

National Aeronautics and
Space Administration

SL-E-0001
REVISION D
MAY 13, 1998

Lyndon B. Johnson Space Center
Houston, Texas 77058

REPLACES
SL-E-0001
REVISION C

SPACE SHUTTLE

SPECIFICATION

ELECTROMAGNETIC
COMPATIBILITY REQUIREMENT

REVISION LOG

REV LTR	CHANGE NO	DESCRIPTION	DATE
		BASELINE ISSUE	06/04/73
A	2	REVISION A (Reference: Level II PRCBD S40129, dated 7/23/86) also includes PRCBD S40481 and Change 1.	05/11/87
B	3	REVISION B (Reference: Level II PRCBD S00125A, dated 9/28/87).	09/29/87
C	7	REVISION C (Reference: Level II PRCBD S00125B, dated 4/11/90) also includes Changes 4 thru 6.	05/24/90
D	9	REVISION D (Reference: Space Shuttle PRCBD S000125H, dated 4/14/98) also includes CAR S041880B; SSP DOC-271 and Change 8.	05/13/98

SL-E-0001
CHANGE NO. 10

CHANGE SHEET
FOR
SL-E-0001 - Space Shuttle
Specification
Electromagnetic Compatibility Requirement

CHANGE NO. 10

This change incorporates technical changes authorized by SSP DOC-270.

July 9, 1998

Robert H. Heselmeyer
Secretary, Program Requirements
Control Board

CHANGE INSTRUCTIONS

1. Remove the following listed Deviation/Waiver (D/W) pages and replace with the same numbered attached D/W pages:

<u>D/W Page</u>	<u>PRCBD No.</u>
(iii)	SSP DOC-270
(iv)	
(1)	
(2)	SSP DOC-270
(3) - (4) (Remove)	SSP DOC-270

2. Remove the following listed pages and replace with the same numbered attached pages:

<u>Page</u>	<u>PRCBD No.</u>
3-3	
3-4	SSP DOC-270
A-9 - A-10	SSP DOC-270

NOTE: A black bar in the margin indicates the information that was changed.

3. Remove the List of Effective Pages, dated May 13, 1998 and replace with List of Effective Pages, dated July 9, 1998.
4. Sign and date this page in the space provided below to show that the changes have been incorporated and file immediately behind the List of Effective Pages.

Signature of person incorporating changes

Date

SL-E-0001 - Space Shuttle
Specification
Electromagnetic Compatibility Requirement

*Revision D (Reference PRCBD No. S000125H, dated 4/14/98; CAR S041880B, dated 4/2/93 and SSP DOC-271)

LIST OF EFFECTIVE PAGES

July 9, 1998

The current status of all pages in this document is as shown below:

<u>Page No.</u>	<u>Change No.</u>	<u>PRCBD No.</u>	<u>Date</u>
(i) - (ii)	Rev. D	*	May 13, 1998
(iii)	10	SSP DOC-270	August 3, 1995
(iv)	Rev. D	*	May 13, 1998
(1)	Rev. D	*	May 13, 1998
(2)	10	SSP DOC-270	August 3, 1995
i - viii	Rev. D	*	May 13, 1998
1-1 - 1-2	Rev. D	*	May 13, 1998
2-1 - 2-4	Rev. D	*	May 13, 1998
3-1 - 3-3	Rev. D	*	May 13, 1998
3-4	10	SSP DOC-270	August 3, 1995
3-5 - 3-8	Rev. D	*	May 13, 1998
4-1 - 4-4	Rev. D	*	May 13, 1998
5-1 - 5-2	Rev. D	*	May 13, 1998
6-1 - 6-2	Rev. D	*	May 13, 1998
A-1 - A-8	Rev. D	*	May 13, 1998
A-9 - A-10	10	SSP DOC-270	August 3, 1995

DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS CONTAINED IN THIS DOCUMENT

This section contains only currently approved Deviations/Waivers to the requirements of SL-E-0001. Deviations/Waivers to these requirements that were approved prior to the STS 51-L accident have been rescinded and are retained in Appendix A of this volume for historical purposes.

