, adjust the loop current until the performance of the test sample is no longer affected by the applied field. Then the adjusted level with the frequency and loop at the location of maximum susceptibility is the susceptibility threshold. Record any susceptibility frequencies and thresholds as well as evidence of EUT susceptibility. Susceptibility limits are shown in PN20005869, sections 5.3.2 and 6.3.2 for instruments and Spacecraft equipment, respectively.

6.1.15 Radiated Susceptibility, Method RS03, Electric Field, 14 kHz to 18 GHz

a. Configure the equipment under test per paragraph 4.2 and as shown in Figure 18.

b. Slowly sweep the CW source generator over the appropriate frequency range while maintaining proper field strength level as required in the test procedure. Susceptibility limits are shown in PN20005869 (EMC Control Plan sections 5.3.1 and 6.3.1 for instruments and Spacecraft equipment, respectively).

c. Monitor the component under test for any malfunction or degradation as outlined in the performance specifications. Should susceptibility occur, establish the threshold level. Record this level(s) and frequency(ies) on the appropriate data sheet, as shown in Figure 21 (see Section 7).

6.1.16 DC Magnetic Properties Test

a. Configure the equipment under test (EUT) as shown in Figure 19.

b. Locate the magnetometer probe 1 meter from the center of the turn table.

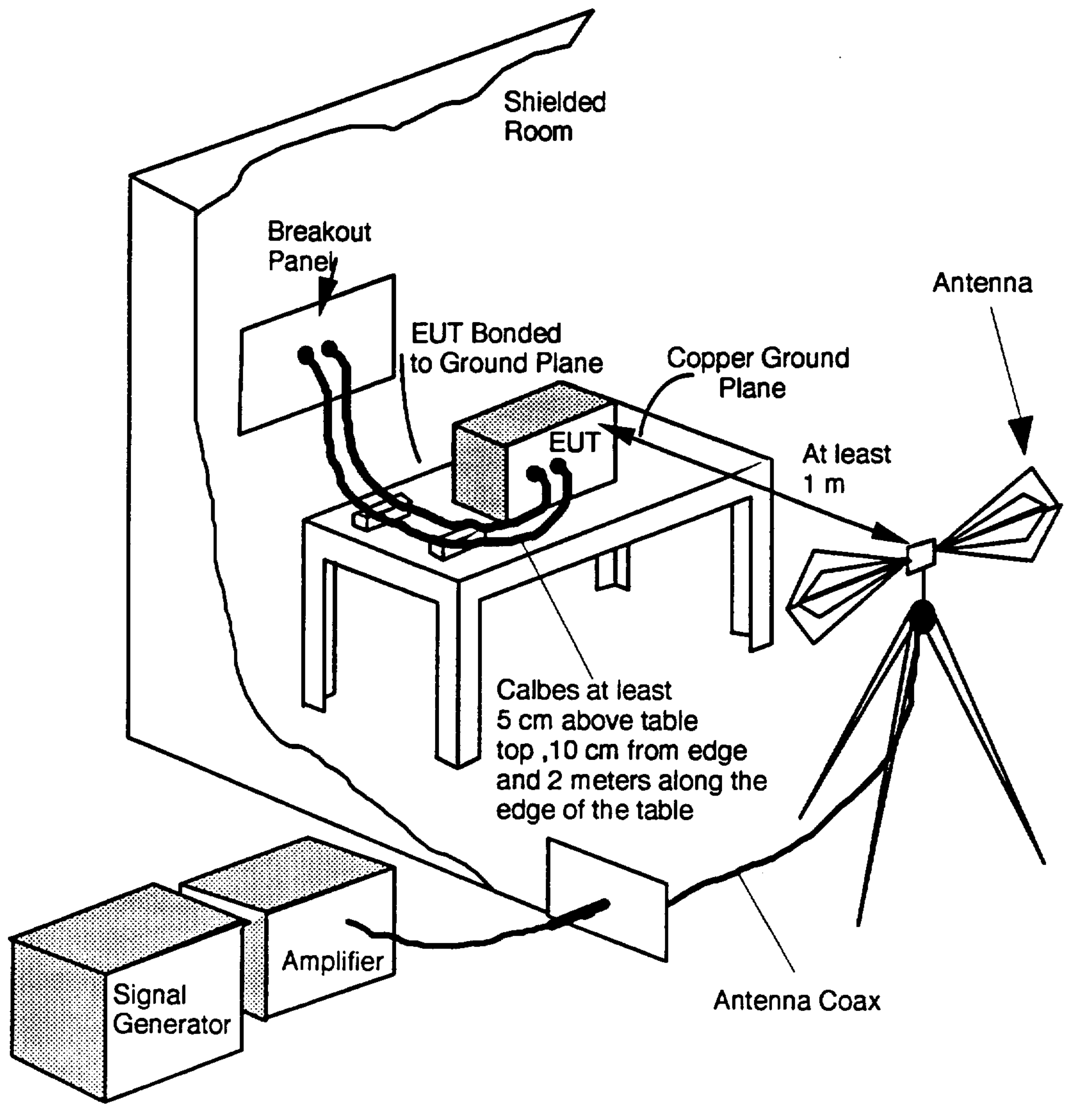


Figure 18. RS03 Test Setup

c. Rotate the EUT through 360 degrees. Measure the peak (plus and minus) magnetic field (in gammas) and note the direction.

d. Orient the EUT along another perpendicular axis and repeat step c.

e. Orient the EUT along the third mutually perpendicular axis and repeat step c.

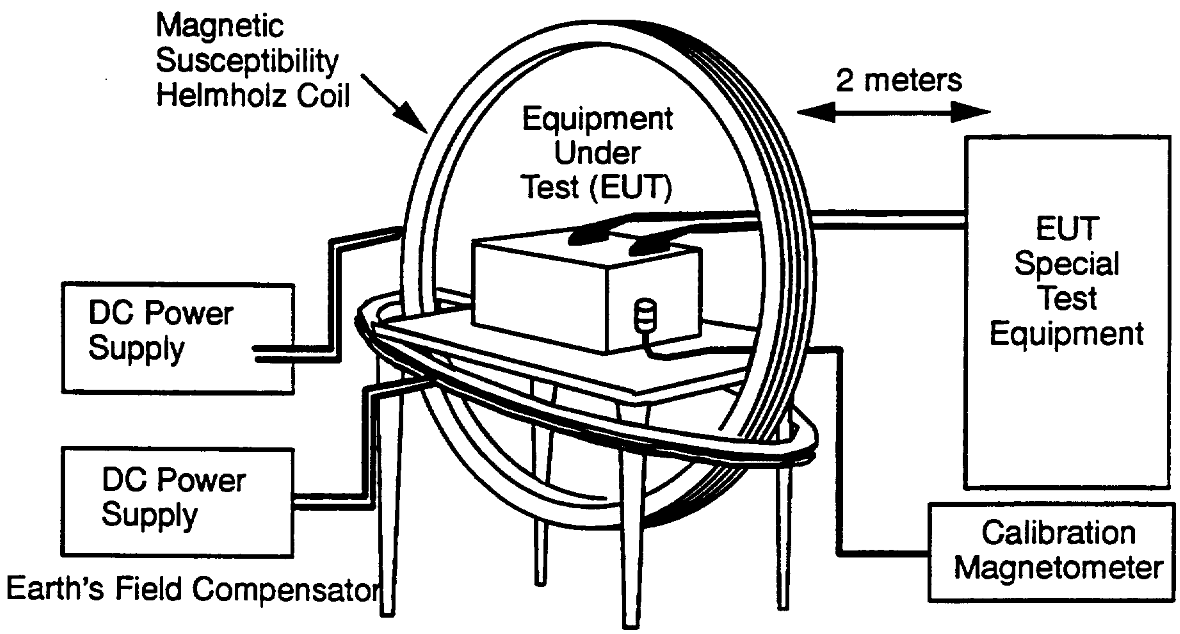


Figure 20. Magnetic Susceptibility Test Setup

6.3 Spacecraft EMC Verification

A general Spacecraft System Level EMC test plan follows. A detailed System Test Procedure will be prepared at least 4 weeks before system testing.

6.3.1 Grounding and Bonding

Grounding and Bonding will be verified by measuring the bonding during the Integration process. Measurements of box, Equipment Module, Instruments, structure and cable bonds will be made during installation.

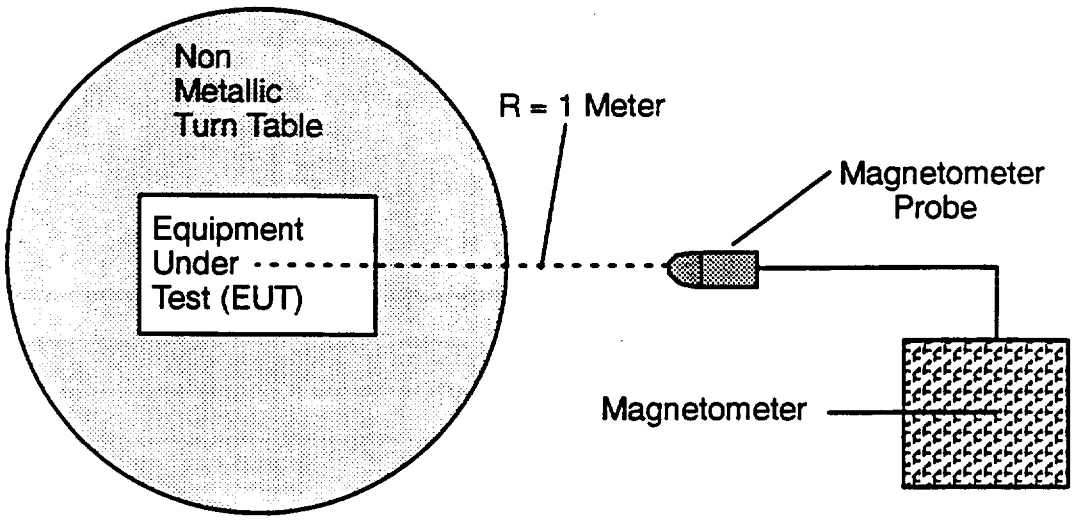


Figure 19. Magnetic Properties Test Setup

f. From the 3 readings, calculate the vector peak magnetic field. Calculate the magnetic moment from

$$M = q \times 10^{-8} * R^3$$

Where: q = magnetic flux [gammas],
R = distance from source [cm]
M = magnetic dipole moment [Amp turn m^2] ($M=0.3\ Am^2$ is the limit)

6.1.17 DC Magnetic Susceptibility

a. Configure the equipment under test (EUT) as shown in Figure 20.

b. Apply the required DC magnetic field by injecting DC current in the Helmholz coil. Check for proper operation of the EUT during application of the field.

c. Turn the EUT to another perpendicular axis and repeat step b.

d. Turn the EUT to the final perpendicular axis and repeat step b. Record all anomalies during this test.

6.2 Major Subassembly EMC Tests

EMC testing will be performed as outlined in Table IV.

Table IV. Major Subassembly EMC Test Matrix

Major Subassembly	CE01	CE03	CE Common Mode	CE06	RE02	RE04	CS01	CS02	CS06	RS01	RS03	DC Magnetics	Magnetic Properties	Ripple	CS03/CS04/CS05	Abnormal Bus Transient
SAA/DEU (1)												(2)	(2)			
HGA	X	X	X	X	X	X	X	X	X	X	X	(2)	(2)		X	X
DAS PANEL (3)																
EPS (4)					X	X				X	X	(2)	(2)	X		

Note 1: DEU tested as a unit. Solar Array testing not planned.
Note 2: Analysis or Test Verification Allowed
Note 3: DAS panel tested as equipment
Note 4: EPS includes Power Equipment Module (PDU, BPCs, FDBs, Power BDU, and Battery), Battery Panel, and SSU. This test will require the Solar Array Power Simulator for test.

6.3.2 Spacecraft Bus (Reserved)

6.3.3 System Level EMC

6.3.3.1 Power Self–Compatibility Tests

After integration of the Spacecraft bus with instruments, spacecraft level tests required by PN20005869 will be performed including the following tests:

a. *Power Profile* testing in which the effects of subsystems and instrument operational transients are measured on the Spacecraft power bus.

b. *Transient Tolerance* tests in which the subsystems and instruments are exercised sequentially through their conducted noisy modes, and their effects on other subsystems and instruments are measured.

6.3.3.2 Spacecraft Self–Compatibility

Spacecraft equipment and instruments will be operated at normal orbital modes so that electrical compatibility may be verified. This involves operating electronics and heaters to determine the effect on sensitive equipment (such as the S–Band Receiver).

The Spacecraft, with Instruments, will be subjected to a full–up test to verify self–compatibility in the vacuum chamber. This test will be performed in as close to a worst case configuration as possible. This includes going through a component switching/ turn–on routine to verify that turn–on and switching transients are not a problem. Prior to running this test, component susceptibilities will be reviewed to ensure that they will not suffer permanent degradation.

7 DATA ACQUISITION

7.1 Data Sheets

Data sheets will be required for recording all measured data parameters. Typical data sheets are illustrated in Figures 21 and 22.

a. Figure 21 shows a typical data sheet for recording susceptibility data.

b. Figure 22 shows a typical photography data sheet.

c. Figures 23 and 24 show automatically recorded emissions data sheets.

Figure 21. Typical Susceptibility Data Sheet

	TESTED BY:
CONDUCTED SUSCEPTIBILITY CS0 ______	
FREQUENCY RANGE	**DATE:**
MODE	**RECEIVER:**
EUT NAME / SERIAL NUMBER	**LINE UNDER TEST:**

FREQUENCY [HZ]		MODULATION [ ]	LEVEL [ ]	THRESHOLD [ ]	REMARKS

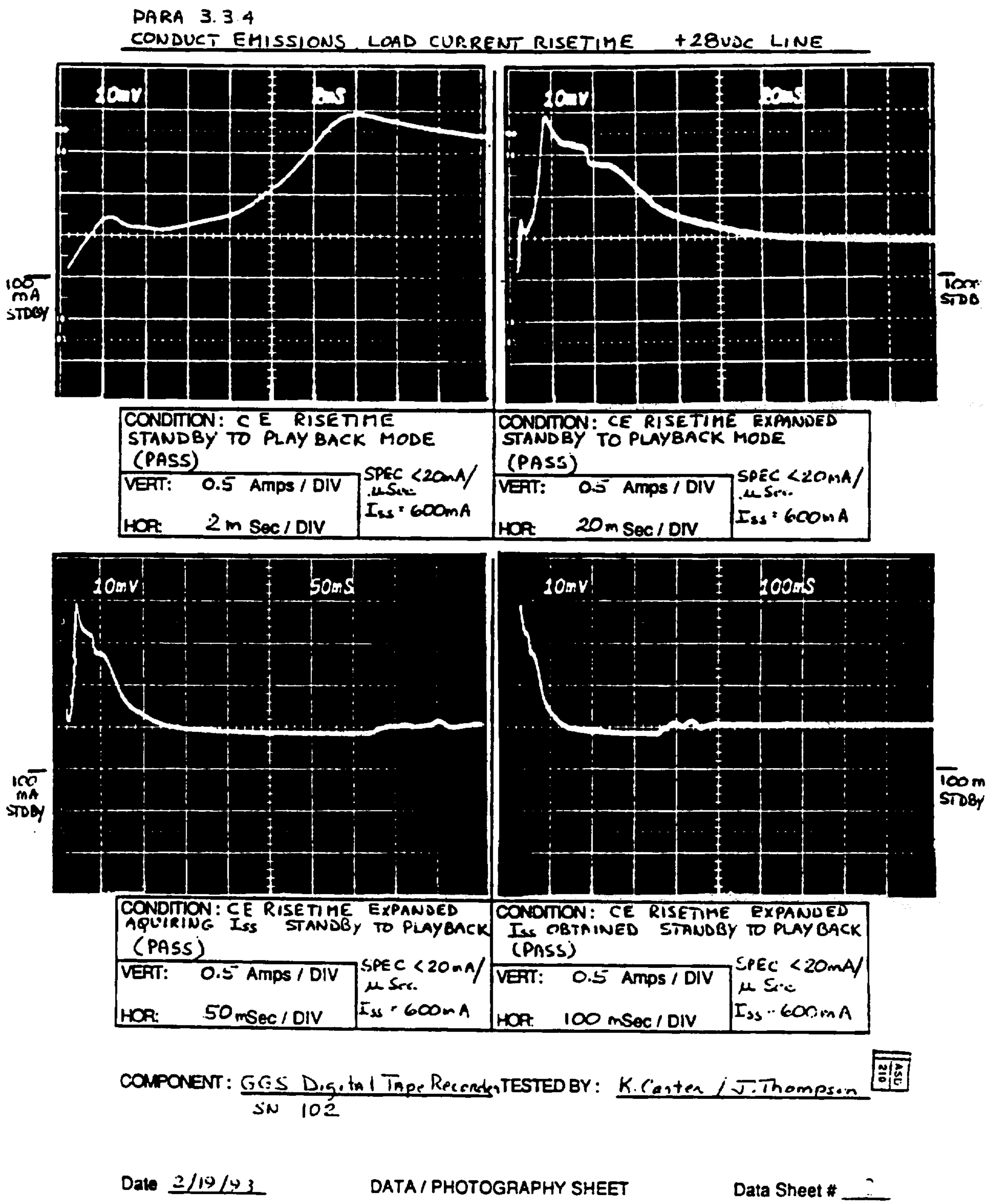


Figure 22. Typical Photography Data Sheet

E.U.T	:	GGS DTR (SER# 102)
TEST PROCEDURE	:	TP-EMC-3282101
TESTED BY	:	J. THOMPSON / K. CARTER
COMMENTS:	:	AMBIENT (STE ON / DTR OFF)

DATE: 22 FEB 1993

SCAN PARAMETERS			TEST TITLE: RADIATED AC H-FIELD (GGS)			
Rvr	Start Freq	Stop Freq	Bandwidth	Atten	Detector	Transducer
7	20 Hz	1 kHz	10 Hz	-20 dB	Peak	ALP-10 LOOP
7	1 kHz	20 kHz	10 Hz	-20 dB	Peak	BBH-3100/A
17	20 kHz	100 kHz	1 kHz	0 dB	Peak	BBH-3100/A
17	100 kHz	500 kHz	1 kHz	0 dB	Peak	BBH-3100/A

GLOBAL PARAMETERS		
BROAD BAND CORRECTION : NO1		SWEEP RATE: 5 SAMPLES/SEC
LIMIT LINE: GGS (H-FIELD)		
SEG 1	START TIME: 08:45:59	STOP TIME: 08:48:49
SEG 2	START TIME: 08:48:49	STOP TIME: 09:06:49
SEG 3	START TIME: 09:06:49	STOP TIME: 09:07:55
SEG 4	START TIME: 09:07:A55	STOP TIME: 09:08:28

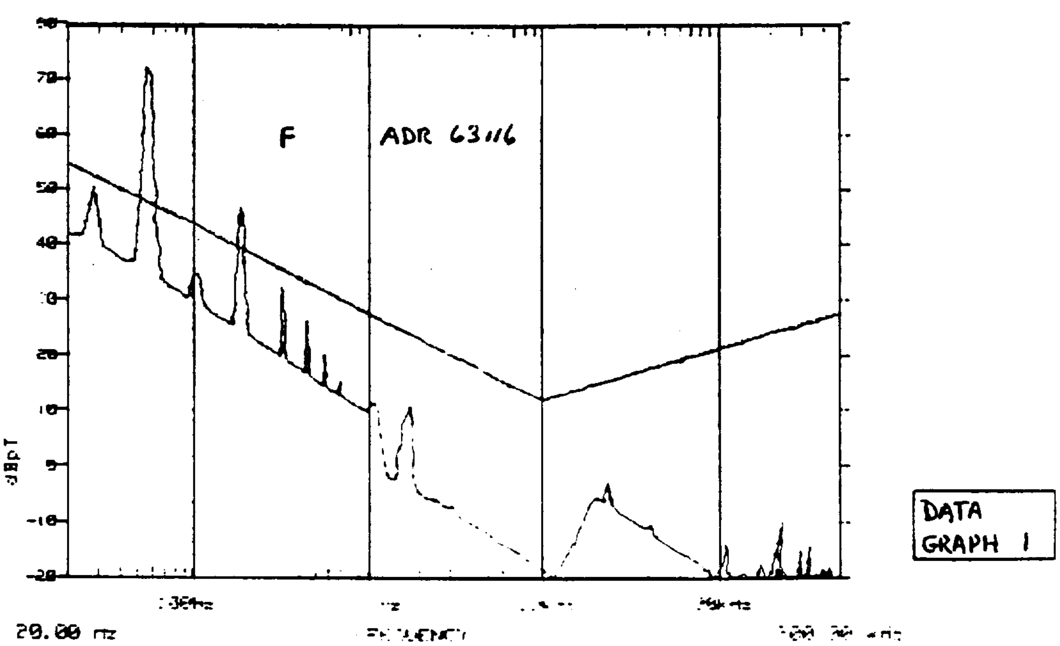


Figure 23. Typical EATON Emissions Data Sheet

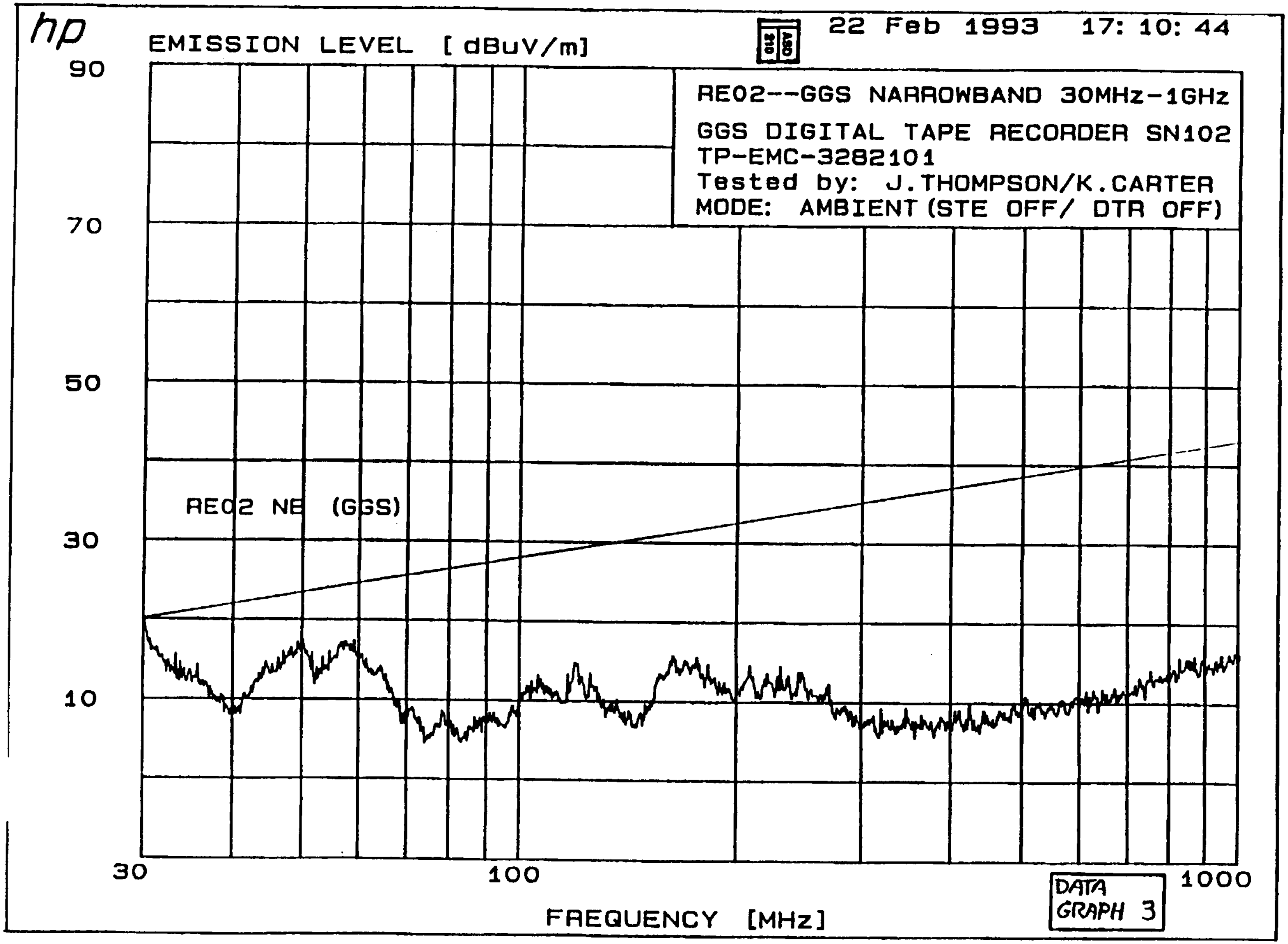


Figure 24. Typical HP8566B Emissions Data Sheet

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8 ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
AF	Audio Frequency
BB	Broadband
CE	Conducted Emissions
CP	Current Probe
CS	Conducted Susceptibility
CW	Continuous Wave
DC	Direct Current
EED	Electro–Explosive Device
E–Field	Electric Field
ELV	Expendable Launch Vehicle
EM	Equipment Module
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMISM	Electromagnetic Interference Safety Margin
EOS	Earth Observing System
ESA	Earth Sensor Assembly
EUT	Equipment Under Test
GSFC	Goddard Space Flight Center
IBDU	Instrument Bus Data Unit
ICD	Interface Control Document
IM	Instrument Module
I/O	Input/Output
LISN	Line Impedance Stabilization Network
NASA	National Aeronautics and Space Administration
NB	Narrowband
PDU	Power Distribution Unit
PMAD	Power Management and Distribution
PXD	Pressure Transducer
p–p	Peak to peak
pps	Pulses per second

RE	Radiated Emissions
RF	Radio Frequency
RFI	Radio Frequency Interference
RS	Radiated Susceptibility
SG	Signal Generator
STD	Standard
STS	Space Transportation System (Space Shuttle)

MARTIN MARIETTA
ASTRO SPACE

EOS–DN–COMM–022

DESIGN NOTE

TITLE: EOS–AM KU–BAND HARDWARE DISTORTION IMPACT ANALYSIS BY CLASS

AUTHOR: JACK LOH Jack Loh 9/9/93

AUTHOR'S MANAGER: Thomas H Melbourne **DATE** 9/9/93

SE&I MANAGER: **DATE** 9/9/93

CHIEF ENGINEER: D. Longnoy **DATE** 9/9/93

REVISIONS

LETTER	DESCRIPTION	DATE	AUTHOR
–	INITIAL RELEASE	9/9/93	JACK LOH

MARTIN MARIETTA
ASTRO SPACE

DESIGN NOTE SUMMARY

DN#: EOS–COMM–022 **Revision:** ______ **Date:** 07 September 1993

Title: EOS–AM Ku–Band Hardware Distortion Impact Analysis by CLASS

Author: Jack Loh **Source ID (ESTA, PD, Memo, etc.):** MEMO

Purpose/Questions Answered:

(1) Determine the impact of hardware distortion on EOS–AM Ku–band link margin in terms of user constraint (UC) loss using the well–established GSFC's Communications Link Analysis and Simulation System (CLASS)
(2) Assess the current Ku–band hardware distortion levels and their effects on links
(3) Identify the sensitivity of hardware distortion parameters on links

Summary/Answers:

(1) The hardware distortion (HD) loss is 0.93dB for the specified levels of distortion (STDN 101.2 3.4.3.7). The UC loss is zero unless the user spacecraft has a HD loss greater than 0.93dB. The current levels of hardware distortion have been assessed and the corresponding HD loss is 0.53dB. Since it is less than 0.93dB, it has zero contribution to the UC loss.
(2) The User Constraint (UC) loss is 0.02dB and 0.08dB due to the non–compliant phase nonlinearity of 3.4deg and 5deg, respectively. The phase nonlinearity specification may be relaxed from 3 deg to 5 deg with an impact of 0.08db or less on links.
(3) The UC loss is most sentitive to the incidental AM. This parameter alone contributes to about 1/3 of the total UC loss for the maximum distortion case. It is also sensitive to data jitter, rise time, and frequency instability.

Recommendations: (Be Specific)	Accepted	Rejected	Baselined	Date
(1) Change the HGA phase nonlinearity requirement from 3 degs to 5 degrees (currently predicted at 3.4degrees), since the impact is less than 0.08dB when increased from 3 deg to 5 deg (all other distortions per SPEC).				

Open Items/Action Required	Responsible Person	Due Date

Comments

Form Completed By Jack Loh Date 9/9/93 Page ___ of ___

EOS Form 007–02/01/93

Interoffice Memo

MARTIN MARIETTA

DN-COMM-022

To:	Tom Milbourne	9/7/93
From:	Jack Loh, x7806, NP-2F	
Subject:	**EOS-AM Ku-Band Hardware Distortion Impact Analysis by CLASS**	
Re:	Impact of HGA phase nonlinearity and other hardware distrotion parameters on KSA Return link performance	

[I] PURPOSE

(1) Evaluate effect of hardware distortion parameters (namely HGA phase nonlinearity spec non-compliance) outside user constraint allowance limits on link margin
(2) Assess sensitivity of individual parameters on link

[II] DEFINITIONS

The following definitions are either directly quotated from [1] or are consistent with [1,2] :

- Hardware distortion — Parameters listed in Table 1, defined in the Appendix I of [1], characterizing the perturbations to communication links due to imperfections of user spacecraft equipment
- HD loss — Hardware Distortion loss (i.e., Eb/No degradation due to hardware distortions) -- This definition is adopted for this report only for the purpose of clarification; it is not used elsewhere. **(HDloss> = 0)**
- UC loss — User Constraint loss; it is the hardware distortion loss above and beyond the ALLOWANCE: HDallow.
- HDallow — The allowed HDloss; it is defined as the hardware distortion loss associated with the maximum allowed perturbation values as specified in sections 3.2.3.7, 3.3.3.7, and 3.4.3.7 for MA, SSA and KSA services, respectively); HDallow >= 0. Note that (UCloss) = (HDloss) - (HDallow)
- ADR — Achieved Data Rate; ADR = 10 log (Ahieved data bit rate); Note that
  ADR = Prec + K, where
  K = a constant for specified data group and modes and incorporates the effect of HDalllow [1], and
  Prec = Minimum power received at TDRS to achieve a return service data channel BER of 10^-5, assuming that the TDRS receiving antenna has a 0dBi gain. For KSA Retun service,
  ADR = 243.0 + Prec (dBW) -------- re: STDN 101.2, Rev.6, P.3-109, Table 3-24
- (EIRP)min — Minimum user spacecraft EIRP, required to produce the required Prec at TDRS,
  (EIRP)min = Prec + |Ls|; where Ls is the space loss; Ls=-132.45+20log(R*F), and
  R=range in km, between TDRS and EOS-am, and F = frequency in MHz.
- M — Link Margin; M = EIRP - (EIRP)min; where EIRP is the user spacecraft EIRP

(All the above quantities are in decibels)

[III] ANALYSIS

The Communications Link Analysis and Simulation System (CLASS), a software package developed by the NASA/GSFC has been used exclusively for the hardware distortion loss analysis (CLASS Menu 4.9). The CLASS is hosted on a HP9000/855 at GSFC, MD, and remotely accessed from Nassau Park, NJ via a modem at the assigned rate of 1200 Bauds. The modem is linked to a Mac Plus emulating a VT100 terminal having a configuration of 7 data bit, even parity and 1 stop bit (i.e., 7E1). The modem control software used for this analysis is VersaTerm Pro.

The hardware distortion parameters permitted by CLASS are summarized in **Table 1** under the column "NSE Limit" (Network System Engineer Limit). There are 24 such parameters and only 18 are relevant to the KSA Return links. Computations excceding the "NSE Limit" values were supported by GSFC (Nancy Smith). A typical printout of CLASS Hardware Distortion Analysis is shown in **Fig.1.**

The analysis was proceeded as follows:

-(T1) Determine the ALLOWANCE HD loss
This is accomplished by using the **Table 1** values under "NSE Limit". The resultant HD loss, HDallow, is HDallow =0.93dB.

(T2) Determine the sensitivity of the perturbations; the SPEC values of **Table 1** were used as input to CLASS, except the parameter to be examined, which was changed from the SPEC value to zero. The results were summarized in **Table 2.**

(T3) Calculate the HD loss associated with the EOS-AM specified values of **Table 1** under column "SPEC". The resultant loss was 0.93dB (almost identical to HDallow).

(T4) Calculate the HD loss based on current hardware prediction, using values under the column "Est. AUG'93" of **Table 1** as inputs to CLASS. The result was 0.53dB. The predictions are based on **Table 5.**

(T5) Determine the impact of phase nonlinearity on HD loss. This was done using the SPEC values of **Table 1**, except the phase nonlinearity was varied from 0° through 5° at 0.5° steps. The resuls are listed in **Table 3** and plotted in **Fig. 2.**.

(T6) Determine the impact of Incidental AM on HD loss. This was done using the SPEC values of Table 1, except that the incidental AM was varied from 0% through 5% at 0.5% steps. The results are shown in **Table 4** and plotted in **Fig.3.**

(T7) Calculate the User Constraint loss: (UC loss) = (HD loss) - HDallow
If (UC loss) = < 0 (the HDloss exceeds the allowed HDallow),
then UCloss = 0 is used in the Link Budget, else, use the computed UCloss in the Link Budget.

The impact of HGA hardware distortion on the KSA Return link margin are determined by CLASS either automatically via the STATIC ANALYSIS, or manually by HARDWARE DISTORTION ANALYSIS based on the derived UC losses. We were recommended by GSFC to use the latter, due to the heavy loading of the STATIC ANALYSIS.

[IV] CONCLUSIONS SUMMARY

(1) The hardware distortion loss allowance for KSA Retrun service (HDallow) has been determined to be 0.93dB. This loss has been accounted for and compensated by the constant "243.0" in the expression [1, Table 3-24, p.3-109]:
ADR = 243.0 + Prec (dBW)
If the actual HDloss is within the allowance (i.e, HDloss = < 0.93 dB), then UC loss = 0 is to be used for Link Budget, else, (UCloss) = (HDloss) - (HDallow) should appear in the Link Budget.

(2) The current prediction of phase nonlinearity is 3.4°, which exceeds the sepcified 3° and hence is non-compliant. The predicted HD losses for 3.4° and 5° phase nonlinearity are 0.95dB and 1.01dB, which correspond to UC losses of 0.02dB and 0.08dB, respectively. Since those numbers are very small, it is concluded that the **Phase Nonlinearity specification may be relaxed to 5° from 3° with little impact (=<0.08dB)**

(3) Using the estimated perturbations of AUG'93 in Table 1, the resultant HDloss is 0.53dB, which is 0.40dB below the 0.93dB allowance. It implies that there is 0.40dB implicit extra link margin for KSA Return link, which does not appear explicitly in the link budget.

(4) As seen from Table 2 that the distortion parameters may be classified according to their impact on HD loss as follows:

- Impact less than 0.02dB (zero to full distortion SPEC value)
  Gain slope, untracked spurious PM, untracked phase noise, gain flatness,
  QPSK modulator phase imbalance, Data modulator phase imbalance,
  Data modulator gain imbalance,
- Impact between 0.02dB and 0.10dB (zero to full distortion SPEC value)
  AM/PM, Phase nonlinearity , Data modulator gain imbalance, Data asymmetry,
- Impact greater than 0.10dB (zero to full distortion SPEC value)
  Frequency instability, Data rise time, Data jitter, Incidental AM

(5) The UC loss is most sensitive to the Incidental AM, as shown in Table 4 and Fig.3 This parameter alone contributes almost 1/3 of the total UC loss, namely, the total UC losses are 0.93 dB and 0.62dB for 5% and 0% Incidental AM, respectively. This parameter is almost entirely contributed by the HGA and insignificant amount by KSA Modulator. The current incidental AM budget is 0% due to KSA Modulator, 2% due to upconverter, and 2% due to the TWTA for a combined total (RSS) of 2.83%. Efforts to keep this parameter at or below 2.8% are deemed worthwhile.

[V] RECOMMENDATIONS

(1) Change the phase nonlinearity specification from 3° to 5°. There would be an impact of 0.08dB increase in HD loss, if all the other perturbations are at their specified values. The current perturbations as shown in Table 1 under the column "Est.AUG'93" (including the 3.4° phase nonlinearity) lead to a HD loss of 0.53dB. Thus, the relaxation of phase nonlinearity specification has insignificant effect on the KSA Return Link Budget.

(2) Adopt the current hardware specs with phase nonlinearity shcnged to 5°, as the baseline values for Ku-band hardware distortion control. Efforts minimize the incidental AM are especially worthwhile.

[VI] REFERNCES

(1) STDN 101.2, REV.6, SPACE NETWORK USERS' GUIDE, SEPTEMBER 1988, GODDARD SPACE FLIGHT CENTER

(2) THE COMMUNICATIONS LINK ANALYSIS AND SIMULATION SYSTEM (CLASS 101), JUNE 1989

(3) MARTIN MARIETTA CORP., COMMUNICATIONS SUBSYSTEM SPECIFICATION FOR THE EOS-AM SPACECRAFT (SP-401), PS20008580, JUNE 1993

(4) MARTIN MARIETTA CORP., CRITICAL ITEM DEVELOPMENT SPECIFICATION HIGH GAIN ANTENNA ASSEMBLY FOR EOS-AM SPACECRAFT (SP-861), PS20008513, JULY 1993

TABLE 1 Hardware distortion parameters for CLASS input, defined via two menus

FIRST MENU

No.	CLASS Input Parameter	Description	NSE Limit	SPEC*1	Est. AUG'93
1	Modulator Gain Imbalance (dB)	baseband data gain imbalance	0.25	0.25	0.25
2	Modulator Phase Imbalance(deg)	baseband phase imbalance	3.0	2	2
3	I/Q Gain Imbalance(dB)	SQPSK modulator gain imb	0.25	0.25	0.25
4	I/Q Phase Imbalance (deg)	SQPSK modulator phase imb	3.0	2	2
5	I-channel Data Asymmetry(%)	re: STDN 101.2 Appendix I	3	3	3
6	Q-channel Data Asymmetry(%)	re: STDN 101.2 Appendix I	3	3	3
7	I-channel rise time(%)	re: STDN 101.2 Appendix I	5	5	2.11
8	Q-channel rise time (%)	re: STDN 101.2 Appendix I	5	5	2.11
9	I-channel PN power suppression	not applicable for KSA RTN			
10	Q-channel PN power suppression	not applicable for KSA RTN			
11	I-channel Data Jitter (rad)	re: STDN 101.2 Appendix I	0.37	0.37	0.13
12	Q-channel Data Jitter (rad)	re: STDN 101.2 Appendix I	0.37	0.37	0.13

SECOND MENU

No.	CLASS Input Parameter	Description	NSE Limit	SPEC*1	Est. AUG'93
1	User Gain Flatness (dB)	re: STDN 101.2 Appendix I	0.3	0.3	0.3
2	User Phase Nonlinearity (deg)	re: STDN 101.2 Appendix I	3	3	3.4
3	User Untracked spurious PM(deg)	re: STDN 101.2 Appendix I	3	2	1.0
4	User Untracked Phase Noise(deg)	re: STDN 101.2 Appendix I	3	2	1.3
5	User Incidental AM (%)	re: STDN 101.2 Appendix I	5	5	2.83
6	User Gain Slope (dB/MHz)	re: STDN 101.2 Appendix I	0.1	0.1	0.06
7	User AM/PM (deg/dB)	re: STDN 101.2 Appendix I	12	12	6
8	User Frequency Stability (Hz)	re: STDN 101.2 Appendix I	4500	4500	4500
9	I-channel PN chip asymmetry	not applicable for KSA RTN			
10	Q-channel PN chip asymmetry	not applicable for KSA RTN			
11	I-channel PN chip jitter	not applicable for KSA RTN			
12	Q-channel PN chip jitter	not applicable for KSA RTN			

*1 STDN 101.2 KSA Return service User Spacecraft Signal Constraints of Table 3-25, also EOS-AM Communications Subsystem Specification PS20008580 Table III. (they have the same requirements)

*2 Out of the 24 parameters, only 18 are applicable to KSA Return links (10 from Menu 1 and 8 from Menu 2)

SENSITIVITY ANALYSIS -- ZERO INDIVIDUAL PARAMETERS

TABLE 2 HARDWARE DISTORTION INPUTS FOR CLASS ANALYSIS

PARAMETERS COMMON TO ALL CASES :

Modulation Type	QPSK	Signal Format	NRZ-M	Filter Flag	Non
Code Rate	1/2	Data Group	2	Mode	N/A
I-ch data rate	75 Mbps	Q-ch data rate	75Mbps	Min. 3dB BW(MHz)	300
TDRS Noise BW	225MH	Q/I power	1.0	Filter Type	N/A
Eb/No	4.4dB	Filter Order	Not used	Filter Ripple	N/A
Ideal BER	1.0E-05				

			<------- (parameter shown set to zero, other inputs per SPEC) ----------->															Est. As of **
(re: STDN 101.2, Appendix I)	Units	SPEC	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AUG'93
1 Modulator Gain Imbalance	dB	0.25	0															0.25
2 Modulator Phase Imbalance	deg	2 0		0														2
3 /IQ Gain Imbalance	dB	0.25			0													0.25
4 I/Q Phase Imbalance	deg	2.0				0												2
5 I-CH Data Asymmetry	%	3					0											3
6 Q-CH Data Asymmetry	%	3					0											3
7 I-CH rise time	%	5						0										2.11
8 Q-CH rise time	%	5						0										2.11
9 I-CH Data Jitter	rad	0.37							0									0.13
10 Q-CH Data Jitter	rad	0.37							0									0.13
11 User Gain Flatness	dB	0.3								0								0.3
12 User Phase Nonlinearity	deg	3									0							3.4
13 User Untracked spurious PM	deg	2										0						1.0
14 User Untracked Phase Noise	deg	2											0					1.3
15 User Incidental AM	%	5												0				2.83
16 User Gain Slope	dB/MHz	0.1													0			0.06
17 User AM/PM	deg	12														0		6
18 User Frequency Instability	Hz	4500															0	4500
User Constraint Loss (dB)	dB	0.93	.92	.92	.86	.92	.84	.80	.79	.92	.89	.93	.93	.62	.93	.89	.80	0.53
Delta UC (=0.93-UC loss)	dB	0.00	.01	.01	.07	.01	.09	.13	.14	.01	.04	.00	.00	.31	.00	.04	.13	0.40

** See Table 5 for justification

SENSITIVITY ANALYSIS

TABLE 3 UC Loss vs. Phase Nonlinearity (all other parameters per SPEC, Table 1)

Phase Nonlinearity (deg)	0°	1°	2°	3°	3.5°	4.0°	4.5°	5°	
Eb/No degradation (dB)		0.89	0.90	0.91	0.93	0.95	0.97	0.99	1.01

** See Figure 2.

TABLE 4 UC Loss vs. Incidental AM (all other parameters per SPEC, Table 1)

Incidental AM (%)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Eb/No degrad. (dB)	0.62	0.65	0.68	0.71	0.74	0.77	0.81	0.84	0.87	0.90	0.93

** See Figure 3.

TABLE 5 ASSESSMENT OF HARDWARE DISTORTION VALUES AS OF AUG'93

PARAMETERS :	Units	SPEC *1	Worst Case	<-------------------Estimate of Aug'93 KSA Modu	Upconveter	TWTA	Antenna Assem ------------------------>	Est as of Aug'93	Note
1 Modulator Gain Imbalance	dB	0.25		0.25	-	-	-	0.25	A
2 Modulator Phase Imbalance	deg	2 0		2	-	-	-	2	A
3 /IQ Gain Imbalance	dB	0.25		0.25	-	-	-	0.25	B
4 I/Q Phase Imbalance	deg	2.0		2	-	-	-	2	B
5 I-CH Data Asymmetry	%	3		3	-	-	-	3	
6 Q-CH Data Asymmetry	%	3		3	-	-	-	3	
7 I-CH rise time	%	5		-	1	1.86	-	2.11	C
8 Q-CH rise time	%	5		-	1	1.86	-	2.11	C
9 I-CH Data Jitter	rad	0.37		0.13	-	-	-	0.13	C
10 Q-CH Data Jitter	rad	0.37		0.13	-	-	-	0.13	C
11 User Gain Flatness	dB	0.3		-	0.28	0.15-	0.15	0.3	D
12 User Phase Nonlinearity	deg	3	5°	-	2.26	1	2	3.4	R
13 User Untracked spurious PM	deg	2			0.09	1	-	1.0	R
14 User Untracked Phase Noise	deg	2		-	0.3	1	-	1.3	S
15 User Incidental AM	%	5		-	2	2	-	2.83	R
16 User Gain Slope	dB/MHz	0.1		-	0.06	0.01	0.003	0.06	R
17 User AM/PM	deg	12		-	2	4	-	6	S
18 User Frequency Instability	Hz	4500		4500	-	-	-	4500	
Remarks		<STDN 101.2>		<pdr,dec'92>	<pdr,aug'93>	<spar est>	<spar est>		

NOTES

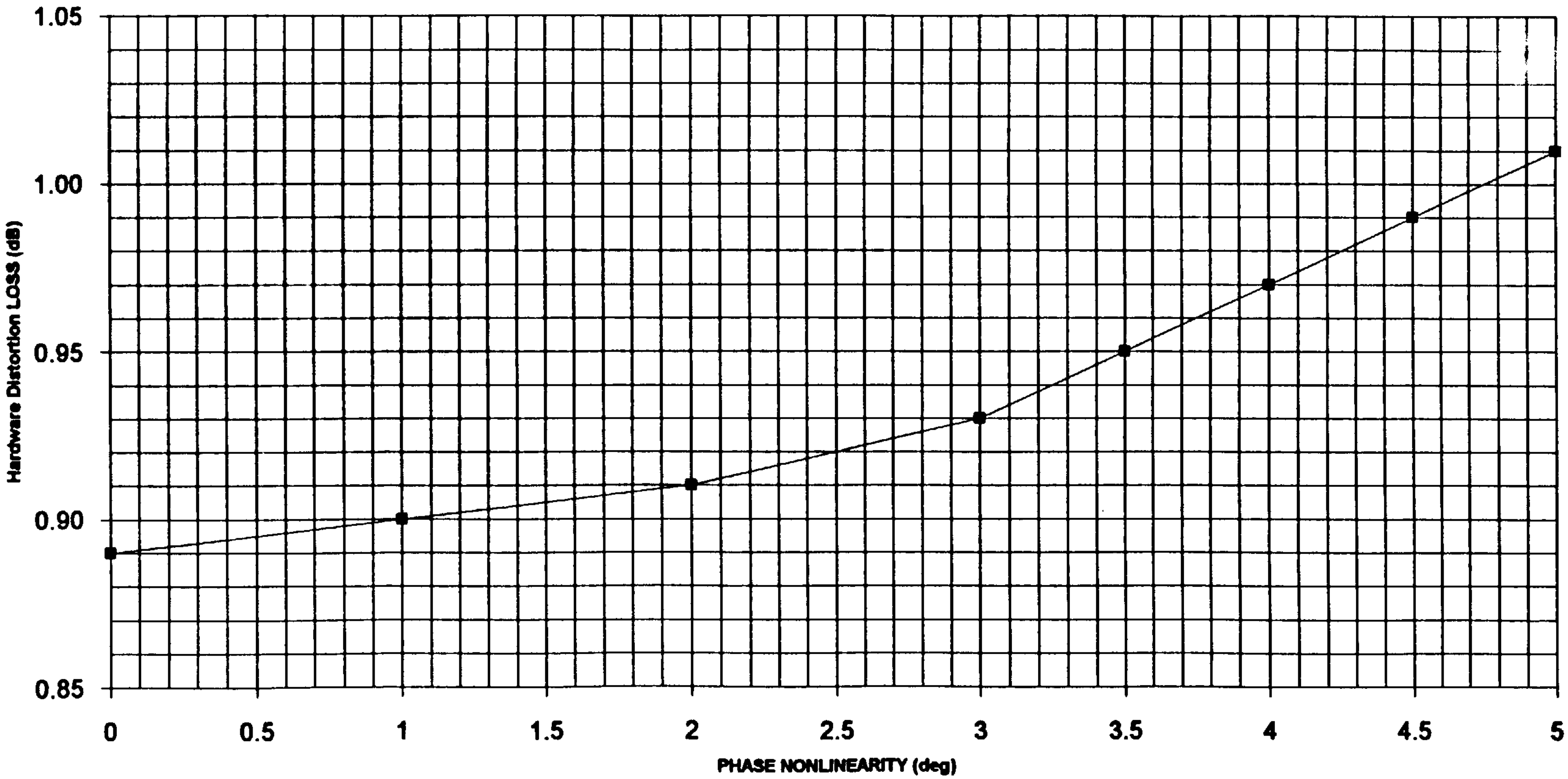
*1	SPEC = STDN 101.2 Spec or EOS-AM Communications Subsystem Spec or HGA spec (all are consistent)
A	Driven by SFE data re-synchronization and re-clocking
B	KSA Modulator design
C	COMMS PDR, AUG'92
D	TWT operates in saturation; Gain flatness is due to that of TWTA (incl FLTR) + Antenna
R	Root Sum of the Squared (RSS)
S	Sum

P. 8/10

```
*********************************************************************
**  HARDWARE DISTORTION ANALYSIS    CLASS ANALYSIS #-8189301   **
*********************************************************************

     ****************************************************
                  8/18/93   10:51:32   RUN #    1
     ****************************************************
                  -------------------------
                  -  I CHANNEL ANALYSIS  -
                  -------------------------

MODULATION TYPE: QPSK        (1)      SIGNAL FORMAT:   NRZ          (0)
FILTER FLAG:     NONE        (0)      CODE RATE:       1/2 CODING   (2)
DATA GROUP:      2           (2)      MODE:                         (0)

I RATE     =    75.000 MBPS           USER MIN. 3dB BW =   300.000 MHZ
Q RATE     =    75.000 MBPS           TDRS NOISE BW    =   225.000 MHZ
Q/I POWER =      1.000                FILTER TYPE      =
Eb/N0      =     4.400 DB             FILTER ORDER     =         0
IDEAL BER =   1.08E-05                FILTER RIPPLE    =       .000 DB

                  ********************************
                  * DEGRADED BER =   2.39E-04   *
                  * EbN0 LOSS =        .93 dB   *
                  ********************************

LIST OF DISTORTIONS INCLUDED:
          ( 4) QPSK MODULATOR PHASE IMBALANCE =     2.000 DEG
          ( 3) DATA MODULATOR PHASE IMBALANCE =     2.000 DEG
          (16) DATA MODULATOR GAIN IMBALANCE  =      .250 DB
          ( 5) QPSK MODULATOR GAIN IMBALANCE  =      .250 DB
          ( 6) I-CHANNEL DATA ASYMMETRY       =     3.000 %
          ( 7) Q-CHANNEL DATA ASYMMETRY       =     3.000 %
          ( 8) I-CHANNEL DATA RISE TIME       =     5.000 %
          ( 9) Q-CHANNEL DATA RISE TIME       =     5.000 %
          (12) I-CHANNEL PN POWER SUPPRESSION =      .300 DB
          (13) Q-CHANNEL PN POWER SUPPRESSION =      .300 DB
          (14) I-CHANNEL DATA BIT JITTER      =      .370 RAD
          (15) Q-CHANNEL DATA BIT JITTER      =      .370 RAD
          (17) USER UNTRACKED PHASE NOISE     =     2.000 DEG
          (18) USER FREQUENCY INSTABILITY     =  4500.000 HZ
          (19) USER GAIN FLATNESS             =      .300 DB
          (20) USER PHASE NON-LINEARITY       =     3.000 DG/MHZ
          (21) USER UNTRACKED SPURIOUS PM     =     2.000 DEG
          (23) USER INCIDENTAL AM             =     5.000 %
          (24) USER GAIN SLOPE                =      .100 DB/MHZ
          (25) USER AM/PM                     =    12.000 DEG/DB
```