THIS PAGE INTENTIONALLY LEFT BLANK

**INDEX OF DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS
CONTAINED IN THIS DOCUMENT**

<u>Number</u>	<u>Title</u>	<u>Para. No.</u>	<u>Page</u>
1.	Rescinded (Reference Level II PRCBD S40019R3, dated 8/26/87)	Apx A	(1)
2.	EMI Safety Margins (Reference Level II PRCBD S22917A, dated 7/23/88)	3.2.3	(1)
3.	Wiring and Cabling (Reference Level II PRCBD S40732K, dated 9/27/88)	3.2.5	(1)
4.	Retired (Reference Level II PRCBD S00125B, dated 4/11/90)	Apx A	(2)
5.	Retired per SSP DOC-270 (Reference Level II PRCBD S052494, dated 7/19/91)	Apx A	(2)

THIS PAGE INTENTIONALLY LEFT BLANK

**DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS
CONTAINED IN THIS DOCUMENT**

1. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87). See Appendix A.

2. **REQUIREMENT:** *Paragraph 3.2.3 EMI Safety Margins. For equipment and functions identified as EMI critical in Paragraph 3.2.2, EMI safety margins shall be designed into the equipment and verified by test or analysis. Unless otherwise specified in the contract, range safety procedures, or system control plan, safety margins less than 6dB (20dB for ordnance) shall not be used.*

WAIVER: The requirement for EMI safety margins of 6dB or greater shall be waived for the very lightweight headset (VLHS).

EFFECTIVITY: STS-26 and subsequent flights.

RATIONALE: The very lightweight headsets (VLHSs) passed all requirements except EMI susceptibility in the range between 237.5 and 238 MHz. The VLHSs were susceptible to 1.4 volts per meter instead of the required 2.0 volts per meter. This susceptibility should cause no problem in the use of the VLHSs. The VLHSs are more compatible with the onboard communication and are much easier for the crew to use than the current mini-headsets.

AUTHORITY: Level II PRCBDs S22917A, dated 7/23/88 and S22917AR1, dated 9/6/89.

3. **REQUIREMENT:** Paragraph 3.2.5 Wiring and Cabling, specifies that wiring and cabling shall be designed to minimize coupling, and obtain optimum separation and use of available wiring space. Cable design shall include provisions for adequate termination of shielded wires. Procedures shall be established to categorize each wire or cable according to its interference and susceptibility characteristics. Wires and cables shall be marked (*preferred*) or *identified* in such a manner that personnel can visually identify, *prior to closeout*, the EMC category for each wire or cable.

WAIVER: The requirement for wire marking is not applicable to the External Tank.

EFFECTIVITY: ET-23, ET-27 thru ET-29, ET-31 thru ET-999.

**DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS
CONTAINED IN THIS DOCUMENT - Concluded**

- RATIONALE:**
1. The ET has an approved EMC control plan, MMC-ET-SE14.
 2. Most cabling is covered by an overall shield which precludes visual identification.
 3. ET is an expendable element.
 4. Retrofit is not cost effective and risk involved outweighs benefits of marking.

AUTHORITY: Level II PRCBD S40732K, dated 9/27/88.

4. **REQUIREMENT:** Retired. (Reference Level II PRCBD S00125B, dated 4/11/90). See Appendix A.
5. **REQUIREMENT:** Retired per SSP DOC-270, dated 8/3/95. (Reference Level II PRCBD S052494, dated 7/19/91.) See Appendix A.

THIS PAGE INTENTIONALLY LEFT BLANK

SL-E-0001

SPACE SHUTTLE

SPECIFICATION

**ELECTROMAGNETIC
COMPATIBILITY REQUIREMENT**

THIS PAGE INTENTIONALLY LEFT BLANK

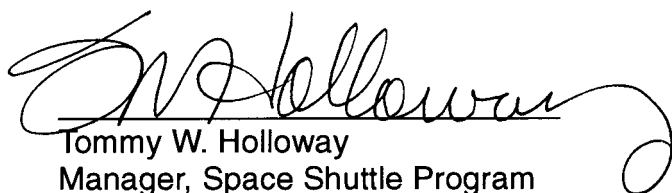
FOREWORD

Efficient management of the Space Shuttle Program (SSP) dictates that effective control of program activities be established. Requirements, directives, procedures, interface agreements, and system capabilities shall be documented, baselined, and subsequently controlled by SSP management.