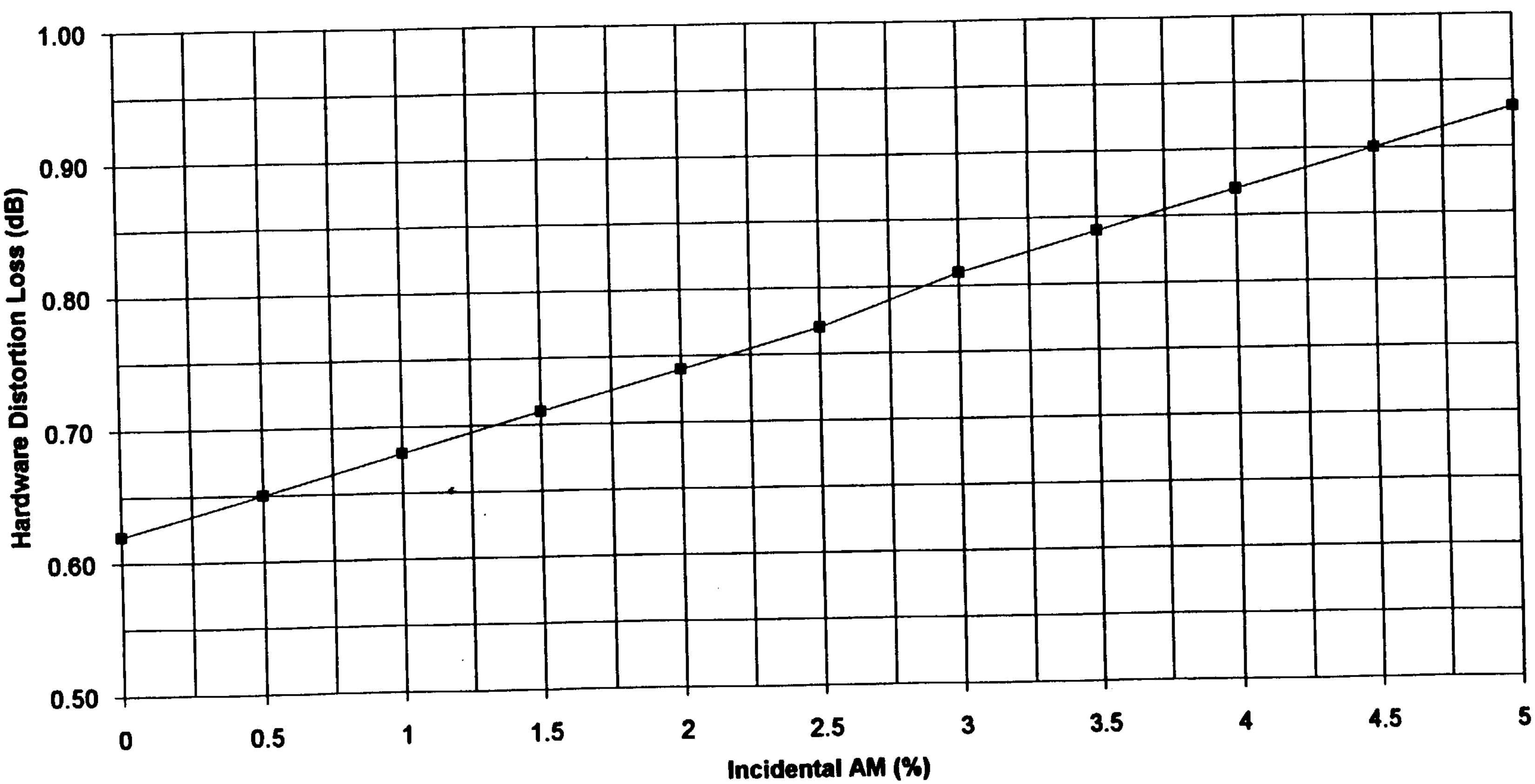
FIGURE 1

Fig.2 HD Loss vs Phase Nonlinearity (all other parameters per SPEC)



Computation Supported by GSFC

Fig. 3 HD Loss vs. Incidental AM (all other parameters per SPEC)



8/31/93 3:51 PM J. Loh

file UC-FIG3.XLC

Next Assembly	Used on
20008500G1	EOS–AM

First Application
EOS–AM

Revisions — Rev C

Ltr	Description	Date	Approved
Initial Issue	—	1–15–93	CM/GSR
Rev A	Revised per ECN–EOS0032	4–1–93	CM/GSR
Rev B	Revised per ECN–EOS0048	7–15–93	CM/GSR
Rev C	Revised per ECN–EOS0061	8–23–93	CM/GSR

Revision Record Continued on Sheet ______

Contract No.	NAS5–32500
Written	Brenda Wilson
Date	4–1–93
Approved	N. Koepp–Baker
Date	4–1–93
Approved	
Date	
Issue	G. Rauscher
Date	4–1–93

MARTIN MARIETTA

Martin Marietta Astro Space
East Windsor, NJ
Valley Forge, PA

**Interface Control Drawing,
Earth Observing System AM Spacecraft to
Multi–angle Imaging SpectroRadiometer**

Size	Code Ident No.	
A	49671	20008830

- Top Assembly Drawing, Earth Observing System AM Spacecraft, 20008500G1
  - Interface Control Drawing, Earth Observing System AM Spacecraft to Multi–angle Imaging SpectroRadiometer, 20008830
    - Interface Control Drawing, Mechanical, Drawing, Earth Observing System AM Spacecraft to Multi–angle Imaging SpectroRadiometer, 20008831
    - Interface Control Drawing, Mechanical, Tables, Earth Observing System AM Spacecraft to Multi–angle Imaging SpectroRadiometer, 20008832
    - Interface Control Drawing, Thermal Earth Observing System AM Spacecraft to Multi–angle Imaging SpectroRadiometer, 20008833
    - Interface Control Drawing, Electrical, Schematic, Earth Observing System AM Spacecraft to Multi–angle Imaging SpectroRadiometer, 20008834
    - Interface Control Drawing, Electrical, Tables, Earth Observing System AM Spacecraft to Multi–angle Imaging SpectroRadiometer, 20008835
    - Interface Control Drawing, Integration and Test Earth Observing System AM Spacecraft to Multi–angle Imaging SpectroRadiometer, 20008836
    - Interface Control Drawing, Command and Telemetry Earth Observing System AM Spacecraft to Multi–angle Imaging SpectroRadiometer, 20008837

Figure 1. Drawing Tree

ASD–EW 2051 3–89

Table I. ICD Revision Status

20008831 MICD Drawing		20008832 MICD Tables		20008833 TICD		20008834 EICD Schematic		20008835 EICD Tables		20008836 I&T ICD		20008837 C&DH ICD	
Issue	Date	Issue	Date	Issue	Date	Issue	Date	Issue	Date	Issue	Date	Issue	Date
Initial	6–29–93	Initial	3–29–93	Initial	12–18–92			Initial	08–27–93				

Size A

Code Ident No. 49671

20008830

Sheet 3

Next Assembly	Used on
20008830	EOS–AM

First Application
EOS–AM

Revisions

Rev [ ]

Ltr	Description	Date	Approved
001	Draft	7–15–93	

Revision Record Continued on Sheet ______

Contract No.	NAS5–32500
Written	B. Wilson
Date	
Approved	F. Komro
Date	
Approved	
Date	
Issued	G. Rauscher
Date	

MARTIN MARIETTA

POST OFFICE BOX 800
PRINCETON, NEW JERSEY 08543–080
TELEPHONE (609) 490–3400

Interface Control Drawing, Integration and Test, Earth Observing System AM Spacecraft to Multi–angle Imaging SpectroRadiometer

Size	Code Ident No.	
A	49671	20008836

Sheet 1 of 139

Approval Signatures

**IN ADDITION TO ECN AND CCB APPROVALS,
ALL CHANGES ON THIS DRAWING SHALL HAVE THE APPROVAL AND THE FULL AGREEMENT OF THE PARTIES LISTED BELOW.**

REV	Spacecraft Program Office	Date	Instrument Program Office	Date	Principal Investigator	Date
Initial Issue	(signature on file) P. Giustino for M. Kavka	9–8–93	T. Reilly		D. Diner	

Size	Code Ident No.	
A	49671	20008836
		Sheet 2

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TBD 2	Table I	18	IGSE date of cal or proof test	B. Wilson (MMC)	Inst. Delivery
TBD 3	Table IIa Table IIb Table IIc	19 20 21	IGSE usage (3 places)	B. Wilson (MMC)	MISR CDR (12/19/94)
TBD 4	3.1.3.1 3.1.3.2	22 22	Test kinematic mount description (3 places)	B. Wilson (MMC)	MISR CDR + 3mo (3/30/95)
TBD 5	3.2.3.1 3.2.3.2	24 24	Drill–alignment fixture description (3 places)	B. Wilson (MMC)	9–30–93
TBD 6	3.4.3.2 3.4.5	26 26	MISR work stand description (2 places)	G. Francis (JPL)	9–30–93
TBD 7	3.5.1 3.5.3.2 3.5.5	27 27 27	MISR transport fixture description (3 places)	G. Francis (JPL)	9–30–93
TBD 8	3.6.3.2 3.6.5	28 28	MISR shipping containers description (2 places)	G. Francis (JPL)	9–30–93
TBD 9	3.7.1 3.7.3.2	29 29	MISR purge unit description (2 places)	G. Francis (JPL)	9–30–93
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TBD 15	3.13.3.1 3.13.3.2 3.13.4 3.13.5	35 35 35 35	SIS description (4 places)	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 16	3.14.3.2 3.14.5	36 37	MISR system test equipment description (2 places)	G. Francis (JPL)	10–30–93
TBD 17	Figure 1–2 to Figure 1–13	41 52	IGSE figures (11 places)	B. Wilson (MMC)	10–30–93

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TBD 19	Figure 2–4	60	MISR I&T ground station layout	G. Francis (JPL)	9–30–93
TBD 20	4.1.5	65	T/V penetration connectors	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 21	4.1.5	65	T/V penetration cable lengths	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 22	4.1.5	65	T/V penetration gas and fluid lines	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 23	Figure 2–10	68	Storage area	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 24	Figure 2–12	71	MISR launch site processing facility	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 25	Figure 2–13	72	MISR launch site ground station	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 26	Table III	3	Instrument facility requirements	G. Francis (JPL)	10–30–93
TBD 27	Table IV	74	IGSE physical requirements	G. Francis (JPL)	10–30–93
TBD 28	Table IV	74	SIS grounding	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 29	Table V	75	IGSE environmental requirements	G. Francis (JPL)	10–30–93
TBD 30	Table VI	77	Consumables	G. Francis (JPL)	10–30–93
TBD 31	Table VII	78	Documentation	G. Francis (JPL)	1–30–94
TBD 32	5.1.1 5.1.2	79 79	Personnel support (2 places)	B. Wilson (MMC)	Inst Delivery –6mo.
TBD 33	5.2.1 5.2.2 5.2.3	79 79 79	Computer Maintenance (3 places)	B. Wilson (MMC)	Inst Delivery –6mo.
TBD 34	5.3.1 (1)	80	Individuals requiring badges at MMC	G. Francis (JPL)	Inst Delivery –6mo
TBD 35	5.3.1 (4)	80	Cleanroom garments at MMC (5 places)	G. Francis (JPL)	Inst Delivery –6mo
TBD 36	5.3.2 (1)	82	Individuals requiring badges at launch site	G. Francis (JPL)	S/C ship – 6mo
TBD 37	5.3.2 (2)	82	Office furniture at launch site (6 places)	B. Wilson (MMC)	S/C ship – 6mo
TBD 38	5.3.2 (3)	82	Ground station furniture at launch site (8 places)	B. Wilson (MMC)	S/C ship – 6mo

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TBD 39	5.3.2 (4)	82	Clean room garments at launch site (5 places)	G. Francis (JPL)	S/C ship – 6mo
TBD 40	Figure 3 Figure 4	86 87	Harness segment ID numbers (2 places)	B. Wilson (MMC)	sIS Delivery –6mo
TBD 41	Figure 4	87	Other connector numbers	B. Wilson (MMC)	SIS Delivery –6mo
TBD 42	Table VIII	88	SIS–MISR harness lengths	G. Francis (JPL)	SIS Delivery –6mo
TBD 43	Table IX	89 to 93	SIS–MISR connector locations (5 places)	B. Wilson (MMC)	SIS Delivery –6mo
TBD 44	Table Xa to Table Xe Table Xq	94 to 101 107	SIS–MISR wire color (28 places)	G. Francis (JPL)	SIS Delivery –6mo
TBD 45	Table Xo	106	SIS–JPL facility power and SIS–IGSE interconnections (8 places)	G. Francis (JPL)	SIS Delivery –6mo
TBD 46	Figure 5 Figure 17	110 to 122	SIS MISR interface circuits and timing diagrams (13 places)	B. Wilson (MMC)	6–30–94
TBD 47	Figure 18 Table XIIIa Table XIIId	124 126 to 127	SCS–IGSE connector numbers (5 places)	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 48	Figure 18	124	SCS–IGSE harness segment ID numbers	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 49	Table XI	125	SCS–IGSE harness length	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 50	Table XII	125	SCS–IGSE connector list	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 51	Figure 19 Figure 20	128 129	SCS–IGSE science data circuit and timing diagram (2 places)	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBD 52	6.3.1 6.3.2 6.3.3 6.3.4.1 6.3.4.2	130 130 130 130 130	Facility–MISR IGSE interface	B. Wilson (MMC)	10–30–93
TBD 53	Table XIV	132	Instrument procedure list	G. Francis (JPL)	Prelim. 1–26–94 Final Inst. Delivery – 6 mo

TBD LOG (cont'd)

ITEM	SECTION	PAGE	SUBJECT	RESPONSIBLE	DUE
TBD 54	Table XiV Table XV 7.1.2	132 133 135	Alignment procedure number (5 places)	B. Wilson (MMC)	Prelim. 1–26–94 Final Inst. Delivery – 6 mo
TBD 55	Table XV	133 134	Instrument prodecure usage (2 places)	G. Francis (JPL)	Prelim. 1–26–94 Final Inst. Delivery – 6 mo
TBD 56	7.2.1	135	IGSE constraint or restraint (2 places)	G. Francis (JPL)	Prelim. 1–26–94 Final Inst. Delivery – 6 mo

TBR LOG

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TBR 1	3.1.1	22	Number of test kinematic mount sets	B. Wilson (MMC)	MISR CDR + 30 days (1/31/95)
TBR 2	4.2	69	Space Launch Complex	B. Wilson (MMC)	S/C Ship –3mo
TBR 3	Figure 3 Figure 4 Table Xa Table Xu	86 87 94 to 109	SIS–MISR connector numbers (30 places)	B. Wilson (MMC)	MISR CDR +3mo (3/30/95)
TBR 4	7.1	135	Procedure description (2 places)	G. Francis (JPL)	Prelim. 1–26–94 Final Inst. Delivery – 6 mo

1 INTRODUCTION

1.1 Purpose

The Integration and Test Interface Control Drawing (I&T ICD), 20008836, when executed, represents an agreement of the detailed implementation of the integration and test (I&T) of the Multi–angle Imaging SpectroRadiometer (MISR) with the Earth Observing System (EOS) AM Spacecraft. This drawing, together with the Mechanical Interface Control Drawing (MICD) Drawing, 20008831, MICD Tables, 20008832, Thermal Interface Control Drawing (TICD), 20008833, Electrical Interface Control Drawing (EICD) Schematic, 20008834, EICD Tables, 20008835, and Command and Telemetry Interface Control Drawing (C&T ICD), 20008837, describe the details of the interfaces between the EOS–AM Spacecraft and MISR. The top–level instrument Interface Control Drawing (ICD), 20008830, provides the instrument ICD tree and revision status for all sub–tier instrument ICDs.

The I&T ICD contains information on Ground Support Equipment (GSE), facilities, procedures, and other support which will be used during pre–delivery, spacecraft–level I&T, and launch site activities.

1.2 Scope

This I&T ICD is limited to the description of operation of the MISR necessary to execute the I&T and launch portion of the EOS–AM program and, as such, concentrates on commands and telemetry via the Bus Data Unit (BDU) and Command and Telemetry (C&T) bus, descriptions of modes to be tested, and instrument operating constraints during test. Science and engineering data is processed during test by the Instrument Ground Support Equipment (IGSE) and is not considered in this document. The material contained herein is not intended to define on–orbit operational requirements.

1.3 Organization

Section 1 provides a brief description of the document's purpose followed by a statement of its scope and concluding with a discussion of its organization .

Section 2 provides a list of the documents referenced in the text and the source of each such document.

Section 3 provides a description of the IGSE used during pre–delivery, spacecraft–level I&T, and launch site activities.

Section 4 contains detailed descriptions of the facilities to be used during spacecraft–level I&T, and launch site activities.

Section 5 provides a description of the support to be provided during spacecraft–level I&T, and launch site activities.

Section 6 describes the interfaces between the MISR IGSE and the Spacecraft Interface Simulator (SIS), Spacecraft Checkout Station (SCS), and facilities.

Section 7 describes the instrument procedures to be used during pre–delivery, spacecraft–level I&T, and launch site activities.

2 REFERENCE DOCUMENTS

The following documents provide additional information relative to the functioning of the MISR IGSE, facilities, procedures, and other support which will be used during pre–delivery, spacecraft–level I&T, and launch site activities. The information contained in these documents is deemed to be supplemental in nature and hence is not included herein.

Reference documents will be provided as required.

3 INSTRUMENT GROUND SUPPORT EQUIPMENT

1. IGSE is listed in Table I.

2. IGSE usage during pre–delivery, spacecraft–level I&T, and launch site activities is identified in Tables IIa through IIc.

3. Each IGSE item is described in the Section 3.x paragraph and shown in the Figure 1–x identified by the same x.

Table I. Instrument Ground Support Equipment List

Item	Item Name	Drawing or ID Number (TBD 1)	Provider	Date of Cal or Proof Test (TBD 2)	Reference Paragraph
Mechanical IGSE					
1	MISR Test Kinematic Mounts		MMC		3.1
2	MISR Drill–Alignment Fixture	MMC 20008831 DAF1	MMC		3.2
3	MISR Master Plate	MMC 20008831 MP1	MMC		3.3
4	MISR Work Stand		JPL		3.4
5	MISR Transport Fixture		JPL		3.5
6	MISR Shipping/Storage Containers		JPL		3.6
7	MISR Purge Unit		JPL		3.7
8	MISR Camera Diode Container Purge Units		JPL		3.8
9	MISR Lifting Fixture		JPL		3.9
10	MISR Mechanisms Handling Fixture		JPL		3.10
11	MISR Dust Cover		JPL		3.11
12	MISR Collimator Array Tool		JPL		3.12
Electrical IGSE					
13	Spacecraft Interface Simulator		MMC		3.13
14	MISR System Test Equipment		JPL		3.14

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Table IIa. Instrument Ground Support Equipment Usage (TBD 3)

Item	EAST WINDSOR ACTIVITIES																	
	Pre–Delivery						Integ			Electrical Systems Test						RF Systems Test		
	Drill Mtg Holes	Drill CP Mtg Holes	Other	Xport	Clean	BAT	Install & Align	CP Install	Elect Integ	Pwr Prof	Trans Tol	Alive Test	Funct Test	Comp Perf Test	Orbits	EMI/ EMC	CTV	End to End
1		N/A	X					N/A										
2	X	N/A						N/A										
3		N/A	X					N/A										
4		N/A				X		N/A										
5		N/A		X				N/A										
6		N/A		X				N/A										
7		N/A			X			N/A										
8		N/A						N/A										
9		N/A					X	N/A										
10		N/A						N/A										
11		N/A			X			N/A										
12		N/A						N/A										
13		N/A	X					N/A										
14		N/A				X		N/A	X	X	X	X	X	X	X	X	X	X

Notes:

Align	Alignment
Alive	Aliveness
BAT	Bench Acceptance Test
Clean	Cleaning
Comp Perf	Comprehensive Performance
CP	Coldplate
CTV	Compatibility Test Van
Elect	Electrical
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
Funct	Functional
Install	Installation
Integ	Integration
Mtg	Mounting
N/A	Not Applicable
Pwr Prof	Power Profile
RF	Radio Frequency
Trans Tol	Transient Tolerance
Xport	Transportation & Handling

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Table IIb. Instrument Ground Support Equipment Usage (TBD 3)

Item	EAST WINDSOR ACTIVITIES																	
	Thermal Vacuum Test								Acoustic/Shock Test					Spacecraft Activity				
	Lnch Mode	T/B	Comp Perf Test	Orbits	Pwr Prof	Trans Tol	Cal	Special	Align	Lnch Mode	Deploy	Special	Alive Test	Leak Check	Comp Perf Test	Mass Prop	BPS to WTR	BPS to Alt Loc
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
13																		
12																		
14	X	X	X	X	X	X	X	X		X		X	X		X			

Notes:

Align	Alignment
Alive	Aliveness
Alt Loc	Alternate Location
BPS	Box, pack, & ship
Cal	Calibration
Comp Perf	Comprehensive Performance
Deploy	Deployment verification
Lnch	Launch
Pwr Prof	Power Profile
T/B	Thermal Balance
Trans Tol	Transient Tolerance
WTR	Western Test Range

Table IIc. Instrument Ground Support Equipment Usage (TBD 3)

	Launch Site (WTR) Activities							
Item	Unbox	Xport	Clean	Comp Perf Test	Close	Move to Pad	Alive Test	Lnch Mode
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14				X			X	X

Notes:

Alive	Aliveness
Clean	Cleaning
Close	Closeouts
Comp Perf	Comprehensive Performance
Lnch	Launch
WTR	Western Test Range
Xport	Transportation & Handling

3.1 MISR Test Kinematic Mounts

The MISR Test Kinematic Mounts are shown in Figures 1–1a thru 1–1c and described in the following sections.

3.1.1 MISR Test Kinematic Mount Description

The MISR Test Kinematic Mount set consists of bearing assemblies, mount bodies, mounting bolts, washers, and bearing retaining plates, built to flight drawings, which provide flight like attachment of the MISR to its IGSE. The MISR Test Kinematic Mounts minimize structural loading of both sides of the kinematic mount interface by not transmitting torsional forces, thereby reducing distortion of the MISR during instrument–level testing. One **(TBR 1)** set of kinematic mounts are provided:

1. Two KM1 mounts which restrain translational motion in one axis normal to the mounting plane

2. A KM2 mount which restrains translational motion in two axes with restraint in one axis normal to the mounting plane and in one axis parallel to the mounting plane

3. A KM3 mount which restrains translational motion in three perpendicular axes

3.1.2 MISR Test Kinematic Mount Usage

The MISR Test Kinematic Mounts are used during instrument–level testing to support the MISR and during instrument–level shock and thermal environmental testing to simulate the spacecraft interface.

3.1.3 MISR Test Kinematic Mount Disposition

The disposition of the MISR Test Kinematic Mounts and their spares, shipping container, and packing material is described in the following sections.

3.1.3.1 MISR Test Kinematic Mount Delivery to JPL

The MISR Test Kinematic Mounts will be delivered to **(TBD 4)** location at the Jet Propulsion Laboratory (JPL) on **(TBD 4)**.

3.1.3.2 MISR Test Kinematic Mount Return to Martin Marietta

The MISR Test Kinematic Mount will be returned to the Martin Marietta Astro Space Division (ASD) East Windsor, NJ, plant Shipping and Receiving Area at the East side of Building 409 on **(TBD 4)**.

3.1.4 MISR Test Kinematic Mount Spares

No spares are provided with the MISR Test Kinematic Mounts.

3.1.5 MISR Test Kinematic Mount Shipping Container and Packing Material

The MISR Test Kinematic Mounts will be packaged in nitrogen–purged plastic bags with desiccant and shipped in standard cardboard boxes with packing foam.

3.2 MISR Drill–Alignment Fixture

MISR Drill–Alignment Fixture is shown in Figure 1–2 and described in the following sections.

3.2.1 MISR Drill–Alignment Fixture Description

The MISR Drill–Alignment Fixture (DAF) is a rectangular frame approximately 43 inches long, 4 inches wide over a 38.5 inch overall width, and 2 inches thick, with a central stiffening member. The template is manufactured from an aluminum plate and contains an optical alignment cube, bushings for drilling pilot holes, and bearings and pins for checking the drilled holes.

3.2.2 MISR Drill–Alignment Fixture Usage

The MISR Drill–Alignment Fixture is used to drill holes in the spacecraft alignment plates and MISR mounting brackets and for transferring the MISR alignment information to the spacecraft coordinate frame.

3.2.3 MISR Drill–Alignment Fixture Disposition

The disposition of the MISR Drill–Alignment Fixture and its spares, shipping container, and packing material is described in the following sections.

3.2.3.1 MISR Drill–Alignment Fixture Delivery to JPL

The MISR Drill–Alignment Fixture will be delivered to **(TBD 5)** location at JPL on **(TBD 5)**.

3.2.3.2 MISR Drill–Alignment Fixture Return to Martin Marietta

The MISR Drill–Alignment Fixture will be returned to the Martin Marietta Astro Space Division (ASD) East Windsor, NJ, plant Shipping and Receiving Area at the East side of Building 409 on **(TBD 5)**.

3.2.4 MISR Drill–Alignment Fixture Spares

No spares are provided for the MISR Drill–Alignment Fixture.

3.2.5 MISR Drill–Alignment Fixture Shipping Container and Packing Material

The MISR Drill–Alignment Fixture shipping container contains identified nesting depressions for all loose items.

3.3 MISR Master Plate

MISR Master Plate is shown in Figure 1–3 and described in the following sections.

3.3.1 MISR Master Plate Description

The MISR Master Plate is a rectangular frame approximately 43 inches long, 4 inches wide over a 40–inch overall width, and 0.75 inches thick, with a central stiffening member. It is manufactured from an aluminum plate.

3.3.2 MISR Master Plate Usage

The MISR Master Plate is used to coordinate the MISR interface mounting holes in the manufacture and check of the MISR Drill–Alignment Fixture.

3.3.3 MISR Master Plate Disposition

The MISR Master Plate its shipping container, and packing material is retained at the Martin Marietta ASD East Windsor, NJ, plant.

3.3.4 MISR Master Plate Spares

No spares are provided for the MISR Master Plate

3.3.5 MISR Master Plate Shipping Container and Packing Material

The MISR Master Plate shipping container contains identified nesting depressions for all loose items.

3.4 MISR Work Stand

The MISR Work Stand is shown in Figure 1–4 and described in the following sections.

3.4.1 MISR Work Stand Description

(TBD 6)

3.4.2 MISR Work Stand Usage

The MISR Work Stand is used to support the MISR instrument during integration and test activities where the instrument is not mounted to the spacecraft structure.

3.4.3 MISR Work Stand Disposition

The disposition of the MISR Work Stand and its spares, shipping container, and packing material is described in the following sections.

3.4.3.1 MISR Work Stand Delivery to Martin Marietta

The MISR Work Stand will be delivered to Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.4.3.2 MISR Work Stand [Return to {Instrument Provider} and/or Storage at Martin Marietta and/or Delivery to Launch Site and/or Delivery to {Other Location} and/or Disposal]

(TBD 6)

3.4.4 MISR Work Stand Spares

No spares are provided for the MISR Work Stand

3.4.5 MISR Work Stand Shipping Container and Packing Material

(TBD 6)

3.5 MISR Transport Fixture

The MISR Transport Fixture is shown in Figure 1–4 and described in the following sections.

3.5.1 MISR Transport Fixture Description

(TBD 7)

3.5.2 MISR Transport Fixture Usage

The MISR Transport Fixture is used to move the MISR instrument whenever lifting is not required.

3.5.3 MISR Transport Fixture Disposition

The disposition of the MISR Transport Fixture and its spares, shipping container, and packing material is described in the following sections.

3.5.3.1 MISR Transport Fixture Delivery to Martin Marietta

The MISR Transport Fixture will be delivered to Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.5.3.2 MISR Transport Fixture [Return to {Instrument Provider} and/or Storage at Martin Marietta and/or Delivery to Launch Site and/or Delivery to {Other Location} and/or Disposal]

(TBD 7)

3.5.4 MISR Transport Fixture Spares

No spares are provided for the MISR Transport Fixture.

3.5.5 MISR Transport Fixture Shipping Container and Packing Material

(TBD 7)

3.6 MISR Shipping Containers

MISR Shipping Containers are shown in Figure 1–6 and described in the following sections.

3.6.1 MISR Shipping Containers Description

The MISR Instrument Shipping Container is a sealable box which provides support and protection for the MISR during transportation and storage. In addition the following shipping containers will also be sent:

- Camera Assembly Shipping Container
- Mechanism Shipping Container
- Calibration Panel Shipping Container
- Diode Assembly Shipping Container
- Electronics Shipping Container

3.6.2 MISR Shipping Containers Usage

The MISR Shipping Container is used whenever the instrument is not mounted on the spacecraft or located in a Class 10,000 clean room. All other shipping containers are used for assembly removals and for storage and shipping back to JPL in the event that repairs are needed.

3.6.3 MISR Shipping Containers Disposition

The disposition of the MISR Shipping Containers, spares, and packing material is described in the following sections.

3.6.3.1 MISR Shipping Containers Delivery to Martin Marietta

The MISR Shipping Containers will be delivered to Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.6.3.2 MISR Shipping Containers [Return to {Instrument Provider} and/or Storage at Martin Marietta and/or Delivery to Launch Site and/or Delivery to {Other Location} and/or Disposal]

(TBD 8)

3.6.4 MISR Shipping Containers Spares

No spares are provided for the MISR Shipping Containers.

3.6.5 MISR Shipping Containers Packing Material

(TBD 8)

3.7 MISR Purge Unit

MISR Purge Unit is shown in Figure 1–7 and described in the following sections.

3.7.1 MISR Purge Unit Description

(TBD 9)

3.7.2 MISR Purge Unit Usage

The MISR Purge Unit will be used to purge the MISR instrument during shipping, storage, and integration and test activities (except on the launch pad) which MISR is not operating.

3.7.3 MISR Purge Unit Disposition

The disposition of the MISR Purge Unit and its spares, shipping container, and packing material is described in the following sections.

3.7.3.1 MISR Purge Unit Delivery to Martin Marietta

The MISR Purge Unit will be delivered to Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.7.3.2 MISR Purge Unit [Return to {Instrument Provider} and/or Storage at Martin Marietta and/or Delivery to Launch Site and/or Delivery to {Other Location} and/or Disposal]

(TBD 9)

3.7.4 MISR Purge Unit Spares

No spares are provided for the MISR Purge Units.

3.8 MISR Camera Diode Container Purge Units

MISR Camera Diode Container Purge Units are shown in Figure 1–8 and described in the following sections.

3.8.1 MISR Camera Diode Container Purge Units Description

(TBD 10)

3.8.2 MISR Camera Diode Container Purge Units Usage

The MISR Camera Diode Container Purge Units envelope the camera assembly when removed and placed in the shipping container.

3.8.3 MISR Camera Diode Container Purge Units Disposition

The disposition of the MISR Camera Diode Container Purge Units and its spares, shipping container, and packing material is described in the following sections.

3.8.3.1 MISR Camera Diode Container Purge Units Delivery to Martin Marietta

The MISR Camera Diode Container Purge Unit will be delivered to Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.8.3.2 MISR Camera Diode Container Purge Units [Return to {Instrument Provider} and/or Storage at Martin Marietta and/or Delivery to Launch Site and/or Delivery to {Other Location} and/or Disposal]

(TBD 10)

3.8.4 MISR Camera Diode Container Purge Units Spares

No spares are provided for the MISR Camera Diode Container Purge Units.

3.9 MISR Lifting Fixture

MISR Lifting Fixture is shown in Figure 1–9 and described in the following sections.

3.9.1 MISR Lifting Fixture Description

(TBD 11)

3.9.2 MISR Lifting Fixture Usage

The MISR Lifting Fixture will be used whenever the MISR instrument must be lifted to be moved.

3.9.3 MISR Lifting Fixture Disposition

The disposition of the MISR Lifting Fixture and its spares, shipping container, and packing material is described in the following sections.

3.9.3.1 MISR Lifting Fixture Delivery to Martin Marietta

The MISR Lifting Fixture will be delivered with certification of proof load testing to Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.9.3.2 MISR Lifting Fixture [Return to {Instrument Provider} and/or Storage at Martin Marietta and/or Delivery to Launch Site and/or Delivery to {Other Location} and/or Disposal]

(TBD 11)

3.9.4 MISR Lifting Fixture Spares

No spares are provided for the MISR Lifting Fixture.

3.9.5 MISR Lifting Fixture Shipping Container and Packing Material

(TBD 11)

3.10 MISR Mechanisms Handling Fixture

MISR Mechanisms Handling Fixture is shown in Figure 1–10 and described in the following sections.

3.10.1 MISR Mechanisms Handling Fixture Description

(TBD 12)

3.10.2 MISR Mechanisms Handling Fixture Usage

The MISR Mechanisms Handling Fixture is used during mechanism assembly removal and handling and is made to accompany the assembly in the shipping container.

3.10.3 MISR Mechanisms Handling Fixture Disposition

The disposition of the MISR Mechanisms Handling Fixture and its spares, shipping container, and packing material is described in the following sections.

3.10.3.1 MISR Mechanisms Handling Fixture Delivery to Martin Marietta

The MISR Mechanisms Handling Fixture will be delivered to Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.10.3.2 MISR Mechanisms Handling Fixture [Return to {Instrument Provider} and/or Storage at Martin Marietta and/or Delivery to Launch Site and/or Delivery to {Other Location} and/or Disposal]

(TBD 12)

3.10.4 MISR Mechanisms Handling Fixture Spares

No spares are provided for the MISR Mechanisms Handling Fixture.

3.10.5 MISR Mechanisms Handling Fixture Shipping Container and Packing Material

(TBD 12)

3.11 MISR Dust Cover

MISR Dust Cover is shown in Figure 1–11 and described in the following sections.

3.11.1 MISR Dust Cover Description

(TBD 13)

3.11.2 MISR Dust Cover Usage

The MISR Dust Cover will be used to cover the MISR instrument during shipping, storage, and all integration and test activities where the instrument is not involved.

3.11.3 MISR Dust Cover Disposition

The disposition of the MISR Dust Cover and its spares, shipping container, and packing material is described in the following sections.

3.11.3.1 MISR Dust Cover Delivery to Martin Marietta

The MISR Dust Cover will be delivered to Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.11.3.2 MISR Dust Cover [Return to {Instrument Provider} and/or Storage at Martin Marietta and/or Delivery to Launch Site and/or Delivery to {Other Location} and/or Disposal]

(TBD 13)

3.11.4 MISR Dust Cover Spares

No spares are provided for the MISR Dust Cover.

3.11.5 MISR Dust Cover Shipping Container and Packing Material

(TBD 13)

3.12 MISR Collimator Array Tool

MISR Collimator Array Tool is shown in Figure 1–12 and described in the following sections.

3.12.1 MISR Collimator Array Tool Description

(TBD 14)

3.12.2 MISR Collimator Array Tool Usage

The MISR Collimator Array Tool is used to verify the alignment of the camera boresights to the instrument boresight cube.

3.12.3 MISR Collimator Array Tool Disposition

The disposition of the MISR Collimator Array Tool and its spares, shipping container, and packing material is described in the following sections.

3.12.3.1 MISR Collimator Array Tool Delivery to Martin Marietta

The MISR Collimator Array Tool will be delivered to Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.12.3.2 MISR Collimator Array Tool [Return to {Instrument Provider} and/or Storage at Martin Marietta and/or Delivery to Launch Site and/or Delivery to {Other Location} and/or Disposal]

(TBD 14)

3.12.4 MISR Collimator Array Tool Spares

No spares are provided for the MISR Collimator Array Tool.

3.12.5 MISR Collimator Array Tool Shipping Container and Packing Material

(TBD 14)

3.13 Spacecraft Interface Simulator

Spacecraft Interface Simulator (SIS) is shown in Figure 1–13 and described in the following sections.

3.13.1 Spacecraft Interface Simulator Description

The SIS is a piece of electrical GSE designed and manufactured by Martin Marietta to simulate spacecraft–to–instrument and SIS–to–IGSE interfaces. It consists of a Sun workstation (including a tape drive and a QMS printer) running OASIS and two racks of equipment which consists of a combination of commercial and custom test equipment. All of the equipment is controlled and monitored from the Sun workstation. It simulates the spacecraft–level test environment in that the same database, procedures, and displays used for spacecraft–level I&T are used on the SIS.

The SIS is capable of controlling IGSE via an IEEE–488 interface and of verifying the presence or absence of a test pattern in the science data. An Ethernet interface is provided to permit non–real–time electronic transfer of files from the SIS to/from another computer. Note that there are no analysis tools provided with the SIS for off–line data analysis.

3.13.2 Spacecraft Interface Simulator Usage

The SIS is used to verify the compatibility of the instrument command and housekeeping telemetry database, including calibration curves and limit definitions, and automated test procedures, known as building blocks, written in CSTOL. The SIS is the source of all commands for the instrument and the SIS GSE during the SIS interface test. The SIS is used for the real–time collection, processing, display, and archiving of housekeeping telemetry. It collects and distributes science data to the IGSE in the same manner as the SCS during spacecraft–level I&T.

3.13.3 Spacecraft Interface Simulator Disposition

The disposition of the SIS and its spares, shipping container, and packing material is described in the following sections.

3.13.3.1 Spacecraft Interface Simulator Delivery to JPL

The SIS will be delivered to **(TBD 15)** at JPL on **(TBD 15)** .

3.13.3.2 Spacecraft Interface Simulator Return to Martin Marietta

3.13.4 Spacecraft Interface Simulator Spares

(TBD 15)

3.13.5 Spacecraft Interface Simulator Shipping Container and Packing Material

(TBD 15)

3.14 MISR System Test Equipment

MISR System Test Equipment is shown in Figure 1–14 and described in the following sections.

3.14.1 MISR System Test Equipment Description

The MISR System Test Equipment is made up of the following items:

Electronics Rack #1:

SPARC 10 Model 41 Workstation
SPARC Printer
UNIX Keyboard with Optical Mouse
1280 X 1024 x 8 Color Monitor
IGSE Power Cable

Electronics Rack #2:

UNIX Keyboard with Optical mouse
Expansion SCSI /SBus Chassis
High Rate Science Bus / Time Mark and Frequency Bus Unit
Quad 1000 Watt Programmable Power Supply Unit
1553 Cable
High Rate Science Data Cable
Time Mark & Frequency Cable
Instrument Power Cable (DC)
IGSE Power Cable (AC)

Color Monitor

1280 X 1024 x 8 Color Monitor

3.14.2 MISR System Test Equipment Usage

The MISR System Test Equipment will be used during all integration and test activities during which the MISR instrument is operating.

3.14.3 MISR System Test Equipment Disposition

The disposition of the MISR System Test Equipment and its spares, shipping container, and packing material is described in the following sections.

3.14.3.1 MISR System Test Equipment Delivery to Martin Marietta

The MISR System Test Equipment will be delivered to Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.14.3.2 MISR System Test Equipment Delivery to Launch Site

(TBD 16)

3.14.4 MISR System Test Equipment Spares

No spares are provided for the MISR System Test Equipment.

3.14.5 MISR System Test Equipment Shipping Container and Packing Material

(TBD 16)

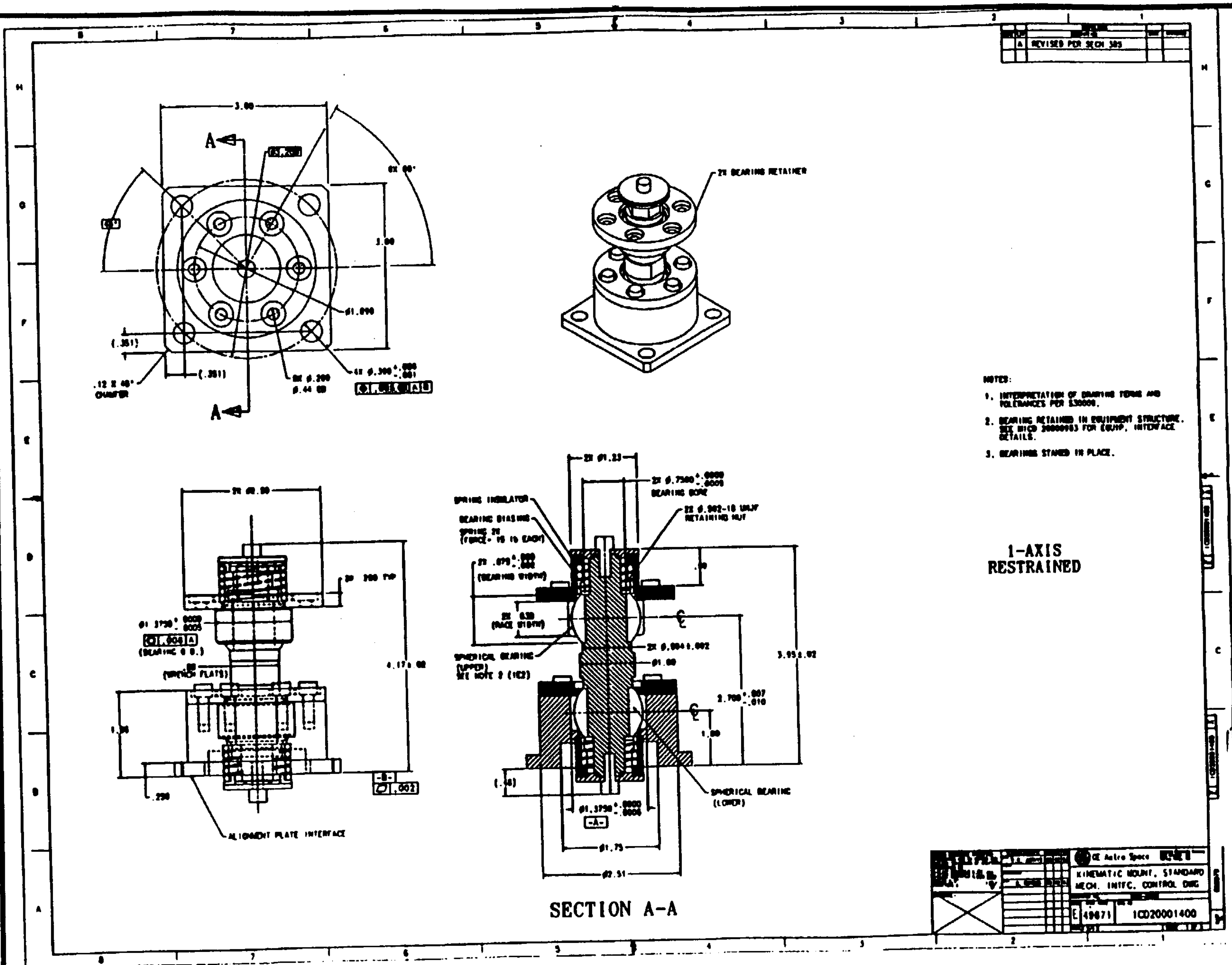

Figure 1–1a. MISR Test Kinematic Mount: 1–Axis

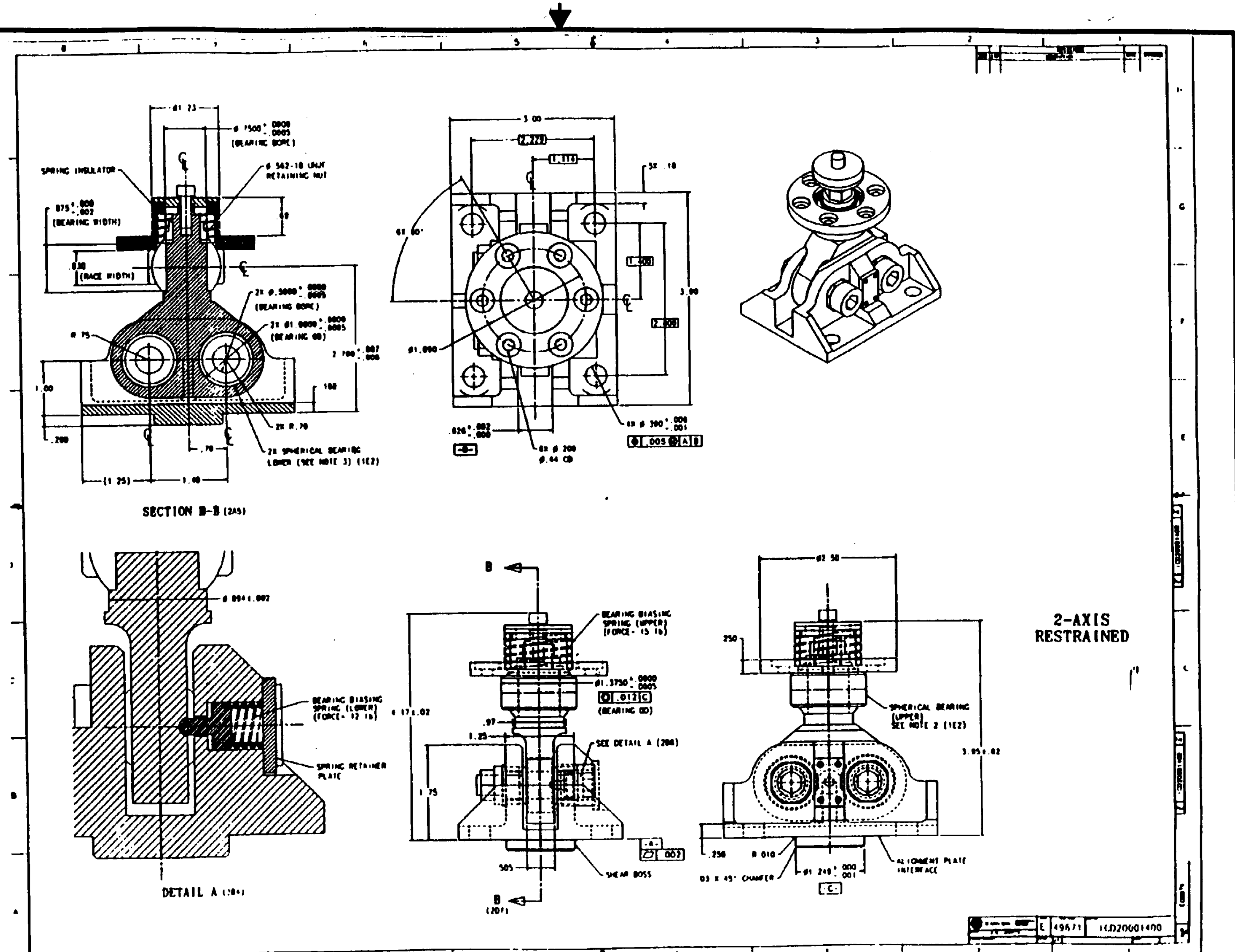

Figure 1–1b. MISR Test Kinematic Mount: 2–Axis

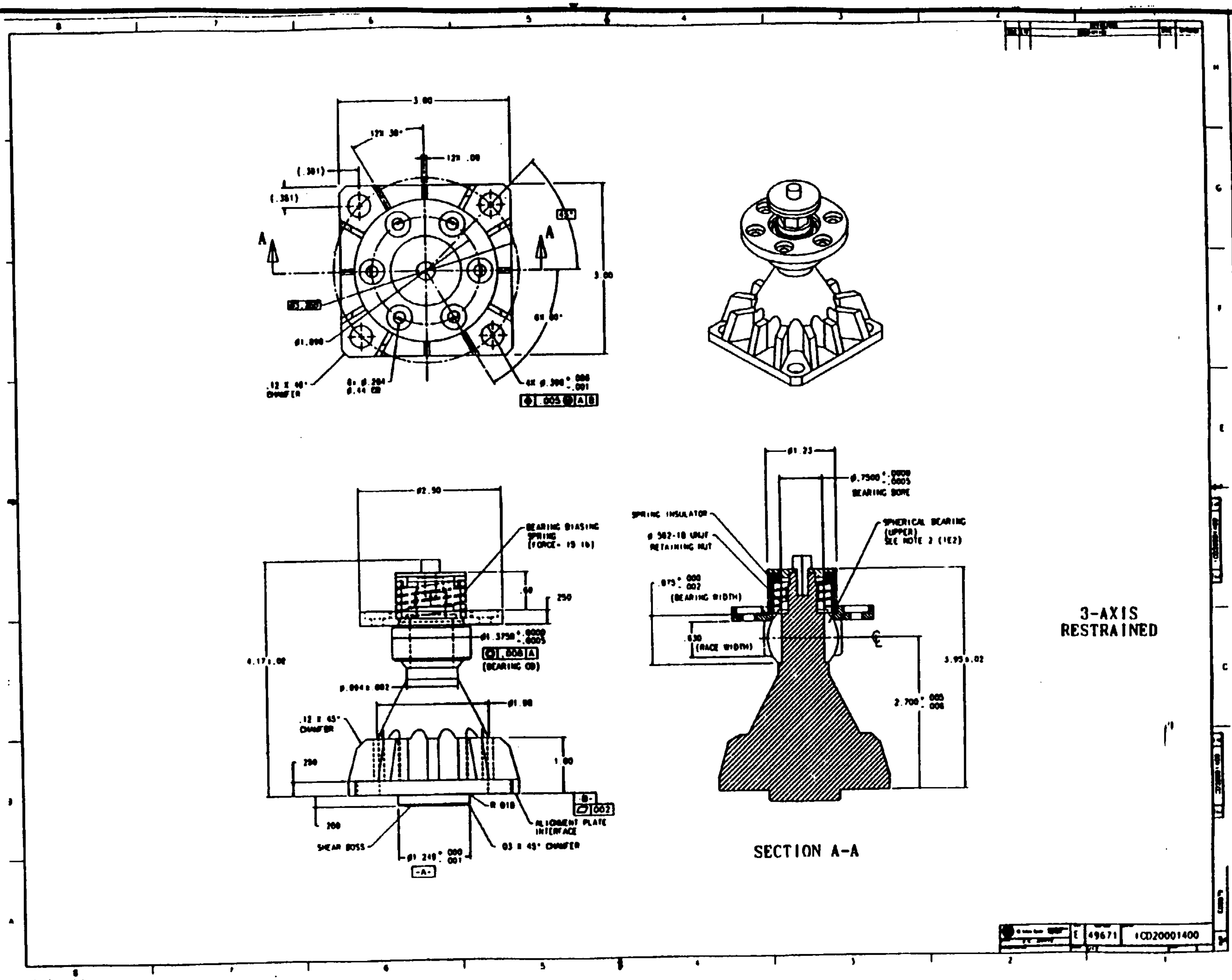

Figure 1–1c. MISR Test Kinematic Mount: 3–Axis

(TBD 17)

Figure 1–2. MISR Drill–Alignment Fixture

(TBD 17)

Figure 1–3. MISR Master Plate

(TBD 17)

Figure 1–4. MISR Work Stand

(TBD 17)

Figure 1–5. MISR Transport Fixture

(TBD 17)

Figure 1–6. MISR Shipping Containers

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(TBD 17)

Figure 1–7. MISR Purge Unit

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Figure 1–8. MISR Camera Diode Container Purge Units

(TBD 17)

Figure 1–9. MISR Lifting Fixture

(TBD 17)

Figure 1–10. MISR Mechanisms Handling Fixture

(TBD 17)

Figure 1-11. MISR Dust Cover

(TBD 17)

Figure 1–12. MISR Collimator Array Tool

(TBD 17)

Figure 1–13. Spacecraft Interface Simulator

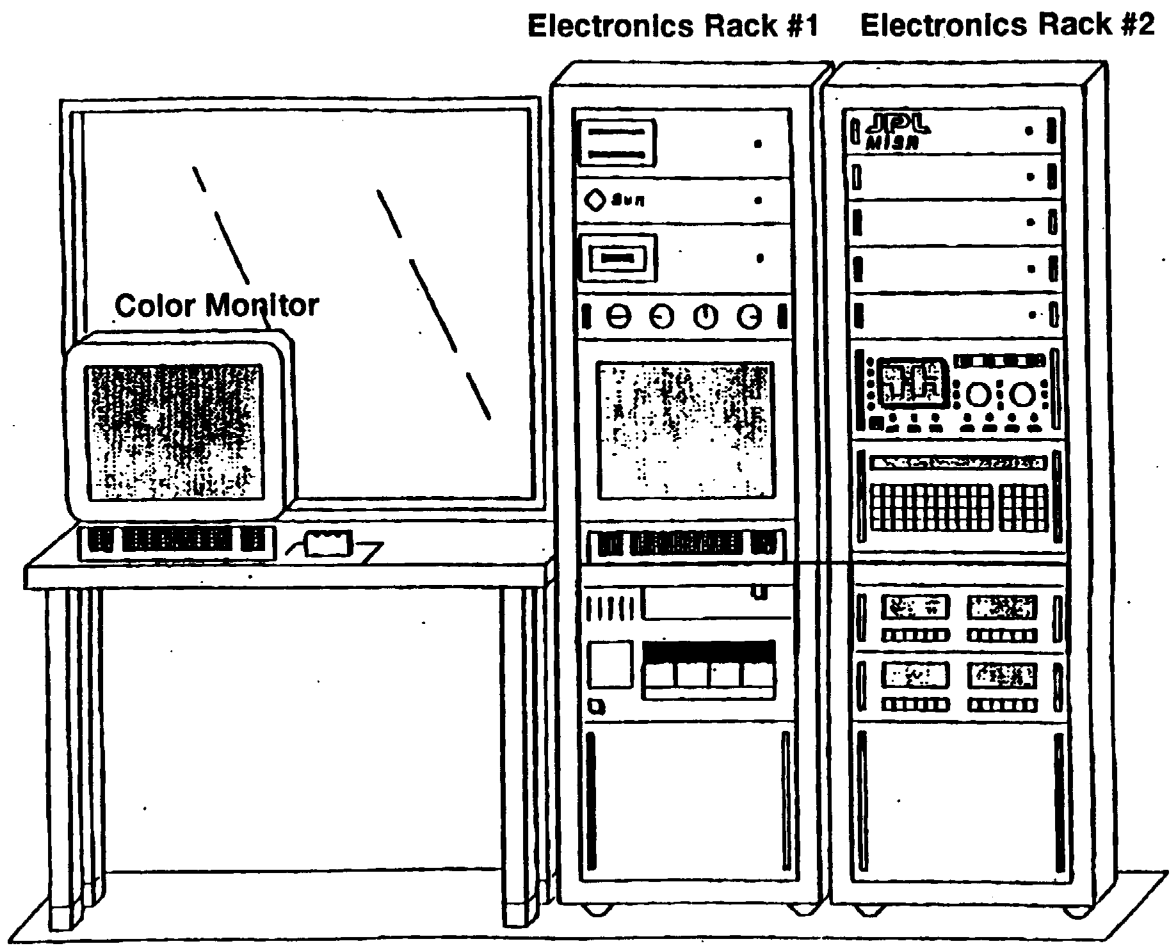

Figure 1–14. MISR System Test Equipment

4 FACILITIES

This section describes the facilities that will be used to support EOS instrument integration, test, and launch site activities.

1. The spacecraft–level I&T and launch site facilities are listed below and described in the following sections. The facility floor plans showing the MISR and IGSE layout are shown in Figures 2–2 through 2–12.

   Spacecraft–level I&T facilities

   a. Shipping and Receiving Area
   b. Bench Acceptance Test Area
   c. MISR Integration and Test Ground Station
   d. Bay 8
   e. 35–foot Thermal Vacuum Chamber
   f. Acoustic Chamber
   g. Storage

   Launch site facilities

   a. Vandenberg Air Force Base (VAFB)
   b. MISR Launch Site Ground Station
   c. Launch Site Processing Facility

2. The MISR requirements which will be supported by the spacecraft–level I&T and launch site facilities are summarized in Table III.

3. The IGSE requirements which will be supported by the Jet Propulsion Laboratory (JPL), spacecraft–level I&T, and launch site facilities are summarized in Tables IV and V.

4.1 Integration and Test Facilities

The EOS integration and test will take place in Building 417 of the Martin Marietta–ASD East Windsor, NJ, plant. The Martin Marietta–ASD East Windsor plant is shown in Figure 2–1, and the Building 417 facility floorplan is shown in Figure 2–2.

4.1.1 Shipping and Receiving Area

All hardware arriving at the Martin Marietta–ASD East Windsor, NJ, plant will be delivered to the Shipping and Receiving Area at the east side of Building 409. This area is a standard shipping dock capable of handling equipment which can be off–loaded manually or with a fork lift. Equipment must pass through a door 7.5 feet wide x 8 feet high. Equipment requiring an overhead crane or which will not fit through the area door will be off–loaded at the east end of Building 417. The Shipping and Receiving Area is located approximately 300 yards away from the Bench Acceptance Test Clean Room. The hallway between these two facilities is slightly more than 7 feet wide and it is not environmentally controlled. All equipment must be received before being moved to the Bench Acceptance Test (BAT) area.

4.1.2 Bench Acceptance Test Area

The instrument and IGSE will be inspected in the BAT area.

4.1.2.1 Bench Acceptance Test Control Room

The BAT Control Room is 35 feet long and 15 feet wide. It is located adjacent to the BAT Clean Room and contains feed throughs directly into the clean room. Windows in the room provide visibility into the clean room. Access to the room is provided by a double door located in the rear of the room. All non–clean–room–compatible IGSE required for instrument BAT, including the instrument I&T ground station, will be located in this room for the duration of the BAT. It is sized to permit simultaneous processing of two instruments. Electrical power requirements documented in this ICD will be accommodated. A floorplan of the BAT Control Room, including IGSE layout, is shown in Figure 2–3.

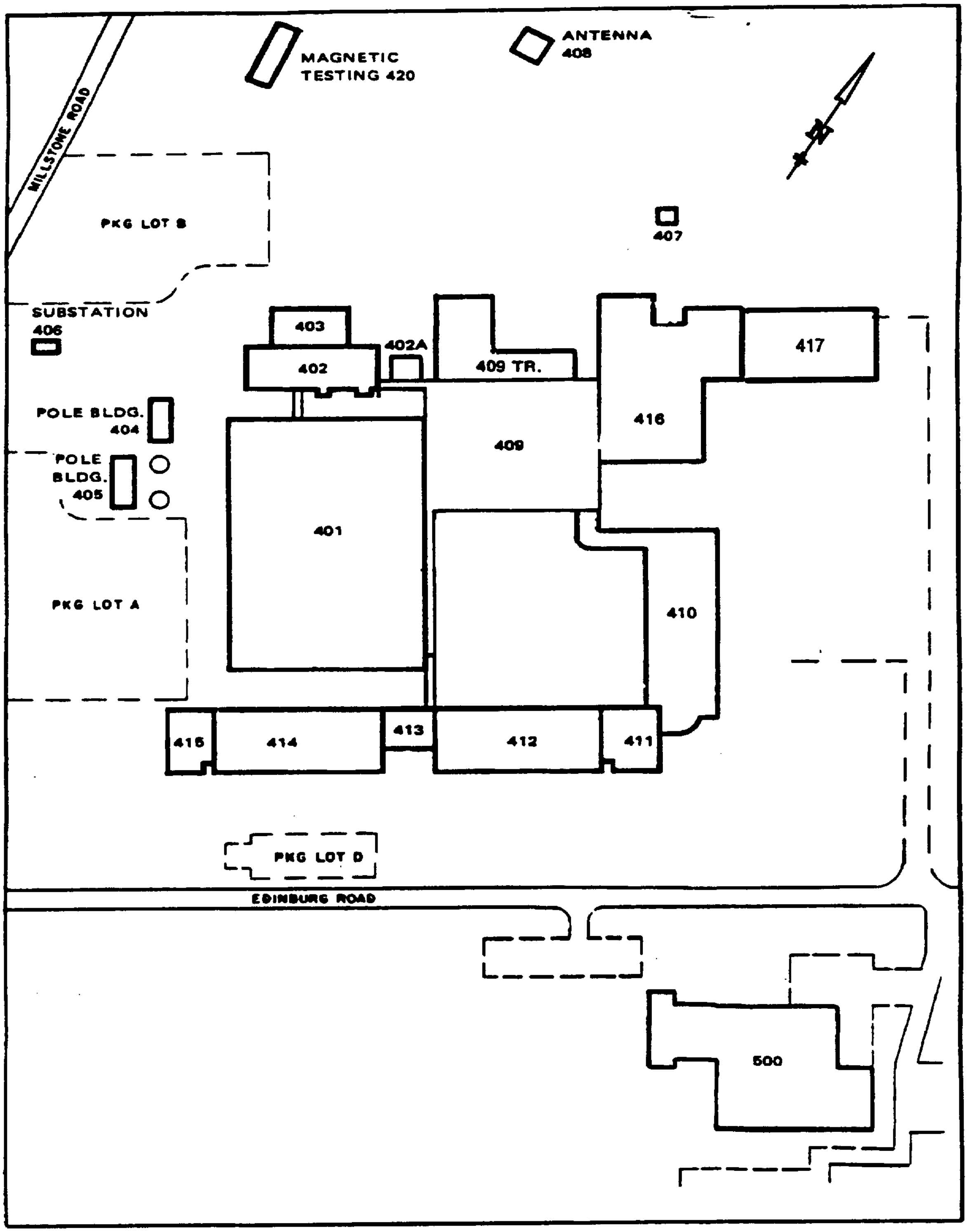

Figure 2–1. Martin Marietta ASD East Windsor Plant

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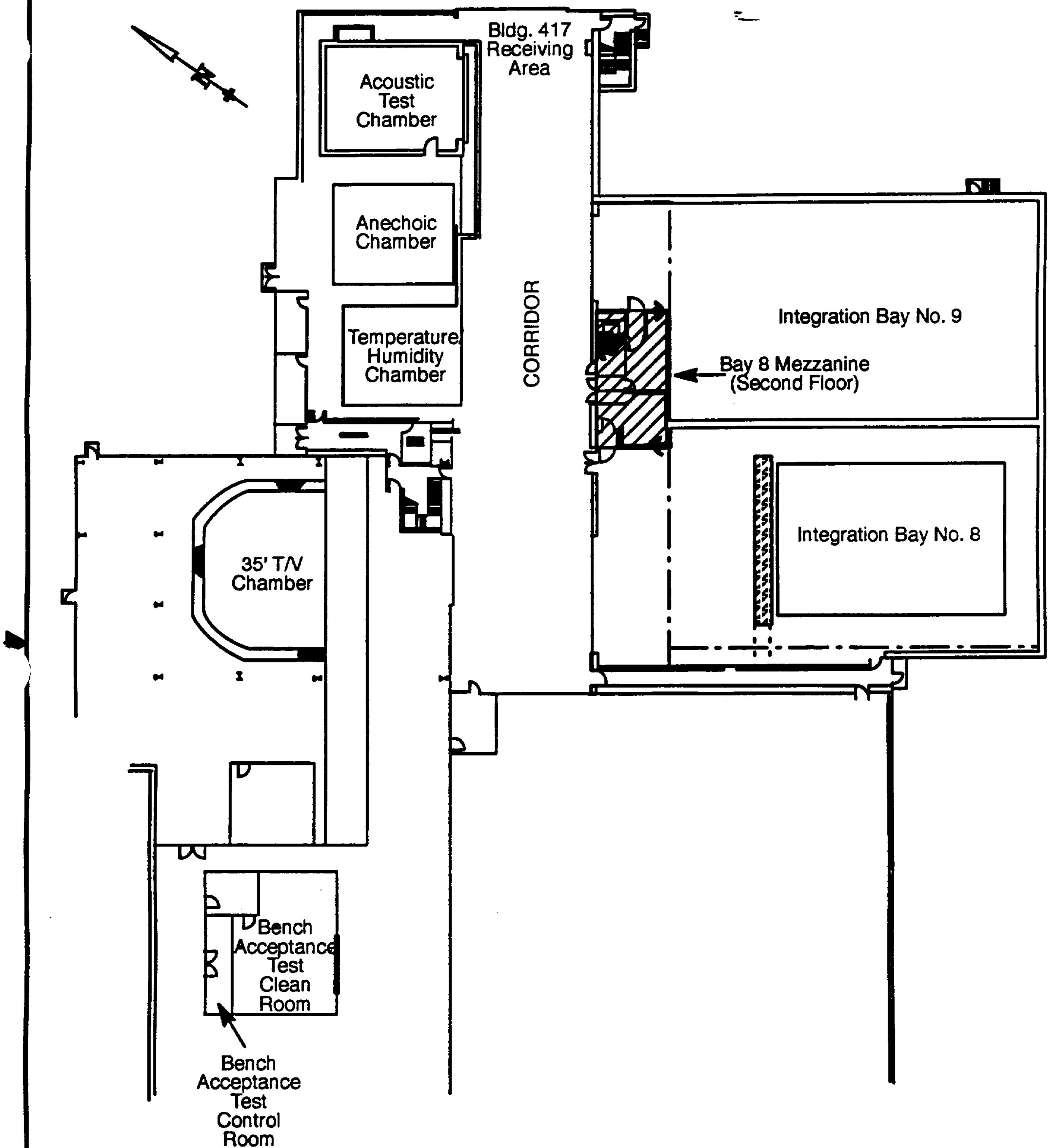
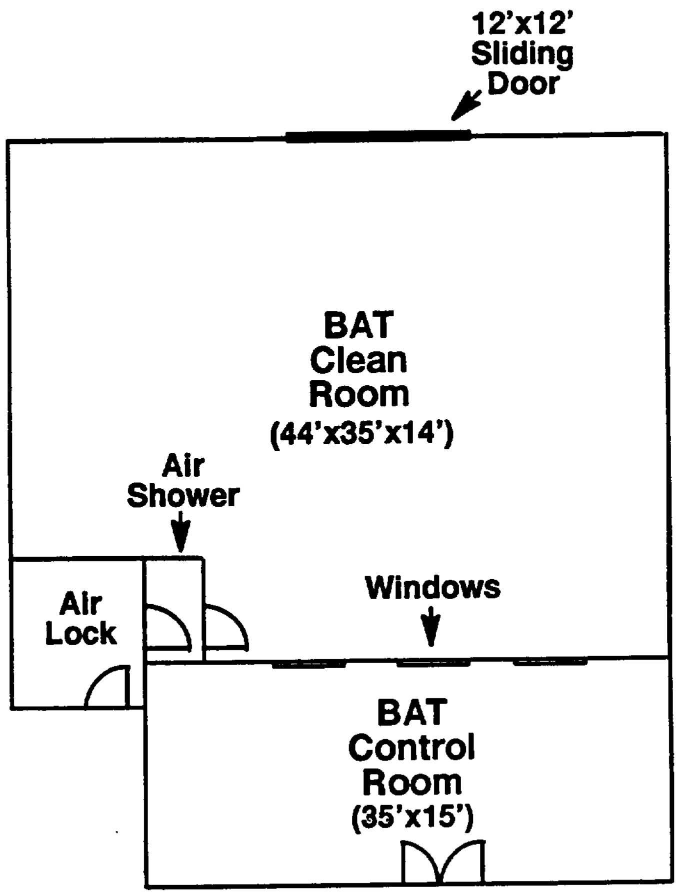


Figure 2–2. Building 417 Facilities



MISR IGSE layout is (TBD 18)

Figure 2–3. Bench Acceptance Test Area Floorplan

4.1.2.2 Bench Acceptance Test Clean Room

The BAT Clean Room is an environmentally controlled room dedicated to EOS instruments for testing and processing prior to spacecraft integration. It is 44 feet long, 35 feet wide and 14 feet high, and is sized to permit simultaneous processing of two instruments. It is maintained at Class 10,000. It is temperature and humidity controlled.

Equipment enters the room through a 12'x12' sliding door. Personnel access is controlled through a separate door with a cypher lock via an air shower. The room does not have an air lock for equipment. A portable two ton crane with a 11' hook height will be provided for lifting operations. Air, vacuum and GN_2 connections are available on the wall at multiple locations in the room. Electrical power requirements documented in this ICD will be accommodated. A floorplan of the BAT Clean Room, including MISR and IGSE layout, is shown in Figure 2–3.

4.1.3 Instrument Integration and Test Ground Station

The Instrument I&T Ground Station will be located on the fourth floor of Building 417, adjacent to the Spacecraft Test Control Room and Spacecraft Checkout Station, subsequent to the BAT and for the duration of the instrument I&T activities. Each instrument will be provided with a ground station area of approximately 150–200 square feet. Separate office space will be provided.

The Instrument I&T ground station area will accommodate the electrical power requirements documented in this ICD. The area provides fluorescent lighting and forced air cooling (three 115,000 BTU air conditioners), and has a raised floor. The ceiling height is approximately 8 feet.

Access to the fourth floor is provided by an elevator which has a door opening of 3.5 feet wide x 7 feet high. The elevator is 6.5 feet deep and rated to lift up to 3000 lbs.

The IGSE layout in the MISR I&T Ground Station is shown in Figure 2–4.

(TBD 19)

Figure 2–4. MISR I&T Ground Station

4.1.4 Bay 8

The Bay 8 floorplan is shown in Figure 2–5.

4.1.4.1 Bay 8 Mezzanine

The Bay 8 Mezzanine is located on the second floor of Building 417 immediately adjacent to Integration Bay 8. It is located above the Bay 8 air lock and shower. It is approximately 41 feet long and 8 feet high. Half of the area is 20 feet wide. The other half of the area is 12 feet wide. It will be used for non–clean–room–compatible GSE that must be located close (within 100 feet) to the spacecraft. To minimize clutter around the spacecraft, as space permits, the mezzanine will be used for clean–room–compatible GSE that does not require Class 10,000 cleanliness control and can be located up to 100 feet from the spacecraft.

The mezzanine is a raised floor area which will accommodate the electrical power requirements documented in this ICD. Personnel access is provided by a door on the first floor. Access is controlled with a cypher lock. Access for equipment is provided by a double door (5 feet wide x 7 feet high) on the second floor which opens into the Building 417 corridor. A fork lift and special equipment loading platform are used to move equipment into the mezzanine.

The Bay 8 Mezzanine, including IGSE layout, is shown in Figure 2–6.

4.1.4.2 Integration Bay 8

Integration Bay 8 is located in Building 417. It is 112 feet long, 64 feet wide and 65 feet high. It contains a seismic mass which is 70 feet long, 45 feet wide and 6 feet deep. On top of the seismic mass is a 100 ton, 13 feet diameter precision rotary table which is used for spacecraft alignment. The bay contains a 20 ton and a 5 ton crane, each with a hook height of 55 feet and a 20' x 40' Table used for spacecraft deployment testing.. It has a laminar flow air handling system which controls the cleanliness of the bay to better than Class 10,000. The air handling system also maintains bay temperature to ±2°F of the set point and bay humidity within the range 30 to 50%. Access to the bay is provided by a 35 foot wide, 45 foot high sliding door. Personnel access is provided via an air lock and air shower. Access is controlled by a cypher lock. Air, vacuum and GN_2 connections are available on the wall at multiple locations in the bay.

Integration Bay 8, including spacecraft and GSE layout, is shown in Figure 2–7.

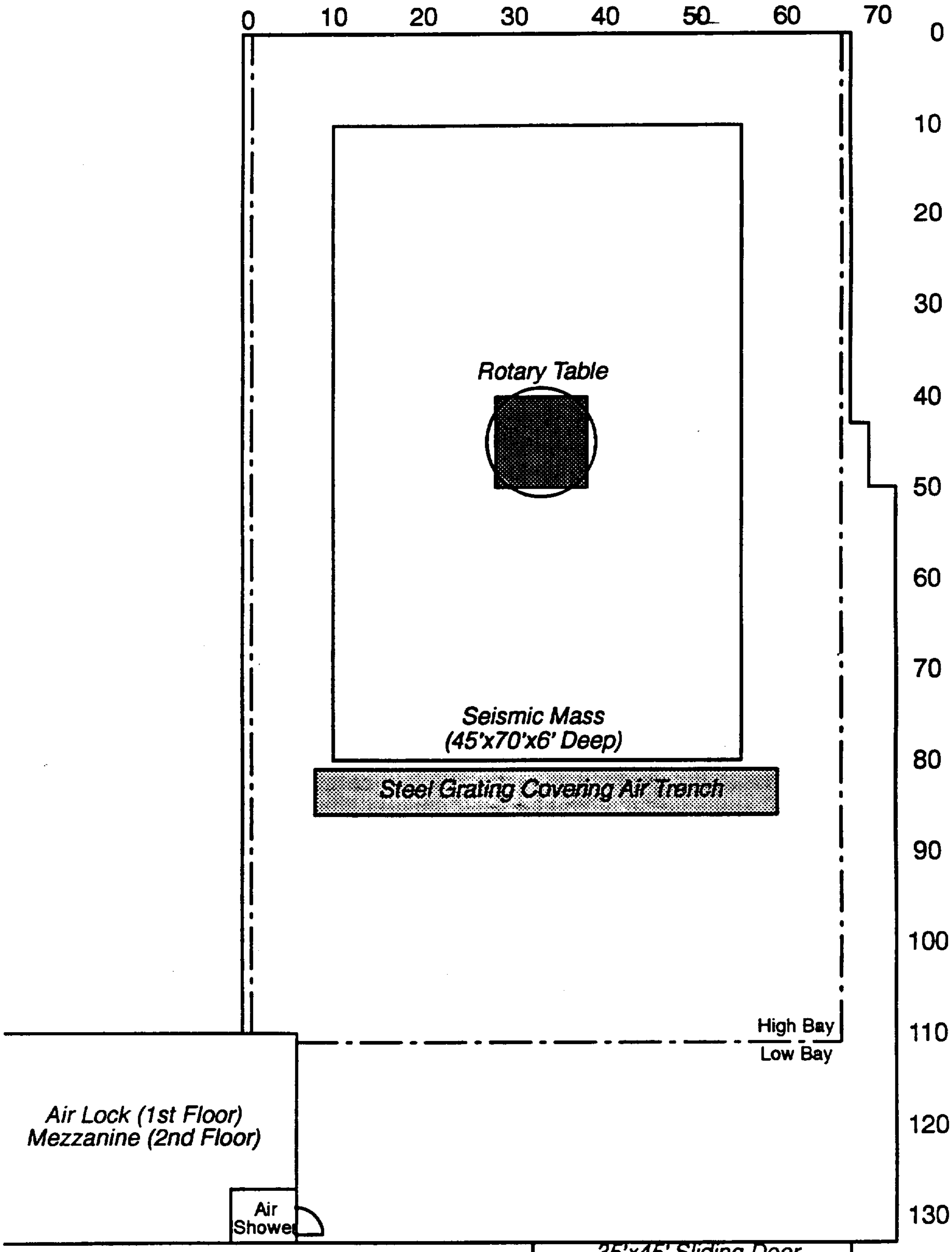


Figure 2–5. Integration Bay 8 Floorplan

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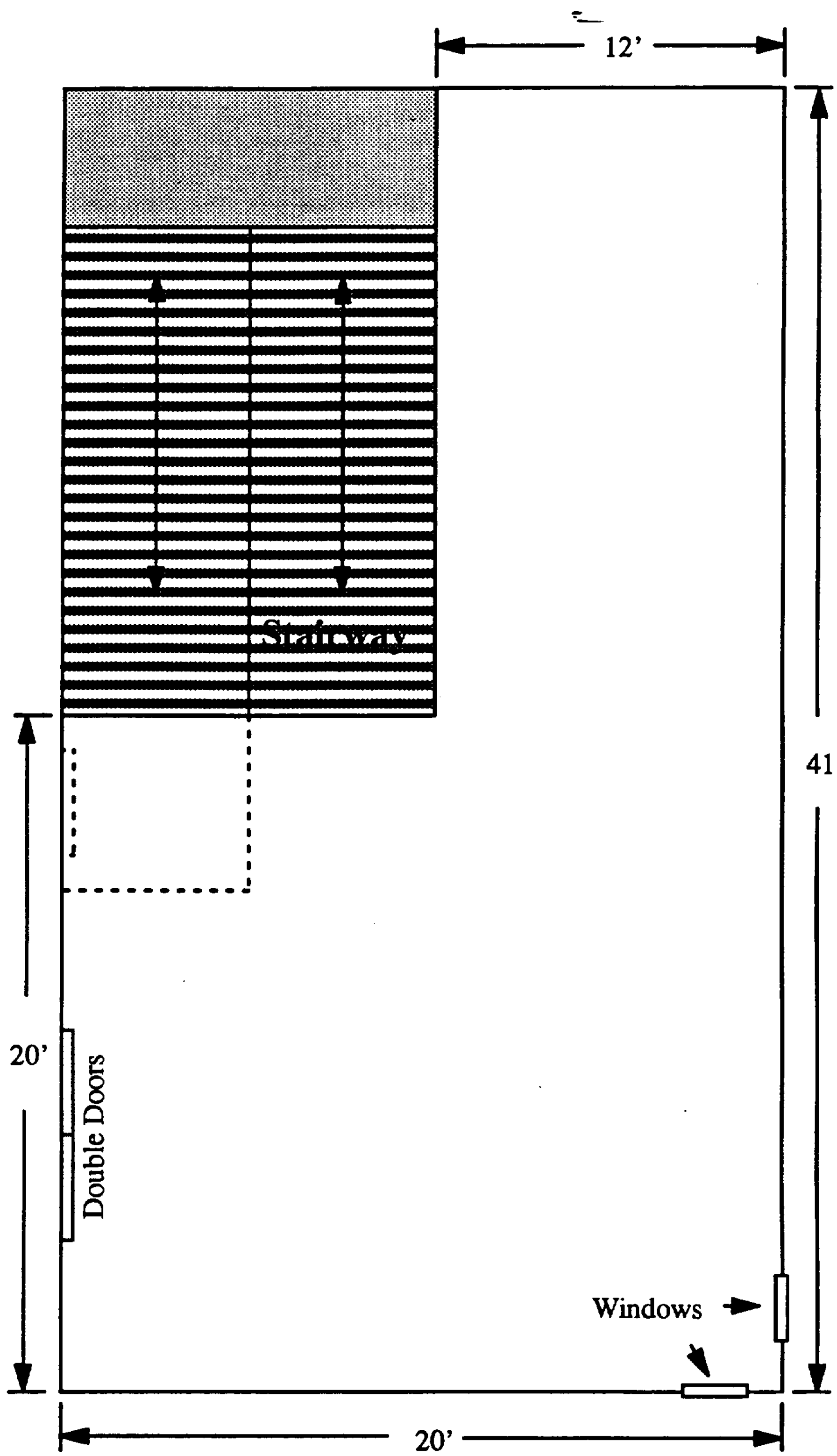

Figure 2–6. Bay 8 Mezzanine

Size	Code Ident No.	
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		Sheet 63

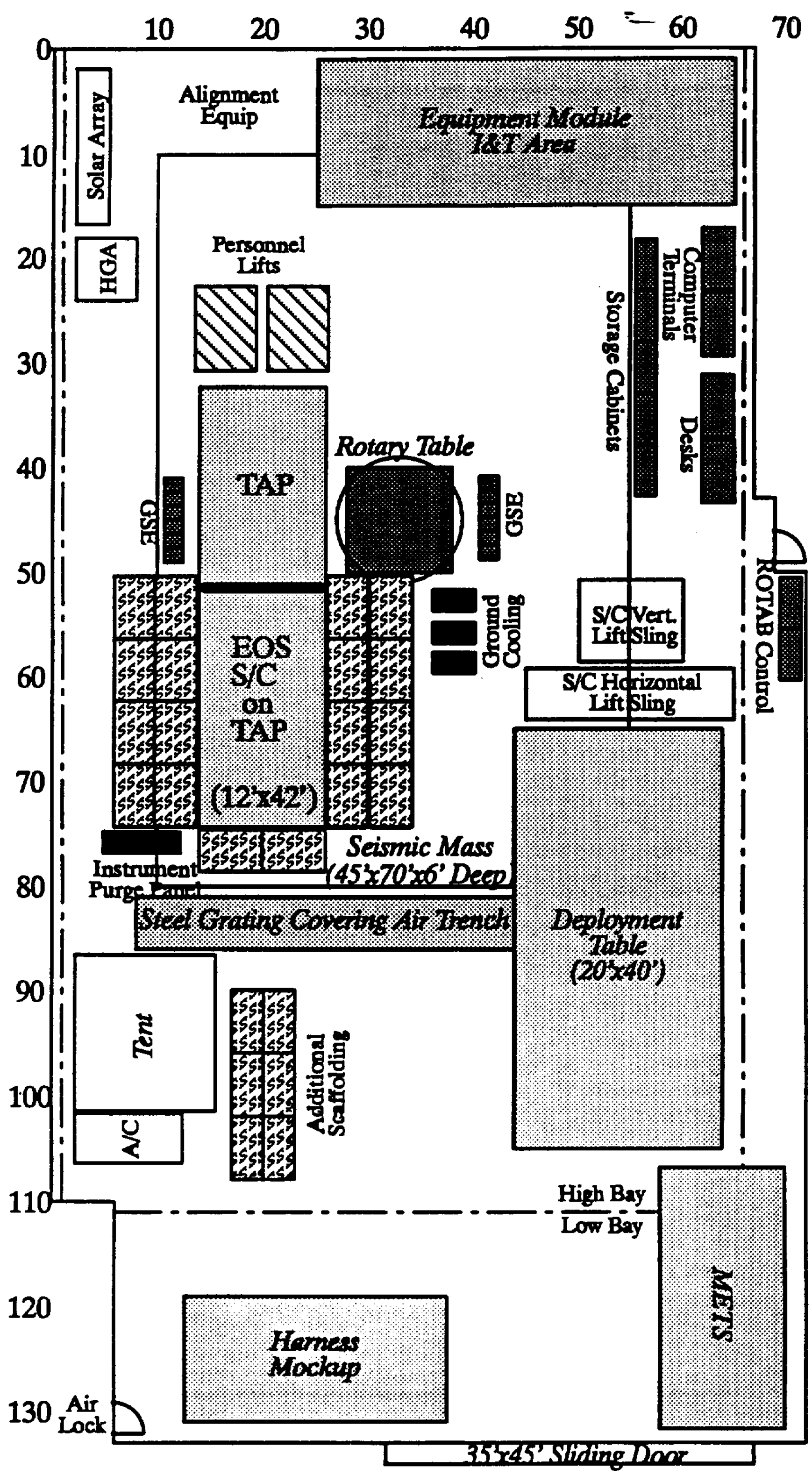

Figure 2–7. Integration Bay 8

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4.1.5 35–foot Thermal Vacuum Chamber

The 35–Foot Thermal Vacuum Chamber has a working diameter of 35 feet and an inside height of 45 feet. The side–opening 49–foot diameter main door is removable and allows for loading fully integrated test items at floor level. At ambient conditions, it is temperature and humidity controlled, and maintained at Class 10,000. Using two mechanical roughing trains and six 48–inch cryogenic pumps, a pressure of $5x10^{-6}$ Torr is achieved after 24 hours.

The interior surfaces of the 35–Foot Thermal Vacuum Chamber are maintained at extremely low temperatures to simulate the low energy, absorbing characteristics of space. These surfaces consist of a system of eight independently controlled black cooling panels (shroud) which line the walls, ceiling and floor, and through which gaseous or liquid nitrogen is circulated. Each panel can be individually thermally controlled from +125 to −185°C when liquid nitrogen is used. All surfaces facing the test article have an emissivity of ≥0.95.

There is a 5 ton crane located on the center line of the chamber ceiling, and three 3 ton cranes located 120° apart, 13 feet from the ceiling center line. Personnel access is provided by a 6.5–foot door. Penetrations for GSE are provided and require the use of **(TBD 20)** connectors and cable lengths >**(TBD 21)** feet. Gas and fluid lines are **(TBD 22)**. Chamber instrumentation includes 580 channels for thermocouples (460 channels for the unit under test and 120 channels for the facility) and a 200 AMU residual gas analyzer (by prior arrangement). Emergency power is available.

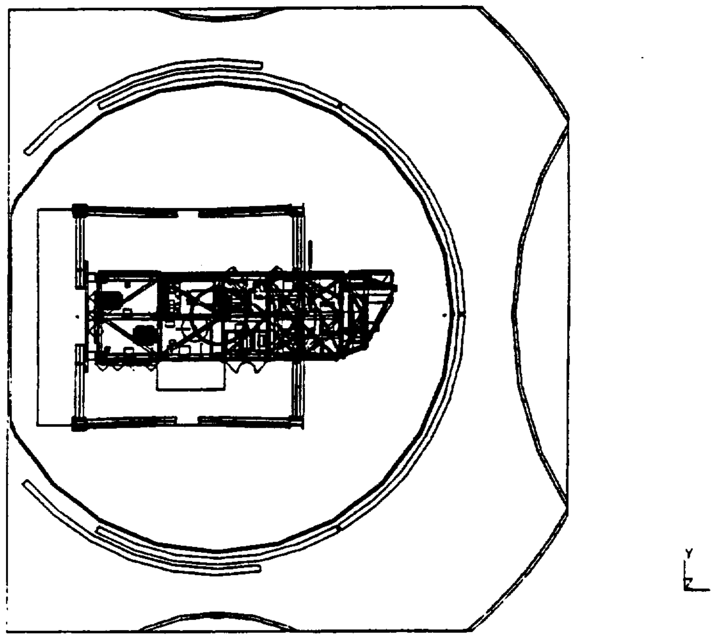
The spacecraft and GSE layout in the 35–foot Thermal Vacuum Chamber is shown in Figure 2–8.

4.1.6 Acoustic Chamber

The Acoustic Chamber is a reinforced concrete reverberant noise test chamber designed for acoustic generated dynamic simulation testing. The acoustic energy is generated by a flow of nitrogen gas, which is frequency controlled by two Wyle WAS 3000 air stream modulators and two Ling EPT 200 modulators, and temperature controlled to 20°C ±5°C. Up to eight microphones within the chamber measure the acoustic levels, which for test are up to 155 dB and have a shaped frequency range from 25 to 10,000 Hz.. The chamber is equipped with safety interlocks and an air ventilation system. At ambient conditions, it is temperature and humidity controlled, and maintained at Class 10,000.

The Acoustic Chamber is 31.5 feet wide, 41.8 feet deep, and 45.5 feet high. The side–opening door is 25 feet wide by 45 feet high.

The spacecraft and GSE layout in the Acoustic Chamber is shown in Figure 2–9.



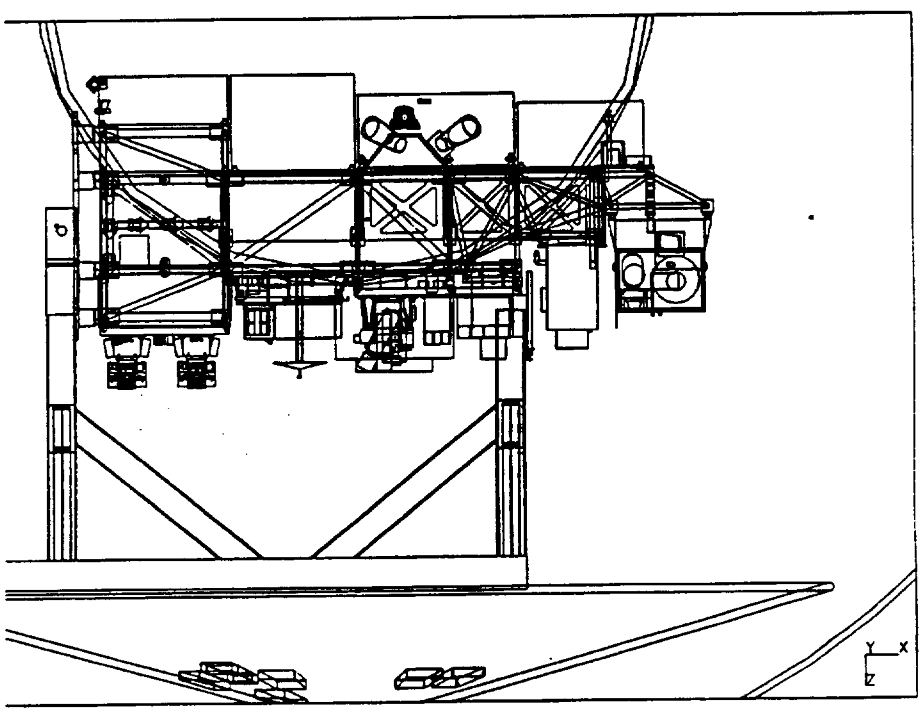


Figure 2–8. 35–Foot Thermal Vacuum Chamber

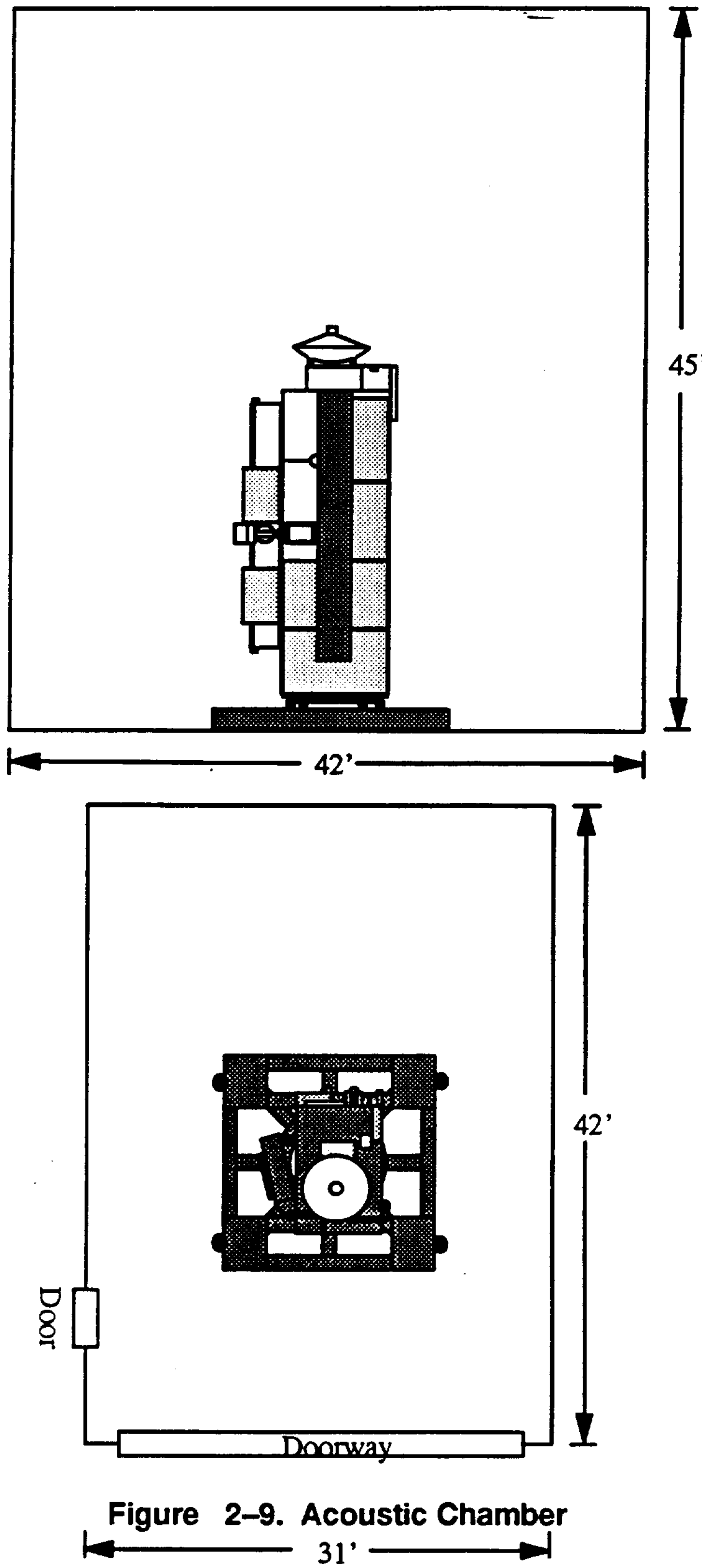


Figure 2–9. Acoustic Chamber

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4.1.7 Storage

4.1.7.1 Bonded Stock

Bonded Stock

4.1.7.2 Other Storage

The storage area

The MISR and IGSE layout in the storage area is shown in Figure 2–10.

(TBD 23)

Figure 2–10. Storage Area

4.2 Launch Site

The EOS launch site activities will take place at the Western Test Range (WTR) at Vandenberg Air Force Base (VAFB) in Building 1610. Administrative support will be located in Building 836 and launch will take place from Space Launch Complex 3 (SLC–3) **(TBR 2)**. The VAFB is shown in Figure 2–11.

4.2.1 Launch Site Processing Facility

The spacecraft and GSE layout in the Launch Site Processing Facility is shown in Figure 2–12.

4.2.2 MISR Launch Site Ground Station

The MISR Launch Site Ground Station

The IGSE layout in the MISR Launch Site Ground Station is shown in Figure 2–13.

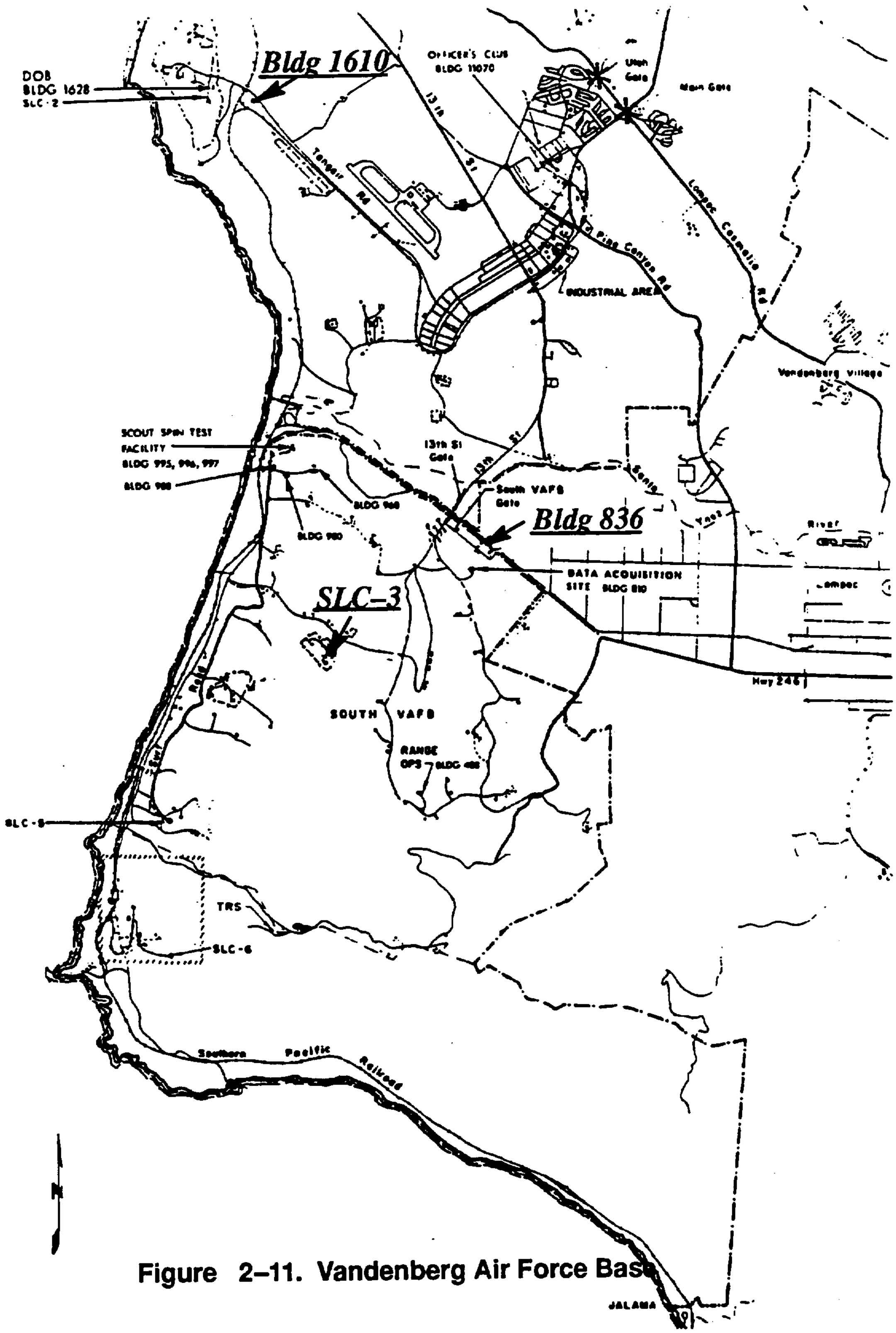

Figure 2–11. Vandenberg Air Force Base

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			Sheet 70

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(TBD 24)

Figure 2–12. MISR Launch Site Processing Facility

(TBD 25)

Figure 2–13. MISR Launch Site Ground Station

Table III. Instrument Facility Requirements (TBD 26)

Parameter	Requirement
Environment	
Temperature (°C)	
Relative humidity (%)	
Lighting	
Cleanliness	Class 10,000 during spacecraft I&T Class 100,000 at the launch site
Access	Cover removal during closeouts at launch site requires access only to external surfaces
Control	
Time	
Comments	

Table IV. Instrument Ground Support Equipment Physical Requirements (TBD 27)

Item	Size (ft) Length	Width	Height	Dia	Weight (lbs)	Electrical Service: Pwr Input (VAC)	(Hz)	(φ)	(Amp)	Pwr Cons (W)	Connector Type	Cable Lgth (ft)	Grounding	Notes
1														
2														
3														
4						208	60	3	30		Male (SIS): NEMA Code L21–30P (Hubble 2815) Female (Facility): NEMA Code L21–30R (Hubble 2813 or 28CM13)		Isolation transformer supplied by MMC connections **(TBD 28)** Other grounding (TBD 28)	1.
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														

Notes:

*	Penetration connector (connector type)
φ	Phase
Amp	Amperes
Cons	Consumption
Dia	Diameter
ft	Feet
Hz	Hertz
lbs	Pounds
Lgth	Length
Pwr	Power
VAC	Volts alternaling current
W	Watts

1. "WYE"

Table V. Instrument Ground Support Equipment Environmental Requirements (TBD 29)

Item	Environment					Access		Comments
	A/C Load (W)	Temp (°C)	RH (%)	Lighting	Clean	Control	Time	
1								
2								
3								
4								
6								
7								
8								
9								
10								
11								
12								
13								
14								

Notes:

- A/C Air conditioning
- C Centigrade
- Clean Cleanliness
- RH Relative humidity
- Temp Temperature
- W Watts

Table VI. Consumables (TBD 30)

Description	Quantity	Provider

Table VII. Documentation (TBD 31)

Description	Provider	Storage Method	Access Control	Access Time	Maintenance Responsibility
Manuals					
Pre–ship data package					
Post–delivery inspection report					
Test data					

5.1 Personnel Support

5.1.1 Martin Marietta–Provided Personnel Support

(TBD 32)

5.1.2 Instrument–Provided Personnel Support

(TBD 32)

5.2 Computer Maintenance

5.2.1 Computer Maintenance at Instrument Provider Facility

(TBD 33)

5.2.2 Computer Maintenance at Martin Marietta

(TBD 33)

5.2.3 Computer Maintenance at Launch Site

(TBD 33)

5.3 Other Martin Marietta–Provided Equipment And Facilities

5.3.1 Other Martin Marietta–Provided Equipment And Facilities at Martin Marietta

Martin Marietta will provide the following additional equipment and facilities at Martin Marietta:

1. Non–escort badges for the following individuals for the period [delivery minus 1 month] through 30 September 1998:

Name	Affiliation	Citizenship
(TBD 34)		

2. Office furniture
   a. 1 telephone line with 2 phones
   b. 2 desks
   c. 2 tables
   d. 3 chairs
   e. 1 filing cabinet
   f. 1 bookcase

3. Ground station furniture
   a. 1 telephone line with 2 phones
   b. 1 line on the I&T voice net with 3 speakers and 3 headsets
   c. 1 modem with dedicated telephone line
   d. 2 desks
   e. 2 tables
   f. 5 chairs
   g. 1 filing cabinet
   h. 1 bookcase

4. Clean room garments
   a. **(TBD 35)** [qty] suits size **(TBD 35)**
   b. **(TBD 35)** [qty] shoes size **(TBD 35)**
   c. **(TBD 35)** [qty] hoods

5. Access to copier, FAX, and mail room

6. Secretarial support

7. General purpose test equipment and standard tools

8. Quality Assurance support

9. Standard test equipment calibration

10. Contamination sampling and laboratory analysis

5.3.2 Other Martin Marietta–Provided Equipment And Facilities at the Launch Site

Martin Marietta will provide or arrange for the following additional equipment and facilities at the launch site :

1. Non–escort badges for the following individuals for the period [ship minus 1 month] through 30 September 1998:

Name	Affiliation	Citizenship
(TBD 36)		

2. Office furniture
   a. **(TBD 37)** [qty] telephone line with [qty] phones
   b. **(TBD 37)** [qty] desks
   c. **(TBD 37)** [qty] tables
   d. **(TBD 37)** [qty] chairs
   e. **(TBD 37)** [qty] filing cabinets
   f. **(TBD 37)** [qty] bookcases

3. Ground station furniture
   a. **(TBD 38)** [qty] telephone line with [qty] phones
   b. **(TBD 38)** [qty] lines on the I&T voice net with [qty] speakers and [qty] headsets
   c. **(TBD 38)** [qty] modem with dedicated telephone line
   d. **(TBD 38)** [qty] desks
   e. **(TBD 38)** [qty] tables
   f. **(TBD 38)** [qty] chairs
   g. **(TBD 38)** [qty] filing cabinets
   h. **(TBD 38)** [qty] bookcases

4. Clean room garments
   a. **(TBD 39)** [qty] suits size **(TBD 39)**
   b. **(TBD 39)** [qty] shoes size **(TBD 39)**
   c. **(TBD 39)** [qty] hoods

5. Access to copier, FAX, and mail room

6. Secretarial support

7. General purpose test equipment and standard tools

8. Quality Assurance support

9. Standard test equipment calibration

10. Contamination sampling and laboratory analysis

6 GROUND SUPPORT EQUIPMENT INTERFACES

1. The SIS–to–MISR interface is described in Section 6.1.

2. The SCS–to–MISR IGSE interface is described in Section 6.2.

3. The facility–to–MISR IGSE interface is described in Section 6.3.

6.1 Spacecraft Interface Simulator–to–MISR Interface

6.1.1 Spacecraft Interface Simulator–to–MISR Harness Definition

1. The block diagram of the harnesses between the SIS and MISR is shown in Figures 3 and 4. (All harnesses, with the exception of the harness from the SIS to the isolation transformer, are supplied by the Instrument Provider.)

2. The SIS–to–MISR harness lengths are shown in Table VIII.

3. The list of the SIS connectors used by the Instrument Provider to fabricate the SIS–to–MISR harnesses is shown in Table IX.

   a. The SIS–to–MISR interconnections are shown in Tables Xa through Xu. The following legend is used for wire type:

Coax	Coaxial transmission line
SC	Single conductor, unshielded
SCS	Single conductor, shielded
TP	Twisted pair, unshielded
TPS	Twisted pair, shielded
Tn	Twisted bundle of n wires, unshielded
TnS	Twisted bundle of n wires, shielded
Twinax	Twinaxial transmission line

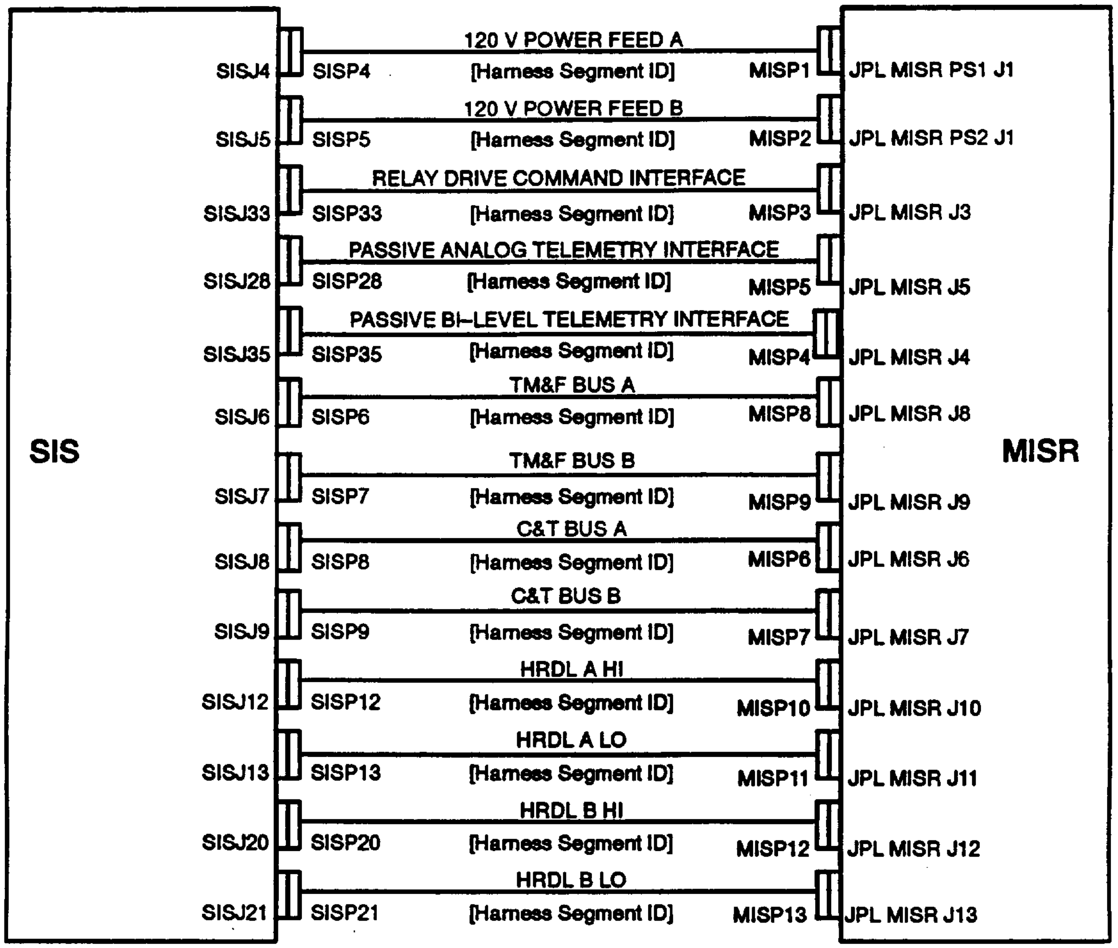
   b. All harnesses which are required by PN20005869, EOS–AM Spacecraft EMC Control Plan, to have an overall outer shield have either a copper tape over–wrap or a braid shield.

   The copper tape is actually copper–plated mylar tape which is one inch wide. The tape is then folded over 1/8 inch, making it 7/8 inch wide. The tape is 0.0017 inches thick (0.0007 inch copper on 0.001 inch mylar). The wrap is lapped half its width.

   Cables using a braid shield use braids similar to MIL–C–27500.