Program requirements controlled by the Manager, Space Shuttle Program, are documented in, attached to, or referenced from Volume I through XVIII of NSTS 07700.

This specification has been prepared specifically to tailor the requirements of MIL-E-6051D, dated September 7, 1967, to the Space Shuttle Program and elements thereof. It is applicable to all NASA Space Shuttle System procurements at the project level or higher.

All elements of the SSP must adhere to these baselined requirements. When it is considered by the Space Shuttle Program element/project managers to be in the best interest of the SSP to change, waive or deviate from these requirements, an SSP Change Request (CR) shall be submitted to the Program Requirements Control Board (PRCB) Secretary. The CR must include a complete description of the change, waiver or deviation and the rationale to justify its consideration. All such requests will be processed in accordance with NSTS 07700, Volume IV - Book 1 and dispositioned by the Manager, Space Shuttle Program, on a Space Shuttle PRCB Directive (PRCBD).



Tommy W. Holloway
Manager, Space Shuttle Program

THIS PAGE INTENTIONALLY LEFT BLANK

CONTENTS

SL-E-0001

1.0	SCOPE	1-1
1.1	PURPOSE	1-1
2.0	APPLICABLE DOCUMENTS	2-1
2.1	SPECIFICATIONS, STANDARDS AND MANUALS	2-1
2.2	OTHER PUBLICATIONS	2-3
3.0	REQUIREMENTS	3-1
3.1	SYSTEM ELECTROMAGNETIC COMPATIBILITY PROGRAM	3-1
	3.1.1 Electromagnetic Compatibility Board	3-1
3.2	SYSTEM REQUIREMENTS	3-1
	3.2.1 Subsystem Compatibility	3-2
	3.2.2 Subsystem/Equipment Criticality	3-2
	3.2.3 EMI Safety Margins	3-2
	3.2.4 Interference and Susceptibility Control	3-3
	3.2.5 Wiring and Cabling	3-3
	3.2.6 Electrical Power	3-4
	3.2.7 Spikes	3-4
	3.2.8 Bonding and Grounding	3-4
	3.2.9 Lightning Protection	3-5
	3.2.10 Static Electricity	3-5
	3.2.11 Personnel Hazards	3-5
	3.2.12 Electromagnetic Hazards to Ordnance	3-5
	3.2.13 External Environment	3-5
	3.2.14 (Deleted)	3-6
	3.2.15 (Deleted)	3-6
3.3	CONTROL PLAN	3-6
	3.3.1 Updating of Control Plan	3-6
3.4	COMMERCIAL SUBSYSTEMS/EQUIPMENTS	3-6
3.5	GOVERNMENT FURNISHED EQUIPMENT	3-7
3.6	SUBSYSTEM EQUIPMENT INSTALLATION	3-7
3.7	REDESIGN OF SYSTEMS	3-7
4.0	QUALITY ASSURANCE PROVISIONS	4-1
4.1	RESPONSIBILITY FOR INSPECTION	4-1
4.2	ELECTROMAGNETIC COMPATIBILITY TEST PROGRAM	4-1

CONTENTS

SL-E-0001

4.3	(DELETED)	4-2
4.3.1	(Deleted)	4-2
4.3.2	(Deleted)	4-2
4.3.3	(Deleted)	4-2
4.3.4	(Deleted)	4-3
4.3.5	(Deleted)	4-3
4.4	(DELETED)	4-3
4.4.1	(Deleted)	4-3
4.4.2	(Deleted)	4-3
4.4.3	(Deleted)	4-3
4.4.4	(Deleted)	4-3
4.4.5	(Deleted)	4-3
4.4.6	(Deleted)	4-3
4.4.7	(Deleted)	4-3
4.4.8	(Deleted)	4-3
4.4.9	(Deleted)	4-3
4.4.10	(Deleted)	4-3
4.5	(DELETED)	4-3
4.5.1	(Deleted)	4-3
4.5.2	(Deleted)	4-3
4.6	(DELETED)	4-3
4.7	(DELETED)	4-3
4.8	(DELETED)	4-3
4.9	(DELETED)	4-3
5.0	PREPARATION FOR DELIVERY	5-1
5.1	NOT APPLICABLE	5-1
6.0	NOTES	6-1
6.1	(DELETED)	6-1
6.2	DEFINITIONS	6-1
6.2.1	Electromagnetic Compatibility	6-1
6.2.2	Electromagnetic Environment	6-1
6.2.3	Electromagnetic Interference	6-1
6.2.4	Malfunction	6-1
6.2.5	Receiver Area Noise Level	6-1