6.1.2 Spacecraft Interface Simulator–to–MISR Interface Circuits and Timing Diagrams

The SIS–to–MISR interface circuits and timing diagrams are shown in Figures 5 through 17.

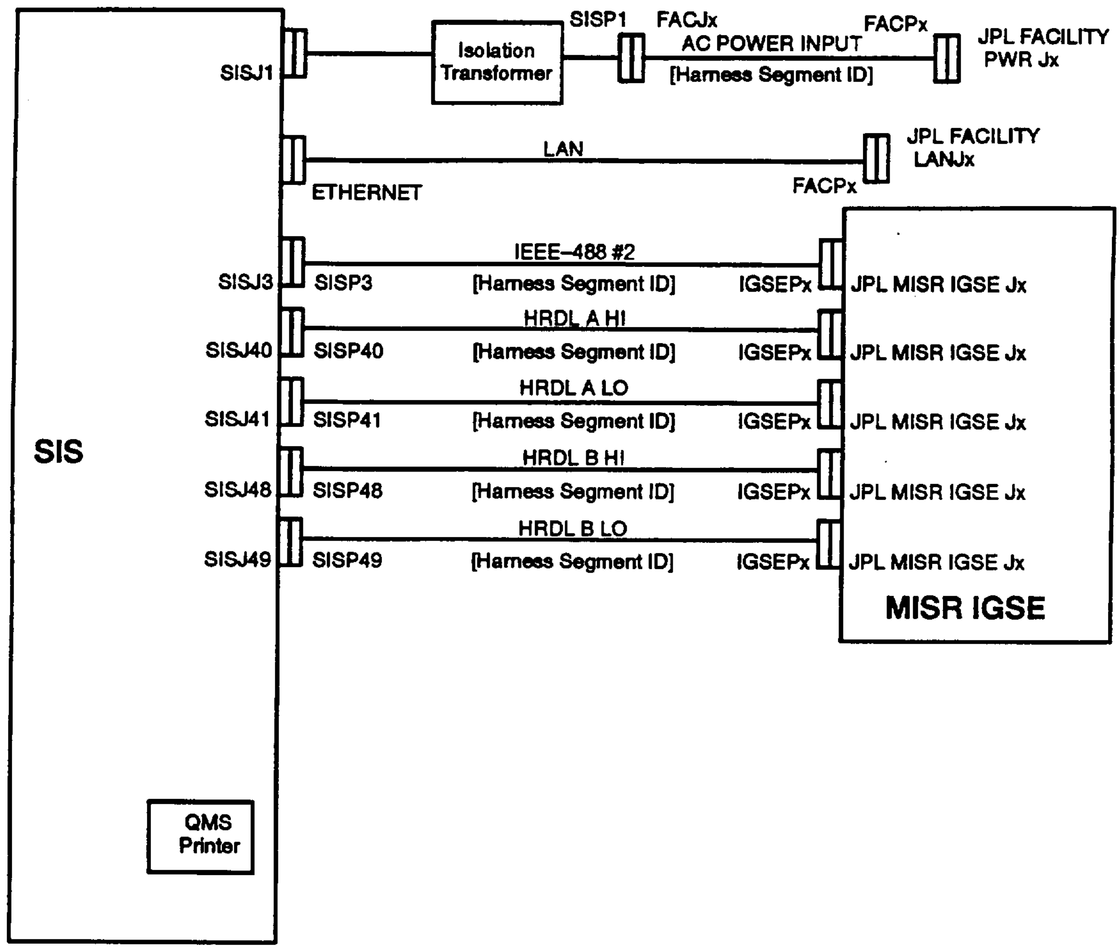


Notes:

SIS Spacecraft Interface Simulator

1. Connector numbers are **(TBR 3)**.
2. Harness Segment ID numbers are **(TBD 40)**.

Figure 3. SIS-to-MISR Harness Block Diagram



Notes:

SIS Spacecraft Interface Simulator

1. SIS and SIS–side harness connector numbers are **(TBR 3)**.
2. Other connector numbers are **(TBD 41)**.
3. Harness Segment ID numbers are **(TBD 40)**.

Figure 4. SIS–to–MISR IGSE Harness Block Diagram

Table VIII. SIS-to-MISR Harness Length (TBD 42)

Description	IGSE Harness Segment ID (TBD 40)	Total # of Segments	Total # of Connector Pairs	Total Length (meters)	Figure #
120V Power Feed A					
120V Power Feed B					
Relay Drive Cmd I/F					
Pass Bi-level Tlm I/F					
Pass Analog Tlm I/F					
TM&F Bus A					
TM&F Bus B					
C&T Bus A					
C&T Bus B					
HRDL A HI				(See Note NO TAG)	
HRDL A LO				(See Note NO TAG)	
HRDL B HI				(See Note NO TAG)	
HRDL B LO				(See Note NO TAG)	
AC Power Input					
LAN					
IEEE-488 #2					
HRDL A HI				(See Note NO TAG)	
HRDL A LO				(See Note NO TAG)	
HRDL B HI				(See Note NO TAG)	
HRDL B LO				(See Note NO TAG)	

Notes:

1. The SIS has an internal high rate cable length of 2.13 m; therefore, the high rate signal must be driven the length of the SIS–to–MODIS cable plus 2.13 m.

Table IX. SIS–to–MISR Connector List

SIS Back Panel Connector		SIS Harness Connector		Drawing Location (TBD 43)		Function
Designation	Type	Designation	Type	Sheet	Zone	
SISJ1	2815	SISP1	2813			AC Power Input
ETHERNET		ETHERNET				LAN
SISJ2		SISP2				IEEE–488 #1
SISJ3	CIB24BF	SISP3	CIB24BA			IEEE–488 #2
SISJ4	MS27468T21F11S	SISP4	MS27467T21F11P			120 V Power – Feed A
SISJ5	MS27468T21F11S	SISP5	MS27467T21F11P			120 V Power – Feed B
SISJ6	BJ79C–215	SISP6	PL75C–215			Time Mark and Frequency Bus – Side A
SISJ7	BJ79C–215	SISP7	PL75C–215			Time Mark and Frequency Bus – Side B
SISJ8	BJ379C–201	SISP8	PL375C–201			Command and Telemetry Bus – Side A
SISJ9	BJ379C–201	SISP9	PL375C–201			Command and Telemetry Bus – Side B
SISJ10						Reserved (Low Rate Science Data Bus – Side A)
SISJ11						Reserved (Low Rate Science Data Bus – Side B)
SISJ12	2034–5023–00	SISP12	2031–5055–00			High Rate Data Link #1A +
SISJ13	2034–5023–00	SISP13	2031–5055–00			High Rate Data Link #1A –

Table IX. SIS–to–MISR Connector List (cont'd)

SIS Back Panel Connector		SIS Harness Connector		Drawing Location (TBD 43)		Function
Designation	Type	Designation	Type	Sheet	Zone	
SISJ14						Reserved (High Rate Data Link #2A +)
SISJ15						Reserved (High Rate Data Link #2A –)
SISJ16						Reserved (High Rate Data Link #3A +)
SISJ17						Reserved (High Rate Data Link #3A –)
SISJ18						Reserved (High Rate Data Link #4A +)
SISJ19						Reserved (High Rate Data Link #4A –)
SISJ20	2034–5023–00	SISP20	2031–5055–00			High Rate Data Link #1B +
SISJ21	2034–5023–00	SISP21	2031–5055–00			High Rate Data Link #1B –
SISJ22						Reserved (High Rate Data Link #2B +)
SISJ23						Reserved (High Rate Data Link #2B –)
SISJ24						Reserved (High Rate Data Link #3B +)
SISJ25						Reserved (High Rate Data Link #3B –)
SISJ26						Reserved (High Rate Data Link #4B+)
SISJ27						Reserved (High Rate Data Link #4B –)

Table IX. SIS–to–MISR Connector List (cont'd)

SIS Back Panel Connector		SIS Harness Connector		Drawing Location (TBD 43)		Function
Designation	Type	Designation	Type	Sheet	Zone	
SISJ28	MS27468T15F35P	SISP28	MS27467T15F35S			Passive Analog Telemetry I/F #1
SISJ29						Reserved (Passive Analog Telemetry I/F #2)
SISJ30						Reserved (Passive Analog Telemetry I/F #3)
SISJ31						Reserved (Passive Analog Telemetry I/F #4)
SISJ32						Reserved (Active Analog Telemetry I/F #1)
SISJ33	MS27468T17F35S	SISP33	MS27467T17F35P			Relay Drive Commands I/F #1
SISJ34						Reserved (Relay Drive Commands I/F #2)
SISJ35	MS27468T17F35P	SISP35	MS27467T17F35S			Passive Bi–Level Telemetry I/F #1
SISJ36						Reserved (Passive Bi–Level Telemetry I/F #2)
SISJ37						Not Used

Table IX. SIS-to-MISR Connector List (cont'd)

SIS Back Panel Connector		SIS Harness Connector		Drawing Location (TBD 43)		Function
Designation	Type	Designation	Type	Sheet	Zone	
J38						Reserved (LRS IGSE I/F A)
J39						Reserved (LRS IGSE I/F B)
J40	2034–5023–00	P40	2031–5055–00			HRS IGSE I/F #1A+
J41	2034–5023–00	P41	2031–5055–00			HRS IGSE I/F #1A–
J42						Reserved HRS IGSE I/F #2A+
J43						Reserved HRS IGSE I/F #2A–
J44						Reserved HRS IGSE I/F #3A+
J45						Reserved HRS IGSE I/F #3A–
J46						Reserved HRS IGSE I/F #4A+
J47						Reserved HRS IGSE I/F #4A–
J48	2034–5023–00	P40	2031–5055–00			HRS IGSE I/F #1B+
J49	2034–5023–00	P41	2031–5055–00			HRS IGSE I/F #1B–
J50						Reserved HRS IGSE I/F #2B+
J51						Reserved HRS IGSE I/F #2B–

Table IX. SIS–to–MISR Connector List (cont'd)

SIS Back Panel Connector		SIS Harness Connector		Drawing Location (TBD 43)		Function
Designation	Type	Designation	Type	Sheet	Zone	
J52						Reserved HRS IGSE I/F #3B+
J53						Reserved HRS IGSE I/F #3B–
J54						Reserved HRS IGSE I/F #4B+
J55						Reserved HRS IGSE I/F #4B–

Table Xa. MISP1: SIS–MISR Power Feed A Interconnections

Pin	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit	Timing Diagram	Notes
		Connector (TBR 3)	Pin					(TBD 44)	(Figure #)	(Figure #)	
A	MISR +120 V Power Feed A–2	SISP4	2	20	T7S	001	001		5	N/A	1
B	INTERLOCK OUT	SISP4	10	20	T7S	001	001		5	N/A	1, 2
C	INTERLOCK IN	SISP4	11	20	T7S	001	001		5	N/A	1, 2
D	Spare										
E	MISR +120 V Power Feed Return A–2	SISP4	7	20	T7S	001	001		5	N/A	1
F	MISR +120 V Power Feed Return A–1	SISP4	6	20	T7S	001	001		5	N/A	1
G	MISR Fault Gnd A	SISP4	5	20	T7S	001	001		5	N/A	1
H	MISR +120 V Power Feed A–1	SISP4	1	20	T7S	001	001		5	N/A	1
J	Spare										
K	Spare										

Notes:

N/A Not applicable

1. Interface cable outer shield bonded to shell of harness connector.
2. INTERLOCK OUT and INTERLOCK IN are jumpered in connector MISP1.

Table Xb. MISP2: SIS–MISR Power Feed B Interconnections

Pin	Function	Destination Connector (TBR 3)	Destination Pin	Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 44)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
A	MISR +120 V Power Feed B–2	SISP5	2	20	T7S	001	001		5	N/A	1
B	INTERLOCK OUT	SISP5	10	20	T7S	001	001		5	N/A	1, 2
C	INTERLOCK IN	SISP5	11	20	T7S	001	001		5	N/A	1, 2
D	Spare										
E	MISR +120 V Power Feed Return B–2	SISP5	7	20	T7S	001	001		5	N/A	1
F	MISR +120 V Power Feed Return B–1	SISP5	6	20	T7S	001	001		5	N/A	1
G	MISR Fault Gnd B	SISP5	5	20	T7S	001	001		5	N/A	1
H	MISR +120 V Power Feed B–1	SISP5	1	20	T7S	001	001		5	N/A	1
J	Spare										
K	Spare										

Notes:

N/A Not applicable

1. Interface cable outer shield bonded to shell of harness connector.
2. INTERLOCK OUT and INTERLOCK IN are jumpered in connector MISP2.

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Table Xc. MISP3: SIS–MISR Relay Drive Commands Interconnections

Pin	Function	Destination Connector (TBR 3)	Destination Pin	Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 44)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
1	PREREG_A_SEL	SISP33	1	24	T2	001	001		6	7	1
2	PREREG_A_SEL_RTN	SISP33	2	24	T2	001	001		6	7	1
3	SPARE										
4	PREREG_A_ON	SISP33	3	24	T2	002	001		6	7	1
5	PREREG_A_ON_RTN	SISP33	4	24	T2	002	001		6	7	1
6	SPARE										
7	SPARE										
8	PREREG_B_SEL	SISP33	5	24	T2	003	001		6	7	1
9	PREREG_B_SEL_RTN	SISP33	6	24	T2	003	001		6	7	1
10	SPARE										
11	PREREG_B_ON	SISP33	7	24	T2	004	001		6	7	1
12	PREREG_B_ON_RTN	SISP33	8	24	T2	004	001		6	7	1
13	SPARE										
14	SPARE										
15	PREREGS_OFF	SISP33	9	24	T2	005	001		6	7	1
16	PREREGS_OFF_RTN	SISP33	10	24	T2	005	001		6	7	1
17	SPARE										
18	SPARE										
19	SPARE										
20	SPARE										
21	SPARE										
22	SPARE										

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.

Table Xc. MISP3: SIS–MISR Relay Drive Commands Interconnections (cont'd)

Pin	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit	Timing Diagram	Notes
		Connector (TBR 3)	Pin					(TBD 44)	(Figure #)	(Figure #)	
23	SPARE										
24	SPARE										
25	SPARE										
26	SUR_HTR_A_ON	SISP33	11	24	T2	006	001		6	7	1
27	SUR_HTR_A_ON_RTN	SISP33	12	24	T2	006	001		6	7	1, 2
28	SPARE										
29	SPARE										
30	SUR_HTR_B_ON	SISP33	13	24	T2	007	001		6	7	1
31	SUR_HTR_B_ON_RTN	SISP33	14	24	T2	007	001		6	7	1
32	SPARE										
33	SPARE										
34	SUR_HTR_OFF	SISP33	15	24	T2	008	001		6	7	1
35	SUR_HTR_OFF_RTN	SISP33	16	24	T2	008	001		6	7	1, 3
36	SPARE										
37	SPARE										

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.
3. Common return group 2 (6 places)
4. Common return group 3 (3 places)

Table Xd. MISP5: SIS–MISR Passive Analog Telemetry Interconnections

Pin	Function	Destination Connector (TBR 3)	Destination Pin	Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 44)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
1	+Z_RAD_TEMP	SISP28	1	24	T2	001	002		8	9	1
2	+Z_RAD_TEMP_RTN	SISP28	2	24	T2	001	002		8	9	1
3	SPARE										
4	–Y_RAD_TEMP	SISP28	3	24	T2	002	002		8	9	1
5	–Y_RAD_TEMP_RTN	SISP28	4	24	T2	002	002		8	9	1
6	SPARE										
7	OPT_BENCH_TEMP1 (–X)	SISP28	5	24	T2	003	002		8	9	1
8	OPT_BENCH_TEMP1_RTN (–X)	SISP28	6	24	T2	003	002		8	9	1
9	SPARE										
10	OPT_BENCH_TEMP2 (+X)	SISP28	7	24	T2	004	002		8	9	1
11	OPT_BENCH_TEMP2_RTN (+X)	SISP28	8	24	T2	004	002		8	9	1
12	SPARE										
13	OPT_BENCH_TEMP3 (CNT)	SISP28	9	24	T2	005	002		8	9	1
14	OPT_BENCH_TEMP3_RTN (CNT)	SISP28	10	24	T2	005	002		8	9	1
15	SPARE										
16	D_AFT_CAM_PS_TEMP	SISP28	11	24	T2	006	002		8	9	1
17	D_AFT_CAM_PS_TEMP_RTN	SISP28	12	24	T2	006	002		8	9	1
18	SPARE										
19	COMP_A_TEMP	SISP28	13	24	T2	008	002		8	9	1
20	COMP_A_TEMP_RTN	SISP28	14	24	T2	008	002		8	9	1

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.

Table Xd. MISP5: SIS–MISR Passive Analog Telemetry Interconnections (cont'd)

Pin	Function	Destination Connector (TBR 3)	Destination Pin	Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 44)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
21	SPARE										
22	SPARE										
23	SPARE										
24	SPARE										
25	SPARE										
26	SPARE										
27	SPARE										
28	SPARE										
29	SPARE										
30	SPARE										
31	SPARE										
32	SPARE										
33	SPARE										
34	SPARE										
35	SPARE										
36	SPARE										
37	SPARE										

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.

Table Xe. MISP4: SIS–MISR Passive Bi–Level Telemetry Interconnections

Pin	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit	Timing Diagram	Notes
		Connector (TBR 3)	Pin					(TBD 44)	(Figure #)	(Figure #)	
1	COVER_OPEN_HI	SISP35	1	24	T2	010	003		10	11	1
2	COVER_OPEN_LO	SISP35	2	24	T2	010	003		10	11	1
3	SPARE										
4	SPARE										
5	COVER_CLOSED_HI	SISP35	3	24	T2	011	003		10	11	1
6	COVER_CLOSED_LO	SISP35	4	24	T2	011	003		10	11	1
7	SPARE										
8	SPARE										
9	FWDCALPANDEP_HI	SISP35	5	24	T2	011	003		10	11	1
10	FWDCALPANDEP_LO	SISP35	6	24	T2	011	003		10	11	1
11	SPARE										
12	SPARE										
13	FWDCALPANSTO_HI	SISP35	7	24	T2	012	003		10	11	1
14	FWDCALPANSTO_LO	SISP35	8	24	T2	012	003		10	11	1
15	SPARE										
16	SPARE										
17	AFTCALPANDEP_HI	SISP35	9	24	T2	012	003		10	11	1
18	SPARE										
19	AFTCALPANDEP_LO	SISP35	10	24	T2	012	003		10	11	1
20	SPARE										

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.

Table Xe. MISP4: SIS–MISR Passive Bi–Level Telemetry Interconnections (cont'd)

Pin	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit	Timing Diagram	Notes
		Connector (TBR 3)	Pin					(TBD 44)	(Figure #)	(Figure #)	
21	SPARE										
22	SPARE										
23	SPARE										
24	SPARE										
25	SPARE										
26	SPARE										
27	SPARE										
28	SPARE										
29	SPARE										
30	SPARE										
31	AFTCALPANSTO_HI	SISP35	11	24	T2	012	003		10	11	1
32	AFTCALPANSTO_LO	SISP35	12	24	T2	012	003		10	11	1
33	SPARE										
34	SPARE										
35	GONIOSTO_HI	SISP35	13	24	T2	012	003		10	11	1
36	GONIOSTO_LO	SISP35	14	24	T2	012	003		10	11	1
37	SPARE										

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.

Table Xf. MISP8: SIS–MISR TM&F Bus – Side A Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
Center	MISR TM&F BUS A HI	SISP6	Center	24	Twinax	N/A	N/A	N/A	12	13	1
Intermediate	MISR TM&F BUS A LO	SISP6	Intermediate	24	Twinax	N/A	N/A	N/A	12	13	1
Outer shield	MISR TM&F BUS A SHIELD	SISP6	Outer Shield	N/A	Twinax	N/A	N/A	N/A	12	13	1

Table Xg. MISP9: SIS–MISR TM&F Bus – Side B Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
Center	MISR TM&F BUS B HI	SISP7	Center	24	Twinax	N/A	N/A	N/A	12	13	1
Intermediate	MISR TM&F BUS B LO	SISP7	Intermediate	24	Twinax	N/A	N/A	N/A	12	13	1
Outer shield	MISR TM&F BUS B SHIELD	SISP7	Outer Shield	N/A	Twinax	N/A	N/A	N/A	12	13	1

Notes:

N/A Not applicable

1. SISP6 and SISP7 are single triaxial contact connectors.
   Interface cable outer shield bonded to shell of harness connector.

Table Xh. MISP6: SIS–MISR C&T Bus A Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
Center	MISR C&T BUS A HI	SISP8	Center	24	Twinax	N/A	N/A	N/A	14	15	1
Intermediate	MISR C&T BUS A LO	SISP8	Intermediate	24	Twinax	N/A	N/A	N/A	14	15	1
Outer shield	MISR C&T BUS A SHIELD	SISP8	Outer Shield	N/A	Twinax	N/A	N/A	N/A	14	15	1

Table XI. MISP7: SIS–MISR C&T Bus B Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
Center	MISR C&T BUS B HI	SISP9	Center	24	Twinax	N/A	N/A	N/A	14	15	1
Intermediate	MISR C&T BUS B LO	SISP9	Intermediate	24	Twinax	N/A	N/A	N/A	14	15	1
Outer shield	MISR C&T BUS B SHIELD	SISP9	Outer Shield	N/A	Twinax	N/A	N/A	N/A	14	15	1

Notes:

N/A Not applicable

1. SISP8 and SISP9 are single triaxial contact connectors.
   Interface cable outer shield bonded to shell of harness connector.

Table Xj. MISP10: SIS–MISR High Rate Data Link – Side A – HI Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
Center	MISR HRDL A HI	SISP12	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer shield	MISR HRDL A HI SHIELD	SISP12	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Table Xk. MISP11: SIS–MISR High Rate Data Link – Side A – LO Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
Center	MISR HRDL A LO	SISP13	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer Shield	MISR HRDL A LO SHIELD	SISP13	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Notes:

N/A Not applicable

1. SISP12 and SISP13 are single coaxial contact connectors.

Table Xm. MISP12: SIS–MISR High Rate Data Link – Side B – HI Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
Center	MISR HRDL B HI	SISP20	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer shield	MISR HRDL B HI SHIELD	SISP20	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Table Xn. MISP13: SIS–MISR High Rate Data Link – Side B – LO Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
Center	MISR HRDL B LO	SISP21	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer Shield	MISR HRDL B LO SHIELD	SISP21	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Notes:

N/A Not applicable

1. SISP20 and SISP21 are single coaxial contact connectors.

Table Xo. FACPx: SIS–JPL Facility Power Interconnections (TBD 45)

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 44)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
	FEED A	SISP1	X								
	FEED B	SISP1	Y								
	FEED C	SISP1	Z								
	NEUTRAL	SISP1	W								
	GROUND	SISP1	GR								

Table Xp. FACPx: SIS–JPL Facility Local Area Network Interconnections (TBD 45)

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 44)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
	COLLISION+	ETHERNET	2								
	TRANSMIT+	ETHERNET	3								
	RECEIVE+	ETHERNET	5								
	VOLTAGE COMMON	ETHERNET	6								
	COLLISION–	ETHERNET	9								
	TRANSMIT–	ETHERNET	10								
	RECEIVE–	ETHERNET	12								
	+12V	ETHERNET	13								

Table Xq. IGSEPx: SIS–IGSE IEEE–488 #2 Interconnections (TBD 45)

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 44)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
	DIO1	SISP3	1								
	DIO2	SISP3	2								
	DIO3	SISP3	3								
	DIO4	SISP3	4								
	EOI	SISP3	5								
	DAV	SISP3	6								
	NRFD	SISP3	7								
	NDAC	SISP3	8								
	IFC	SISP3	9								
	SQR	SISP3	10								
	ATN	SISP3	11								
	SHIELD	SISP3	12								
	DIO5	SISP3	13								
	DIO6	SISP3	14								
	DIO7	SISP3	15								
	DIO8	SISP3	16								
	REM	SISP3	17								
	GND	SISP3	18								
	GND	SISP3	19								
	GND	SISP3	20								
	GND	SISP3	21								
	GND	SISP3	22								
	GND	SISP3	23								
	SIGNAL GROUND	SISP3	24								

Table Xr. IGSEPx: SIS–IGSE High Rate Data Link – Side A – HI Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
Center	MISR HRDL A HI	SISP40	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer shield	MISR HRDL A HI SHIELD	SISP40	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Table Xs. IGSEPx: SIS–IGSE High Rate Data Link – Side A – LO Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
Center	MISR HRDL A LO	SISP41	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer Shield	MISR HRDL A LO SHIELD	SISP41	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Notes:

N/A Not applicable

1. SISP40 and SISP41 are single coaxial contact connectors.

Table Xt. IGSEPx: SIS–IGSE High Rate Data Link – Side B – HI Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
Center	MISR HRDL B HI	SISP48	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer shield	MISR HRDL B HI SHIELD	SISP48	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Table Xu. IGSEPx: SIS–IGSE High Rate Data Link – Side B – LO Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 3)	Pin								
Center	MISR HRDL B LO	SISP49	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer Shield	MISR HRDL B LO SHIELD	SISP49	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Notes:

N/A Not applicable

1. SISP48 and SISP49 are single coaxial contact connectors.

(TBD 46)

Figure 5. SIS–to–MISR Power Interface Circuit

(TBD 46)

Figure 6. SIS–to–MISR BDU Relay Drive Command Interface Circuit(s)

(TBD 46)

Figure 7. SIS–to–MISR BDU Relay Drive Command Timing Diagram(s)

ASD–EW 2051 3–89

(TBD 46)

Figure 8. SIS–to–MISR BDU Passive Analog Telemetry Interface Circuit(s)

(TBD 46)

Figure 9. SIS-to-MISR BDU Passive Analog Telemetry Timing Diagram(s)

(TBD 46)

Figure 10. SIS-to-MISR BDU Passive Bi-Level Telemetry Interface Circuit(s)

(TBD 46)

Figure 11. SIS–to–MISR BDU Passive Bi–Level Telemetry Timing Diagram(s)

(TBD 46)

Figure 12. SIS–to–MISR Time Mark and Frequency Bus Interface Circuit

(TBD 46)

Figure 13. SIS–to–MISR Time Mark and Frequency Bus Timing Diagram

(TBD 46)

Figure 14. SIS–to–MISR Command and Telemetry Bus Interface Circuit

(TBD 46)

Figure 15. SIS–to–MISR Command and Telemetry Bus Timing Diagram

(TBD 46)

Figure 16. SIS–to–MISR Science Data Interface Circuit

(TBD 46)

Figure 17. SIS-to-MISR Science Data Timing Diagram

6.2 Spacecraft Checkout Station–to–IGSE Interface

6.2.1 Spacecraft Checkout Station–to–IGSE Harness Definition

1. The block diagram of the harnesses between the SCS and IGSE is shown in Figure 18. (All harnesses are supplied by the Spacecraft Integrator.)

2. The SCS–to–IGSE harness lengths are shown in Table XI.

3. The list of the IGSE connectors used by the Spacecraft Integrator to fabricate the SCS–to–IGSE harnesses is shown in Table XII.

   a. The SCS–to–IGSE interconnections are shown in Tables XIIIa through XIIId. The following legend is used for wire type:

Coax	Coaxial transmission line
SC	Single conductor, unshielded
SCS	Single conductor, shielded
TP	Twisted pair, unshielded
TPS	Twisted pair, shielded
Tn	Twisted bundle of n wires, unshielded
TnS	Twisted bundle of n wires, shielded
Twinax	Twinaxial transmission line

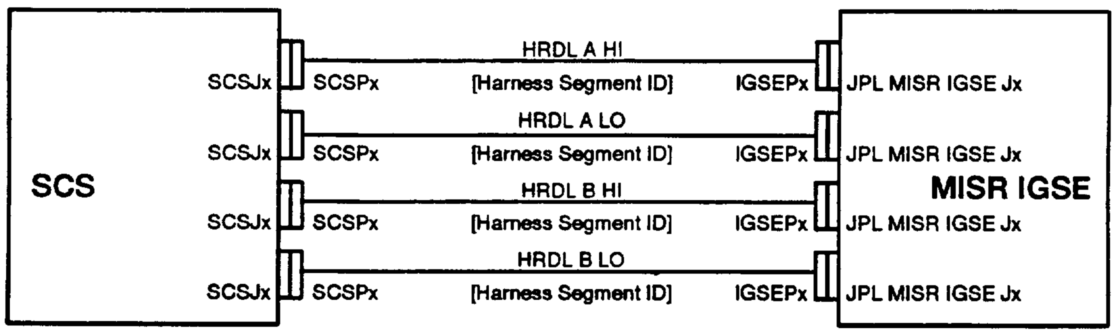
   b. All harnesses which are required by PN20005869, EOS–AM Spacecraft EMC Control Plan, to have an overall outer shield have either a copper tape over–wrap or a braid shield.

   The copper tape is actually copper–plated mylar tape which is one inch wide. The tape is then folded over 1/8 inch, making it 7/8 inch wide. The tape is 0.0017 inches thick (0.0007 inch copper on 0.001 inch mylar). The wrap is lapped half its width.

   Cables using a braid shield use braids similar to MIL–C–27500.

6.2.2 Spacecraft Checkout Station–to–IGSE Interface Circuit and Timing Diagram

The SCS–to–IGSE interface circuit and timing diagram are shown in Figures 19 and 20.



Notes:

SCS Spacecraft Checkout Station

1. Connector numbers are **(TBD 47)**.
2. Harness Segment ID numbers are **(TBD 48)**.

Figure 18. SCS–to–IGSE Harness Block Diagram

Table XI. Estimated SCS–to–IGSE Harness Length (TBD 49)

Description	Instrument Harness Segment ID (as shown in Figure 18)	Total # of Segments	Total # of Connector Pairs	Total Length (meters)	Figure #
HRDL A HI					18
HRDL A LO					18
HRDL B HI					18
HRDL B LO					18

Table XII. SCS–to–IGSE Connector List (TBD 50)

SCS Back Panel Connector		SCS Harness Connector		Drawing Location		Function
Designation	Type	Designation	Type	Sheet	Zone	
						High Rate Data Link A HI
						High Rate Data Link A LO
						High Rate Data Link B HI
						High Rate Data Link B LO

Table XIIIa. IGSEPx: SCS–IGSE High Rate Data Link – Side A – HI Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBD 47)	Pin								
Center	MISR HRDL A HI	SCSPx	Center	16	G2 Coax	N/A	N/A	N/A	19	20	1
Outer shield	MISR HRDL A HI SHIELD	SCSPx	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	19	20	1

Table XIIIb. IGSEPx: SCS–IGSE High Rate Data Link – Side A – LO Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBD 47)	Pin								
Center	MISR HRDL A LO	SCSPx	Center	16	G2 Coax	N/A	N/A	N/A	19	20	1
Outer Shield	MISR HRDL A LO SHIELD	SCSPx	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	19	20	1

Notes:

N/A Not applicable

1. SCSPx and SCSPx are single coaxial contact connectors.

Table XIIIc. IGSEPx: SCS–IGSE High Rate Data Link – Side B – HI Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBD 47)	Pin								
Center	MISR HRDL B HI	SCSPx	Center	16	G2 Coax	N/A	N/A	N/A	19	20	1
Outer shield	MISR HRDL B HI SHIELD	SCSPx	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	19	20	1

Table XIIId. IGSEPx: SCS–IGSE High Rate Data Link – Side B – LO Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBD 47)	Pin								
Center	MISR HRDL B LO	SCSPx	Center	16	G2 Coax	N/A	N/A	N/A	19	20	1
Outer Shield	MISR HRDL B LO SHIELD	SCSPx	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	19	20	1

Notes:

N/A Not applicable

1. SCSPx and SCSPx are single coaxial contact connectors.

(TBD 51)

Figure 19. SCS–to–IGSE Science Data Interface Circuit

(TBD 51)

Figure 20. SCS–to–IGSE Science Data Timing Diagram

6.3 Facility–to–MISR IGSE Interface

6.3.1 Thermal Vacuum Chamber Penetration

(TBD 52)

6.3.2 Purge

(TBD 52)

6.3.3 Remote Data Processing

(TBD 52)

6.3.4 Computer Network

6.3.4.1 Internet Address

The MISR internet address **(TBD 52).**

6.3.4.2 Socket Address

The MISR socket address **(TBD 52).**

7 INSTRUMENT PROCEDURES

1. Instrument procedures are listed in Table XIV.

2. Instrument procedure usage during spacecraft–level I&T activities is identified in Table XV.

3. Each instrument procedure is described in Section 7.1.

4. IGSE constraints and restraints are described in Section 7.2.

Table XIV. Instrument Procedure List (TBD 53)

Number		Procedure Name	Reference Paragraph	Source
Martin Marietta	MISR			
AP–20001400		Assembly Procedure: Kinematic Mount Engineering Development Models to Instrument Test Models	7.1.1	MMC
(TBD 54)		Alignment Procedure: MISR Alignment at Spacecraft Level Integration	7.1.2	MMC

Table XV. Instrument Procedure Usage (TBD 55)

East Windsor Activity	Procedure
Pre–Delivery	
Drill Mounting Holes	
Drill Coldplate Mounting Holes	N/A
Other	MMC AP–20001400
Transportation & Handling	
Cleaning	
IGSE Set–up & Check–out	
BAT	
Integration	
Installation & Alignment	(TBD 54)
Coldplate Installation	N/A
Electrical Integration	
Electrical Systems Test	
Power Profile	
Transient Tolerance	
Aliveness Test	
Functional Test	
Comprehensive Performance Test	
Orbits	
RF Systems Test	
EMI/EMC	
Compatibility Test Van	
End–to–End Test	

Table XV. Instrument Procedure Usage (cont'd) (TBD 55)

East Windsor Activity	Procedure
Thermal Vacuum Test Launch Mode Thermal Balance Comprehensive Performance Test Power Profile Transient Tolerance Calibration Special	
Acoustic/Shock Test Alignment Launch Mode Deployment Verification Aliveness Test	(TBD 54)
Spacecraft Activity Leak Check Comprehensive Performance Test Mass Properties	
Box, Pack, & Ship to WTR	
Box, Pack, & Ship to Other Location	

Launch Site (WTR) Activity	Procedure
Unbox	
Transportation & Handling	
Cleaning	
Closeouts	
IGSE Set–up & Check–out	
Comprehensive Performance Test	
Move to Pad	
Aliveness Test	
Launch Mode	

7.1 Instrument Procedure Description (TBR 4)

7.1.1 MMC AP–20001400, Assembly Procedure: Kinematic Mount Engineering Development Models to Instrument Test Models

MMC AP–20001400, "Assembly Procedure: Kinematic Mount Engineering Development Models to Instrument Test Models" describes the assembly, installation, and shimming of the test kinematic mounts.

7.1.2 (TBD 54), Alignment Procedure, MISR Alignment at Spacecraft Level Integration

(TBD 54), "Alignment Procedure, MISR Alignment at Spacecraft Level Integration" describes the alignment of the MISR instrument during spacecraft level integration. This procedure defines the method of alignment using the 3–axis kinematic mount, 2–axis kinematic mount, and the 1–axis kinematic mount located in the (–X,+Y) position for alignment. The remaining 1–axis mount will be shimmed to remove chatter.

7.2 Instrument Ground Support Equipment Constraints and Restraints

7.2.1 (TBD 56) [Constraint or Restraint]

(TBD 56)

APPENDIX A

10 ACRONYMS AND ABBREVIATIONS

Amp	Amperes
ASD	Astro–Space Division
BAT	Bench Acceptance Test
BDU	Bus Data Unit
BPS	Box, Pack, & Ship
C&T	Command and Telemetry
C&T ICD	Command and Telemetry Interface Control Drawing
Cal	Calibration
CTV	Compatibility Test Van
DAF	Drill–Alignment Fixture
EICD	Electrical Interface Control Drawing
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOS	Earth Observing System
ft	Feet
GSE	Ground Support Equipment
Hz	Hertz
I&T	Integration and Test
I&T ICD	Interface Control Drawing
ICD	Interface Control Drawing
IGSE	Instrument Ground Support Equipment
JPL	Jet Propulsion Laboratory
MICD	Mechanical Interface Control Drawing
MMC	Martin Marietta Corporation
MISR	Multi–angle Imaging SpectroRadiometer
N/A	Not Applicable
RF	Radio Frequency
RH	Relative Humidity
SCS	Spacecraft Checkout Station
SIS	Spacecraft Interface Simulator
SLC–3	Space Launch Complex 3
STE	System Test Equipment
SVS	Space View Source
TICD	Thermal Interface Control Drawing

V	Volts
VAC	Volts Alternating Current
VAFB	Vandenberg Air Force Base
W	Watts
WTR	Western Test Range

Next Assembly	Used on
20008500G1	EOS–AM

First Application
EOS–AM

Revisions — Rev B

Ltr	Description	Date	Approved
Initial Issue		04–08–93	CM–GSR
Rev. A	Revised per ECN EOS0045	07–15–93	CM–GSR
Rev. B	Revised per ECN EOS0057	08–23–93	CM–GSR

Revision Record Continued on Sheet ______

	Contract No. NAS5–32500	
(signature on file)	Written C. Wilda	Date 04–08–93
(signature on file)	Approved N. Koepp–Baker	Date 04–08–93
	Approved	Date
(signature on file)	Issued G. Rauscher	Date 04–08–93

MARTIN MARIETTA

Martin Marietta Astro Space
East Windsor, NJ
Valley Forge, PA

**Interface Control Drawing,
Earth Observing System AM Spacecraft to
Moderate Resolution Imaging Spectroradiometer**

Size	Code Ident No.	
A	49671	20008840

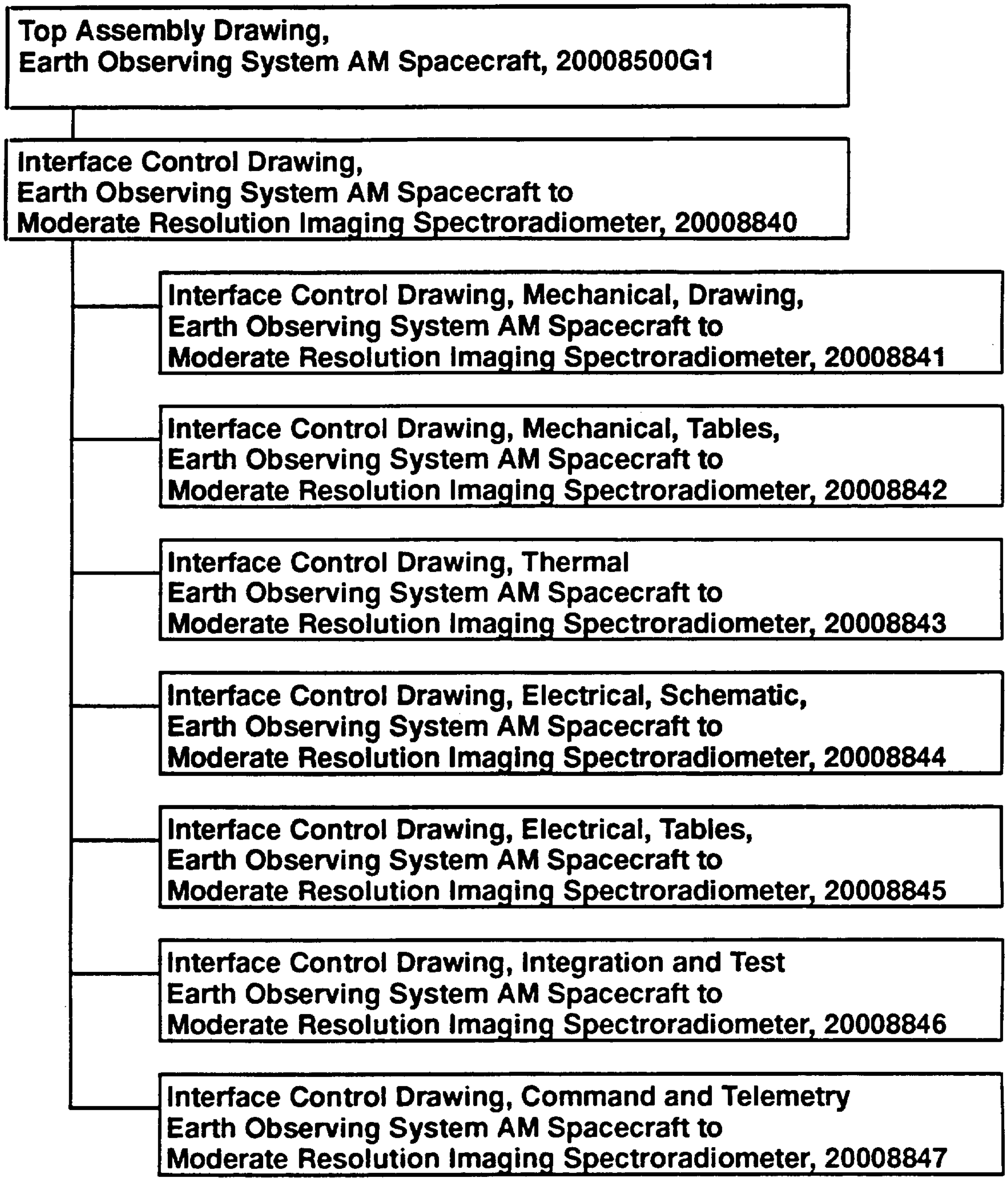


Figure 1. Drawing Tree

Table I. ICD Revision Status

20008841 MICD Drawing		20008842 MICD Tables		20008843 TICD		20008844 EICD Schematic		20008845 EICD Tables		20008846 I&T ICD		20008847 C&DH ICD	
Issue	Date	Issue	Date	Issue	Date	Issue	Date	Issue	Date	Issue	Date	Issue	Date
Initial	08–12–93	Initial	04–08–93	Initial	06–07–93			Initial	08–12–93				

Next Assembly	Used on	Revisions		Rev Draft 001	
20008840	EOS–AM	Ltr	Description	Date	Approved
First Application EOS–AM		001	Preliminary	07–15–93	

Revision Record Continued on Sheet ______

Contract No. NAS5–32500	
Written C. Wilda Date	
Approved F. Komro Date	
Approved Date	
Issued G. Rauscher Date	

MARTIN MARIETTA
POST OFFICE BOX 800
PRINCETON, NEW JERSEY 08543–0800
TELEPHONE (609) 490–3400

Interface Control Drawing, Integration and Test, Earth Observing System AM Spacecraft to Moderate Resolution Imaging Spectroradiometer

Size	Code Ident No.	
A	49671	20008846

Approval Signatures

**IN ADDITION TO ECN AND CCB APPROVALS,
ALL CHANGES ON THIS DRAWING SHALL HAVE THE APPROVAL AND THE FULL AGREEMENT
OF THE PARTIES LISTED BELOW.**

REV	Spacecraft Program Office	Date	Instrument Program Office	Date	Principal Investigator	Date
Initial Issue	(signature on file) P. Giustino for M. Kavka	9–8–93	L. Candell		W. Barnes	

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TBD 2	Table I	18	IGSE date of cal or proof test	C. Wilda (MMC)	PFM delivery
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TBD 4	3.2.3.1 3.2.3.2 3.2.3.3 3.2.3.4	24 24 24 24	Drill–alignment fixture information (5 places)	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 5	3.4.5	27	Lifting sling information	G. Plews (SBRC)	MODIS CDR + 3 months (3/31/94)
TBD 6	3.5.4 3.5.5	28 28	MODIS shipping container information (2 places)	G. Plews (SBRC)	MODIS CDR + 3 months (3/31/94)
TBD 7	3.6.1 3.6.2 3.6.4 3.6.5	29	Bench test cooler information (4 places)	G. Plews (SBRC)	MODIS CDR + 3 months (3/31/94)
TBD 8	3.7.1	30	Earth view source information	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 9	3.8.1 3.8.2 3.8.4 3.8.5	31	Space view source information (4 places)	G. Plews (SBRC)	MODIS CDR + 3 months (3/31/94)
TBD 10	3.9.1 3.9.2 3.9.4 3.9.5	32	PRC SBS information (4 places)	G. Plews (SBRC)	MODIS CDR + 3 months (3/31/94)
TBD 11	3.10.1	33	SAM SBS information	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 12	3.11.1	34	MEM SBS information	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 13	3.12.1	35	FAM SBS information	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 14	3.13.3.2 3.13.4 3.13.5	36	SIS information (3 places)	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 15	3.14.1 3.14.2 3.14.4 3.14.5	37	STE information (4 places)	G. Plews (SBRC)	MODIS CDR + 3 months (3/31/94)

TBD LOG (cont'd)

ITEM	SECTION	PAGE	SUBJECT	RESPONSIBLE	DUE
TBD 16	Figure 1–4 to Figure 1–14	43 to 53	IGSE figures (11 places)	C. Wilda (MMC)	MODIS CDR + 30 days (1/31/94)
TBD 17	Figure 2–3	58	MODIS IGSE layout	C. Wilda (MMC)	PFM delivery – 6 months
TBD 18	Figure 2–4	60	MODIS I&T ground station layout	C. Wilda (MMC)	PFM delivery – 6 months
TBD 19	4.1.5	65	T/V penetration connectors	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 20	4.1.5	65	T/V penetration cable lengths	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 21	4.1.5	65	T/V penetration gas and fluid lines	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 22	4.1.7.1 4.1.7.2 Figure 2–10	68	Storage area (3 places)	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 23	Figure 2–12	71	Launch site processing facility	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 24	Figure 2–13	72	MODIS launch site ground station	C. Wilda (MMC)	S/C ship – 6 months
TBD 25	Table III	73	Instrument facility requirements (2 places)	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 26	Table IV	74 75	IGSE physical requirements (2 places)	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 27	Table IV	75	SIS grounding (2 places)	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 28	Table V	76	IGSE environmental requirements	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 29	Table VI	78	Consumables	G. Plews (SBRC)	PFM delivery – 6 months
TBD 30	Table VII	79	Documentation	G. Plews (SBRC)	PFM delivery – 6 months
TBD 31	5.1.1 5.1.2	80	Personnel support (2 places)	C. Wilda (MMC)	PFM delivery – 6 months
TBD 32	5.2.1 5.2.2 5.2.3	80	Computer maintenance contract (3 places)	C. Wilda (MMC)	PFM delivery – 6 months
TBD 33	5.2.1 (1)	81	Individuals requiring badges at MMC	G. Plews (SBRC)	PFM delivery – 6 months

TBD LOG (cont'd)

ITEM	SECTION	PAGE	SUBJECT	RESPONSIBLE	DUE
TBD 34	5.2.1 (4)	81	Clean room garments at MMC (5 places)	G. Plews (SBRC)	PFM delivery – 6 months
TBD 35	5.2.2 (1)	83	Individuals requiring badges at launch site	G. Plews (SBRC)	S/C ship – 6 months
TBD 36	5.2.2 (2)	83	Office furniture at launch site (7 places)	G. Plews (SBRC)	S/C ship – 6 months
TBD 37	5.2.2 (3)	83	Ground station furniture at launch site (10 places)	G. Plews (SBRC)	S/C ship – 6 months
TBD 38	5.2.2 (4)	83	Clean room garments at launch site (5 places)	G. Plews (SBRC)	S/C ship – 6 months
TBD 39	Figure 3 Figure 4 Table VIII	87 88 89	SIS–MODIS harness segment ID numbers (3 places)	C. Wilda (MMC)	MODIS CDR + 30 days (1/31/94)
TBD 40	Figure 4	88	Other connector numbers	G. Plews (SBRC)	MODIS CDR + 3 months (3/31/94)
TBD 41	Table VIII	89	SIS–MODIS harness lengths	G. Plews (SBRC)	MODIS CDR + 3 months (3/31/94)
TBD 42	Table IX	90 to 94	SIS–MODIS connector locations (5 places)	C. Wilda (MMC)	MODIS CDR + 30 days (1/31/94)
TBD 43	Table Xa to Table Xd and Table Xn to Table Xp	95 to 104 and 109 to 110	SIS–MODIS wire color (13 places)	G. Plews (SBRC)	MODIS CDR + 3 months (3/31/94)
TBD 44	Table Xn Table Xo Table Xp	109 109 110	SIS–SBRC facility power, SIS–SBRC facility LAN, and SIS–IGSE interconnections (8 places)	G. Plews (SBRC)	MODIS CDR + 3 months (3/31/94)
TBD 45	Figure 5 to Figure 17	113 to 125	SIS–MODIS interface circuits and timing diagrams (13 places)	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 46	Figure 18 Table XIIIa to Table XIIId	127 129 to 130	SCS–IGSE connector numbers (5 places)	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 47	Figure 18	127	SCS–IGSE harness segment ID numbers	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 48	Table XI	128	SCS–IGSE harness lengths	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 49	Table XII	128	SCS–IGSE connector list	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)

TBD LOG (cont'd)

ITEM	SECTION	PAGE	SUBJECT	RESPONSIBLE	DUE
TBD 50	Figure 19 Figure 20	131 132	SCS–IGSE science data circuit and timing diagram (2 places)	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 51	6.3.1 6.3.2 6.3.3 6.3.4.1 6.3.4.2	133	Facility–MODIS IGSE interface (5 places)	C. Wilda (MMC)	PFM delivery – 6 months
TBD 52	Table XIV	135	Instrument procedure list	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 53	Table XV	136 137	Instrument procedure usage (2 places)	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
TBD 54	7.2.1	139	IGSE constraint or restraint (2 places)	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)

TBR LOG

ITEM	SECTION	PAGE	SUBJECT	RESPONSIBLE	DUE
TBR 1	Table I Table IIb	18 20	SVS and PRC SBS (16 places)	G. Plews (SBRC)	MODIS CDR + 30 days (1/31/94)
TBR 2	3.1.1	22	Number of test kinematic mounts	C. Wilda	MODIS CDR + 30 days (1/31/94)
TBR 3	3.2.2	24	Use of drill–alignment fixture for drilling mounting brackets	G. Plews (SBRC)	MODIS CDR + 30 days (1/31/94)
TBR 4	4.2	69	SLC–3	C. Wilda	launch vehicle selection + 30 days
TBR 5	Figure 3 Figure 4 Table Xa to Table X7	87 88 95 to 112	SIS–MODIS connector numbers (27 places)	C. Wilda	MODIS CDR + 30 days (1/31/94)
TBR 6	7.1	138	Preliminary procedure description (2 places)	C. Wilda (MMC)	MODIS CDR + 3 months (3/31/94)
			Final procedure description	C. Wilda (MMC)	PFM delivery – 6 months

1 INTRODUCTION

1.1 Purpose

The Integration and Test Interface Control Drawing (I&T ICD), 20008846, when executed, represents an agreement of the detailed implementation of the Integration and Test (I&T) of the Moderate Resolution Imaging Spectroradiometer (MODIS) with the Earth Observing System (EOS) AM Spacecraft. This drawing, together with the Mechanical Interface Control Drawing (MICD) Drawing, 20008841, MICD Tables, 20008842, Thermal Interface Control Drawing (TICD), 20008843, Electrical Interface Control Drawing (EICD) Schematic, 20008844, EICD Tables, 20008845, and Command and Telemetry Interface Control Drawing (C&T ICD), 20008847, describe the details of the interfaces between the EOS–AM Spacecraft and MODIS. The top–level instrument Interface Control Drawing (ICD), 20008840, provides the instrument ICD tree and revision status for all sub–tier instrument ICDs.

The I&T ICD contains information on Ground Support Equipment (GSE), facilities, procedures, and other support which will be used during pre–delivery, spacecraft–level I&T, and launch site activities.

1.2 Scope

This I&T ICD is limited to the description of operation of the MODIS necessary to execute the I&T and launch portion of the EOS–AM program and, as such, concentrates on commands and telemetry via the Bus Data Unit (BDU) and Command and Telemetry (C&T) bus, descriptions of modes to be tested, and instrument operating constraints during test. Science and engineering data is processed during test by the Instrument Ground Support Equipment (IGSE) and is not considered in this document. The material contained herein is not intended to define on–orbit operational requirements.

1.3 Organization

Section 1 provides a brief description of the document's purpose followed by a statement of its scope and concluding with a description of its organization.

Section 2 provides a list of the documents referenced in the text and the source of each such document.

Section 3 provides a description of the IGSE used during pre–delivery, spacecraft–level I&T, and launch site activities.

Section 4 contains detailed descriptions of the facilities to be used during spacecraft–level I&T, and launch site activities.

Section 5 provides a description of the support to be provided during spacecraft–level I&T, and launch site activities.

Section 6 describes the interfaces between the MODIS IGSE and the Spacecraft Interface Simulator (SIS), Spacecraft Checkout Station (SCS), and facilities.

Section 7 describes the instrument procedures to be used during pre–delivery, spacecraft–level I&T, and launch site activities.

2 REFERENCE DOCUMENTS

The following documents provide additional information relative to the functioning of the MODIS IGSE, facilities, procedures, and other support which will be used during pre–delivery, spacecraft–level I&T, and launch site activities. The information contained in these documents is deemed to be supplemental in nature and hence is not included herein.

Reference documents will be provided as required.

3 INSTRUMENT GROUND SUPPORT EQUIPMENT

1. IGSE is listed in Table I.

2. IGSE usage during pre–delivery, spacecraft–level I&T, and launch site activities is identified in Tables IIa through IIc.

3. Each IGSE item is described in the Section 3.x paragraph and shown in the Figure 1–x identified by the same x.

Table I. Instrument Ground Support Equipment List

Item	Item Name	Drawing or ID Number (TBD 1)	Provider	Date of Cal or Proof Test (TBD 2)	Reference Paragraph
Mechanical IGSE					
1	MODIS Test Kinematic Mounts		MMC		3.1
2	MODIS Drill–Alignment Fixture	MMC 20008841 DAF1	MMC		3.2
3	MODIS Master Plate	MMC 20008841 MP1	MMC		3.3
4	MODIS Lifting Sling		SBRC		3.4
5	MODIS Shipping Container		SBRC		3.5
6	Bench Test Cooler	SBRC SK 114951	SBRC		3.6
7	Earth View Source		MMC		3.7
8	Space View Source **(TBR 1)**		SBRC		3.8
9	PRC Space Background Simulator **(TBR 1)**		SBRC		3.9
10	SAM Space Background Simulator		MMC		3.10
11	MEM Space Background Simulator		MMC		3.11
12	FAM Space Background Simulator		MMC		3.12
Electrical IGSE					
13	Spacecraft Interface Simulator		MMC		3.13
14	System Test Equipment		SBRC		3.14

Table IIa. Instrument Ground Support Equipment Usage

Item	EAST WINDSOR ACTIVITIES																	
	Pre–Delivery						Integ			Electrical Systems Test						RF Systems Test		
	Drill Mtg Holes	Drill CP Mtg Holes	Other	Xport	Clean	BAT	Install & Align	CP Install	Elect Integ	Pwr Prof	Trans Tol	Alive Test	Funct Test	Comp Perf Test	Orbits	EMI/ EMC	CTV	End to End
1		N/A	X					N/A										
2	X	N/A						N/A										
3		N/A	X					N/A										
4		N/A					X	N/A										
5		N/A		X				N/A										
6		N/A				X		N/A										
7		N/A						N/A										
8		N/A						N/A										
9		N/A				X		N/A										
10		N/A						N/A										
11		N/A						N/A										
12		N/A						N/A										
13		N/A	X					N/A										
14		N/A				X		N/A	X	X	X	X	X	X	X	X	X	X

Notes:

Align	Alignment
Alive	Aliveness
BAT	Bench Acceptance Test
Clean	Cleaning
Comp Perf	Comprehensive Performance
CP	Coldplate
CTV	Compatibility Test Van
Elect	Electrical
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
Funct	Functional
Install	Installation
Integ	Integration
Mtg	Mounting
N/A	Not applicable
Pwr Prof	Power Profile
RF	Radio Frequency
Trans Tol	Transient Tolerance
Xport	Transportation & Handling

Table IIb. Instrument Ground Support Equipment Usage

Item	EAST WINDSOR ACTIVITIES																	
	Thermal Vacuum Test								Acoustic/Shock Test					Spacecraft Activity				
	Lnch Mode	T/B	Comp Perf Test	Orbits	Pwr Prof	Trans Tol	Cal	Special	Align	Lnch Mode	Deploy	Special	Alive Test	Leak Check	Comp Perf Test	Mass Prop	BPS to WTR	BPS to Alt Loc
1																		
2																		
3																		
4																		
5																		
6																		
7		X	X	X	X	X	X	X										
8		(TBR 1)	(TBR 1)	(TBR 1)	(TBR 1)	(TBR 1)	(TBR 1)	(TBR 1)										
9		(TBR 1)	(TBR 1)	(TBR 1)	(TBR 1)	(TBR 1)	(TBR 1)	(TBR 1)										
10		X	X	X	X	X	X	X										
11		X	X	X	X	X	X	X										
12		X	X	X	X	X	X	X										
13																		
14	X	X	X	X	X	X	X	X		X		X	X		X			

Notes:

Align	Alignment
Alive	Aliveness
Alt Loc	Alternate Location
BPS	Box, pack, & ship
Cal	Calibration
Comp Perf	Comprehensive Performance
Deploy	Deployment verification
Lnch	Launch
Pwr Prof	Power Profile
T/B	Thermal Balance
Trans Tol	Transient Tolerance
WTR	Western Test Range

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Table IIc. Instrument Ground Support Equipment Usage

	Launch Site (WTR) Activities							
Item	Unbox	Xport	Clean	Comp Perf Test	Close	Move to Pad	Alive Test	Lnch Mode
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14				X			X	X

Notes:

Alive	Aliveness
Clean	Cleaning
Close	Closeouts
Comp Perf	Comprehensive Performance
Lnch	Launch
WTR	Western Test Range
Xport	Transportation & Handling

3.1 MODIS Test Kinematic Mounts

The MODIS Test Kinematic Mounts are shown in Figures 1–1a through 1–1c and described in the following sections.

3.1.1 MODIS Test Kinematic Mount Description

The MODIS Test Kinematic Mount set consists of bearing assemblies, mount bodies, mounting bolts, washers, and bearing retaining plates, built to flight drawings, which provide flight–like attachment of the MODIS to its IGSE. The MODIS Test Kinematic Mounts minimize structural loading of both sides of the kinematic mount interface by not transmitting torsional forces, thereby reducing thermal distortion of the MODIS during instrument–level testing. One **(TBR 2)** each of three types of kinematic mount are provided:

1. A KM1 mount which restrains translational motion in one axis normal to the mounting plane
2. A KM2 mount which restrains translational motion in two axes with restraint in one axis normal to the mounting plane and in one axis parallel to the mounting plane
3. A KM3 mount which restrains translational motion in three perpendicular axes

3.1.2 MODIS Test Kinematic Mount Usage

The MODIS Test Kinematic Mounts are used during instrument–level testing to support the MODIS and during instrument–level shock and thermal environmental testing to simulate the spacecraft interface.

3.1.3 MODIS Test Kinematic Mount Disposition

The disposition of the MODIS Test Kinematic Mounts and their spares, shipping container, and packing material is described in the following sections.

3.1.3.1 MODIS Test Kinematic Mounts Delivery to Loral/ABC

The MODIS Test Kinematic Mounts will be delivered to **(TBD 3)** location at Loral/ABC on 15 December 1993.

3.1.3.2 MODIS Test Kinematic Mounts Delivery to SBRC

The MODIS Test Kinematic Mounts will be delivered to B20 Shipping/Receiving at the Santa Barbara Research Center (SBRC), 7406 Hollister Avenue, Goleta, CA, on **(TBD 3)**.

3.1.3.3 MODIS Test Kinematic Mount Disposal

(TBD 3)

3.1.4 MODIS Test Kinematic Mounts Spares

No spares are provided with the MODIS Test Kinematic Mounts.

3.1.5 MODIS Test Kinematic Mounts Shipping Container and Packing Material

The MODIS Test Kinematic Mounts will be packaged in nitrogen–purged plastic bags with desiccant and shipped in standard cardboard boxes with packing foam.

3.2 MODIS Drill–Alignment Fixture

The MODIS Drill–Alignment Fixture (DAF) is shown in Figure 1–2 and described in the following sections.

3.2.1 MODIS Drill–Alignment Fixture Description

The MODIS DAF is a truncated triangular frame approximately 54 inches long, 4 inches wide over a 44–inch overall width, and 2 inches thick, with a central stiffening member. It is manufactured from an aluminum plate and contains an optical alignment cube, bushings for drilling pilot holes, and bearings and pins for checking the drilled holes.

3.2.2 MODIS Drill–Alignment Fixture Usage

The MODIS DAF is used for drilling holes in the spacecraft alignment plates and MODIS mounting brackets **(TBR 3)** and for transferring the MODIS alignment information to the spacecraft coordinate frame.

3.2.3 MODIS Drill–Alignment Fixture Disposition

The disposition of the MODIS DAF and its spares, shipping container, and packing material is described in the following sections.

3.2.3.1 MODIS Drill–Alignment Fixture Delivery to Loral/ABC

The MODIS DAF will be delivered to **(TBD 4)** location at Loral/ABC on **(TBD 4)**.

3.2.3.2 MODIS Drill–Alignment Fixture Return to Martin Marietta

The MODIS DAF will be returned to the Martin Marietta Corporation (MMC) Astro–Space Division (ASD) East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 on **(TBD 4)**.

3.2.3.3 MODIS Drill–Alignment Fixture Delivery to SBRC

The MODIS DAF will be delivered to B20 Shipping/Receiving at SBRC, 7406 Hollister Avenue, Goleta, CA, on **(TBD 4)**.

3.2.3.4 MODIS Drill–Alignment Fixture Return to Martin Marietta

The MODIS DAF will be returned to the Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 on **(TBD 4)**. The DAF will be accompanied by the alignment data.

3.2.4 MODIS Drill–Alignment Fixture Spares

No spares are provided for the MODIS DAF.

3.2.5 MODIS Drill–Alignment Fixture Shipping Container and Packing Material

The MODIS DAF shipping container contains identified nesting depressions for all loose items.

3.3 MODIS Master Plate

The MODIS Master Plate is shown in Figure 1–3 and described in the following sections.

3.3.1 MODIS Master Plate Description

The MODIS Master Plate is a truncated triangular frame approximately 52 inches long, 4 inches wide over a 40–inch overall width, and 0.75 inches thick, with a central stiffening member. It is manufactured from an aluminum plate.

3.3.2 MODIS Master Plate Usage

The MODIS Master Plate is used to coordinate the MODIS interface mounting holes in the manufacture and check of the MODIS Drill–Alignment Fixture.

3.3.3 MODIS Master Plate Disposition

The MODIS Master Plate, its shipping container, and packing material is retained at the Martin Marietta ASD East Windsor, NJ, plant.

3.3.4 MODIS Master Plate Spares

No spares are provided for the MODIS Master Plate.

3.3.5 MODIS Master Plate Shipping Container and Packing Material

The MODIS Master Plate shipping container contains identified nesting depressions for all loose items.

3.4 MODIS Lifting Sling

The MODIS Lifting Sling is shown in Figure 1–4 and described in the following sections.

3.4.1 MODIS Lifting Sling Description

The MODIS Lifting Sling attaches to the MODIS mainframe on the +z side of the mainframe and permits transfer of the MODIS via MODIS lifting/lowering operations along the z–direction. When this sling is used, the system z–axis positive direction is up.

3.4.2 MODIS Lifting Sling Usage

The MODIS Lifting Sling is used to transfer the MODIS from the MODIS Shipping Container to the spacecraft at instrument installation.

3.4.3 MODIS Lifting Sling Disposition

The disposition of the MODIS Lifting Sling and its spares, shipping container, and packing material is described in the following sections.

3.4.3.1 MODIS Lifting Sling Delivery to Martin Marietta

The MODIS Lifting Sling will be delivered to the Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.4.3.2 MODIS Lifting Sling Return to SBRC

The MODIS Lifting Sling will be returned to B20 Shipping/Receiving at SBRC, 7406 Hollister Avenue, Goleta, CA, at spacecraft delivery to the launch site.

3.4.4 MODIS Lifting Sling Spares

N/A

3.4.5 MODIS Lifting Sling Shipping Container and Packing Material

(TBD 5)

3.5 MODIS Shipping Container

The MODIS Shipping Container is shown in Figure 1–5 and described in the following sections.

3.5.1 MODIS Shipping Container Description

The MODIS Shipping Container is a sealable box which provides support and protection for the MODIS during transportation and storage.

3.5.2 MODIS Shipping Container Usage

The MODIS Shipping Container is used whenever the instrument is not mounted on the spacecraft or located in a Class 10,000 clean room.

3.5.3 MODIS Shipping Container Disposition

The disposition of the MODIS Shipping Container and its spares, shipping container, and packing material is described in the following sections.

3.5.3.1 MODIS Shipping Container Delivery to Martin Marietta

The MODIS Shipping Container will be delivered to the Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.5.3.2 MODIS Shipping Container Return to SBRC

The MODIS Shipping Container will be returned to B20 Shipping/Receiving at SBRC, 7406 Hollister Avenue, Goleta, CA, at spacecraft delivery to the launch site.

3.5.4 MODIS Shipping Container Spares

(TBD 6)

3.5.5 MODIS Shipping Container Packing Material

(TBD 6)

3.6 Bench Test Cooler

The Bench Test Cooler (BTC) is shown in Figure 1–6 and described in the following sections.

3.6.1 Bench Test Cooler Description

(TBD 7)

3.6.2 Bench Test Cooler Usage

(TBD 7)

3.6.3 Bench Test Cooler Disposition

The disposition of the BTC and its spares, shipping container, and packing material is described in the following sections.

3.6.3.1 Bench Test Cooler Delivery to Martin Marietta

The BTC will be delivered to the Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.6.3.2 Bench Test Cooler Return to SBRC

The BTC will be returned to B20 Shipping/Receiving at SBRC, 7406 Hollister Avenue, Goleta, CA, at spacecraft delivery to the launch site.

3.6.4 Bench Test Cooler Spares

(TBD 7)

3.6.5 Bench Test Cooler Shipping Container and Packing Material

(TBD 7)

3.7 Earth View Source

The Earth View Source (EVS) is shown in Figure 1–7 and described in the following sections.

3.7.1 Earth View Source Description

The EVS consists of the floor shroud of the 35' thermal vacuum chamber controlled to a temperature of **(TBD 8)**.

3.7.2 Earth View Source Usage

The EVS is used during thermal vacuum testing to provide Earth radiation simulation for the Nadir Aperture.

3.8 Space View Source

The Space View Source (SVS) is shown in Figure 1–8 and described in the following sections.

3.8.1 Space View Source Description

(TBD 9)

3.8.2 Space View Source Usage

(TBD 9)

3.8.3 Space View Source Disposition

The disposition of the SVS and its spares, shipping container, and packing material is described in the following sections.

3.8.3.1 Space View Source Delivery to Martin Marietta

The SVS will be delivered to the Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.8.3.2 Space View Source Return to SBRC

The SVS will be returned to B20 Shipping/Receiving at SBRC, 7406 Hollister Avenue, Goleta, CA, at spacecraft delivery to the launch site.

3.8.4 Space View Source Spares

(TBD 9)

3.8.5 Space View Source Shipping Container and Packing Material

(TBD 9)

3.9 PRC Space Background Simulator

The Passive Radiative Cooler (PRC) Space Background Simulator (SBS) is shown in Figure 1–9 and described in the following sections.

3.9.1 PRC Space Background Simulator Description

(TBD 10)

3.9.2 PRC Space Background Simulator Usage

(TBD 10)

3.9.3 PRC Space Background Simulator Disposition

The disposition of the PRC SBS and its spares, shipping container, and packing material is described in the following sections.

3.9.3.1 PRC Space Background Simulator Delivery to Martin Marietta

The PRC SBS will be delivered to the Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.9.3.2 PRC Space Background Simulator

The PRC SBS will be returned to B20 Shipping/Receiving at SBRC, 7406 Hollister Avenue, Goleta, CA, at spacecraft delivery to the launch site.

3.9.4 PRC Space Background Simulator Spares

(TBD 10)

3.9.5 PRC Space Background Simulator Shipping Container and Packing Material

(TBD 10)

3.10 SAM Space Background Simulator

The Space View Analog Electronics Module (SAM) SBS is shown in Figure 1–10 and described in the following sections.

3.10.1 SAM Space Background Simulator Description

The SAM SBS consists of the shroud of the 35' thermal vacuum chamber controlled to a temperature of **(TBD 11)**.

3.10.2 SAM Space Background Simulator Usage

The SAM SBS is used during thermal vacuum testing to provide space radiation simulation for the Space View Analog Electronics Module radiator.

3.11 MEM Space Background Simulator

The Main Electronics Module (MEM) SBS is shown in Figure 1–11 and described in the following sections.

3.11.1 MEM Space Background Simulator Description

The MEM SBS consists of the shroud of the 35' thermal vacuum chamber controlled to a temperature of **(TBD 12)**.

3.11.2 MEM Space Background Simulator Usage

The MEM SBS is used during thermal vacuum testing to provide space radiation simulation for the Space View Analog Electronics Module radiator.

3.12 FAM Space Background Simulator

The Forward Analog Electronics Module (FAM) SBS is shown in Figure 1–12 and described in the following sections.

3.12.1 FAM Space Background Simulator Description

The FAM SBS consists of the shroud of the 35' thermal vacuum chamber controlled to a temperature of **(TBD 13)**.

3.12.2 FAM Space Background Simulator Usage

The FAM SBS is used during thermal vacuum testing to provide space radiation simulation for the Space View Analog Electronics Module radiator.

3.13 Spacecraft Interface Simulator

The SIS is shown in Figure 1–13 and described in the following sections.

3.13.1 Spacecraft Interface Simulator Description

The SIS is a piece of electrical GSE designed and manufactured by Martin Marietta to simulate spacecraft–to–instrument and SIS–to–IGSE interfaces. It consists of a Sun workstation (including a tape drive and a QMS printer) running OASIS and two racks of equipment which consists of a combination of commercial and custom test equipment. All of the equipment is controlled and monitored from the Sun workstation. It simulates the spacecraft–level test environment in that the same database, procedures, and displays used for spacecraft–level I&T are used on the SIS.

The SIS is capable of controlling IGSE via an IEEE–488 interface and of verifying the presence or absence of a test pattern in the science data. An ethernet interface is provided to permit non–real–time electronic transfer of files from the SIS to/from another computer. Note that there are no analysis tools provided with the SIS for off–line data analysis.

3.13.2 Spacecraft Interface Simulator Usage

The SIS is used to verify the compatibility of the instrument command and housekeeping telemetry database, including calibration curves and limit definitions, and automated test procedures, known as building blocks, written in CSTOL. The SIS is the source of all commands for the instrument and the SIS GSE during the SIS interface test. The SIS is used for the real–time collection, processing, display, and archiving of housekeeping telemetry. It collects and distributes science data to the IGSE in the same manner as the SCS during spacecraft–level I&T.

3.13.3 Spacecraft Interface Simulator Disposition

The disposition of the SIS and its spares, shipping container, and packing material is described in the following sections.

3.13.3.1 Spacecraft Interface Simulator Delivery to SBRC

The SIS will be delivered to B20 Shipping/Receiving at SBRC, 7406 Hollister Avenue, Goleta, CA, in October 1994.

3.13.3.2 Spacecraft Interface Simulator Return to Martin Marietta

(TBD 14)

3.13.4 Spacecraft Interface Simulator Spares

(TBD 14)

3.13.5 Spacecraft Interface Simulator Shipping Container and Packing Material

(TBD 14)

3.14 System Test Equipment

The System Test Equipment (STE) is shown in Figure 1–14 and described in the following sections.

3.14.1 System Test Equipment Description

(TBD 15)

3.14.2 System Test Equipment Usage

(TBD 15)

3.14.3 System Test Equipment Disposition

The disposition of the STE and its spares, shipping container, and packing material is described in the following sections.

3.14.3.1 System Test Equipment Delivery to Martin Marietta

The STE will be delivered to the Martin Marietta ASD East Windsor, NJ, plant Shipping and Receiving Area at the east side of Building 409 at instrument delivery.

3.14.3.2 System Test Equipment Delivery to Launch Site

The STE will be delivered to the launch site at spacecraft delivery to the launch site.

3.14.3.3 System Test Equipment

The STE will be returned to B20 Shipping/Receiving at SBRC, 7406 Hollister Avenue, Goleta, CA, after launch.

3.14.4 System Test Equipment Spares

(TBD 15)

3.14.5 System Test Equipment Shipping Container and Packing Material

(TBD 15)

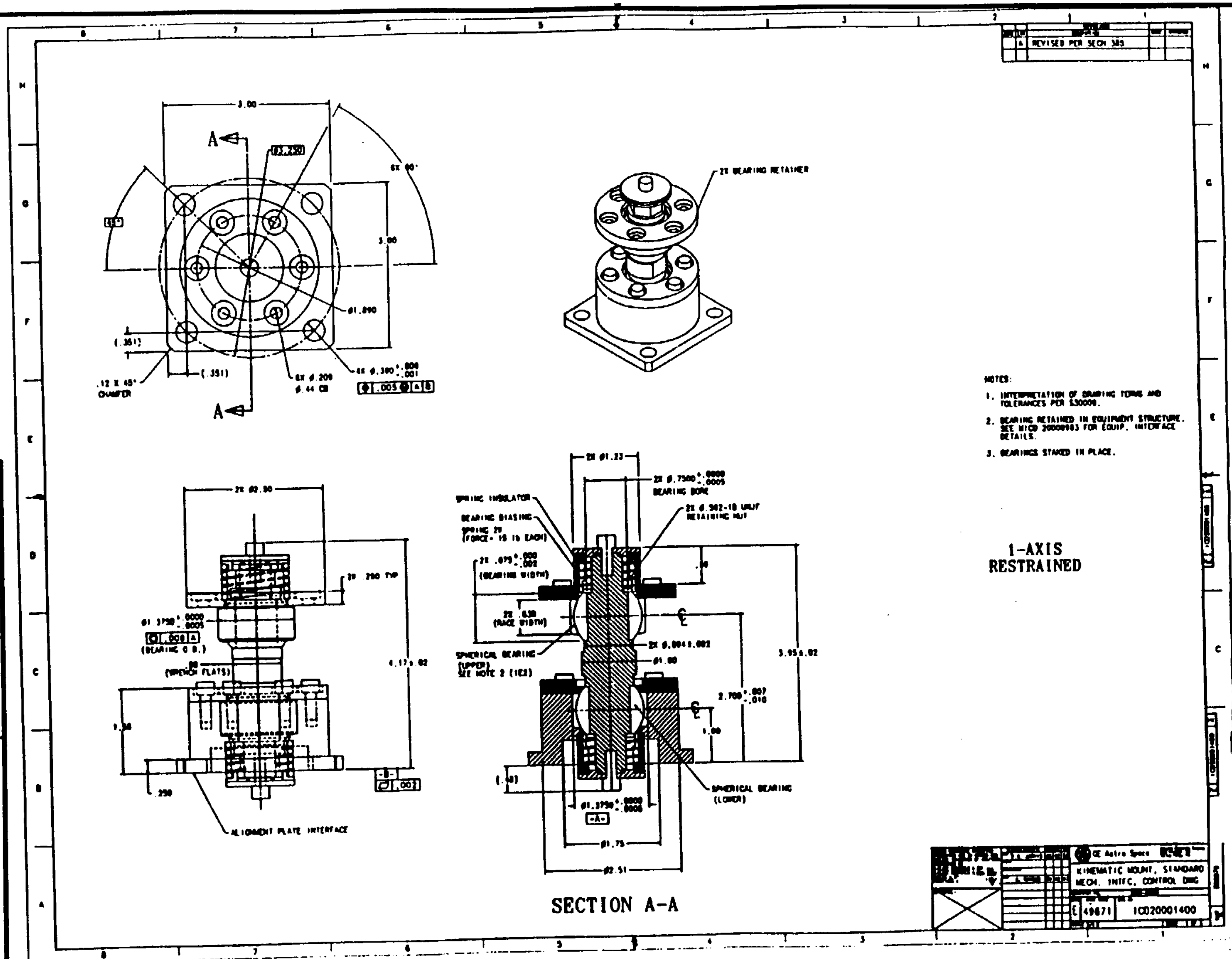

Figure 1–1a. MODIS Test Kinematic Mount: 1–Axis

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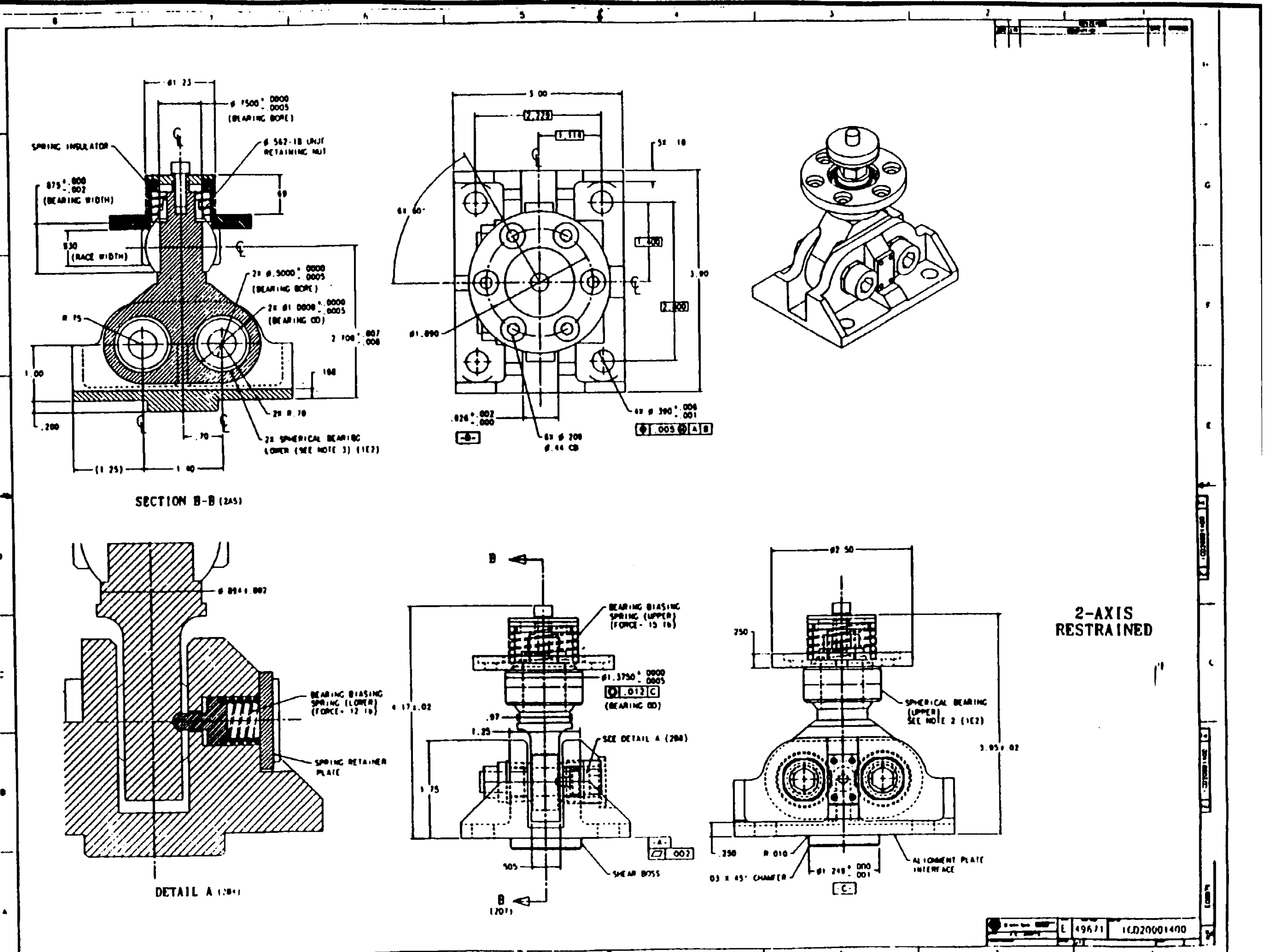

Figure 1–1b. MODIS Test Kinematic Mount: 2–Axis

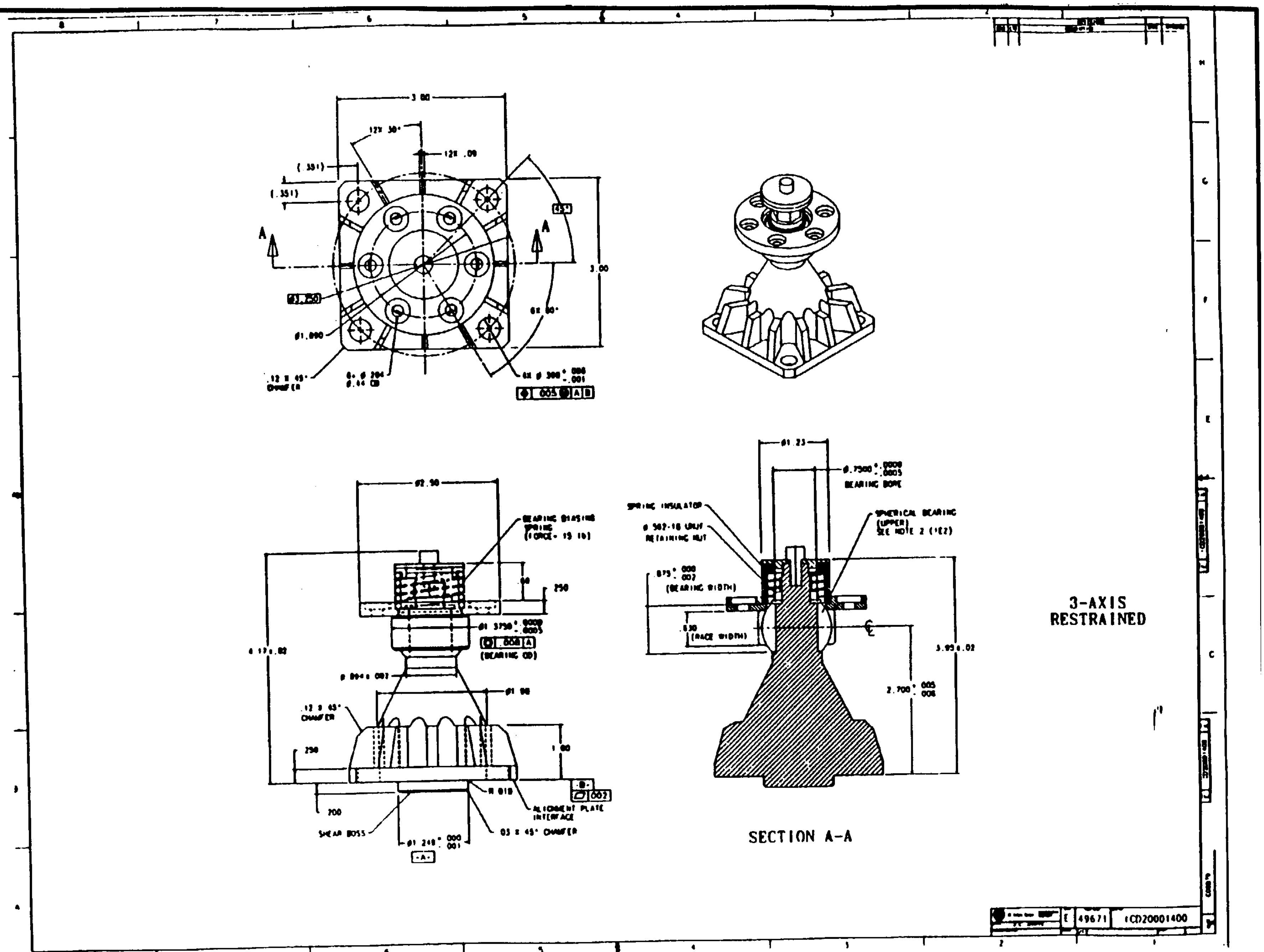

Figure 1–1c. MODIS Test Kinematic Mount: 3–Axis

Size A

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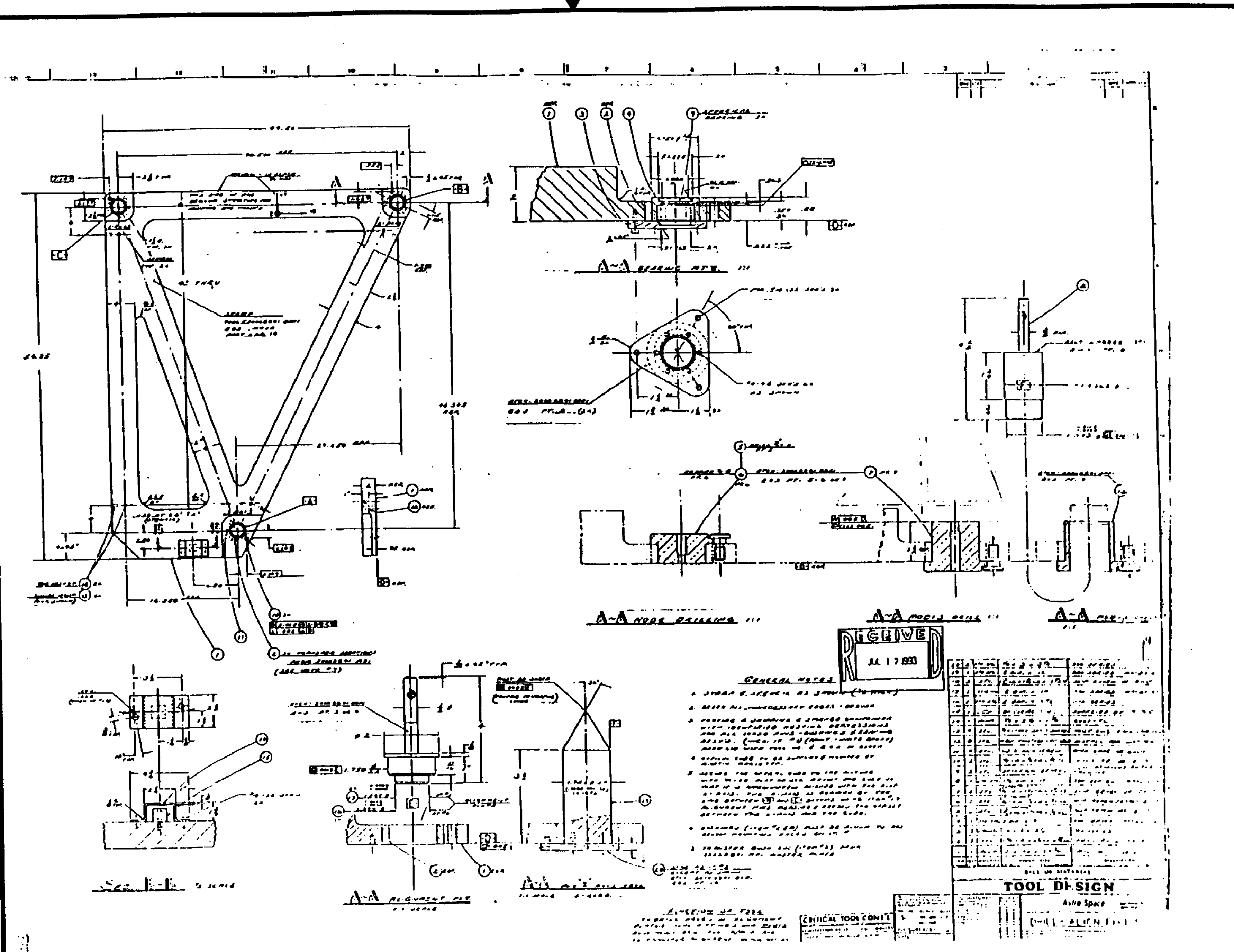

Figure 1-2. MODIS Drill-Alignment Fixture

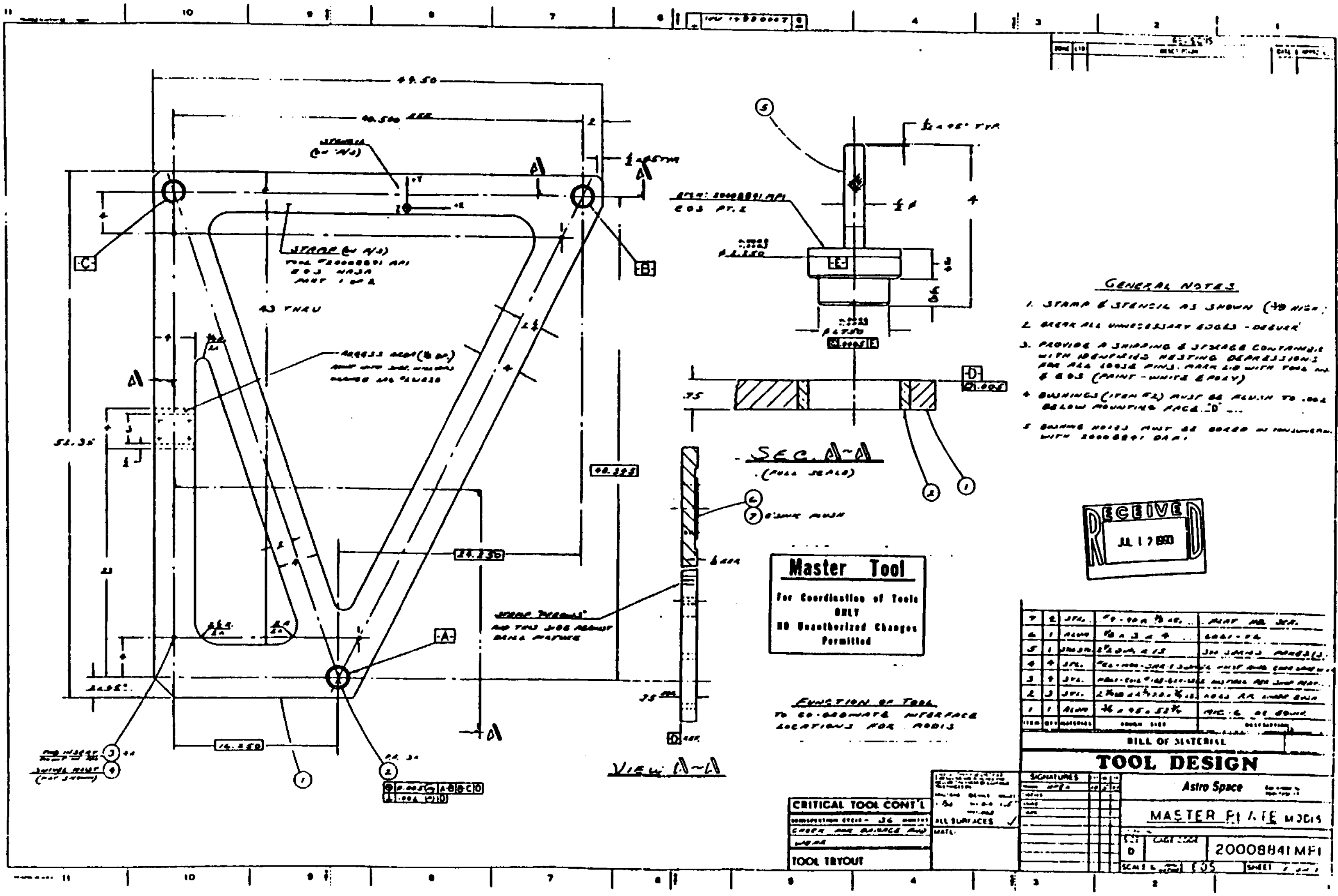

Figure 1–3. MODIS Master Plate

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(TBD 16)

Figure 1–4. MODIS Lifting Sling

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(TBD 16)

Figure 1–5. MODIS Shipping Container

(TBD 16)

Figure 1–6. Bench Test Cooler

(TBD 16)

Figure 1–7. Earth View Source

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(TBD 16)

Figure 1–8. Space View Source

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(TBD 16)

Figure 1–9. PRC Space Background Simulator

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(TBD 16)

Figure 1–10. SAM Space Background Simulator

(TBD 16)

Figure 1-11. MEM Space Background Simulator

(TBD 16)

Figure 1–12. FAM Space Background Simulator

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(TBD 16)

Figure 1–13. Spacecraft Interface Simulator

(TBD 16)

Figure 1–14. System Test Equipment

4 FACILITIES

This section describes the facilities that will be used to support EOS–AM instrument integration, test, and launch site activities.

1. The I&T and launch site facilities are listed below and described in the following sections. The facility floor plans showing the MODIS and IGSE layout are shown in Figures 2–1 through 2–13.

   I&T Facilities

   a. Shipping and Receiving Area
   b. Bench Acceptance Test Area
   c. MODIS Integration and Test Ground Station
   d. Bay 8
   e. 35–foot Thermal Vacuum Chamber
   f. Acoustic Chamber
   g. Storage

   Launch Site

   a. Vandenberg Air Force Base (VAFB)
   b. Launch Site Processing Facility
   c. MODIS Launch Site Ground Station

2. The MODIS requirements which will be supported by the I&T and launch site facilities are summarized in Table III.

3. The IGSE requirements which will be supported by the I&T and launch site facilities are summarized in Tables IV and V.

4 FACILITIES

This section describes the facilities that will be used to support EOS–AM instrument integration, test, and launch site activities.

1. The I&T and launch site facilities are listed below and described in the following sections. The facility floor plans showing the MODIS and IGSE layout are shown in Figures 2–1 through 2–13.

   I&T Facilities

   a. Shipping and Receiving Area
   b. Bench Acceptance Test Area
   c. MODIS Integration and Test Ground Station
   d. Bay 8
   e. 35–foot Thermal Vacuum Chamber
   f. Acoustic Chamber
   g. Storage

   Launch Site

   a. Vandenberg Air Force Base (VAFB)
   b. Launch Site Processing Facility
   c. MODIS Launch Site Ground Station

2. The MODIS requirements which will be supported by the I&T and launch site facilities are summarized in Table III.

3. The IGSE requirements which will be supported by the I&T and launch site facilities are summarized in Tables IV and V.

4.1 Integration and Test Facilities

The EOS integration and test will take place in Building 417 of the Martin Marietta ASD East Windsor, NJ, plant. The Martin Marietta ASD East Windsor plant is shown in Figure 2–1, and the Building 417 facility floorplan is shown in Figure 2–2.

4.1.1 Shipping and Receiving Area

All hardware arriving at the Martin Marietta ASD East Windsor, NJ, plant will be delivered to the Shipping and Receiving Area at the east side of Building 409. This area is a standard shipping dock capable of handling equipment which can be offloaded manually or with a fork lift. Equipment must pass through a door 7.5 feet wide x 8 feet high. Equipment requiring an overhead crane or which will not fit through the area door will be offloaded at the east end of Building 417. The Shipping and Receiving Area is located approximately 300 yards away from the Bench Acceptance Test Clean Room. The hallway between these two facilities is slightly more than 7 feet wide and it is not environmentally controlled. All equipment must be received before being moved to the Bench Acceptance Test (BAT) area.

4.1.2 Bench Acceptance Test Area

The instrument and IGSE will be inspected in the BAT area.

4.1.2.1 Bench Acceptance Test Control Room

The BAT Control Room is 35 feet long and 15 feet wide. It is located adjacent to the BAT Clean Room and contains feed throughs directly into the clean room. Windows in the room provide visibility into the clean room. Access to the room is provided by a double door located in the rear of the room. All non–clean–room–compatible IGSE required for instrument BAT, including the instrument I&T ground station, will be located in this room for the duration of the BAT. It is sized to permit simultaneous processing of two instruments. Electrical power requirements documented in this ICD will be accommodated. A floorplan of the BAT Control Room, including IGSE layout, is shown in Figure 2–3.

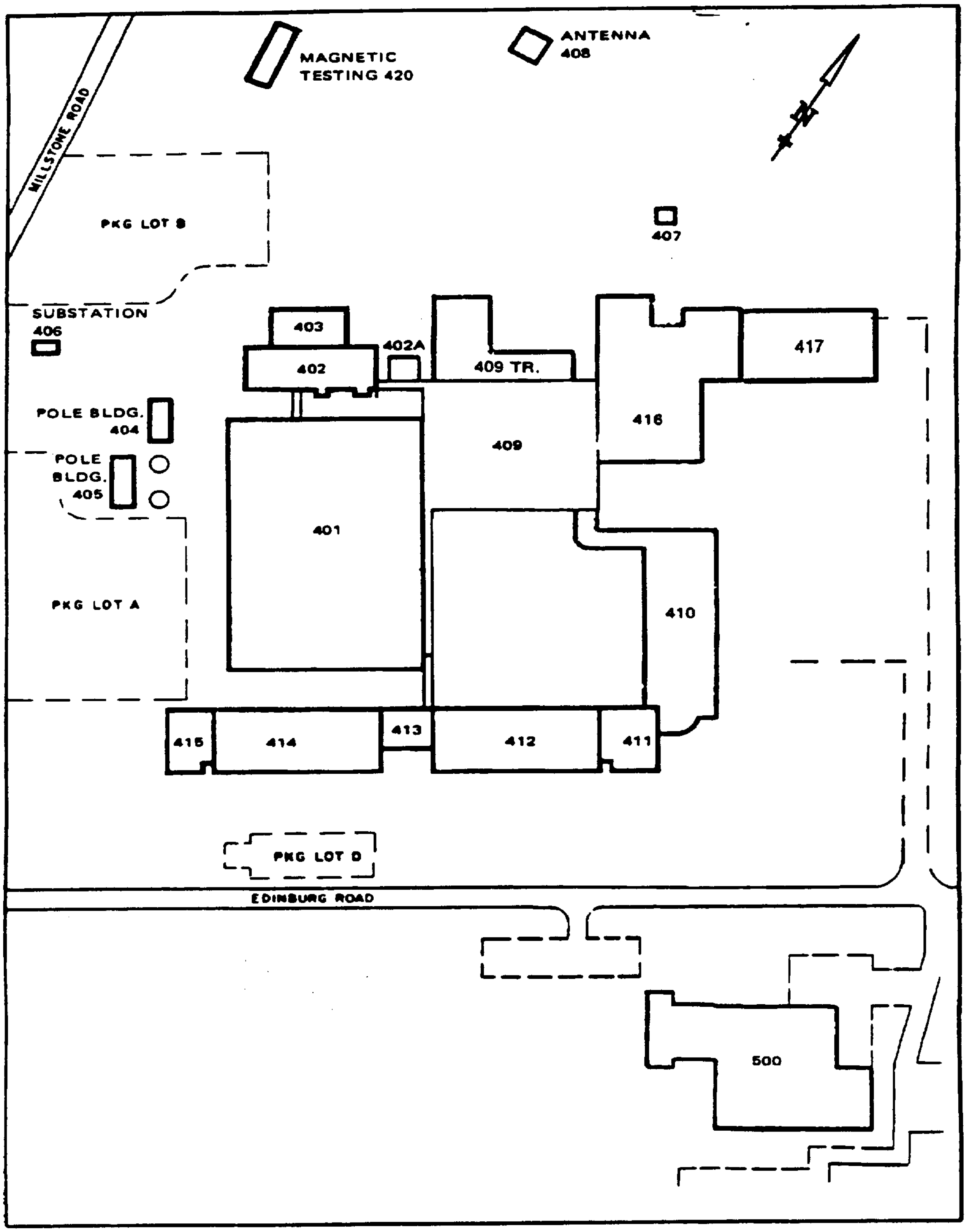

Figure 2–1. Martin Marietta ASD East Windsor Plant

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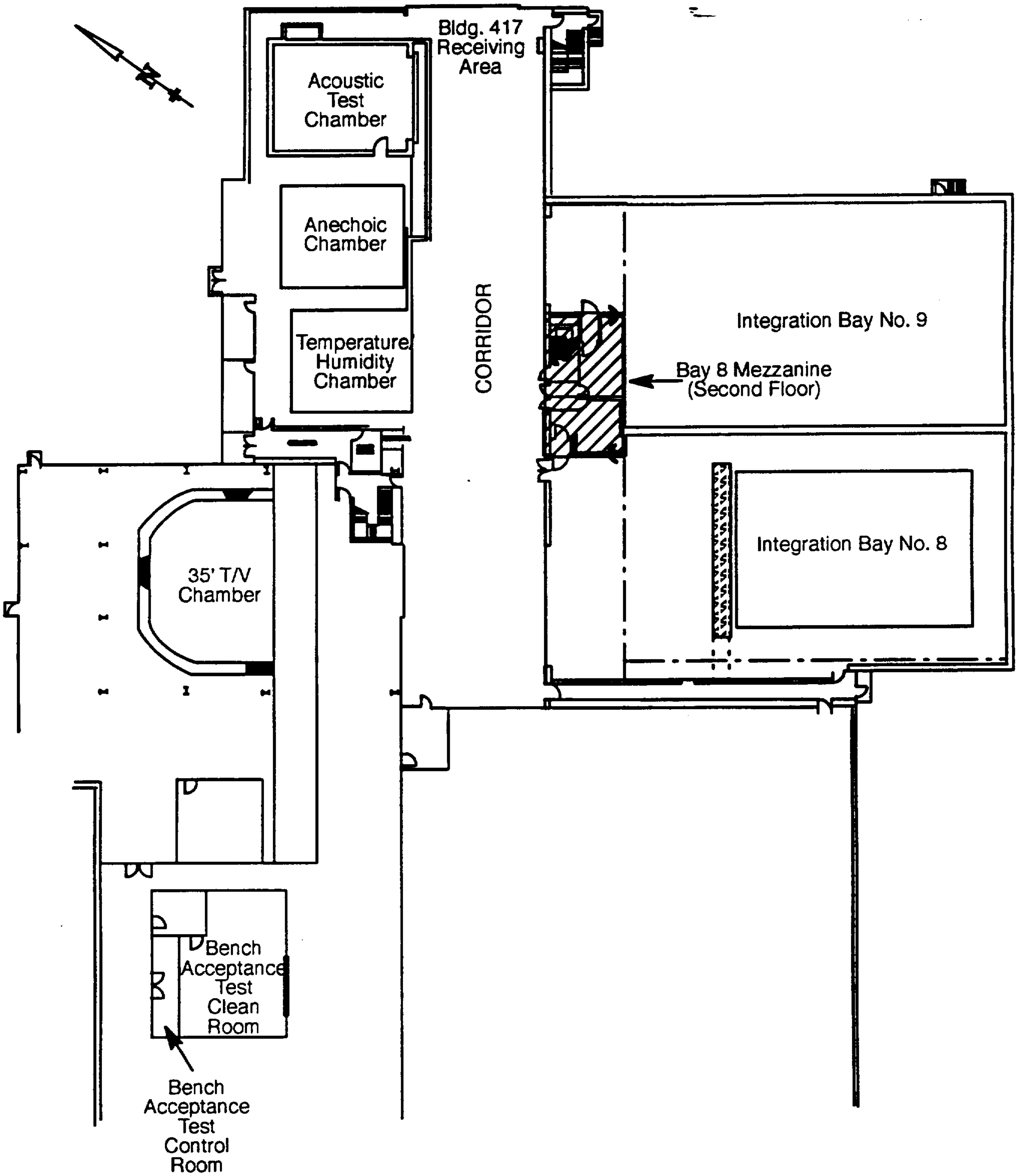

Figure 2–2. Building 417 Facilities

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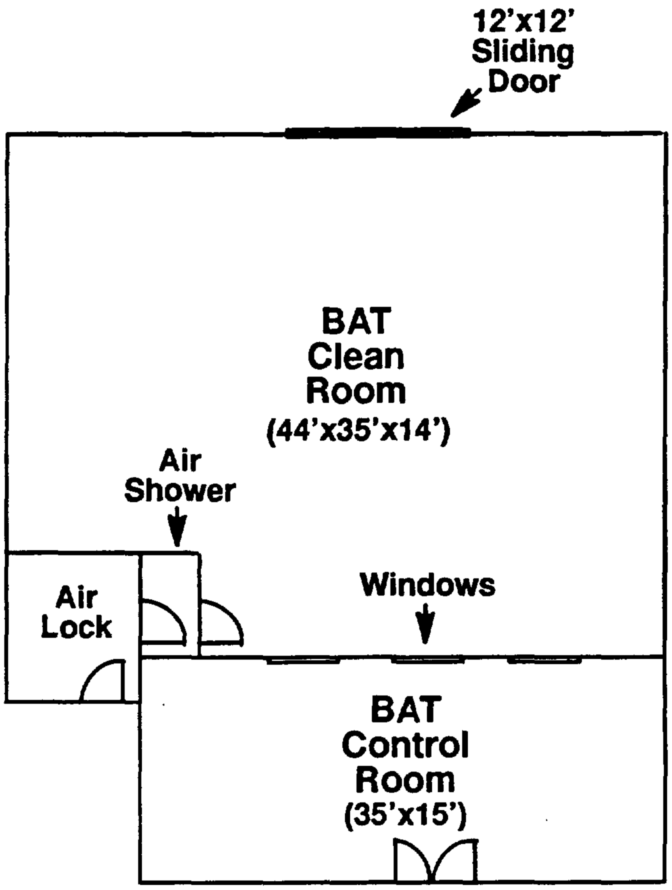

MODIS IGSE layout is (TBD 17)

Figure 2–3. Bench Acceptance Test Area Floorplan

4.1.2.2 Bench Acceptance Test Clean Room

The BAT Clean Room is an environmentally controlled room dedicated to EOS instruments for testing and processing prior to spacecraft integration. It is 44 feet long, 35 feet wide and 14 feet high, and is sized to permit simultaneous processing of two instruments. It is maintained at Class 10,000. It is temperature and humidity controlled.

Equipment enters the room through a 12'x12' sliding door. Personnel access is controlled through a separate door with a cypher lock via an air shower. The room does not have an air lock for equipment. A portable two ton crane with a 11' hook height will be provided for lifting operations. Air, vacuum and GN_2 connections are available on the wall at multiple locations in the room. Electrical power requirements documented in this ICD will be accommodated. A floorplan of the BAT Clean Room, including MODIS and IGSE layout, is shown in Figure 2–3.