CONTENTS

SL-E-0001

6.2.6	Subsystem	6-1
6.2.7	System	6-1
6.2.8	Unaccepted Response	6-2
6.2.9	Undesirable Response	6-2
6.3	(DELETED)	6-2

APPENDICES

SL-E-0001

A	ARCHIVED DEVIATIONS/WAIVERS	A-1
---	-----------------------------------	-----

1.0 SCOPE

1.1 PURPOSE

This specification outlines the overall requirements for systems electromagnetic compatibility, including control of the system electromagnetic environment, lightning protection, static electricity, bonding and grounding. It is applicable to complete systems, including all associated subsystems/equipments. *Requirements which have been taken from MIL-E-6051D without change are shown in standard type. Requirements which have been altered or added for specific application to the Space Shuttle are shown in italics. MIL-E-6051D paragraphs that are not applicable to the Space Shuttle are not included (indicated by "Deleted").*

THIS PAGE INTENTIONALLY LEFT BLANK

2.0 APPLICABLE DOCUMENTS

2.1 SPECIFICATIONS, STANDARDS AND MANUALS

The following documents of issue and date specified or, if unspecified, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein. "Current Issue" is shown in place of the specific date and issue when the document is under Space Shuttle Program Requirements Control Board (PRCB) control. The Current Issue may be determined from NSTS 08102, Document Description and Status Report.

SPECIFICATIONS

Military

MIL-B-5087 Bonding, Electrical and Lightning Protection for Aerospace Systems

Ref. Para. 3.2.8, 3.2.8.4

National Aeronautics and Space Administration (NASA)

NSTS 07636 *Lightning Protection Criteria Document*
(Current Issue)

Ref. Para. 3.2.8, 3.2.8.4, 3.2.9

NSTS 20007 *Space Shuttle Lightning Protection Verification Document*
(Current Issue)

Ref. Para. 3.2.9

SL-E-0002 Specification, Electromagnetic Interference Characteristics, Requirements for Equipment
(Current Issue)

Ref. Para. 3.2.4.1, 3.3c

STANDARDS

Military

*MIL-STD-461A
August 1, 1968
(as amended by
Specification
SL-E-0002, Current
Issue)*

*Electromagnetic Interference Characteristics,
Requirements for Equipment*

Ref. Para. 3.3c

*MIL-STD-462
July 31, 1967 (with
Notice 1, dated
August 1, 1968, and
Notice 2, dated
May 1, 1970)*

*Electromagnetic Interference Characteristics,
Measurement of*

Ref. Para. 3.2.4.1

MANUALS

Air Force

*AFETRM 127-1
Sept. 1, 1972*

Range Safety Manual, Vol. 1

Ref. Para. 3.2.12

*ESMCR 127-1
July 30, 1984*

*Eastern Space and Missile Center Regulation
127-1, Range Safety*

Ref. Para. 3.2.12

AFSC DH1-4

Electromagnetic Compatibility

Ref. Para. 3.2.4.1

CONTRACTOR

MF0004-002

*Electrical Design Requirements for Electrical
Equipment Utilized on the Space Shuttle Vehicle*

Ref. Para. 3.2.6, 3.2.7

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 OTHER PUBLICATIONS

The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

The American Society of Mechanical Engineers

USAS C1
1965

National Electrical Code

Ref. Para. 3.2.8.4

(Application for copies should be addressed to The American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.)

THIS PAGE INTENTIONALLY LEFT BLANK

3.0 REQUIREMENTS

3.1 SYSTEM ELECTROMAGNETIC COMPATIBILITY PROGRAM

The Orbiter Vehicle prime contractor shall act as integration contractor for the overall Electromagnetic Compatibility Program (EMCP) for the Shuttle System. This overall program shall include the necessary approach, planning, technical criteria and management controls, and shall be based on this specification, the statement of work, the Shuttle System Specification, and other applicable contract documents. Each element contractor, subcontractor, associate contractor, et cetera, involved shall accomplish their individual parts of the overall EMCP.

3.1.1 Electromagnetic Compatibility Board

An electromagnetic compatibility board shall be established to govern the system EMCP, to ensure that participating element contractors establish their individual effort in consonance with the requirements, and to insure that EMC program requirements are met. The electromagnetic compatibility board shall be chaired by the NASA/JSC. Members of the board will include representatives of MSFC, KSC, JSC, integration contractor, element contractors, and invited subcontractors.

3.1.1.1 (Deleted)

3.1.1.2 (Deleted)

3.2 SYSTEM REQUIREMENTS

The system and all associated subsystem/equipment, both airborne and ground, shall be designed to achieve system compatibility. Every effort shall be made to meet these requirements during initial design rather than on an after-the-fact basis. Since each system has its own unique requirements and characteristics, which general EMC design criteria documents may not satisfactorily cover, the system and subsystems/equipments control plans shall be used for supplementary requirements as necessary. As a minimum, the system design program shall cover the following areas:

- a. Subsystem/equipment criticality categories
- b. Degradation criteria
- c. Interference and susceptibility control
- d. Wiring and cable
- e. Electrical power

- f. Bonding and grounding
- g. Lightning protection
- h. Static electricity
- i. Personnel hazards
- j. EM hazards to explosives and ordnance
- k. External environment
- l. Suppression components

3.2.1 Subsystem Compatibility

Compatibility shall be demonstrated between all subsystems to a specific requirement during all modes of operation while the subsystems are individually or collectively operated. *Training devices and simulators shall also be designed for compatibility.

**Second sentence deleted.*

3.2.2 Subsystem/Equipment Criticality

All subsystems/equipment or functions installed in or associated with the system shall be classified as Electromagnetic Interference (EMI) critical equipment if their failure or unintended operation could cause one or more of the following:

- a. Loss of life or injury to flight or ground crew.*
- b. Loss or extensive damage to the flight vehicle or ground facility.*

Classification as EMI critical equipment shall be based on the equipment susceptibility characteristics and the FMEA (Failure Mode and Effects Analysis) for that equipment or function.

3.2.3 EMI Safety Margins

For equipment and functions identified as EMI critical in Para. 3.2.2, EMI safety margins shall be designed into the equipment and verified by test or analysis. Unless otherwise specified in the contract, range safety procedures, or system control plan, safety margins less than 6dB (20dB for ordnance) shall not be used.

Deviation/Waiver 2 is applicable to Paragraph 3.2.3.
Refer to the Deviations/Waivers Section in front of the document.

3.2.3.1 (Deleted)

3.2.4 Interference and Susceptibility Control

Interference and susceptibility within the system shall be controlled by adequate design provisions to eliminate undesired responses and emissions from all electronic and electrical subsystems/equipments in or associated with the system regardless of whether the output is electrical, aural, video, or mechanical. This requirement applies to the entire frequency ranges (including generated harmonics, spurious emissions, and susceptibilities) utilized by the installed subsystems, those for which installation provisions have been made, and associated ground support equipment. This requirement specifically includes operation of subsystems/equipments when operating with their installed antennas or sensing elements when performing their intended function in all modes of operation. When subjected to the tests required in Section 4 in accordance with the approved system test plan, there shall be neither unacceptable response nor malfunction of any subsystem/equipment because of electromagnetic interference produced by any or all of the subsystems/equipments associated with the system.