4.1.3 Instrument Integration and Test Ground Station

The Instrument I&T Ground Station will be located on the fourth floor of Building 417, adjacent to the Spacecraft Test Control Room and SCS, subsequent to the BAT and for the duration of the instrument I&T activities. Each instrument will be provided with a ground station area of approximately 150–200 square feet. Separate office space will be provided.

The Instrument I&T ground station area will accommodate the electrical power requirements documented in this ICD. The area provides fluorescent lighting and forced air cooling (three 115,000 BTU air conditioners), and has a raised floor. The ceiling height is approximately 8 feet.

Access to the fourth floor is provided by an elevator which has a door opening of 3.5 feet wide x 7 feet high. The elevator is 6.5 feet deep and rated to lift up to 3000 lbs.

The IGSE layout in the MODIS I&T Ground Station is shown in Figure 2–4.

(TBD 18)

Figure 2–4. MODIS I&T Ground Station

4.1.4 Bay 8

The Bay 8 floorplan is shown in Figure 2–5.

4.1.4.1 Bay 8 Mezzanine

The Bay 8 Mezzanine is located on the second floor of Building 417 immediately adjacent to Integration Bay 8. It is located above the Bay 8 air lock and shower. It is approximately 41 feet long and 8 feet high. Half of the area is 20 feet wide. The other half of the area is 12 feet wide. It will be used for non–clean–room–compatible GSE that must be located close (within 100 feet) to the spacecraft. To minimize clutter around the spacecraft, as space permits, the mezzanine will be used for clean–room–compatible GSE that does not require Class 10,000 cleanliness control and can be located up to 100 feet from the spacecraft.

The mezzanine is a raised floor area which will accommodate the electrical power requirements documented in this ICD. Personnel access is provided by a door on the first floor. Access is controlled with a cypher lock. Access for equipment is provided by a double door (5 feet wide x 7 feet high) on the second floor which opens into the Building 417 corridor. A fork lift and special equipment loading platform are used to move equipment into the mezzanine.

The Bay 8 Mezzanine, including IGSE layout, is shown in Figure 2–6.

4.1.4.2 Integration Bay 8

Integration Bay 8 is located in Building 417. It is 112 feet long, 64 feet wide and 65 feet high. It contains a seismic mass which is 70 feet long, 45 feet wide and 6 feet deep. On top of the seismic mass is a 100 ton, 13 feet diameter precision rotary table which is used for spacecraft alignment. The bay contains a 20 ton and a 5 ton crane, each with a hook height of 55 feet, and a 20' x 40' table used for spacecraft deployment testing. It has a laminar flow air handling system which controls the cleanliness of the bay to better than Class 10,000. The air handling system also maintains bay temperature to ±2°F of the set point and bay humidity within the range 30 to 50%. Access to the bay is provided by a 35 foot wide, 45 foot high sliding door. Personnel access is provided via an air lock and air shower. Access is controlled by a cypher lock. Air, vacuum and GN_2 connections are available on the wall at multiple locations in the bay.

Integration Bay 8, including spacecraft and GSE layout, is shown in Figure 2–7.

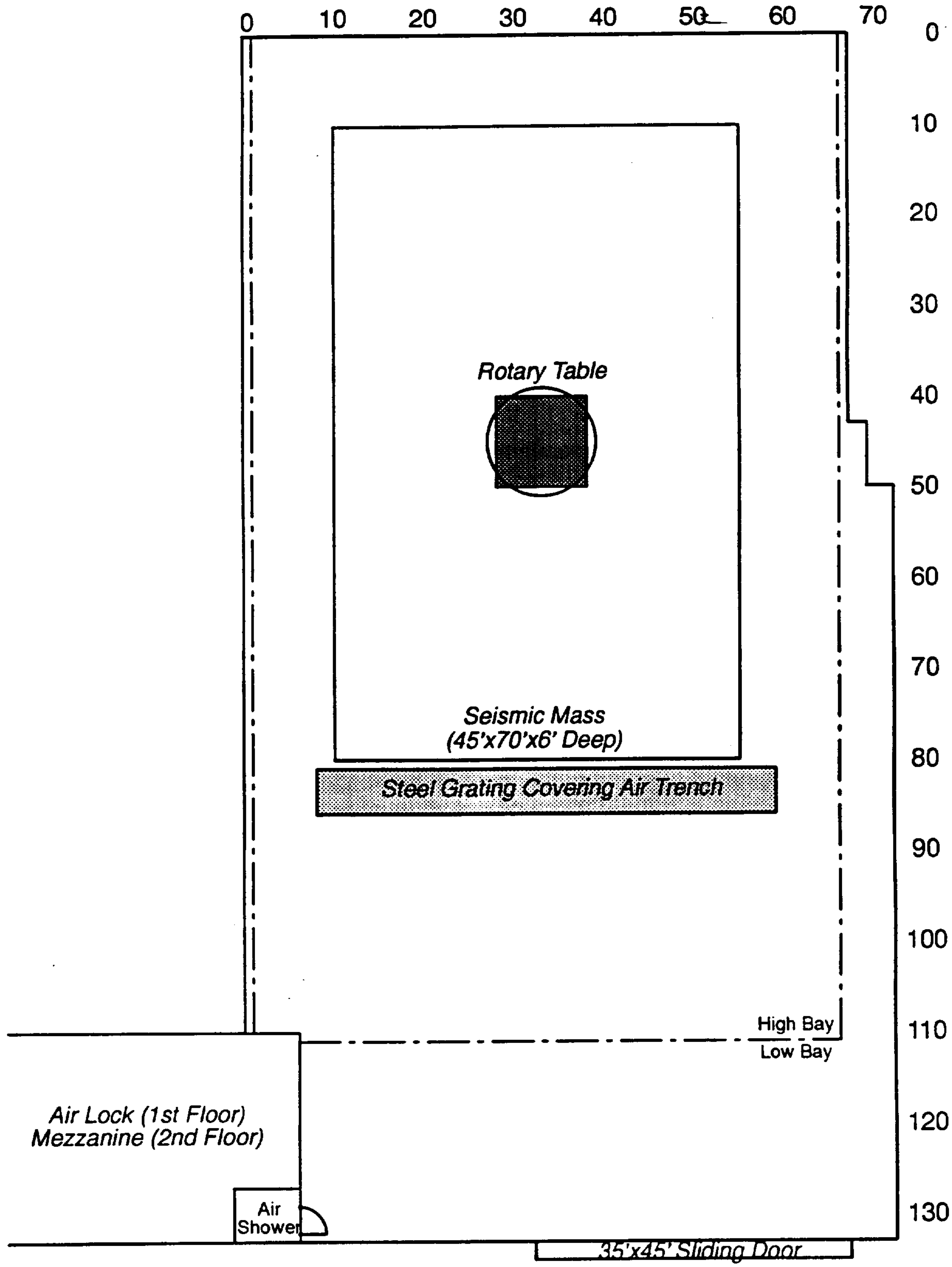

Figure 2–5. Integration Bay 8 Floorplan

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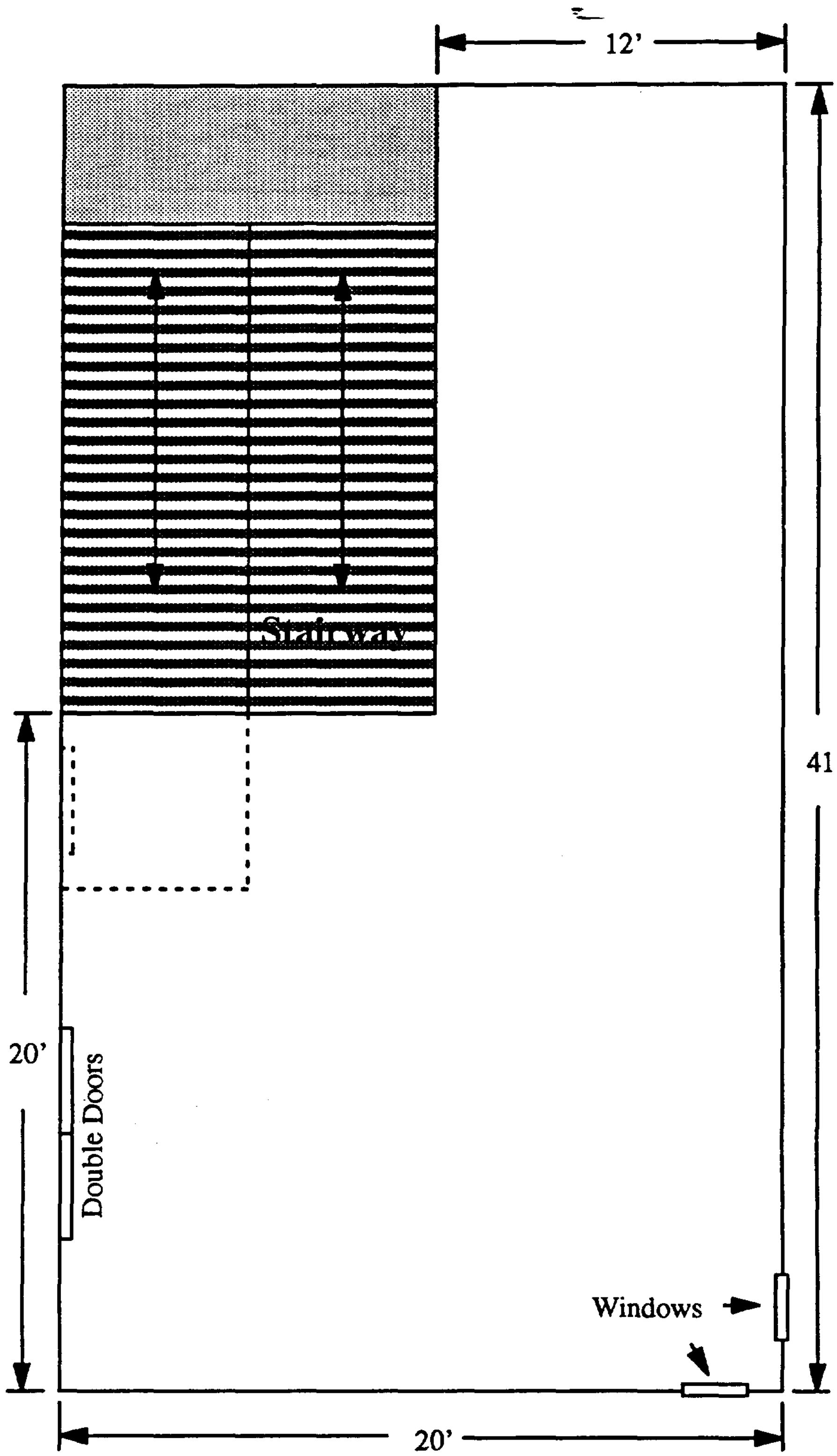

Figure 2–6. Bay 8 Mezzanine

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		Sheet 63

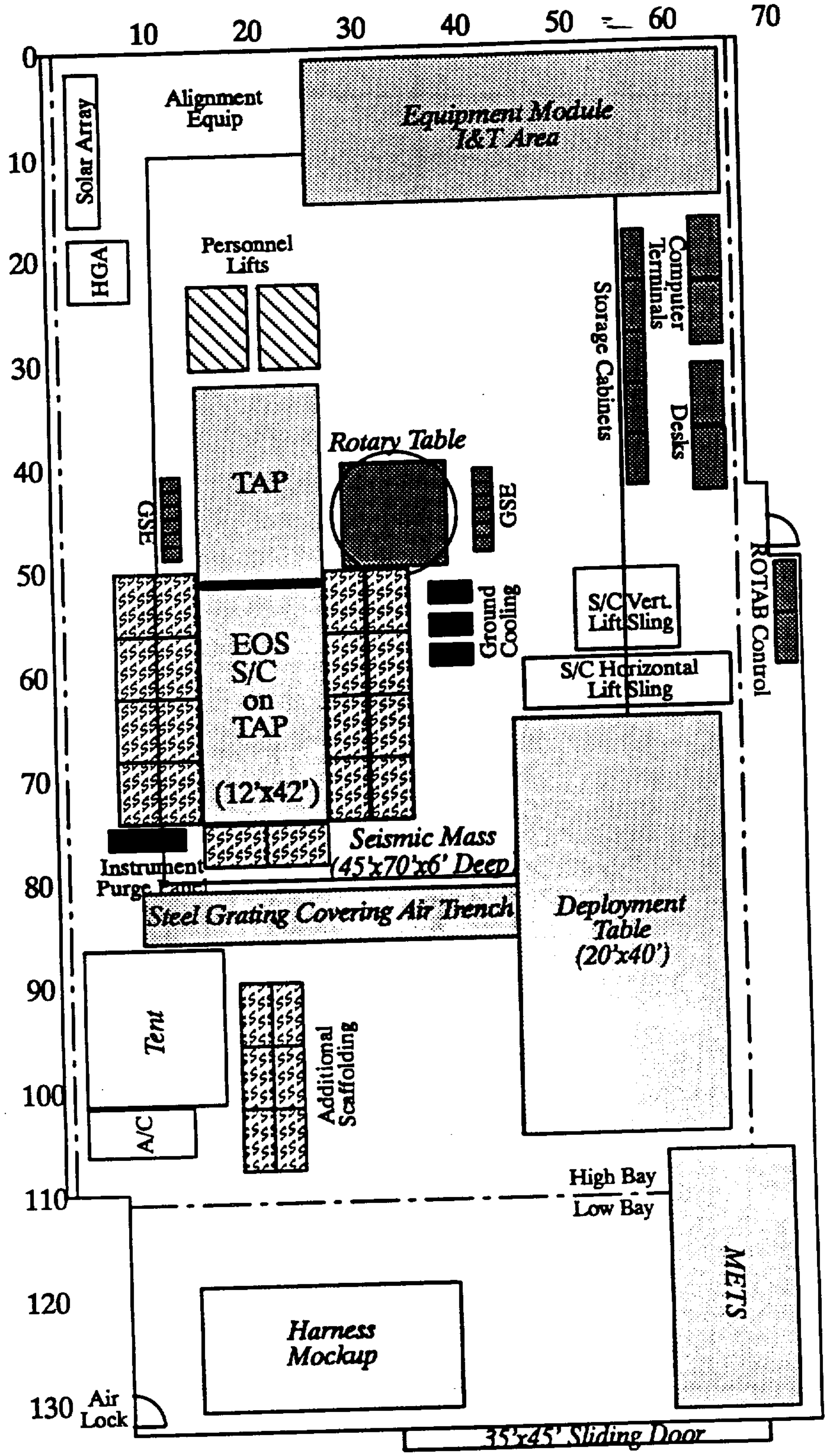

Figure 2–7. Integration Bay 8

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		Sheet 64

4.1.5 35–foot Thermal Vacuum Chamber

The 35–Foot Thermal Vacuum Chamber has a working diameter of 35 feet and an inside height of 45 feet. The side–opening 49–foot diameter main door is removable and allows for loading fully integrated test items at floor level. At ambient conditions, it is temperature and humidity controlled, and maintained at Class 10,000. Using two mechanical roughing trains and six 48–inch cryogenic pumps, a pressure of 5×10^{-6} Torr is achieved after 24 hours.

The interior surfaces of the 35–Foot Thermal Vacuum Chamber are maintained at extremely low temperatures to simulate the low energy, absorbing characteristics of space. These surfaces consist of a system of eight independently controlled black cooling panels (shroud) which line the walls, ceiling and floor, and through which gaseous or liquid nitrogen is circulated. Each panel can be individually thermally controlled from +125 to –185°C when liquid nitrogen is used. All surfaces facing the test article have an emissivity of $\geq$0.95.

There is a 5 ton crane located on the center line of the chamber ceiling, and three 3 ton cranes located 120° apart, 13 feet from the ceiling center line. Personnel access is provided by a 6.5–foot door. Penetrations for GSE are provided and require the use of **(TBD 19)** connectors and cable lengths >**(TBD 20)** feet. Gas and fluid lines are **(TBD 21)**. Chamber instrumentation includes 580 channels for thermocouples (460 channels for the unit under test and 120 channels for the facility) and a 200 AMU residual gas analyzer (by prior arrangement). Emergency power is available.

The spacecraft and GSE layout in the 35–foot Thermal Vacuum Chamber is shown in Figure 2–8.

4.1.6 Acoustic Chamber

The Acoustic Chamber is a reinforced concrete reverberant noise test chamber designed for acoustic generated dynamic simulation testing. The acoustic energy is generated by a flow of nitrogen gas, which is frequency controlled by two Wyle WAS 3000 air stream modulators and two Ling EPT 200 modulators, and temperature controlled to 20°C ±5°C. Up to eight microphones within the chamber measure the acoustic levels, which for test are up to 155 dB and have a shaped frequency range from 25 to 10,000 Hz.. The chamber is equipped with safety interlocks and an air ventilation system. At ambient conditions, it is temperature and humidity controlled, and maintained at Class 10,000.

The Acoustic Chamber is 31.5 feet wide, 41.8 feet deep, and 45.5 feet high. The side–opening door is 25 feet wide by 45 feet high.

The spacecraft and GSE layout in the Acoustic Chamber is shown in Figure 2–9.

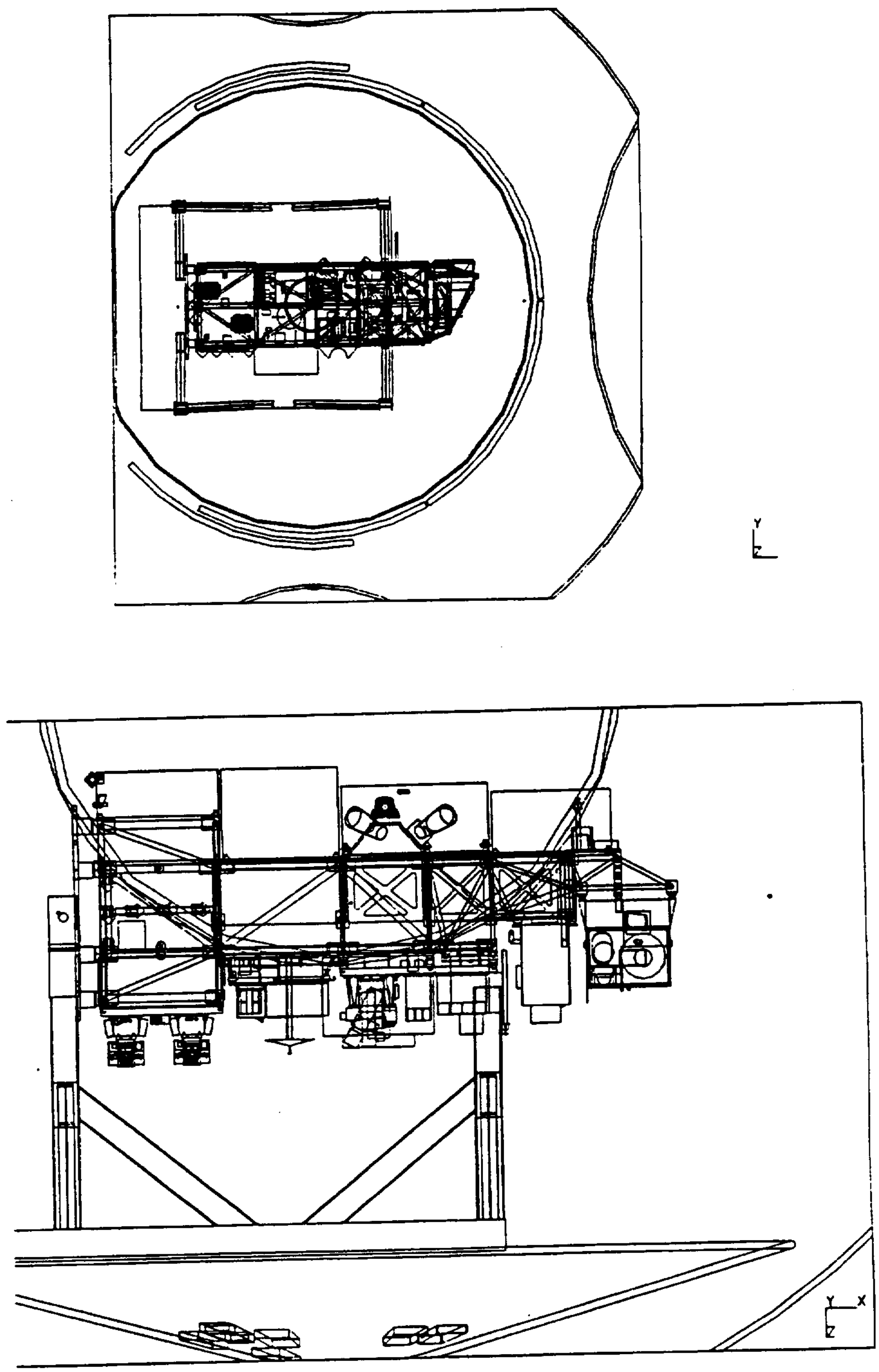

Figure 2–8. 35–Foot Thermal Vacuum Chamber

Size	Code Ident No.	
A	49671	20008846
		Sheet 66

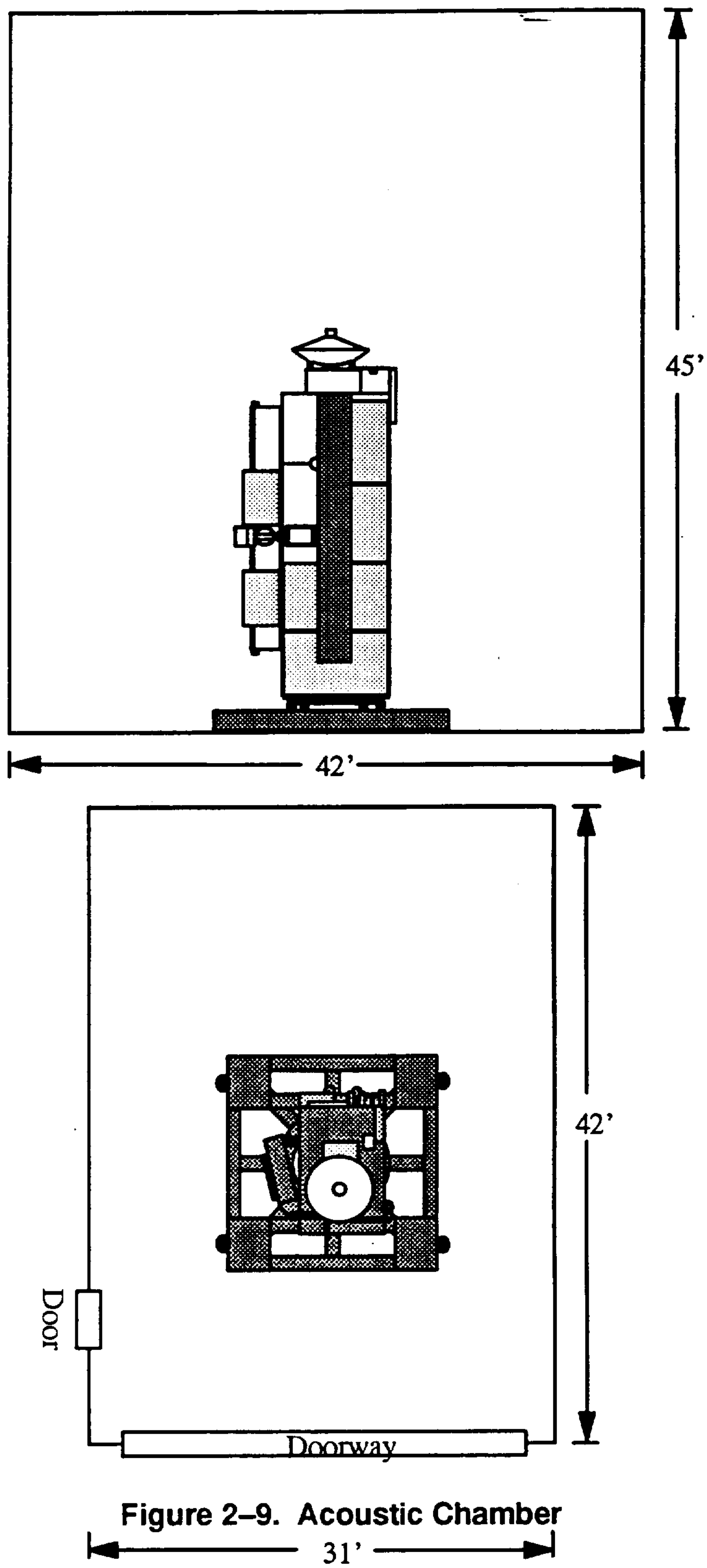

Figure 2–9. Acoustic Chamber

Size	Code Ident No.	
A	49671	20008846
		Sheet 67

4.1.7 Storage

4.1.7.1 Bonded Stock

Bonded Stock **(TBD 22)**

4.1.7.2 Other Storage

The storage area **(TBD 22)**

The MODIS and IGSE layout in the storage area is shown in Figure 2–10.

(TBD 22)

Figure 2–10. Storage Area

4.2 Launch Site

The EOS launch site activities will take place at the Western Test Range (WTR) VAFB in Building 1610. Administrative support will be located in Building 836 and launch will take place from Space Launch Complex 3 (SLC–3) **(TBR 4)**. The VAFB is shown in Figure 2–11.

4.2.1 Launch Site Processing Facility

The spacecraft and GSE layout in the Launch Site Processing Facility is shown in Figure 2–12.

4.2.2 MODIS Launch Site Ground Station

The MODIS Launch Site Ground Station

The IGSE layout in the MODIS Launch Site Ground Station is shown in Figure 2–13.

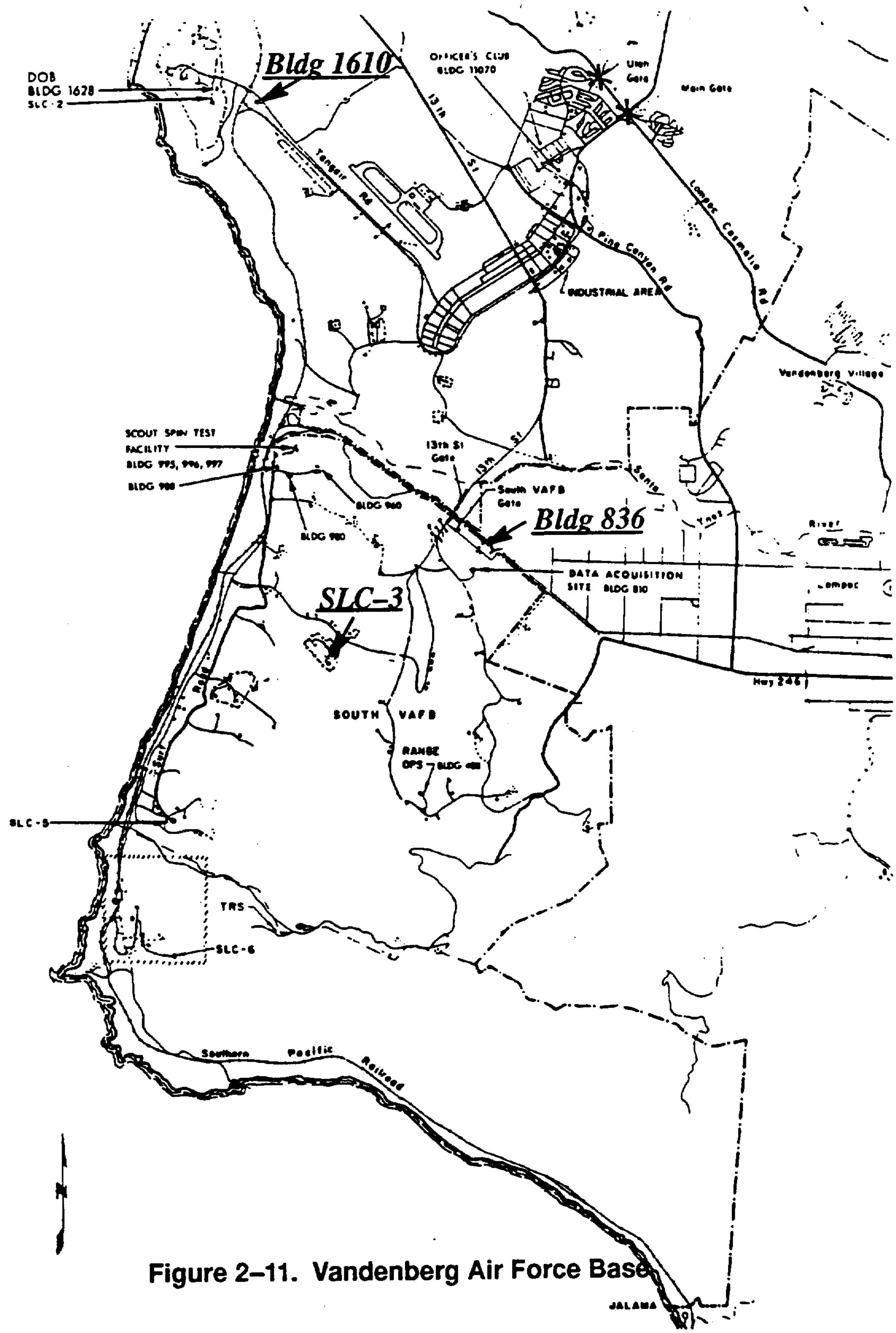

Figure 2–11. Vandenberg Air Force Base

Size	Code Ident No.	
A	49671	20008846
		Sheet 70

(TBD 23)

Figure 2–12. Launch Site Processing Facility

(TBD 24)

Figure 2–13. MODIS Launch Site Ground Station

Table III. Instrument Facility Requirements

Parameter	Requirement
Environment	
Temperature (°C)	17–26
Relative humidity (%)	50% maximum
Lighting	No special lighting requirement
Cleanliness	Class 10,000 during spacecraft I&T Class 100,000 at the launch site
Access	No internal access to the instrument has been identified. Inspection and cleaning during spacecraft I&T and launch activities require access only to external surfaces. Cover removal during closeouts at launch site requires access only to external surfaces.
Control	**(TBD 25)**
Time	**(TBD 25)**
Comments	

Table IV. Instrument Ground Support Equipment Physical Requirements (TBD 26)

Item	Size (ft)				Weight (lbs)	Electrical Service							Grounding	Notes
	Length	Width	Height	Dia		Pwr Input				Pwr Cons (W)	Connector Type	Cable Lgth (ft)		
						(V)	(Hz)	(φ)	(Amp)					
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

Notes:

*	Penetration connector (connector type)
φ	Phase
Amp	Amperes
Cons	Consumption
Dia	Diameter
ft	Feet
Hz	Hertz
lbs	Pounds
Lgth	Length
Pwr	Power
V	Volts
W	Watts

Table IV. Instrument Ground Support Equipment Physical Requirements (cont'd) (TBD 26)

Item	Size (ft)				Weight	Electrical Service								Grounding	Notes
	Length	Width	Height	Dia	(lbs)	Pwr Input (VAC)	Pwr Input (Hz)	Pwr Input (φ)	Pwr Input (Amp)	Pwr Cons (W)	Connector Type	Cable Lgth (ft)			
11															
12															
13						208	60	3	30		Male (SIS): NEMA Code L21–30P (Hubble 2815) Female (Facility): NEMA Code L21–30R (Hubble 2813 or 28CM13)			Isolation transformer supplied by MMC connections **(TBD 27)** Other grounding (TBD 27)	1
14															

Notes:

- * Penetration connector (connector type)
- φ Phase
- Amp Amperes
- Cons Consumption
- Dia Diameter
- ft Feet
- Hz Hertz
- lbs Pounds
- Lgth Length
- N/A Not applicable
- Pwr Power
- VAC Volts alternating current
- W Watts

1. "WYE"

Table V. Instrument Ground Support Equipment Environmental Requirements (TBD 28)

Item	Environment					Access		Comments
	A/C Load (W)	Temp (°C)	RH (%)	Lighting	Clean	Control	Time	
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								

Notes:

A/C Air conditioning
C Centigrade
Clean Cleanliness
RH Relative humidity
Temp Temperature
W Watts

5 SUPPORT

1. Consumables used during instrument–level I&T, spacecraft–level I&T, and launch site activities are identified in Table VI.

2. Documentation support during instrument–level I&T, spacecraft–level I&T, and launch site activities is identified in Table VII.

3. Personnel support during instrument–level I&T, spacecraft–level I&T, and launch site activities is identified in Section 5.1.

4. Computer maintenance contract support instrument–level I&T, spacecraft–level I&T, and launch site activities is identified in Section 5.2.

5. Other Martin Marietta–provided equipment and facilities are identified in Section 5.3.

Table VI. Consumables (TBD 29)

Description	Quantity	Provider

Table VII. Documentation (TBD 30)

Description	Provider	Storage Method	Access Control	Access Time	Maintenance Responsibility
Manuals					
Pre–ship data package					
Post–delivery inspection report					
Test data					

5.1 Personnel Support

5.1.1 Martin Marietta–Provided Personnel Support

(TBD 31)

5.1.2 Instrument–Provided Personnel Support

(TBD 31)

5.2 Computer Maintenance Contract

5.2.1 Computer Maintenance Contract at Instrument Provider Facility

(TBD 32)

5.2.2 Computer Maintenance Contract at Martin Marietta

(TBD 32)

5.2.3 Computer Maintenance Contract at Launch Site

(TBD 32)

5.3 Other Martin Marietta–Provided Equipment And Facilities

5.3.1 Other Martin Marietta–Provided Equipment And Facilities at Martin Marietta

Martin Marietta will provide the following additional equipment and facilities at Martin Marietta:

1. Non–escort badges for the following individuals for the period [delivery minus 1 month] through 30 September 1998:

Name	Affiliation	Citizenship
(TBD 33)		

2. Office furniture
   a. 1 telephone line with 2 phones
   b. 2 desks
   c. 2 tables
   d. 3 chairs
   e. 1 filing cabinet
   f. 1 bookcase

3. Ground station furniture
   a. 1 telephone line with 2 phones
   b. 1 line on the I&T voice net with 3 speakers and 3 headsets
   c. 1 modem with dedicated telephone line
   d. 3 tables
   e. 5 chairs
   f. 1 filing cabinet
   g. 1 bookcase

4. Clean room garments
   a. **(TBD 34)** [qty] suits size **(TBD 34)**
   b. **(TBD 34)** [qty] shoes size **(TBD 34)**
   c. **(TBD 34)** [qty] hoods

5. Access to copier, FAX, and mail room

6. Secretarial support

7. General purpose test equipment and standard tools

8. Quality Assurance support

9. Standard test equipment calibration

10. Contamination sampling and laboratory analysis

5.3.2 Other Martin Marietta–Provided Equipment And Facilities at the Launch Site

Martin Marietta will provide or arrange for the following additional equipment and facilities at the launch site :

1. Non–escort badges for the following individuals for the period [ship minus 1 month] through 30 September 1998:

Name	Affiliation	Citizenship
(TBD 35)		

2. Office furniture
   a. **(TBD 36)** [qty] telephone line with **(TBD 36)** [qty] phones
   b. **(TBD 36)** [qty] desks
   c. **(TBD 36)** [qty] tables
   d. **(TBD 36)** [qty] chairs
   e. **(TBD 36)** [qty] filing cabinets
   f. **(TBD 36)** [qty] bookcases

3. Ground station furniture
   a. **(TBD 37)** [qty] telephone line with **(TBD 37)** [qty] phones
   b. **(TBD 37)** [qty] lines on the I&T voice net with **(TBD 37)** [qty] speakers and **(TBD 37)** [qty] headsets
   c. **(TBD 37)** [qty] modem with dedicated telephone line
   d. **(TBD 37)** [qty] tables
   e. **(TBD 37)** [qty] chairs
   f. **(TBD 37)** [qty] filing cabinets
   g. **(TBD 37)** [qty] bookcases

4. Clean room garments
   a. **(TBD 38)** [qty] suits size **(TBD 38)**
   b. **(TBD 38)** [qty] shoes size **(TBD 38)**
   c. **(TBD 38)** [qty] hoods

5. Access to copier, FAX, and mail room

6. Secretarial support

7. General purpose test equipment and standard tools

8. Quality Assurance support

9. Standard test equipment calibration

10. Contamination sampling and laboratory analysis

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6 GROUND SUPPORT EQUIPMENT INTERFACES

1. The SIS–to–MODIS interface is described in Section 6.1.

2. The SCS–to–MODIS IGSE interface is described in Section 6.2.

3. The facility–to–MODIS IGSE interface is described in Section 6.3.

6.1 Spacecraft Interface Simulator–to–MODIS Interface

6.1.1 Spacecraft Interface Simulator–to–MODIS Harness Definition

1. The block diagram of the harnesses between the SIS and MODIS is shown in Figures 3 and 4. (All harnesses, with the exception of the harness from the SIS to the isolation transformer, are supplied by the Instrument Provider.)

2. The SIS–to–MODIS harness lengths are shown in Table VIII.

3. The list of the SIS connectors used by the Instrument Provider to fabricate the SIS–to–MODIS harnesses is shown in Table IX.

   a. The SIS–to–MODIS interconnections are shown in Tables Xa through Xt. The following legend is used for wire type:

Coax	Coaxial transmission line
SC	Single conductor, unshielded
SCS	Single conductor, shielded
TP	Twisted pair, unshielded
TPS	Twisted pair, shielded
Tn	Twisted bundle of n wires, unshielded
TnS	Twisted bundle of n wires, shielded
Twinax	Twinaxial transmission line

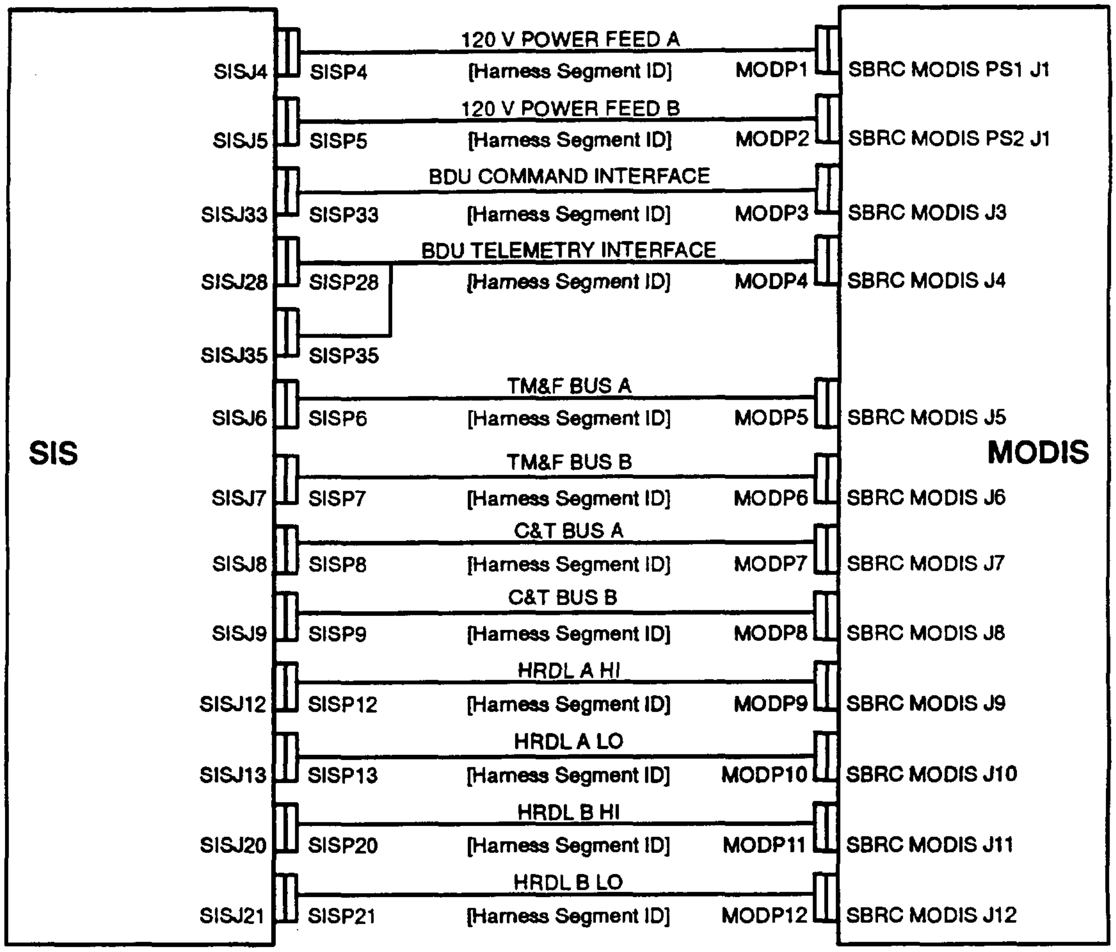
   b. All harnesses which are required by PN20005869, EOS–AM Spacecraft EMC Control Plan, to have an overall outer shield have either a copper tape over–wrap or a braid shield.

   The copper tape is actually copper–plated mylar tape which is one inch wide. The tape is then folded over 1/8 inch, making it 7/8 inch wide. The tape is 0.0017 inches thick (0.0007 inch copper on 0.001 inch mylar). The wrap is lapped half its width.

   Cables using a braid shield use braids similar to MIL–C–27500.

6.1.2 Spacecraft Interface Simulator–to–MODIS Interface Circuits and Timing Diagrams

The SIS–to–MODIS interface circuits and timing diagrams are shown in Figures 5 through 17.

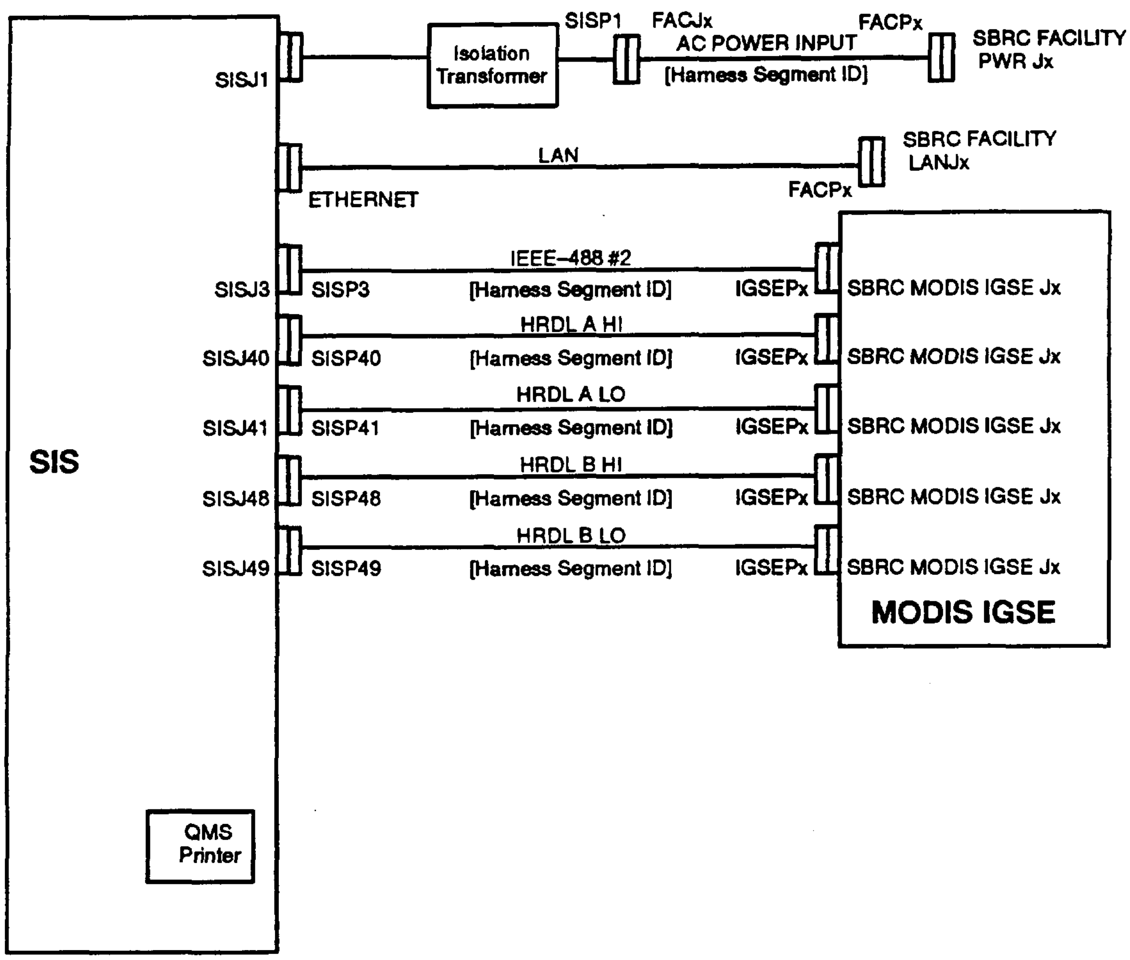


<u>Notes</u>:

SIS Spacecraft Interface Simulator

1. Connector numbers are **(TBR 5)**.
2. Harness Segment ID numbers are **(TBD 39)**.

Figure 3. SIS–to–MODIS Harness Block Diagram



Notes:

SIS Spacecraft Interface Simulator

1. SIS and SIS–side harness connector numbers are **(TBR 5)**.
2. Other connector numbers are **(TBD 40)**.
3. Harness Segment ID numbers are **(TBD 39)**.

Figure 4. SIS–to–MODIS IGSE Harness Block Diagram

Table VIII. SIS–to–MODIS Harness Length (TBD 41)

Description	Instrument Harness Segment ID (TBD 39)	Total # of Segments	Total # of Connector Pairs	Total Length (meters)	Figure #
120V Power Feed A					
120V Power Feed B					
BDU Cmd I/F					
BDU Tlm I/F					
TM&F Bus A					
TM&F Bus B					
C&T Bus A					
C&T Bus B					
HRDL A HI				(See Note 1)	
HRDL A LO				(See Note 1)	
HRDL B HI				(See Note 1)	
HRDL B LO				(See Note 1)	
AC Power Input					
IEEE–488 #2					
HRDL A HI				(See Note 1)	
HRDL A LO				(See Note 1)	
HRDL B HI				(See Note 1)	
HRDL B LO				(See Note 1)	
LAN					

Notes:

1. The SIS has an internal high rate cable length of 2.13 m; therefore, the high rate signal must be driven the length of the SIS–to–MODIS cable plus 2.13 m.

Table IX. SIS–to–MODIS Connector List

SIS Back Panel Connector		SIS Harness Connector		Drawing Location (TBD 42)		Function
Designation	Type	Designation	Type	Sheet	Zone	
SISJ1	2815	SISP1	2813			AC Power Input
SISJ2						Reserved (IEEE–488 #1)
SISJ3	CIB24BF	SISJ3	CIB24BA			IEEE–488 #2
SISJ4	MS27468T21F11S	SISP4	MS27467T21F11P			120 V Power – Feed A
SISJ5	MS27468T21F11S	SISP5	MS27467T21F11P			120 V Power – Feed B
SISJ6	BJ79C–215	SISP6	PL75C–215			Time Mark and Frequency Bus – Side A
SISJ7	BJ79C–215	SISP7	PL75C–215			Time Mark and Frequency Bus – Side B
SISJ8	BJ379C–201	SISP8	PL375C–201			Command and Telemetry Bus – Side A
SISJ9	BJ379C–201	SISP9	PL375C–201			Command and Telemetry Bus – Side B
SISJ10						Reserved (Low Rate Science Data Bus – Side A)
SISJ11						Reserved (Low Rate Science Data Bus – Side B)
SISJ12	2034–5023–00	SISP12	2031–5055–00			High Rate Data Link #1A +
SISJ13	2034–5023–00	SISP13	2031–5055–00			High Rate Data Link #1A –

Table IX. SIS–to–MODIS Connector List (cont'd)

SIS Back Panel Connector		SIS Harness Connector		Drawing Location (TBD 42)		Function
Designation	Type	Designation	Type	Sheet	Zone	
SISJ14						Reserved (High Rate Data Link #2A +)
SISJ15						Reserved (High Rate Data Link #2A –)
SISJ16						Reserved (High Rate Data Link #3A +)
SISJ17						Reserved (High Rate Data Link #3A –)
SISJ18						Reserved (High Rate Data Link #4A +)
SISJ19						Reserved (High Rate Data Link #4A –)
SISJ20	2034–5023–00	SISP20	2031–5055–00			High Rate Data Link #1B +
SISJ21	2034–5023–00	SISP21	2031–5055–00			High Rate Data Link #1B –
SISJ22						Reserved (High Rate Data Link #2B +)
SISJ23						Reserved (High Rate Data Link #2B –)
SISJ24						Reserved (High Rate Data Link #3B +)
SISJ25						Reserved (High Rate Data Link #3B –)
SISJ26						Reserved (High Rate Data Link #4B+)
SISJ27						Reserved (High Rate Data Link #4B –)

Table IX. SIS–to–MODIS Connector List (cont'd)

SIS Back Panel Connector		SIS Harness Connector		Drawing Location (TBD 42)		Function
Designation	Type	Designation	Type	Sheet	Zone	
SISJ28	MS27468T15F35P	SISP28	MS27467T15F35S			Passive Analog Telemetry I/F #1
SISJ29						Reserved (Passive Analog Telemetry I/F #2)
SISJ30						Reserved (Passive Analog Telemetry I/F #3)
SISJ31						Reserved (Passive Analog Telemetry I/F #4)
SISJ32						Reserved (Active Analog Telemetry I/F #1)
SISJ33	MS27468T17F35S	SISP33	MS27467T17F35P			Relay Drive Commands I/F #1
SISJ34						Reserved (Relay Drive Commands I/F #2)
SISJ35	MS27468T15F35P	SISP35	MS27467T15F35S			Passive Bi–Level Telemetry I/F #1
SISJ36						Reserved (Passive Bi–Level Telemetry I/F #2)
SISJ37						Not Used

Table IX. SIS–to–MODIS Connector List (cont'd)

SIS Back Panel Connector		SIS Harness Connector		Drawing Location (TBD 42)		Function
Designation	Type	Designation	Type	Sheet	Zone	
J38						Reserved (LRS IGSE I/F A)
J39						Reserved (LRS IGSE I/F B)
J40	2034–5023–00	P40	2031–5055–00			HRS IGSE I/F #1A+
J41	2034–5023–00	P41	2031–5055–00			HRS IGSE I/F #1A–
J42						Reserved HRS IGSE I/F #2A+
J43						Reserved HRS IGSE I/F #2A–
J44						Reserved HRS IGSE I/F #3A+
J45						Reserved HRS IGSE I/F #3A–
J46						Reserved HRS IGSE I/F #4A+
J47						Reserved HRS IGSE I/F #4A–
J48	2034–5023–00	P40	2031–5055–00			HRS IGSE I/F #1B+
J49	2034–5023–00	P41	2031–5055–00			HRS IGSE I/F #1B–
J50						Reserved HRS IGSE I/F #2B+
J51						Reserved HRS IGSE I/F #2B–

Table IX. SIS–to–MODIS Connector List (cont'd)

SIS Back Panel Connector		SIS Harness Connector		Drawing Location (TBD 42)		Function
Designation	Type	Designation	Type	Sheet	Zone	
J52						Reserved HRS IGSE I/F #3B+
J53						Reserved HRS IGSE I/F #3B–
J54						Reserved HRS IGSE I/F #4B+
J55						Reserved HRS IGSE I/F #4B–
ETHERNET	DB–15	ETHERNET	DB–15			LAN

Table Xa. MODP1: SIS–MODIS Power Feed A Interconnections

Pin	Function	Destination Connector (TBR 5)	Destination Pin	Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 43)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
A	MODIS +120 V POWER FEED A–1	SISP4	1	20	T7S	001	001		5	N/A	1
B	MODIS +120 V POWER FEED A–2	SISP4	2	20	T7S	001	001		5	N/A	1
C	SPARE										
D	MODIS FAULT GROUND A	SISP4	5	20	T7S	001	001		5	N/A	1
E	MODIS +120 V POWER FEED RETURN A–1	SISP4	6	20	T7S	001	001		5	N/A	1
F	MODIS +120 V POWER FEED RETURN A–2	SISP4	7	20	T7S	001	001		5	N/A	1
G	INTERLOCK OUT	SISP4	10	20	T7S	001	001		5	N/A	1, 2
H	INTERLOCK IN	SISP4	11	20	T7S	001	001		5	N/A	1, 2
J	SPARE										
K	SPARE										

Notes:

N/A Not applicable

1. Interface cable outer shield bonded to shell of harness connector.
2. INTERLOCK OUT and INTERLOCK IN are jumpered in connector MODP1.

Table Xb. MODP2: SIS–MODIS Power Feed B Interconnections

Pin	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit	Timing Diagram	Notes
		Connector (TBR 5)	Pin					(TBD 43)	(Figure #)	(Figure #)	
A	MODIS +120 V POWER FEED B–1	SISP5	1	20	T7S	001	001		5	N/A	1
B	MODIS +120 V POWER FEED B–2	SISP5	2	20	T7S	001	001		5	N/A	1
C	SPARE										
D	MODIS FAULT GROUND B	SISP5	5	20	T7S	001	001		5	N/A	1
E	MODIS +120 V POWER FEED RETURN B–1	SISP5	6	20	T7S	001	001		5	N/A	1
F	MODIS +120 V POWER FEED RETURN B–2	SISP5	7	20	T7S	001	001		5	N/A	1
G	INTERLOCK OUT	SISP5	10	20	T7S	001	001		5	N/A	1, 2
H	INTERLOCK IN	SISP5	11	20	T7S	001	001		5	N/A	1, 2
J	SPARE										
K	SPARE										

Notes:

N/A Not applicable
1. Interface cable outer shield bonded to shell of harness connector.
2. INTERLOCK OUT and INTERLOCK IN are jumpered in connector MODP2.

Table Xc. MODP3: SIS–MODIS BDU Commands Interconnections

Pin	Function	Destination Connector (TBR 5)	Destination Pin	Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 43)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
1	CP_A_ON_B_OFF	SISP33	1	24	T2	001	001		6	7	1, 2
2	CP_A_ON_B_OFF_RTN	SISP33	2	24	T2	001	001		6	7	1, 2
3	SPARE										
4	CP_B_ON_A_OFF	SISP33	3	24	T2	002	001		6	7	1, 2
5	CP_B_ON_A_OFF_RTN	SISP33	4	24	T2	002	001		6	7	1, 2
6	SPARE										
7	SPARE										
8	CP_STD_RESET	SISP33	5	24	T2	003	001		6	7	1, 2
9	CP_STD_RESET_RTN	SISP33	6	24	T2	003	001		6	7	1, 2
10	CP_UPLD_RESET	SISP33	7	24	T2	004	001		6	7	1, 2
11	CP_UPLD_RESET_RTN	SISP33	8	24	T2	004	001		6	7	1, 2
12	SPARE										
13	SPARE										
14	SPARE										
15	ENABL_FAILSAFE	SISP33	9	24	T2	005	001		6	7	1, 2
16	ENABL_FAILSAFE_RTN	SISP33	10	24	T2	005	001		6	7	1, 2
17	SPARE										
18	SPARE										
19	SPARE										
20	SPARE										
21	SPARE										
22	SPARE										

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.

Table Xc. MODP3: SIS–MODIS BDU Commands Interconnections (cont'd)

Pin	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit	Timing Diagram	Notes
		Connector (TBR 5)	Pin					(TBD 43)	(Figure #)	(Figure #)	
23	PS1_ON	SISP33	11	24	T2	006	001		6	7	1, 2
24	PS1_ON_RTN	SISP33	12	24	T2	006	001		6	7	1, 2, 3
25	PS1PS2_OFF_A	SISP33	13	24	T2	007	001		6	7	1, 2
26	PS1PS2_OFF_A_RTN	SISP33	14	24	T2	007	001		6	7	1, 2, 4
27	SPARE										
28	SPARE										
29	SPARE										
30	PS1PS2_OFF_B	SISP33	15	24	T2	008	001		6	7	1, 2
31	PS1PS2_OFF_B_RTN	SISP33	16	24	T2	008	001		6	7	1, 2, 4
32	PS1PS2_ON	SISP33	17	24	T2	009	001		6	7	1, 2
33	PS1PS2_ON_RTN	SISP33	18	24	T2	009	001		6	7	1, 2, 3
34	SPARE										
35	SPARE										
36	SPARE										
37	SPARE										
38	PS2_ON	SISP33	19	24	T2	010	001		6	7	1, 2
39	PS2_ON_RTN	SISP33	20	24	T2	010	001		6	7	1, 2, 3
40	PS1PS2_SD_DISABL	SISP33	21	24	T2	011	001		6	7	1, 2
41	PS1PS2_SD_DISABL_RTN	SISP33	22	24	T2	011	001		6	7	1, 2, 4
42	SPARE										

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.
3. Common return group 1 (6 places)
4. Common return group 2 (4 places)

Table Xc. MODP3: SIS–MODIS BDU Commands Interconnections (cont'd)

Pin	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit	Timing Diagram	Notes
		Connector (TBR 5)	Pin					(TBD 43)	(Figure #)	(Figure #)	
43	SPARE										
44	SPARE										
45	PS1PS2_SD_ENABL	SISP33	23	24	T2	012	001		6	7	1, 2
46	PS1PS2_SD_ENABL_RTN	SISP33	24	24	T2	012	001		6	7	1, 2, 3
47	SURVHTR_A_ENABL	SISP33	25	24	T2	013	001		6	7	1, 2
48	SURVHTR_A_ENABL_RTN	SISP33	26	24	T2	013	001		6	7	1, 2, 3
49	SPARE										
50	SPARE										
51	SURVHTR_B_ENABL	SISP33	27	24	T2	014	001		6	7	1, 2
52	SURVHTR_B_ENABL_RTN	SISP33	28	24	T2	014	001		6	7	1, 2, 3
53	SURVHTRS_DISABL	SISP33	29	24	T2	015	001		6	7	1, 2
54	SURVHTRS_DISABL_RTN	SISP33	30	24	T2	015	001		6	7	1, 2, 4
55	SPARE										

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.
3. Common return group 1 (6 places)
4. Common return group 2 (4 places)

Table Xd. MODP4: SIS–MODIS BDU Telemetry Interconnections

Pin	Function	Destination Connector (TBR 5)	Destination Pin	Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 43)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
1	TR_RC_CLDSTG_HI	SISP28	1	24	T2	001	002		8	9	1, 2
2	TR_RC_CLDSTG_HI_RTN	SISP28	2	24	T2	001	002		8	9	1, 2
3	SPARE										
4	TR_AOP_BY_RC	SISP28	3	24	T2	002	002		8	9	1, 2
5	TR_AOP_BY_RC_RTN	SISP28	4	24	T2	002	002		8	9	1, 2
6	SPARE										
7	SPARE										
8	TR_MF_NEAR_KM3	SISP28	5	24	T2	003	002		8	9	1, 2
9	TR_MF_NEAR_KM3_RTN	SISP28	6	24	T2	003	002		8	9	1, 2
10	SPARE										
11	SPARE										
12	SPARE										
13	TR_MF_OB_BLKHD	SISP28	7	24	T2	004	002		8	9	1, 2
14	TR_MF_OB_BLKHD_RTN	SISP28	8	24	T2	004	002		8	9	1, 2
15	SPARE										
16	TR_ME_NX_HEATSINK	SISP28	9	24	T2	005	002		8	9	1, 2
17	TR_ME_NX_HEATSINK_RTN	SISP28	10	24	T2	005	002		8	9	1, 2
18	SPARE										
19	TR_SA_MTR_ENCDR	SISP28	11	24	T2	006	002		8	9	1, 2
20	TR_SA_MTR_ENCDR_RTN	SISP28	12	24	T2	006	002		8	9	1, 2
21	SPARE										
22	TR_FAM_RADIATOR	SISP28	13	24	T2	007	002		8	9	1, 2

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.

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Table Xd. MODP4: SIS–MODIS BDU Telemetry Interconnections (cont'd)

Pin	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit	Timing Diagram	Notes
		Connector (TBR 5)	Pin					(TBD 43)	(Figure #)	(Figure #)	
23	TR_FAM_RADIATOR_RTN	SISP28	14	24	T2	007	002		8	9	1, 2
24	SPARE										
25	TR_SAM_RADIATOR	SISP28	15	24	T2	008	002		8	9	1, 2
26	TR_SAM_RADIATOR_RTN	SISP28	16	24	T2	008	002		8	9	1, 2
27	SPARE										
28	TR_ME_PSRADIATOR	SISP28	17	24	T2	009	002		8	9	1, 2
29	TR_ME_PSRADIATOR_RTN	SISP28	18	24	T2	009	002		8	9	1, 2
30	SPARE										
31	SPARE										
32	SPARE										
33	CR_NAD_1_LATCHED	SISP35	1	24	T2	010	003		10	11	1, 2
34	CR_NAD_1_LATCHED_RTN	SISP35	2	24	T2	010	003		10	11	1, 2
35	CR_NAD_2_LATCHED	SISP35	3	24	T2	011	003		10	11	1, 2
36	CR_NAD_2_LATCHED_RTN	SISP35	4	24	T2	011	003		10	11	1, 2
37	SPARE										
38	SPARE										
39	SPARE										
40	SPARE										
41	SPARE										
42	SPARE										
43	SPARE										
44	CR_SVD_1_LATCHED	SISP35	5	24	T2	012	003		10	11	1, 2

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.

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Table Xd. MODP4: SIS-MODIS BDU Telemetry Interconnections (cont'd)

Pin	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit	Timing Diagram	Notes
		Connector (TBR 5)	Pin					(TBD 43)	(Figure #)	(Figure #)	
45	CR_SVD_1_LATCHED_RTN	SISP35	6	24	T2	012	003		10	11	1, 2
46	CR_SVD_2_LATCHED	SISP35	7	24	T2	013	003		10	11	1, 2
47	CR_SVD_2_LATCHED_RTN	SISP35	8	24	T2	013	003		10	11	1, 2
48	SPARE										
49	SPARE										
50	SPARE										
51	SPARE										
52	SPARE										
53	SPARE										
54	CR_SDD_LATCHED	SISP35	9	24	T2	014	003		10	11	1, 2
55	CR_SDD_LATCHED_RTN	SISP35	10	24	T2	014	003		10	11	1, 2
56	CR_CP_A_ON	SISP35	11	24	T2	015	003		10	11	1, 2
57	CR_CP_A_ON_RTN	SISP35	12	24	T2	015	003		10	11	1, 2
58	SPARE										
59	SPARE										
60	SPARE										
61	SPARE										
62	SPARE										
63	SPARE										
64	SPARE										
65	CR_CP_B_ON	SISP35	13	24	T2	016	003		10	11	1, 2
66	CR_CP_B_ON_RTN	SISP35	14	24	T2	016	003		10	11	1, 2

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.

Table Xd. MODP4: SIS–MODIS BDU Telemetry Interconnections (cont'd)

Pin	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit	Timing Diagram	Notes
		Connector (TBR 5)	Pin					(TBD 43)	(Figure #)	(Figure #)	
67	SPARE										
68	SPARE										
69	SPARE										
70	SPARE										
71	SPARE										
72	SPARE										
73	SPARE										
74	SPARE										
75	SPARE										
76	SPARE										
77	CR_ENABL_FAILSAF	SISP35	19	24	T2	017	003		10	11	1, 2
78	CR_ENABL_FAILSAF_RTN	SISP35	20	24	T2	017	003		10	11	1, 2
79	SPARE										
80	SPARE										
81	CR_PS1_ON	SISP35	21	24	T2	018	003		10	11	1, 2
82	CR_PS1_ON_RTN	SISP35	22	24	T2	018	003		10	11	1, 2
83	SPARE										
84	CR_PS2_ON	SISP35	23	24	T2	019	003		10	11	1, 2
85	CR_PS2_ON_RTN	SISP35	24	24	T2	019	003		10	11	1, 2
86	CR_PS1_SD_ENABL	SISP35	25	24	T2	020	003		10	11	1, 2
87	CR_PS1_SD_ENABL_RTN	SISP35	26	24	T2	020	003		10	11	1, 2
88	SPARE										

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.

Table Xd. MODP4: SIS–MODIS BDU Telemetry Interconnections (cont'd)

Pin	Function	Destination Connector (TBR 5)	Destination Pin	Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 43)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
89	SPARE										
90	SPARE										
91	SPARE										
92	CR_PS2_SD_ENABL	SISP35	27	24	T2	021	003		10	11	1, 2
93	CR_PS2_SD_ENABL_RTN	SISP35	28	24	T2	021	003		10	11	1, 2
94	CR_SRVHTRA_ENABL	SISP35	29	24	T2	022	003		10	11	1, 2
95	CR_SRVHTRA_ENABL_RTN	SISP35	30	24	T2	022	003		10	11	1, 2
96	SPARE										
97	SPARE										
98	CR_SRVHTRB_ENABL	SISP35	31	24	T2	023	003		10	11	1, 2
99	CR_SRVHTRB_ENABL_RTN	SISP35	32	24	T2	023	003		10	11	1, 2
100	SPARE										

Notes:

1. Interface cable outer shield bonded to shell of harness connector.
2. All twisted pair signals will be enclosed in an overall shield.

Table Xe. MODP5: SIS–MODIS TM&F Bus – Side A Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 5)	Pin								
Center	MODIS TM&F BUS A HI	SISP6	Center	24	Twinax	N/A	N/A	N/A	12	13	1
Intermediate	MODIS TM&F BUS A LO	SISP6	Intermediate	24	Twinax	N/A	N/A	N/A	12	13	1
Outer shield	MODIS TM&F BUS A SHIELD	SISP6	Outer Shield	N/A	Twinax	N/A	N/A	N/A	12	13	1

Table Xf. MODP6: SIS–MODIS TM&F Bus – Side B Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 5)	Pin								
Center	MODIS TM&F BUS B HI	SISP7	Center	24	Twinax	N/A	N/A	N/A	12	13	1
Intermediate	MODIS TM&F BUS B LO	SISP7	Intermediate	24	Twinax	N/A	N/A	N/A	12	13	1
Outer shield	MODIS TM&F BUS B SHIELD	SISP7	Outer Shield	N/A	Twinax	N/A	N/A	N/A	12	13	1

Notes:

N/A Not applicable

1. SISP6 and SISP7 are single triaxial contact connectors.
Interface cable outer shield bonded to shell of harness connector.

Table Xg. MODP7: SIS–MODIS C&T Bus A Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 5)	Pin								
Center	MODIS C&T BUS A HI	SISP8	Center	24	Twinax	N/A	N/A	N/A	14	15	1
Intermediate	MODIS C&T BUS A LO	SISP8	Intermediate	24	Twinax	N/A	N/A	N/A	14	15	1
Outer shield	MODIS C&T BUS A SHIELD	SISP8	Outer Shield	N/A	Twinax	N/A	N/A	N/A	14	15	1

Table Xh. MODP8: SIS–MODIS C&T Bus B Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 5)	Pin								
Center	MODIS C&T BUS B HI	SISP9	Center	24	Twinax	N/A	N/A	N/A	14	15	1
Intermediate	MODIS C&T BUS B LO	SISP9	Intermediate	24	Twinax	N/A	N/A	N/A	14	15	1
Outer shield	MODIS C&T BUS B SHIELD	SISP9	Outer Shield	N/A	Twinax	N/A	N/A	N/A	14	15	1

Notes:

N/A Not applicable

1. SISP8 and SISP9 are single triaxial contact connectors.
Interface cable outer shield bonded to shell of harness connector.

Table Xi. MODP9: SIS–MODIS High Rate Data Link – Side A – HI Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 5)	Pin								
Center	MODIS HRDL A HI	SISP12	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer shield	MODIS HRDL A HI SHIELD	SISP12	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Table Xj. MODP10: SIS–MODIS High Rate Data Link – Side A – LO Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 5)	Pin								
Center	MODIS HRDL A LO	SISP13	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer Shield	MODIS HRDL A LO SHIELD	SISP13	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Notes:

N/A Not applicable

1. SISP12 and SISP13 are single coaxial contact connectors.

Table Xk. MODP11: SIS–MODIS High Rate Data Link – Side B – HI Interconnections

Contact	Function	Destination: Connector (TBR 5)	Destination: Pin	Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
Center	MODIS HRDL B HI	SISP20	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer shield	MODIS HRDL B HI SHIELD	SISP20	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Table Xm. MODP12: SIS–MODIS High Rate Data Link – Side B – LO Interconnections

Contact	Function	Destination: Connector (TBR 5)	Destination: Pin	Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
Center	MODIS HRDL B LO	SISP21	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer Shield	MODIS HRDL B LO SHIELD	SISP21	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Notes:

N/A Not applicable

1. SISP20 and SISP21 are single coaxial contact connectors.

Table Xn. FACPx: SIS–SBRC Facility Power Interconnections (TBD 44)

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 43)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 5)	Pin								
	FEED A	SISP1	X								
	FEED B	SISP1	Y								
	FEED C	SISP1	Z								
	NEUTRAL	SISP1	W								
	GROUND	SISP1	GR								

Table Xo. FACPx: SIS–SBRC Facility Local Area Network Interconnections (TBD 44)

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 43)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 5)	Pin								
	COLLISION+	ETHERNET	2								
	TRANSMIT+	ETHERNET	3								
	RECEIVE+	ETHERNET	5								
	VOLTAGE COMMON	ETHERNET	6								
	COLLISION–	ETHERNET	9								
	TRANSMIT–	ETHERNET	10								
	RECEIVE–	ETHERNET	12								
	+12V	ETHERNET	13								

Table Xp. IGSEPx: SIS–IGSE IEEE–488 #2 Interconnections (TBD 44)

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color (TBD 43)	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 5)	Pin								
	DIO1	SISP3	1								
	DIO2	SISP3	2								
	DIO3	SISP3	3								
	DIO4	SISP3	4								
	EOI	SISP3	5								
	DAV	SISP3	6								
	NRFD	SISP3	7								
	NDAC	SISP3	8								
	IFC	SISP3	9								
	SQR	SISP3	10								
	ATN	SISP3	11								
	SHIELD	SISP3	12								
	DIO5	SISP3	13								
	DIO6	SISP3	14								
	DIO7	SISP3	15								
	DIO8	SISP3	16								
	REM	SISP3	17								
	GND	SISP3	18								
	GND	SISP3	19								
	GND	SISP3	20								
	GND	SISP3	21								
	GND	SISP3	22								
	GND	SISP3	23								
	SIGNAL GROUND	SISP3	24								

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Table Xq. IGSEPx: SIS–IGSE High Rate Data Link – Side A – HI Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 5)	Pin								
Center	MODIS HRDL A HI	SISP40	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer shield	MODIS HRDL A HI SHIELD	SISP40	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Table Xr. IGSEPx: SIS–IGSE High Rate Data Link – Side A – LO Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBR 5)	Pin								
Center	MODIS HRDL A LO	SISP41	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer Shield	MODIS HRDL A LO SHIELD	SISP41	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Notes:

N/A Not applicable

1. SISP40 and SISP41 are single coaxial contact connectors.

Table Xs. IGSEPx: SIS–IGSE High Rate Data Link – Side B – HI Interconnections

Contact	Function	Destination Connector (TBR 5)	Destination Pin	Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
Center	MODIS HRDL B HI	SISP48	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer shield	MODIS HRDL B HI SHIELD	SISP48	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Table Xt. IGSEPx: SIS–IGSE High Rate Data Link – Side B – LO Interconnections

Contact	Function	Destination Connector (TBR 5)	Destination Pin	Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
Center	MODIS HRDL B LO	SISP49	Center	16	G2 Coax	N/A	N/A	N/A	16	17	1
Outer Shield	MODIS HRDL B LO SHIELD	SISP49	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	16	17	1

Notes:

N/A Not applicable

1. SISP48 and SISP49 are single coaxial contact connectors.

(TBD 45)

Figure 5. SIS–to–MODIS Power Interface Circuit

(TBD 45)

Figure 6. SIS–to–MODIS BDU Relay Drive Command Interface Circuit(s)

(TBD 45)

Figure 7. SIS–to–MODIS BDU Relay Drive Command Timing Diagram(s)

(TBD 45)

Figure 8. SIS–to–MODIS BDU Passive Analog Telemetry Interface Circuit(s)

(TBD 45)

Figure 9. SIS–to–MODIS BDU Passive Analog Telemetry Timing Diagram(s)

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(TBD 45)

Figure 10. SIS-to-MODIS BDU Passive Bi-Level Telemetry Interface Circuit(s)

Size A

Code Ident No. 49671

20008846

Sheet 118

(TBD 45)

Figure 11. SIS–to–MODIS BDU Passive Bi–Level Telemetry Timing Diagram(s)

(TBD 45)

Figure 12. SIS–to–MODIS Time Mark and Frequency Bus Interface Circuit

(TBD 45)

Figure 13. SIS–to–MODIS Time Mark and Frequency Bus Timing Diagram

(TBD 45)

Figure 14. SIS-to-MODIS Command and Telemetry Bus Interface Circuit

(TBD 45)

Figure 15. SIS–to–MODIS Command and Telemetry Bus Timing Diagram

(TBD 45)

Figure 16. SIS–to–MODIS Science Data Interface Circuit

(TBD 45)

Figure 17. SIS–to–MODIS Science Data Timing Diagram

6.2 Spacecraft Checkout Station–to–IGSE Interface

6.2.1 Spacecraft Checkout Station–to–IGSE Harness Definition

1. The block diagram of the harnesses between the SCS and IGSE is shown in Figure 18. (All harnesses are supplied by the Spacecraft Integrator.)

2. The SCS–to–IGSE harness lengths are shown in Table XI.

3. The list of the IGSE connectors used by the Spacecraft Integrator to fabricate the SCS–to–IGSE harnesses is shown in Table XII.

   a. The SCS–to–IGSE interconnections are shown in Tables XIIIa through XIIId. The following legend is used for wire type:

      Coax Coaxial transmission line
      SC Single conductor, unshielded
      SCS Single conductor, shielded
      TP Twisted pair, unshielded
      TPS Twisted pair, shielded
      Tn Twisted bundle of n wires, unshielded
      TnS Twisted bundle of n wires, shielded
      Twinax Twinaxial transmission line

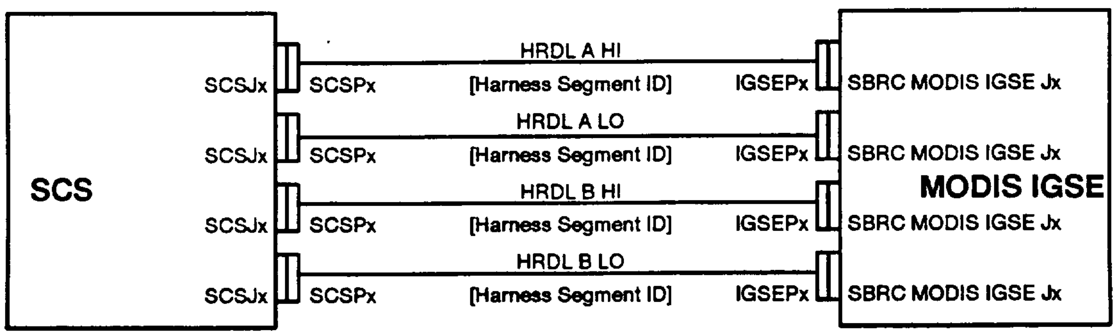
   b. All harnesses which are required by PN20005869, EOS–AM Spacecraft EMC Control Plan, to have an overall outer shield have either a copper tape over–wrap or a braid shield.

      The copper tape is actually copper–plated mylar tape which is one inch wide. The tape is then folded over 1/8 inch, making it 7/8 inch wide. The tape is 0.0017 inches thick (0.0007 inch copper on 0.001 inch mylar). The wrap is lapped half its width.

      Cables using a braid shield use braids similar to MIL–C–27500.

6.2.2 Spacecraft Checkout Station–to–IGSE Interface Circuit and Timing Diagram

The SCS–to–IGSE interface circuit and timing diagram are shown in Figures 19 and 20.



Notes:

SCS Spacecraft Checkout Station

1. Connector numbers are **(TBD 46)**.
2. Harness Segment ID numbers are **(TBD 47)**.

Figure 18. SCS–to–IGSE Harness Block Diagram

Table XI. SCS–to–IGSE Harness Length (TBD 48)

Description	Instrument Harness Segment ID (as shown in Figure 18)	Total # of Segments	Total # of Connector Pairs	Total Length (meters)	Figure #
HRDL A HI					18
HRDL A LO					18
HRDL B HI					18
HRDL B LO					18

Table XII. SCS–to–IGSE Connector List (TBD 49)

SCS Back Panel Connector		SCS Harness Connector		Drawing Location		Function
Designation	Type	Designation	Type	Sheet	Zone	
						High Rate Data Link A HI
						High Rate Data Link A LO
						High Rate Data Link B HI
						High Rate Data Link B LO

Table XIIIa. IGSEPx: SCS–IGSE High Rate Data Link – Side A – HI Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBD 46)	Pin								
Center	MODIS HRDL A HI	SCSPx	Center	16	G2 Coax	N/A	N/A	N/A	19	20	1
Outer shield	MODIS HRDL A HI SHIELD	SCSPx	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	19	20	1

Table XIIIb. IGSEPx: SCS–IGSE High Rate Data Link – Side A – LO Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBD 46)	Pin								
Center	MODIS HRDL A LO	SCSPx	Center	16	G2 Coax	N/A	N/A	N/A	19	20	1
Outer Shield	MODIS HRDL A LO SHIELD	SCSPx	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	19	20	1

Notes:

N/A Not applicable

1. SCSPx and SCSPx are single coaxial contact connectors.

Table XIIIc. IGSEPx: SCS–IGSE High Rate Data Link – Side B – HI Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBD 46)	Pin								
Center	MODIS HRDL B HI	SCSPx	Center	16	G2 Coax	N/A	N/A	N/A	19	20	1
Outer shield	MODIS HRDL B HI SHIELD	SCSPx	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	19	20	1

Table XIIId. IGSEPx: SCS–IGSE High Rate Data Link – Side B – LO Interconnections

Contact	Function	Destination		Wire Size	Wire Type	Twist Group	Shield Group	Color	Interface Circuit (Figure #)	Timing Diagram (Figure #)	Notes
		Connector (TBD 46)	Pin								
Center	MODIS HRDL B LO	SCSPx	Center	16	G2 Coax	N/A	N/A	N/A	19	20	1
Outer Shield	MODIS HRDL B LO SHIELD	SCSPx	Outer Shield	N/A	G2 Coax	N/A	N/A	N/A	19	20	1

Notes:

N/A Not applicable

1. SCSPx and SCSPx are single coaxial contact connectors.

(TBD 50)

Figure 19. SCS–to–IGSE Science Data Interface Circuit

(TBD 50)

Figure 20. Science Data Timing Diagram

6.3 Facility-to-MODIS IGSE Interface

6.3.1 Thermal Vacuum Chamber Penetration

(TBD 51)

6.3.2 Purge

(TBD 51)

6.3.3 Remote Data Processing

(TBD 51)

6.3.4 Computer Network

6.3.4.1 Internet Address

The MODIS internet address is **(TBD 51).**

6.3.4.2 Socket Address

The MODIS socket address **(TBD 51).**

7 INSTRUMENT PROCEDURES

1. Instrument procedures are listed in Table XIV.

2. Instrument procedure usage during instrument–level I&T, spacecraft–level I&T, and launch activities is identified in Table XV.

3. Each instrument procedure is described in Section 7.1.

4. IGSE constraints and restraints are described in Section 7.2.

Table XIV. Instrument Procedure List (TBD 52)

Number		Procedure Name	Reference Paragraph	Source
MMC	MODIS			
AP–20001400		Assembly Procedure: Kinematic Mount Engineering Development Models to Instrument Test Models	7.1.1	MMC

Table XV. Instrument Procedure Usage (TBD 53)

East Windsor Activity	Procedure
Pre–Delivery	
Drill Mounting Holes	
Drill Coldplate Mounting Holes	N/A
Other	MMC AP–20001400
Transportation & Handling	
Cleaning	
IGSE Set–up & Check–out	
BAT	
Integration	
Installation & Alignment	
Coldplate Installation	N/A
Electrical Integration	
Electrical Systems Test	
Power Profile	
Transient Tolerance	
Aliveness Test	
Functional Test	
Comprehensive Performance Test	
Orbits	
RF Systems Test	
EMI/EMC	
Compatibility Test Van	
End–to–End Test	

Table XV. Instrument Procedure Usage (cont'd) (TBD 53)

East Windsor Activity	Procedure
Thermal Vacuum Test	
Launch Mode	
Thermal Balance	
Comprehensive Performance Test	
Power Profile	
Transient Tolerance	
Calibration	
Special	
Acoustic/Shock Test	
Alignment	
Launch Mode	
Deployment Verification	
Aliveness Test	
Spacecraft Activity	
Leak Check	
Comprehensive Performance Test	
Mass Properties	
Box, Pack, & Ship to WTR	
Box, Pack, & Ship to Other Location	

Launch Site (WTR) Activity	Procedure
Unbox	
Transportation & Handling	
Cleaning	
Closeouts	
IGSE Set–up & Check–out	
Comprehensive Performance Test	
Move to Pad	
Aliveness Test	
Launch Mode	

7.1 Instrument Procedure Description (TBR 6)

7.1.1 MMC AP–20001400, Assembly Procedure: Kinematic Mount Engineering Development Models to Instrument Test Models

MMC AP–20001400, "Assembly Procedure: Kinematic Mount Engineering Development Models to Instrument Test Models" describes the assembly, installation, and shimming of the test kinematic mounts.

7.2 Instrument Ground Support Equipment Constraints and Restraints

7.2.1 (TBD 54) [Constraint or Restraint]

(TBD 54)

APPENDIX A

10 ACRONYMS AND ABBREVIATIONS

Amp	Amperes
ASD	Astro–Space Division
BAT	Bench Acceptance Test
BDU	Bus Data Unit
BPS	Box, Pack, & Ship
BTC	Bench Test Cooler
C&T	Command and Telemetry
C&T ICD	Command and Telemetry Interface Control Drawing
Cal	Calibration
CTV	Compatibility Test Van
DAF	Drill–Alignment Fixture
EICD	Electrical Interface Control Drawing
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOS	Earth Observing System
EVS	Earth View Source
FAM	Forward Analog Electronics Module
ft	Feet
GSE	Ground Support Equipment
Hz	Hertz
I&T	Integration and Test
I&T ICD	Interface Control Drawing
ICD	Interface Control Drawing
IGSE	Instrument Ground Support Equipment
MEM	Main Electronics Module
MICD	Mechanical Interface Control Drawing
MMC	Martin Marietta Corporation
MODIS	Moderate Resolution Imaging Spectroradiometer
N/A	Not Applicable
PRC	Passive Radiative Cooler
RF	Radio Frequency
RH	Relative Humidity
SAM	Space View Analog Electronics Module
SBRC	Santa Barbara Research Center

SBS	Space Background Simulator
SCS	Spacecraft Checkout Station
SIS	Spacecraft Interface Simulator
SLC–3	Space Launch Complex 3
STE	System Test Equipment
SVS	Space View Source
TICD	Thermal Interface Control Drawing
V	Volts
VAC	Volts Alternating Current
VAFB	Vandenberg Air Force Base
W	Watts
WTR	Western Test Range

Next Assembly	Used on
20008500G1	EOS–AM

First Application
EOS–AM

Revisions | Rev 001

Ltr	Description	Date	Approved
Initial Issue		8/4/93	CM/GSR

Revision Record Continued on Sheet ______

Contract No.	NAS5–32500
Written	R. Thomas
Date	8/3/93
Approved	F. Komro
Date	8/3/93
Issued	G. Rauscher
Date	8/3/93

MARTIN MARIETTA
POST OFFICE BOX 800
PRINCETON, NEW JERSEY 08543–0800
TELEPHONE (609) 490–3400

Interface Control Drawing, Earth Observing System AM Spacecraft to Measurement Of Pollution In The Troposphere

Size	Code Ident No.	
A	49671	20008850

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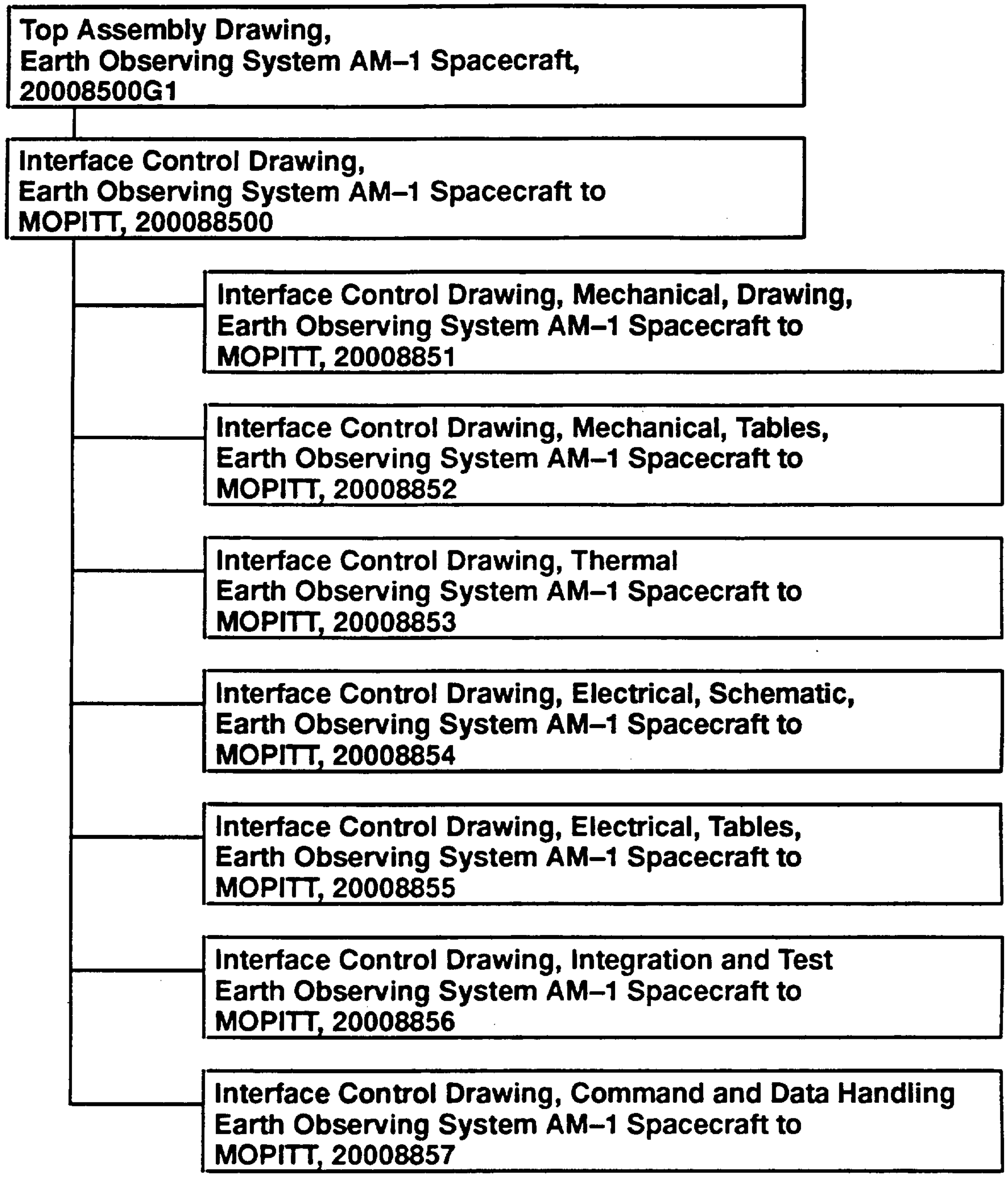

Figure 1. Drawing Tree

ASD–EW 2051 3–89

Table I. ICD Revision Status

20008851 MICD Drawing		20008852 MICD Tables		20008853 TICD		20008854 EICD Schematic		20008855 EICD Tables		20008856 I&T ICD		20008857 C&DH ICD	
Issue	Date	Issue	Date	Issue	Date	Issue	Date	Issue	Date	Issue	Date	Issue	Date
draft 001	8/2/93												

Size A | Code Ident No. 49671 | 20008850 | Sheet 3

Next Assembly	Used on
20008850	EOS–AM

First Application
EOS–AM

Revisions		Rev	
Ltr	Description	Date	Appr
001	Draft	9/7/93	

Revision Record Continued on Sheet

Contract No.	NAS5–32500
Written	R. Thomas
Date	
Approved	F. Komro
Date	
Approved	
Date	
Issued	G. Rauscher
Date	

MARTIN MARIETTA
POST OFFICE BOX 800
PRINCETON, NEW JERSEY 08543-
TELEPHONE (609) 490–3400

Interface Control Drawing, Thermal, Earth Observing System AM Spacecraft to Measurements of Pollution in The Tropospher

Size	Code Ident No.	
A	49671	20008853

PURPOSE

The Thermal Interface Control Drawing (TICD), 20008853, when executed, represents an agreement o the detailed implementation of the thermal interface between the Earth Observing System (EOS) AM Spacecraft and the Measurements Of Pollution In The Troposphere (MOPITT). This drawing, together with the Mechanical Interface Control Drawing (MICD) Drawing, 20008851; MICD Tables, 20008852 Electrical Interface Control Drawing (EICD) Schematic, 20008854; EICD Tables, 20008855; Integration and Test Interface Control Drawing (I&T ICD), 20008856; and Command and Telemetry Interface Contro Drawing (C&T ICD), 20008857; describe the details of the interfaces between the EOS–AM Spacecraf and MOPITT. The top–level instrument Interface Control Drawing (ICD), 20008850, provides the instrument ICD tree and revision status for all sub–tier instrument ICDs.

SCOPE

The TICD contains information on surface properties, thermal model analysis cases, power dissipation thermal control, and temperature limits for use in instrument and spacecraft thermal design and validation of the spacecraft accommodation of the instrument thermal environment.

Approval Signatures

IN ADDITION TO ECN AND CCB APPROVALS, ALL CHANGES ON THIS DRAWING SHALL HAVE THE APPROVAL AND THE FULL AGREEMENT OF THE PARTIES LISTED BELOW.

REV	Spacecraft Program Office	Date	Instrument Program Office	Date	Instrument Contractor	Date	Principal Investigator	Date
	Signature on File M. Kavka	9/14/93	R. Colley		J. Dorey		J. Drummond	

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TBD LOG

ITEM	SECTION	PAGE	SUBJECT	RESPONSIBLE	DUE
TBD 001	Table I	19	Calculated Surface Areas	MOPITT	MOPITT PDR
TBD 002	Table III	24	Operating and Non–Operating Temperature Range	MOPITT	MOPITT PDR
TBD 003	Table IVa	25	Power Dissipation Detailed Model electrical dissipation and heater power	MOPITT	MOPITT PDR
*TBD 004	Figure 5c	30	Power Dissipation Profile–Surv. Mode Average Power. Dissipation	MOPITT	MOPITT PDR
TBD 005	Table Va	33	Temperature Control Majority of Table	MOPITT	MOPITT PDR
TBD 006	Table Vb	34	Temperature Control Majority of Table	MOPITT	MOPITT PDR
TBD 007	Figure 6	35	Heater and Sensor Locations Entire Table	MOPITT	MOPITT PDR
TBD 008	Table VIa	36	Temperature Limits Entire Table	MOPITT	MOPITT PDR

* Where the majority of the table information is TBD, the entire table has been identified as TBD in the table title. Table information will be filled in as it becomes available.

TBR LOG

ITEM	SECTION	PAGE	SUBJECT	RESPONSIBLE	DUE
TBR 001	Figure 5a	28	Power Dissipation Profile–Launch Mode Launch & Survival Power	MOPITT	MOPITT PDR
TBR 002	Figure 5b	29	Power Dissipation Profile–Surv. Mode Ave. Heater Power Dissipa.	MOPITT	MOPITT PDR

1 THERMAL DESCRIPTION

1.1 MOPITT Thermal Design Description

The MOPITT instrument is designed to be cooled partially by the EOS–AM Capillary Pumped Heat Transport System (CPHTS) and partially by a passive radiator. The instrument Power Supply module (PSM) only is cooled by the passive radiator which is integral with the PSM housing. The PSM and radiator are located on the +Y side of the instrument. The remainder of the instrument's components are located within the instrument housing and are cooled via conduction through the instrument baseplate to the CPHTS coldplate.

All thermally non–functional surfaces are covered with MLI to minimize radiative exchange with the surroundings. Conductive exchange with the EOS Spacecraft is limited by the instrument's three kinematic mounts.

MOPITT has two sets of apertures, one for Earth viewing (gathering science data) and one for space viewing (calibration). These apertures are normally open and will only be closed during instrument Safe Mode. These apertures are located on the +Z and +Y faces of the instrument.

The physical thermal design features are shown in Figures 1a & 1b; thermal Fields of View (FoV) that went into making up the instrument model are shown in Figure 2; resulting thermal FoV accommodation is shown in Figure 3 ; relationship between the physical and Thermal Radiation Analyzer System (TRASYS) model surfaces is shown in Figures 4a, 4b, 4c, 4d and 4e; and surfaces are described in Table I.

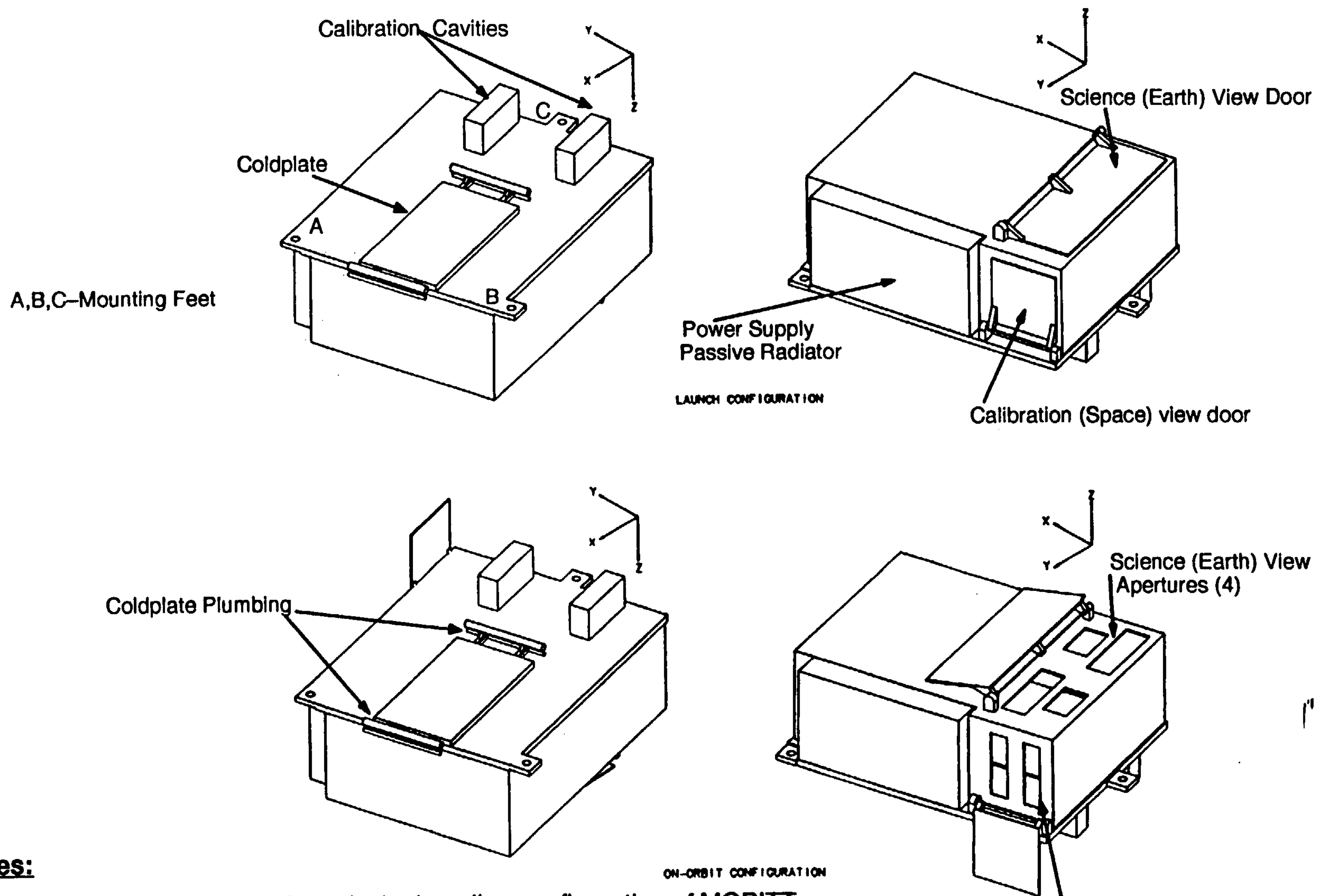
1.2 Thermal Interface Description

The MOPITT thermal interface with the EOS–AM spacecraft is via the CPHTS coldplate.

1.3 Coldplate Thermal Interface Characteristics

An analysis performed by MMC thermal engineering provides the interface temperatures at the 1 inch thick MOPITT baseplate resulting from the power dissipations of the components in the layout shown in Figure 1b. The nodal model of the baseplate is shown in Figure 4d. The nodal model of the coldplate is shown in Figure 4e. The power dissipations associated with each node are shown in Table IVb and the calculated baseplate and coldplate temperatures for a 17.0°C evaporator vapor temperature are shown in Table IVc. In order to maintain the coldplate surface between 20 and 25°C the CPHTS setpoint should be raised 0.8°C to 17.8°C. The results of the calculations for a 17.8°C evaporator temperature are summarized as follows:

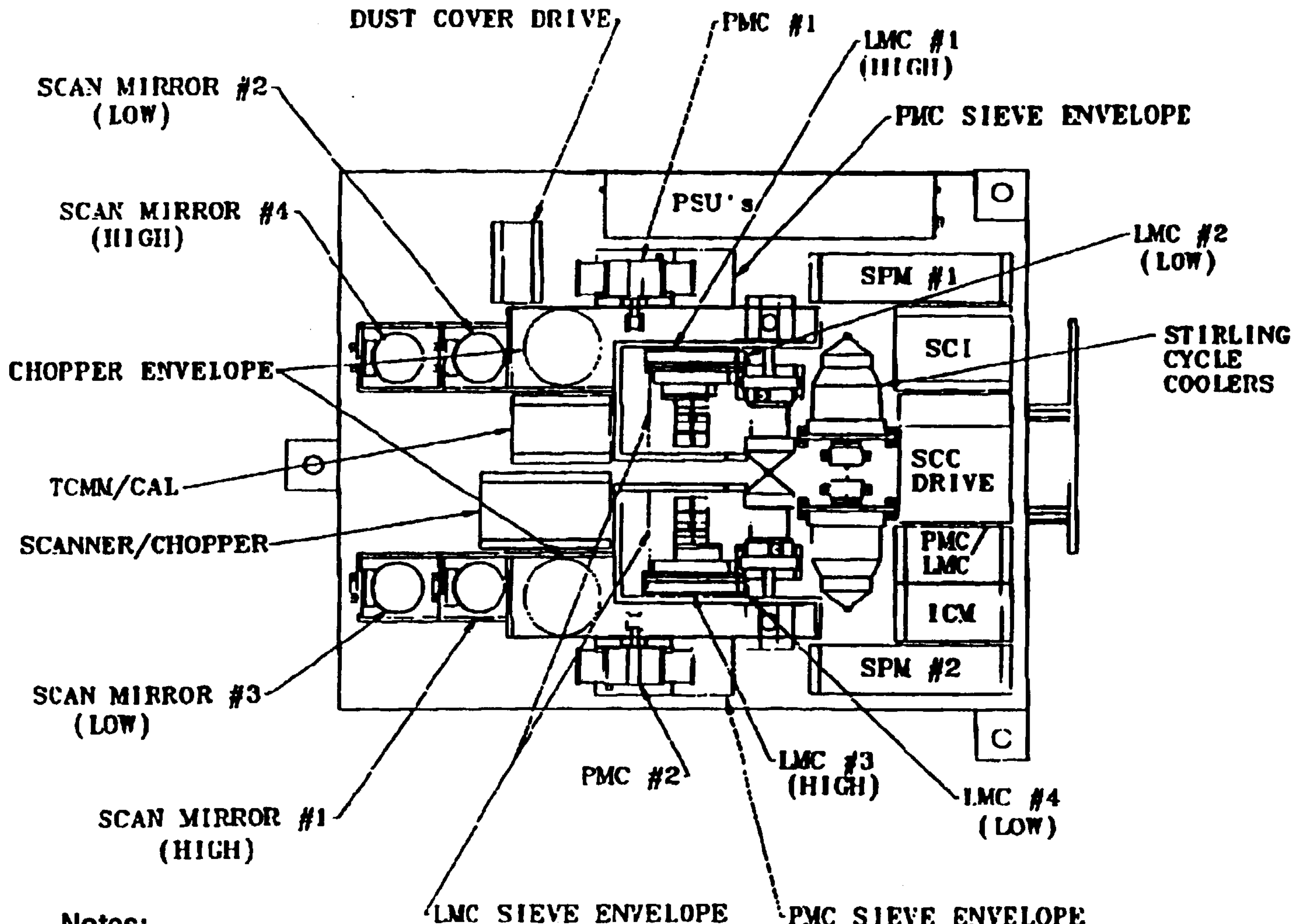
MOPITT Baseplate Temperature	$22.1°C < T < 28.4°C$	$\Delta T = 6.3°C$
MOPITT Coldplate Temperature	$20.0°C < T < 22.3°C$	$\Delta T = 2.3°C$
MOPITT Coldplate Flux	$0.44 W/in^2 < q/A < 1.29 W/in^2$	



Notes:

1. The figure shown above is the baseline configuration of MOPITT. The latest RTM reflected in this document represents a previous configuration.