3.2.4.1 Subsystems/Equipments

Subsystems/equipments shall be designed to meet the requirements of Specification SL-E-0002 and MIL-STD-462. Since some of the limits in these standards are severe, the impact of these limits on system effectiveness, cost, and weight shall be considered. Proposed modification to the limits shall be included in the EMC plans for the system and subsystem/equipments. Air Force System Command Design Handbook 1-4 (AFSC DH1-4) shall be used for general design guidance and criteria. For equipment or functions classified as EMI critical, signal input terminal susceptibility shall be determined in addition to the above requirements. Specification SL-E-0002 and MIL-STD-462 requirements are not applicable to ground equipment procurements unless specifically required by the procuring activity to ensure compliance with the safety margin requirements of Paragraph 3.2.3.

3.2.5 Wiring and Cabling

Wiring and cabling shall be designed to minimize coupling, and obtain optimum separation and use of available wiring space. Cable design shall include provisions for adequate termination of shielded wires. *Procedures shall be established to categorize each wire or cable according to its interference and susceptibility characteristics. Wires or cables shall be marked (*preferred*) or *identified* in such a manner that personnel can visually identify, *prior to closeout*, the EMC category for each wire or cable.

**Third sentence deleted.*

Deviation/Waiver 3 is applicable to Paragraph 3.2.5.
Refer to the Deviations/Waivers Section in front of the document.

3.2.6 Electrical Power

Subsystems/equipments for *Shuttle System* installation shall not malfunction nor have unacceptable responses when applied with electrical power conforming to MF0004-002. This specifically includes surges, ripples, voltages, and other electrical conditions that can cause interference or susceptibility.

3.2.7 Spikes

Subsystems/equipments shall not malfunction nor have unacceptable responses when spikes, as defined in MF0004-002, are applied to the input power terminals.

3.2.8 Bonding and Grounding

Electrical bonding shall be in accordance with MIL-B-5087 in all areas, except in the area of lightning protection where the requirements of NSTS 07636 shall apply.

3.2.8.1 (Deleted)

3.2.8.1.1 (Deleted)

3.2.8.2 External Ground for Servicing Equipment

Each item of servicing equipment or ground *support* equipment shall have a grounding wire suitable for connection to an earth ground rod. In addition, all servicing equipment that handles flammables, explosives, oxygen, or other potentially hazardous material shall have a permanent bonding cable attached for connection to the *Shuttle System*.
(Last sentence deleted).

3.2.8.3 External Grounds

External grounding points for *the Shuttle System* shall be specified in the system specification or EMC plan.

3.2.8.4 Grounding at Bases and Fixed Sites

Grounding provisions at fixed sites such as airbase ramps, fueling and defueling, and other hazardous servicing areas, and ground based subsystems shall, as a minimum, meet the requirements of the National Electrical Code USAS C1 1965, NSTS 07636, and MIL-B-5087.

3.2.9 Lightning Protection

The Shuttle system and elements thereof shall be designed in accordance with NSTS 07636. NSTS 20007 is to be used for verification that the vehicle design meets the requirements criteria document NSTS 07636, and specifically identifies the analysis and test method to be used for new and existing equipment.

3.2.10 Static Electricity

The system shall be designed to prevent static electricity from degrading system effectiveness. *All elements of the system such as aerospace vehicles, launch sites, ground sites, fueling and servicing area shall be protected.

**Second sentence deleted.*

3.2.10.1 (Deleted)

3.2.10.2 (Deleted)

3.2.11 Personnel Hazards

The system design shall include provisions for protection of personnel from R-F hazards, electromagnetic, electrostatic and shock hazards. Where possible, protection provisions shall be designed into associated subsystems/equipments. When protection by design is not technically feasible, adequate safety precautions shall be included in operating and maintenance manuals.

3.2.12 Electromagnetic Hazards to Ordnance

The system design shall include provisions to protect ordnance subsystems from inadvertent ignition or dudding caused by any form of electromagnetic or electrostatic energy. All wiring, cabling, and hardware associated with the ordnance subsystems shall be carefully designed to prevent stray pickup and eliminate undesired energy. All modes of operation during the mission, including loading, unloading, checkout, pre-launch, et cetera shall be considered. For the purpose of this specification, the term ordnance will be interpreted to include rockets, explosives, electroexplosive devices, squibs, flares, igniters, explosive bolts, destruct devices, et cetera. *Ordnance system design and test requirements shall be in accordance with Paragraph 3.6.9 of AFETRM 127-1, Range Safety Manual, Volume 1 or, for new designs, ESMCR 127-1, Range Safety.*

3.2.13 External Environment

As specified in the contract, the system design shall include consideration of the electromagnetic environment from sources not part of, and external to the system.