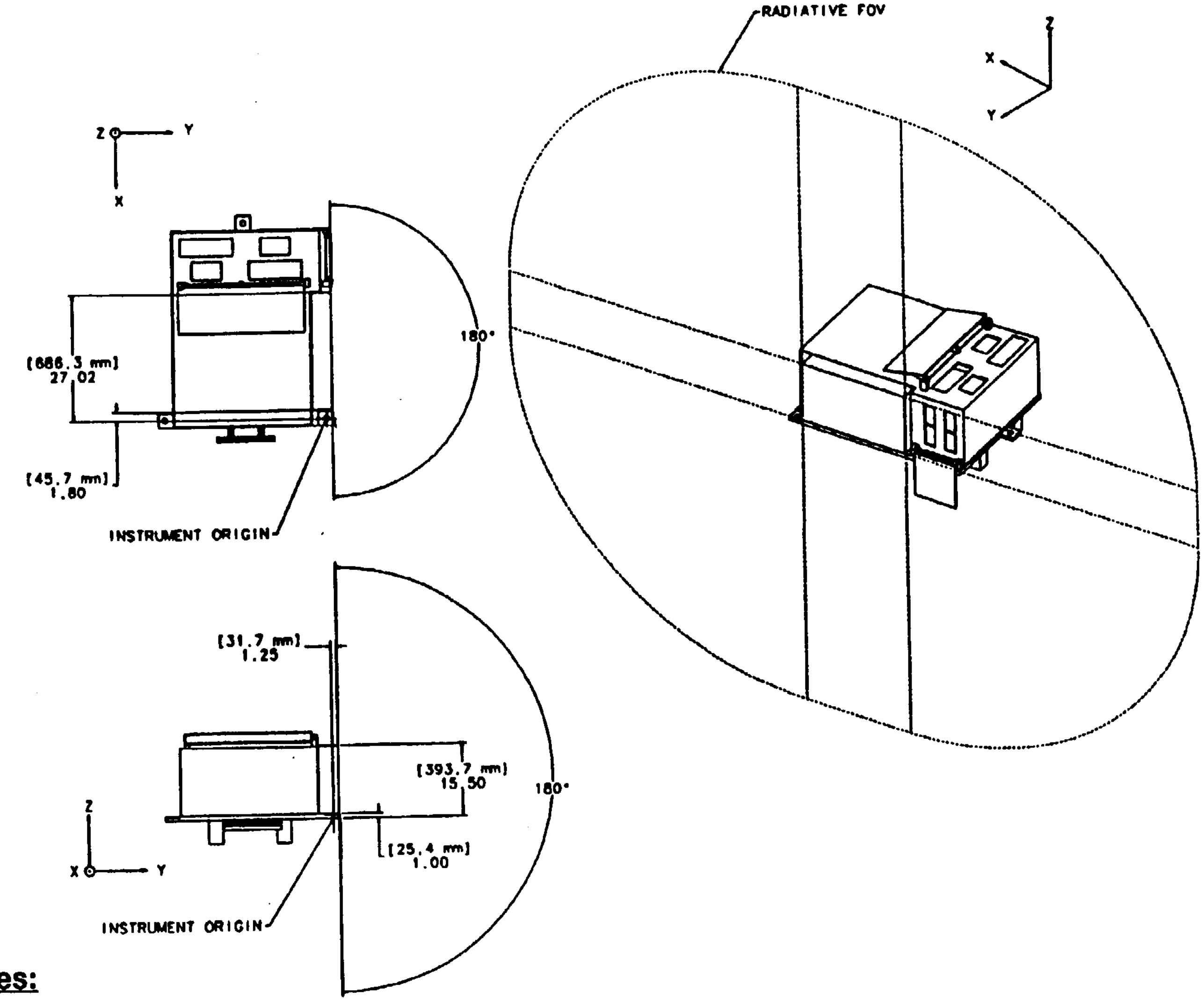
Figure 1a. Thermal Design Features



Notes:

1. The above layout was used in determining the current baseplate interface temperatures.

Figure 1b. Thermal Design Features – Baseplate Component Layout



Notes:

1. The thermal FoV Shown in this figure is a design goal and not intended to indicate a requirement.

Figure 2. Thermal Fields of View

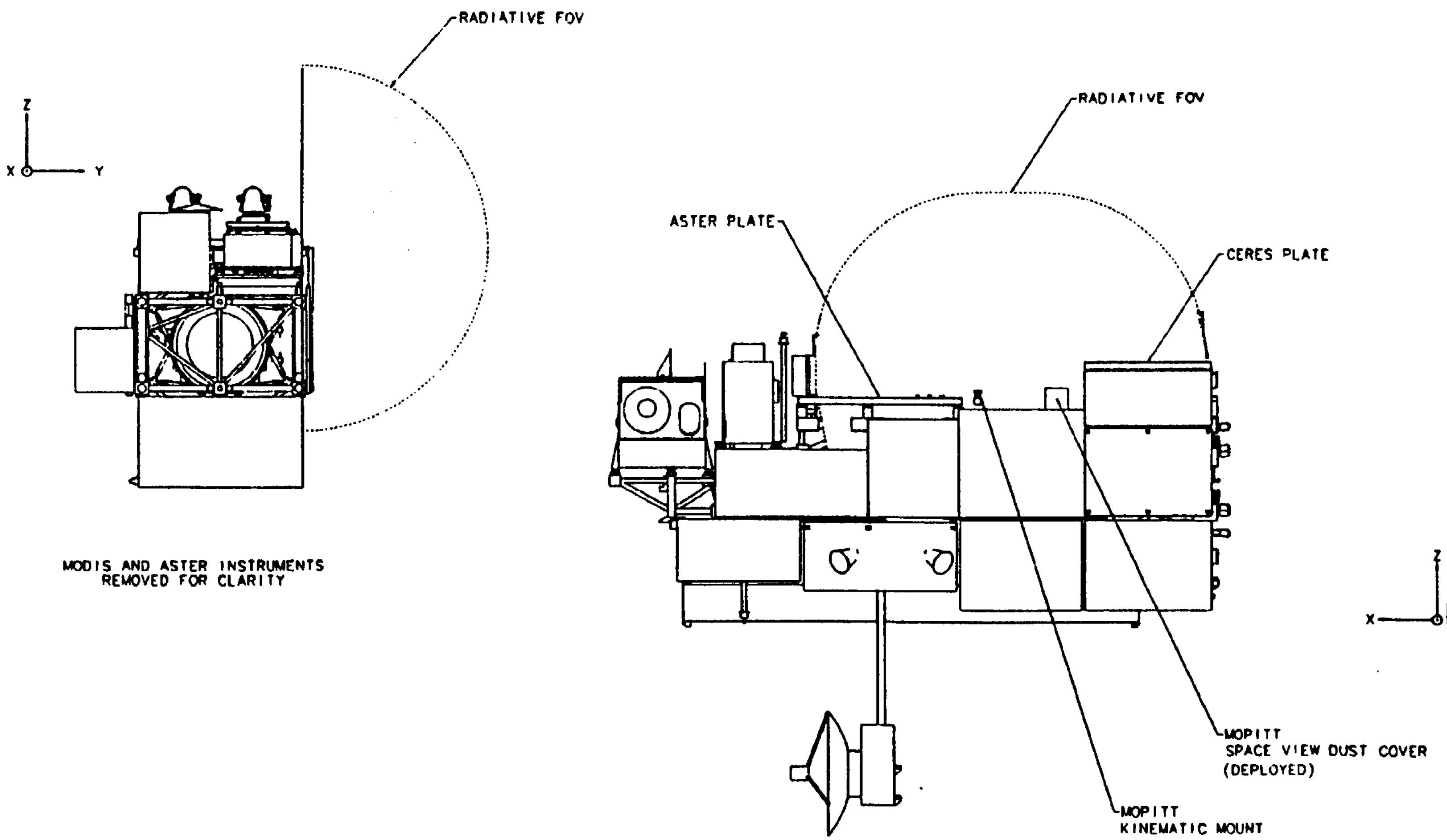
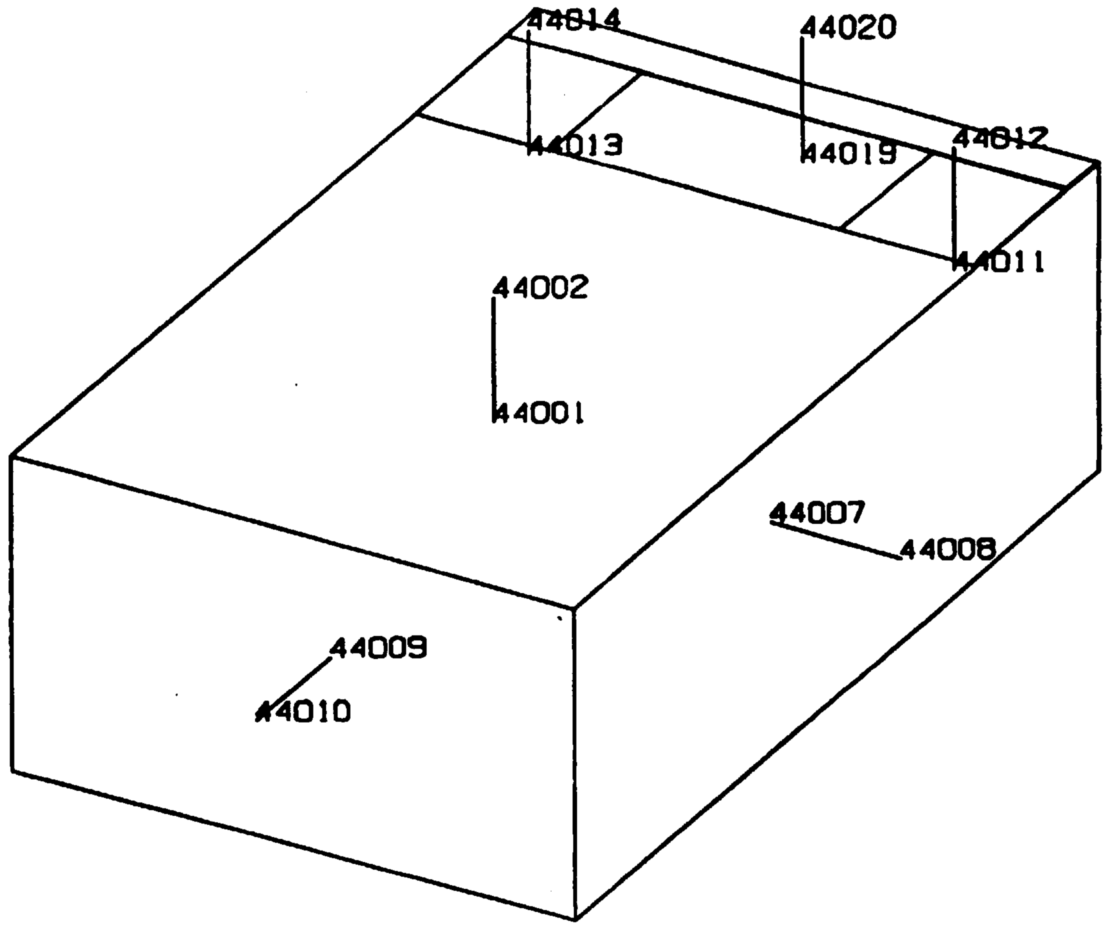
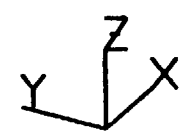


Figure 3. Thermal Fields of View Accommodation

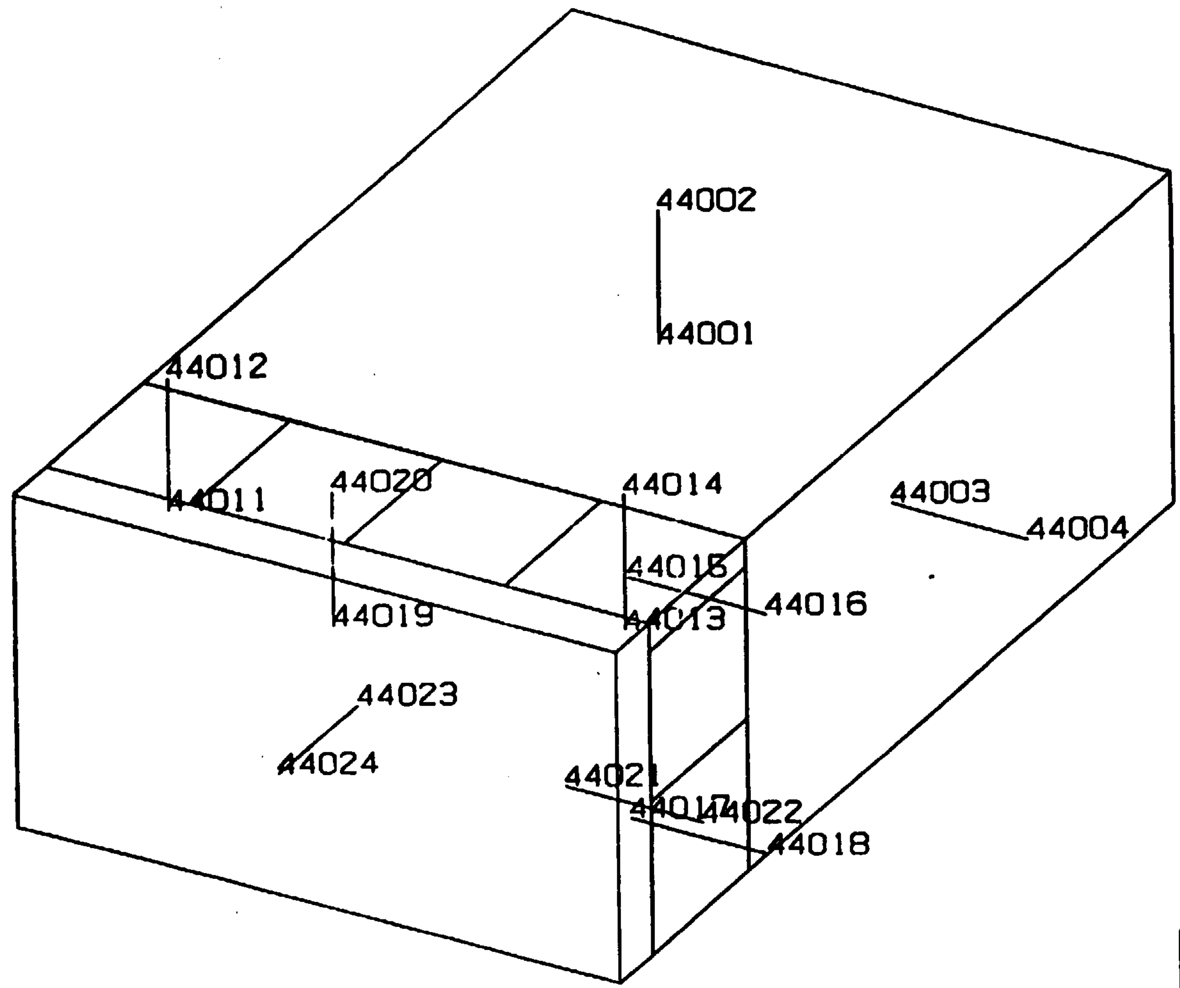


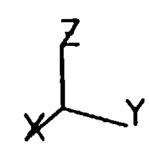


Notes:

1. See Table I for surface properties.
2. The model shown above does not reflect the current baseline configuration shown in Figure 1. The above figure will be updated when new RTMs are available.

Figure 4a. Surface Designations – Minus X, Minus Y, and Plus Z Surfaces

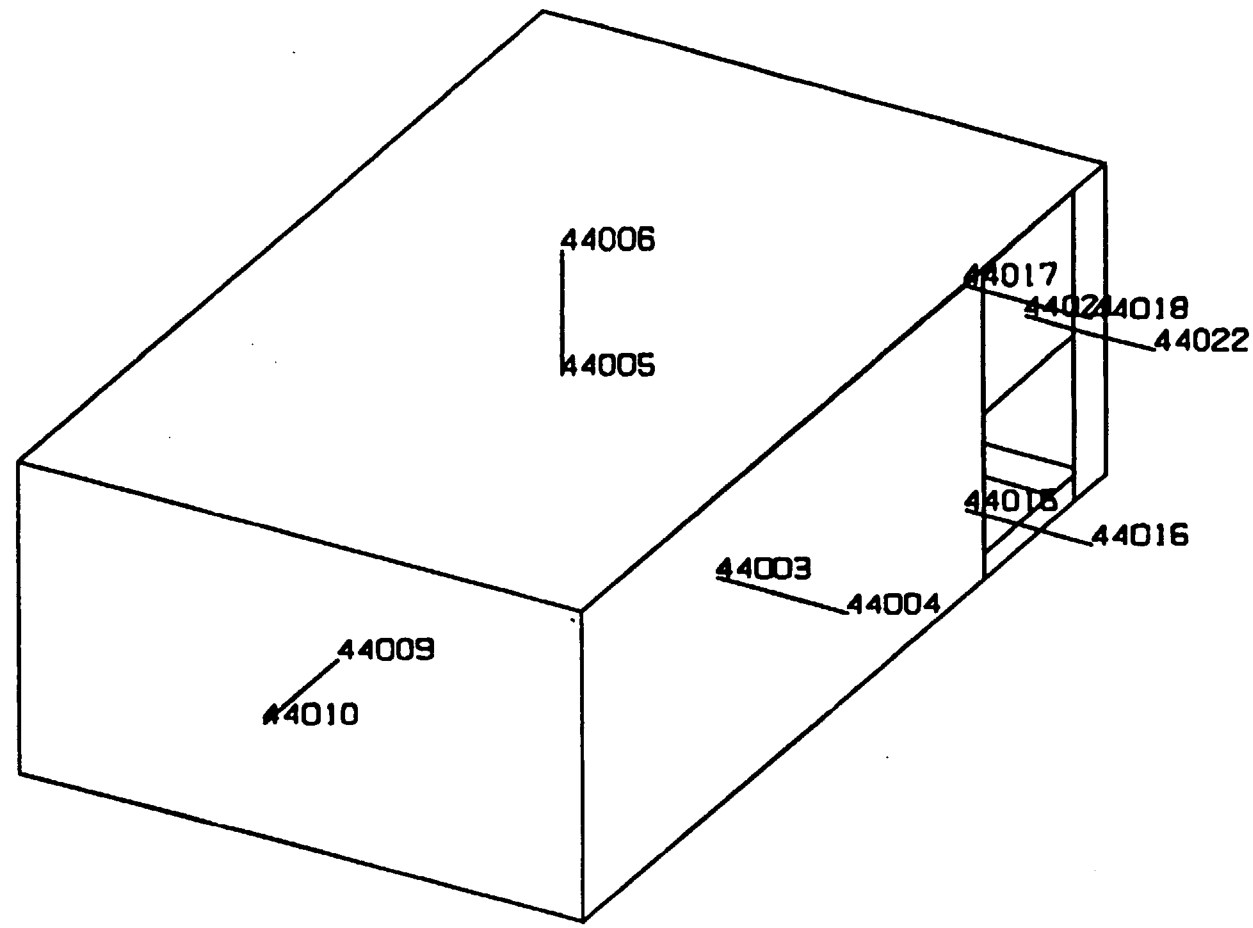




Notes:

1. See Table I for surface properties.
2. The model shown above does not reflect the current baseline configuration shown in figure 1. The above Figure will be updated when new RTMs are available.

Figure 4b. Surface Designations – Plus X, Plus Y, and Plus Z Surfaces



Notes:

1. See Table I for surface properties.
2. The model shown above does not reflect the current baseline configuration shown in figure 1. The above Figure will be updated when new RTMs are available.

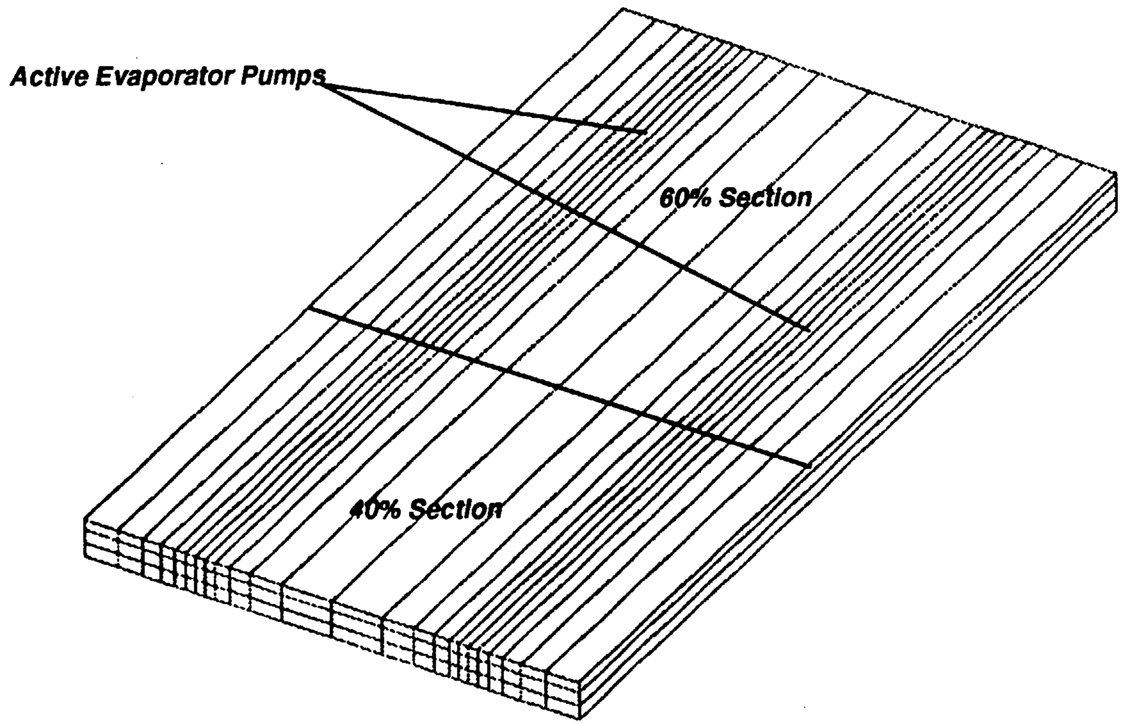
Figure 4c. Surface Designations – Plus Y, Minus X, and Minus Z Surfaces

Inches	10.46	3.71	2.02	3.63	2.26	2.53	4.01	5.78	7.42
3.83	1001	1002	1003	1004	1005	1006	1007	1008	1009
3.68	2001	2002	2003	2004	2005	2006	2007	2008	2009
2.76	3001	3002	3003	3004	3005	3006	3007	3008	3009
2.76	4001	4002	4004	4004	4005	4006	4007	4008	4009
3.98	5001	5002	5003	5004	5005	5006	5007	5008	5009
3.21	6001	6002	6003	6004	6005	6006	6007	6008	6009
1.84	7001	7002	7003	7004	7005	7006	7007	7008	7009
5.21	8001	8002	8003	8004	8005	8006	8007	8008	8009
3.06	9001	9002	9003	9004	9005	9006	9007	9008	9009

Notes:

1. The model shown above reflects the current baseline configuration for the shown in figure 1.

Figure 4d. Surface Designations – Baseplate Nodal Model Thermal Analysis



Notes:

1. The model shown above reflects the current baseline configuration shown in figure 1.

Figure 4e. Surface Designations – CPHTS Coldplate Nodal Model Thermal Analysyis

Table I. Surface Properties

TRASYS Surface ID	Coating	Area (in²)		Surface Emissivity		Surface Absorptivity	
		Calculated (TBD001)	TRASYS	BOL	EOL	BOL	EOL
44001	Black Paint		776.28	0.90	0.90	0.90	0.90
44002	MLI		776.28	0.82	0.76	0.43	0.55
44003	Black Paint		441.81	0.90	0.90	0.90	0.90
44004	MLI		441.81	0.82	0.76	0.43	0.55
44005	Black Paint		1012.50	0.90	0.90	0.90	0.90
44006	MLI		1012.50	0.82	0.76	0.43	0.55
44007	Black Paint		576.25	0.90	0.90	0.90	0.90
44008	MLI		576.25	0.82	0.76	0.43	0.55
44009	Black Paint		355.71	0.90	0.90	0.90	0.90
44010	MLI		355.71	0.82	0.76	0.43	0.55
44011	Black Paint		42.69	0.90	0.90	0.90	0.90
44012	MLI		42.69	0.82	0.76	0.43	0.55
44013	Black Paint		42.69	0.90	0.90	0.90	0.90
44014	MLI		42.69	0.82	0.76	0.43	0.55
44015	Black Paint		8.37	0.90	0.90	0.90	0.90
44016	MLI		8.37	0.82	0.76	0.43	0.55
44017	Black Paint		46.71	0.90	0.90	0.90	0.90
44018	MLI		46.71	0.82	0.76	0.43	0.55
44019	Black Paint		59.05	0.90	0.90	0.90	0.90
44020	MLI		59.05	0.82	0.76	0.43	0.55
44021	Black Paint		33.61	0.90	0.90	0.90	0.90
44022	MLI		33.61	0.82	0.76	0.43	0.55
44023	Black paint		355.71	0.90	0.90	0.90	0.90
44024	MLI		355.71	0.82	0.76	0.43	0.55

Notes:

BOL	Beginning of life
C	Celsius
EOL	End of life
ID	Identification
in	Inch
TRASYS	Thermal Radiation Analyzer System

2 REDUCED THERMAL MODELS

The Reduced Thermal Models (RTMs) used for spacecraft–level analysis are identified in Table II.

2.1 Reduced Thermal Model Analysis Cases

The Systems Improved Numerical Differencing Analyzer (SINDA) RTM Analysis Cases are described below, and the resulting temperature predictions are provided in Table III.

2.1.1 Analysis Case 1 – End of Life Science Mode

Analysis Case 1, End of Life (EOL) Science Mode, provides worst case maximum temperature predictions and heater power estimates (if required) for the Science Mode. The spacecraft is assumed to be in the normal operational Earth–oriented orbit and at normal altitude. A rotating (sun–tracking) Solar Array is assumed. EOL thermal surface properties for the spacecraft and instruments are used. Peak power dissipation profiles (as received with the instrument reduced thermal models) for the science data gathering mode of each instrument are included. The thermal worst hot case duty cycles for all housekeeping equipment are used to provide a hot spacecraft interface. Instrument doors and covers are assumed to be open. Three EOL Science cases were run with differing angles between the solar vector and the orbit plane (i.e., beta angles = 13.5, 18, and 30.8 degrees).

2.1.2 Analysis Case 2 – Beginning of Life Science/Standby Mode

Analysis Case 2, Beginning of Life (BOL) Science/Standby Mode, provides worst case minimum temperature predictions and heater power estimates for the Science/Standby Mode. The spacecraft is assumed to be in the normal operational Earth–oriented orbit and at normal altitude. A rotating Solar Array is assumed. BOL thermal surface properties for the spacecraft and instruments are used. The instrument power dissipations are assumed to be at standby levels throughout the orbits (i.e., science data taking peak dissipations are not included). For instruments with no transient power dissipations provided in the RTMs, the same power dissipations as the EOL Science Mode are used. The cold case power duty cycles for all housekeeping equipment are used. Instrument doors and covers are assumed to be open. Three bounding BOL Science/Standby cases were run with differing angles between the solar vector and the orbit plane (i.e., beta angles = 15, 24.5, and 30 degrees).

2.1.3 Analysis Case 3 – Beginning of Life Survival Mode

Analysis Case 3, BOL Survival Mode, provides worst case minimum temperature predictions and maximum heater power estimates for the Survival Mode. Survival Mode represents a critically low power availability condition; therefore, the instruments and much of the housekeeping equipment are powered off. Instrument and survival heaters are assumed to be enabled (i.e., power comes on when set points are reached). The spacecraft is assumed to be in the normal operational Earth–oriented orbit and at normal altitude. A rotating Solar Array is assumed. BOL thermal surface properties for the spacecraft and instruments are used. Instrument doors and covers are assumed to be open. Three bounding BOL Survival cases were run with differing angles between the solar vector and the orbit plane (i.e., beta angles = 15, 24.5, and 30 degrees).

2.1.4 Analysis Case 4 – Orbital Acquisition and Initialization

Analysis Case 4, Orbital Acquisition and Initialization (OAI), provides temperature predictions and heater power requirements used to determine the spacecraft energy balance in the initial part of the mission before the solar array is deployed. It is assumed that the entire spacecraft (except batteries and propulsion tanks) is at 10° C at the beginning of the injection orbit. Batteries and propulsion tanks are assumed to be at 20° C. The spacecraft is Earth oriented but at injection orbit altitudes of 550 to 705 km; and the Solar Array and High Gain Antenna are stowed. The models were run for 10 orbits to determine how far temperatures would drop and how much heater power is required if solar array deployment is delayed past nominal deployment. The appropriate acquisition and initialization housekeeping equipment is assumed to be on, instruments off, and survival heaters enabled. BOL thermal surface properties for the spacecraft and instruments are used. Instrument doors and covers are assumed to be closed. Three OAI cases were run with differing angles between the solar vector and the orbit plane (i.e., beta angles = 15, 24.5, and 30 degrees).

2.1.5 Analysis Case 5 – End of Life Sun–Pointing Safe Mode

Analysis Case 5, EOL Sun–Pointing Safe Mode (SPSM), provides maximum temperature predictions for equipment and instruments with –X surface exposures during SPSM. (SPSM is entered when the spacecraft loses Earth lock. In this mode, the Solar Array is "parked" normal to the spacecraft X–axis, with the cells looking in the –X direction.) The spacecraft is assumed to be in an inertially fixed orbit at normal altitude with the solar array cells and the spacecraft –X axis always normal to the sun. The appropriate housekeeping equipment is assumed to be on, instruments off, and survival heaters enabled. EOL thermal surface properties for the spacecraft and instruments are used. Instrument doors and covers are assumed to be open. Since there may be no roll control in this mode, this case was modeled for two roll positions about the X–axis: #1 with the ±X and ±Z surfaces alternately perpendicular to the Earth around the orbit; and #2 with the ±X and ±Y surfaces alternately perpendicular to the Earth around the orbit. Both cases were run at beta angle = 30.8 degrees.

2.1.6 Analysis Case 6 – Beginning of Life Sun–Pointing Safe Mode

Analysis Case 6, BOL SPSM, provided temperature predictions and maximum heater power estimates for the SPSM. The altitude and orbital orientations of the spacecraft and the Solar Array are the same as the EOL SPSM for both roll positions, except that the BOL cases were run at beta angle = 15 degrees. The appropriate housekeeping equipment is assumed to be on, instruments off, and survival heaters enabled. BOL thermal surface properties for the spacecraft and instruments are used. Instrument doors and covers are assumed to be open.

2.1.7 Analysis Case 7 – Orbital Acquisition and Initialization Sun–Pointing Safe Mode

Analysis Case 7, OAI SPSM, provides temperature predictions and heater power estimates for the OAI SPSM. (OAI SPSM is entered when the spacecraft fails to acquire the Earth during the injection orbit.) The spacecraft and deployed Solar Array orbital orientations are similar to the EOL and BOL SPSM cases (i.e., the OAI SPSM cases are SPSM #2 upside down); except that the injection orbit altitudes of 550 to 705 km are used and two OAI SPSM cases were run with differing angles between the solar vector and the orbit plane (i.e., beta angles = 15 and 24.5 degrees). The appropriate housekeeping equipment is assumed to be on, instruments off, and survival heaters enabled. BOL thermal surface properties for the spacecraft and instruments are used. Instrument doors and covers are assumed to be closed.

2.2 Power Dissipation

The power dissipations used for spacecraft–level analysis are identified in Table IVa through IVc. Power dissipation profiles are shown in Figures 5a through 5d. Two types of instances in the orbit which may be significant to instrument operation or spacecraft thermal environment are indicated on the profiles. The following legend is used:

Terminators	Day/Night and Night/Day Terminators are indicated on the profile. The Day/Night Terminator is when the spacecraft ground track passes from the daylight side to the night side of the Earth. The Night/Day Terminator is when the spacecraft ground track passes from the night side to the daylight side of the Earth.
Eclipse	Eclipse Entry is when the spacecraft enters the Earth eclipse of the Sun. Eclipse Exit is when the spacecraft exits the Earth eclipse of the Sun.

Table II. Reduced Thermal Models

	Revision			
	Preliminary	Preliminary		
Date	July 1992	November 1992		
TRASYS22 file name	MOPTV1–T.INP	MPT–THV3.INP		
SINDA87 file name	MOPITSV2.INP	MPT–SHV3.INP		
Node #	26001–26022	44001–44033		

Notes:

SINDA Systems Improved Numerical Differencing Analyzer
TRASYS Thermal Radiation Analyzer System

Table III. Analysis Case Temperature Predictions

SINDA Node #	Temperature Range (C) (TBD002)		Analysis Case Temperature Predictions (C)						
	Op	Non–Op	1 (max)	2 (min)	3 (min)	4 (min)	5 (max)	6 (min)	7 (min)
44005			26	21	–7	6	–18	–20	–20
44031			29	24	–7	6	–18	–20	–20
44032			28	23	–7	6	–18	–20	–20
44033			57	52	–7	6	–18	–18	–18
Orbit Avg. Heater Power (W)	N/A	N/A	0.0	0.0	0.0	N/A	14	14	5

Notes:

BOL Beginning of life
C Celsius
EOL End of life
max Maximum
min Minimum
Non–Op Non–operating
Op Operating
SINDA Systems Improved Numerical Differencing Analyzer

Table IVa. Power Dissipation
(See Note 1)

Node #/Description	Average Power Dissipation (Watts)		
	Mode		
	Safe	Survival	Science
44005–BSP	0	0	60.0
44031–SCC CONT	0	0	30.0
44032–SCC COMP	0	0	60.0
44033–PWRSUP	0	0	50.0
Total RTM electrical dissipation	0	0	200.0
Detailed model electrical dissipation	**(TBD003)**	**(TBD003)**	**(TBD003)**
Detailed model heater power	**(TBD003)**	**(TBD003)**	**(TBD003)**

Notes:

BSP Base Plate
SCC CONT Stirling Cycle Cooler Controller
SCC COMP Stirling Cycle Cooler Compressor
PWRSUP Power Supply

1. Values in this table correspond to those used in the RTM's

Table IVb. Power Dissipation – Baseplate Power Dissipations

Node Numbers	Dissipation (watts)	Description
2003, 2004, 2005	5.335	PMC & Drive Electronics
2008, 2009	13.04	SPM #1 (Detector Elect.)
3001	2.37	Calibration Sources
4001	2.37	Calibration Sources
3002, 3003, 4002, 4003	4.305	Optical Bench, Chopper, Scan Motor
3004	2.37	PMC Sieve
4004	2.37	LMC Sieve
4004, 4005, 4006	7.87	LMC
7009, 8009	4.74	ICM
5002, 5003	9.48	Chopper/Heater Drive Elect., TCMM
5004, 5005	2.795	LMC Drive Electronics
5007, 5008, 6007, 6008	56.88	Cooler Assembly
5009, 6009	29.03	Cooler Drive Electronics
6002, 6003, 7002, 7003	1.78	Chopper Drive
6002, 6003, 7002, 7003	1.82	Scan Mirror Drive
6004, 6005, 7004, 7005	2.795	LMC Drive Electronics
7004	2.37	LMC Sieve
3009, 4009	13.04	SCI
8001	4.74	Calibration Sources
8002,8003	4.305	Optical Bench, Chopper, Scan Motor
8004, 8005, 8006	7.87	LMC
9003, 9004, 9005	5.335	PMC & Drive Electronics
9008, 9009	13.04	SPM #2 (Detector Elect.)
Total	200.05	

Table IVc. Power Dissipation–Baseplate and Coldplate Calculated Temperatures

MOPITT TOTAL INPUT HEAT ADDITION TO COLDPLATE = 200.050 W
HEAT ADDITION TO EVAPORATOR PUMPS = 200.055 W
EVAPORATOR VAPOR TEMPERATURE = 17.000 C

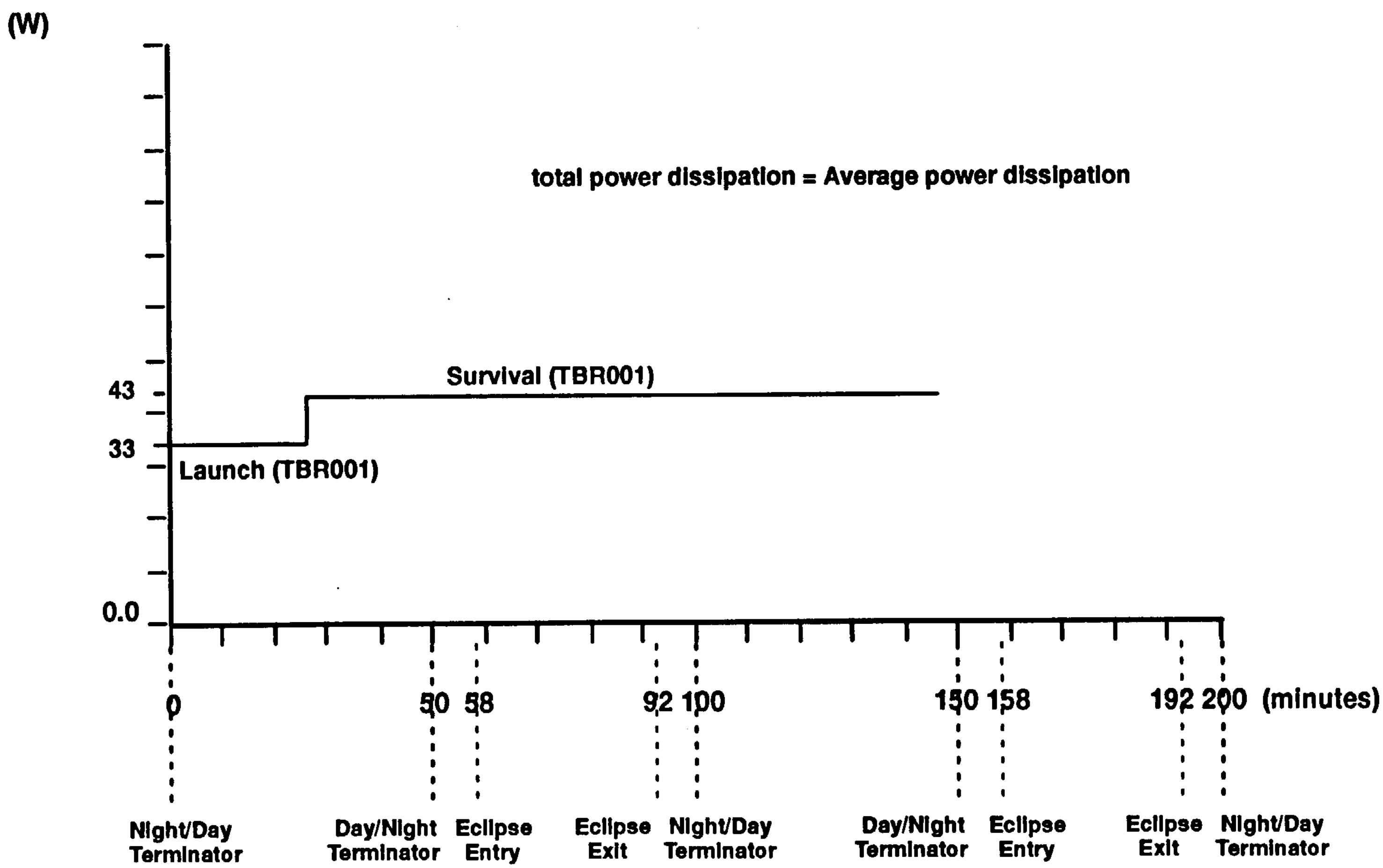
COLDPLATE TEMPERATURES (C) 40% SECTION	COLDPLATE TEMPERATURES (C) 60% SECTION	COLDPLATE FLUXES (W/SQ IN) 40% SECTION	COLDPLATE FLUXES (W/SQ IN) 60% SECTION	
21.498	20.966	0.564	0.487	
21.304	20.797	0.602	0.511	
21.045	20.572	0.731	0.623	
20.778	20.341	0.865	0.739	I
20.542	20.136	0.983	0.841	I Evaporator Pump
20.319	19.940	1.094	0.939	I
20.072	19.723	1.196	1.033	I Evaporator Pump
19.769	19.457	1.187	1.059	I
19.602	19.312	1.271	1.132	
19.865	19.549	1.139	1.013	
20.468	20.082	0.837	0.747	
21.015	20.565	0.564	0.506	
21.161	20.681	0.488	**0.435**	
20.913	20.441	0.608	0.527	
20.561	20.127	0.784	0.684	
20.262	19.861	0.933	0.817	
19.996	19.625	1.066	0.935	I
19.749	19.404	1.190	1.045	I Evaporator Pump
19.569	19.241	1.280	1.127	I
19.547	**19.213**	**1.291**	1.141	I Evaporator Pump
19.762	19.386	1.216	1.058	I
20.166	19.716	1.109	0.902	
20.560	20.039	0.912	0.741	
20.860	20.275	0.848	0.690	

NOTE:
Numbers in bold correspond to upper & lower values on baseplate & coldplate

BASEPLATE TEMPERATURES (C)

26.977	26.332	25.950	25.484	24.878	24.417	23.940	23.677	23.585	
27.102	26.495	26.176	25.647	24.792	24.151	23.608	23.579	23.558	
27.307	26.718	26.200	25.511	24.204	23.450	22.850	22.578	22.809	
27.385	26.848	26.196	25.358!	!23.368	22.526	22.011	21.662	21.940!	Coldplate Outline
27.354	27.067	26.189	24.802!	!22.689	21.936	21.966	21.683	21.493!	
27.378	26.823	25.983	24.751!	!22.629	21.898	21.993	21.689	21.343!	Coldplate Outline
27.455	26.845	26.134	25.190	23.132	22.348	21.986	21.586	21.470	
27.617	26.985	26.449	25.756	24.707	23.905	23.115	22.656	22.537	
27.517	26.933	26.653	26.115	25.196	24.442	23.763	23.754	23.521	

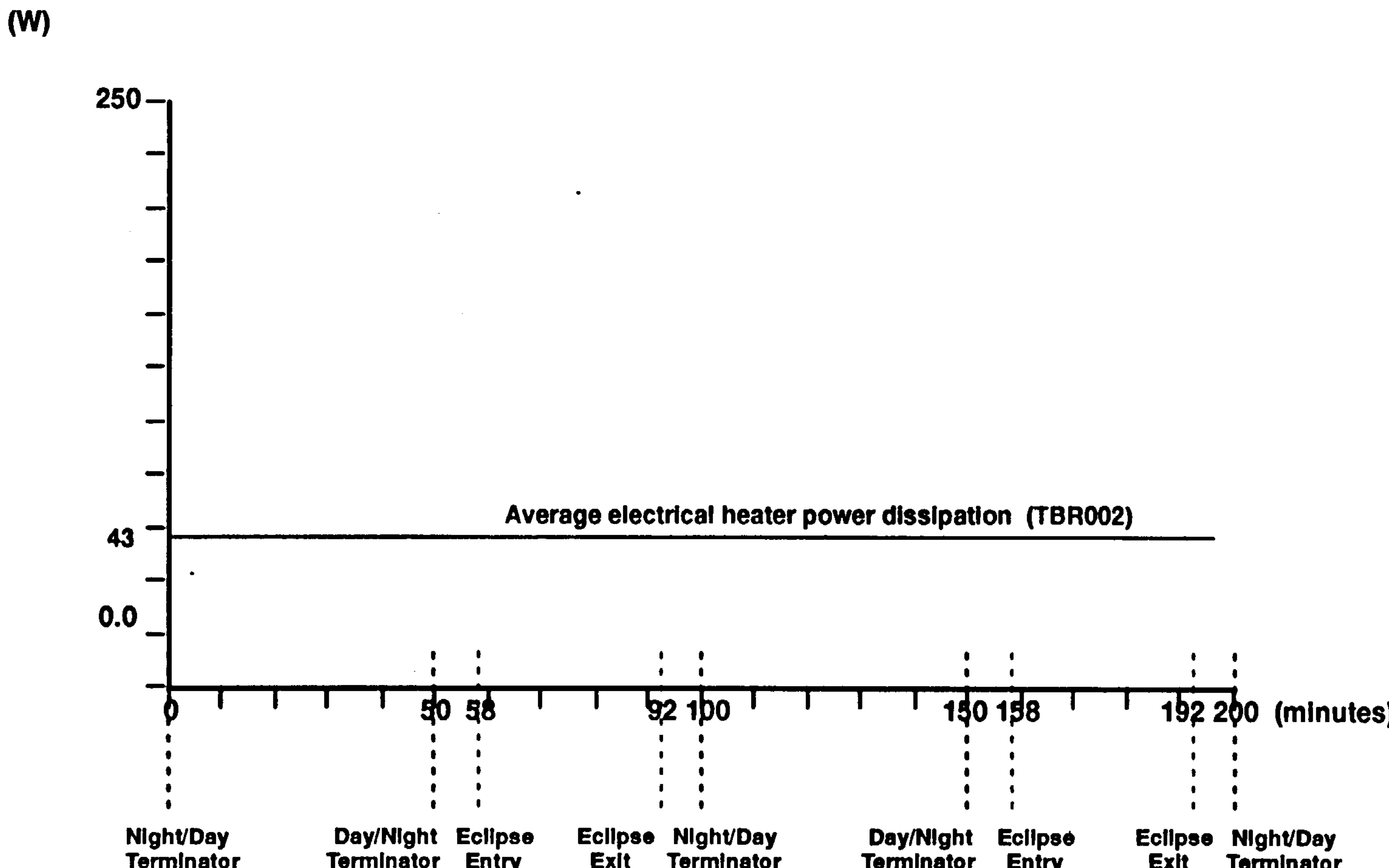
Size	Code Ident No.	
A	49671	20008853
		Sheet 27



Notes:

1. Power dissipation includes 22% contingency
2. Power profiles are estimates for the baseline configuration provided by COM DEV and are not reflected in the RTM and tables included in this document. This applies to Figures 5a through 5d.

Figure 5a. Power Dissipation Profile – Launch Mode



Notes:

1. Power dissipation includes 22% contingency
2. Launch and survival power are estimates provided by COM DEV and are not reflected in the RTM and tables included in this document.
3. See Note 2 on Figure 5a

Figure 5b. Power Dissipation Profile – Survival Mode

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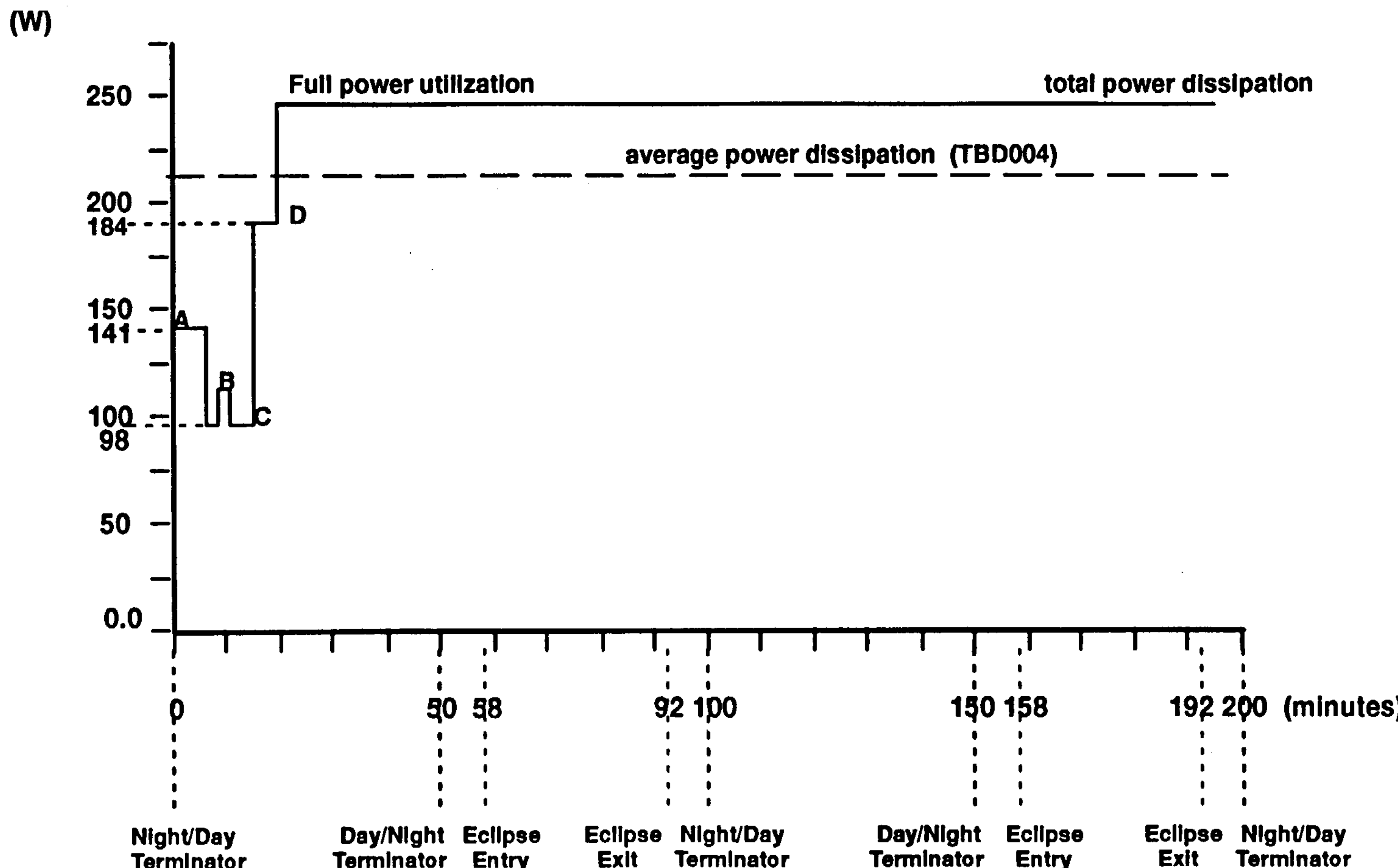


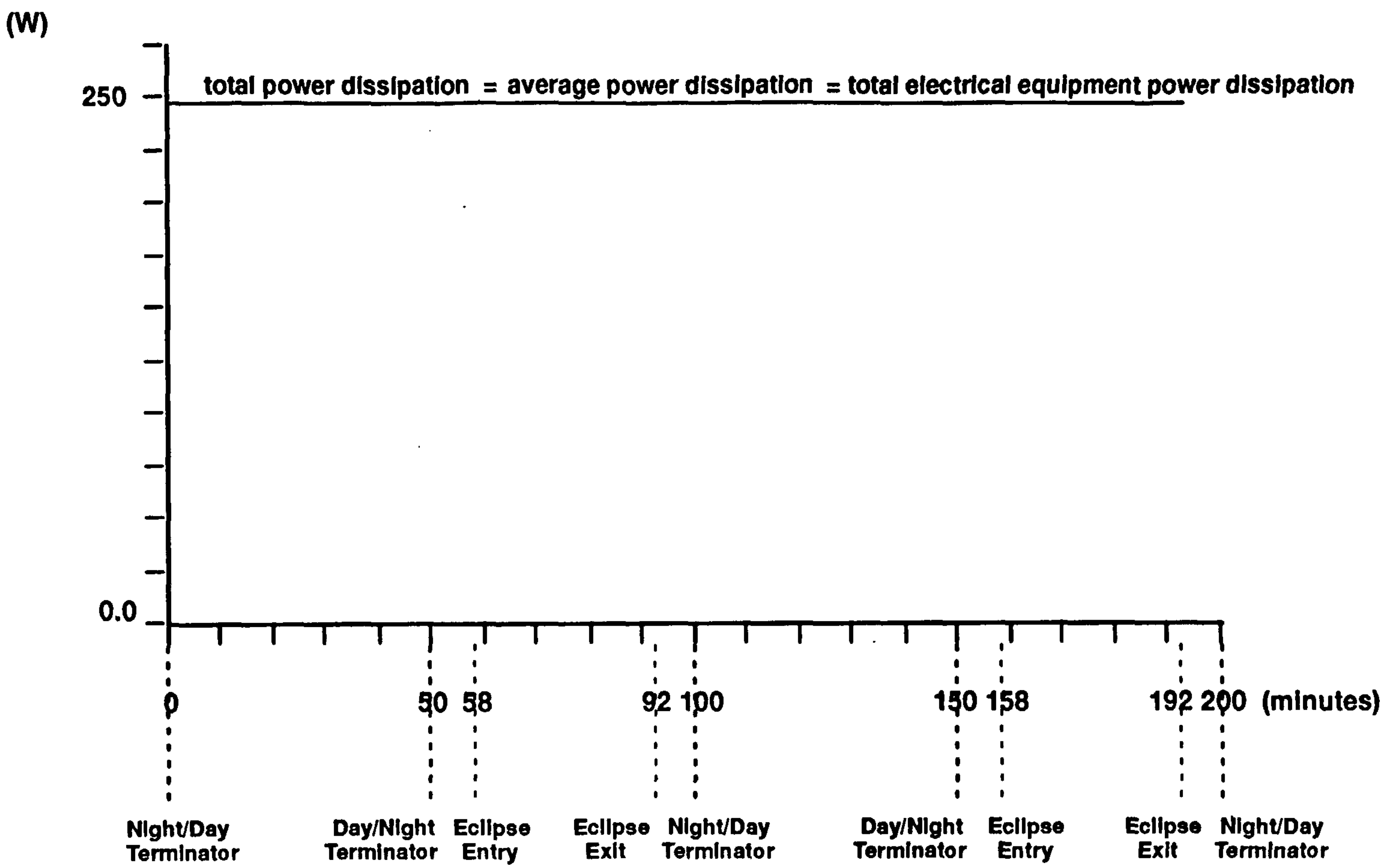
Notes:

1. A=Power–On (Electronics & Heater)
   B=Dust Cover Open
   C=Coolers –On
   D=All Drives On
2. See Note 2 on Figure 5a

Figure 5c. Power Dissipation Profile – Safe Mode

Size A | Code Ident No. 49671 | 20008853 | Sheet 30

Size A
Code Ident No. 49671
20008853
Sheet 31



Notes:

1. Power dissipation includes 22% contingency
2. See Note 2 on Figure 5a

Figure 5d. Power Dissipation Profile – Standby–by and Science Mode

3 THERMAL CONTROL

1. Heaters, coolers, control sensors, and temperature telemetry sensors are described in Table V.

2. Heater and sensor locations are shown in Figure 6.

3. Temperature limits are given in Table VI.

Table Va. Temperature Control (TBD005)*

ID	PSM – primary	PSM – Redundant	Dust Cover 1 Motor/ Bearing Primary	Dust Cover 1 Motor/ Bearing Redundant
Function	Survival Heater	Survival Heater	Survival Heater	Survival Heater
Type	Thermostat	Thermostat	Thermostat	Thermostat
Location/RTM node **Device** **Control Sensor** **Telemetry Sensor**				
Temperature Telemetry Sensor Acronym				
Heat Sink	Power Supply Housing	Power Supply Housing	Motor Case	Motor Case
Control Method	Thermostatic	Thermostatic	Thermostatic	Thermostatic
Power Source	110VDC	110VDC	110VDC	110VDC
Dissipation (W) **Rated Power** **@ Specified Voltage**				
Set Points (C) **On** **Off**				

Notes:

* Where the majority of the table information is TBD, the entire table has been identified as TBD in the table title. Table information will be filled in as it becomes available.

C Celsius

ID Identifier

W Watt

PSM Power Supply Module

Table Vb. Temperature Control – (Continued) (TBD006)*

ID	Dust cover 2 Motor/ Bearing Primary	Dust cover 2 Motor/ Bearing Redundant	Dust Cover Latch 1	Dust Cover Latch 2
Function	Survival Heater	Survival Heater	Survival Heater	Survival Heater
Type	Thermostat	Thermostat	Thermostat	Thermostat
Location/RTM node **Device** **Control Sensor** **Telemetry Sensor**				
Temperature Telemetry Sensor Acronym				
Heat Sink	Motor Case	Motor Case	Latch Case	Latch Case
Control Method	Thermostatic	Thermostatic	Thermostatic	Thermostatic
Power Source	110VDC	110VDC	110VDC	110VDC
Dissipation (W) **Rated Power** **@ Specified Voltage**				
Set Points (C) **On** **Off**				

Notes:

* Where the majority of the table information is TBD, the entire table has been identified as TBD in the table title. Table information will be filled in as it becomes available.

- * Coolers only
- C Celsius
- ID Identifier
- W Watt

(TBD007)

Notes:

Figure 6. Heater and Sensor Locations

Table VIa. Temperature Limits
(See Note 1) (TBD008)

Mode	Average (C)	Telemetry Acronym MOP–Tx–__________		Telemetry Acronym MOP–Tx–__________	
		Minimum (C)	Maximum (C)	Minimum (C)	Maximum (C)
Launch					
Safe					
Survival (see Note 2.)					
Turn–on					
Standby					
Science					

Notes:

** Where the majority of the table information is TBD, the entire table has been identified as TBD in the table title. Table information will be filled in as it becomes available.

1. Telemetry identified by * is invalid when instrument power is off.
2. Survival limits represent temperatures beyond which the instrument cannot recover and meet performance requirements.

Table VII. Reference Documents*

Document Number	Date	Document Title	Source

* Table information will be filled in as required.