Consideration shall be given to the intended mission profiles, the available electromagnetic environment data, and the degree to which the external environment can reduce the desired systems effectiveness.

3.2.14 (Deleted)

3.2.15 (Deleted)

3.3 CONTROL PLAN

The integration contractor shall prepare an EMC Control Plan which will outline the contractor's approach to achieve electromagnetic compatibility. The plan shall include the following areas:

- a. Internal organization and responsibilities*
- b. System EMC analysis*
- c. Subcontractor EMC management including specific tests from Table II of MIL-STD-461A, as amended by SL-E-0002, which were made applicable to each subsystem/equipment procurement*
- d. System EMC demonstration*
- e. EMC documentation and reporting*

3.3.1 Updating of Control Plan

The control plan shall be kept updated by use of supplements or revised pages as specified by the contracts. Information required by Paragraph 3.3, but not available at the time of original submission of the EMC plan, shall be included in supplements.

3.4 COMMERCIAL SUBSYSTEMS/EQUIPMENTS

When commercial off-the-shelf subsystems/equipments, either airborne or ground, are considered for use in a system, the following rules shall be used in selecting and utilizing the equipment in the system:

- a. The equipment may be considered adequate if the system requirements are not significantly more stringent than those to which the equipment was designed, and interference test reports are available to adequately demonstrate compliance; however, compliance with the requirements relating to subsystems/equipments shall not relieve the contractor of the responsibility of providing system compatibility.

- b. Where compliance with interference requirements cannot be substantiated due to unavailability of test reports, the contractor may perform laboratory interference tests for qualification of the subsystem as negotiated with the procuring activity.
- c. After evaluation of the data, if it is determined that more stringent requirements are necessary, it shall be the responsibility of the contractor to implement these requirements, or select another equipment with adequate characteristics.

3.5 GOVERNMENT FURNISHED EQUIPMENT

Government Furnished Equipment (GFE) that is required for use in the system shall be acceptable from an *EMC* viewpoint, provided the interference and susceptibility requirements as outlined below are met:

- a. New subsystem/equipment designs must have met, as a minimum, the requirements of Paragraph 3.2.4.1 and be supported by approved qualification test reports.
- b. When compliance with applicable military specifications cannot be substantiated, the contractor may perform laboratory test for qualification of subsystem to the applicable requirements as negotiated with the procuring activity.
- c. GFE, which cannot meet the requirements, and for which external suppression measures are ineffective, may be modified in accordance with the terms of the contract if approved by the procuring activity. If such procedures are not specified in the contract, the contractor shall advise the procuring activity, by letter, of subsystems/equipments that cannot meet the requirement and pertinent details concerning the modifications required.

3.6 SUBSYSTEM EQUIPMENT INSTALLATION

The contractor is responsible for the proper installation engineering of all subsystems/equipments to achieve a compatible installation. Where it is demonstrated that interference caused by Government furnished equipment cannot be eliminated either by proper installation, control of the system electromagnetic environment, or by reasonable modification to the subsystem/equipment, as permitted by the contract, the procuring activity may consider waiving the requirement applicable to the particular equipment upon request from the contractor in accordance with the terms of the contract.

3.7 REDESIGN OF SYSTEMS

When this document is applied to a system redesign (modification) program, the contractor's control plan shall propose requirements suitable for the system for review and approval by the procuring activity.

THIS PAGE INTENTIONALLY LEFT BLANK

4.0 QUALITY ASSURANCE PROVISIONS

4.1 RESPONSIBILITY FOR INSPECTION

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 ELECTROMAGNETIC COMPATIBILITY TEST PROGRAM

The Shuttle System level Electromagnetic Compatibility Test Program (EMCTP) shall be prepared by the Shuttle integration contractor and shall also include Orbiter element level requirements. Each element contractor shall prepare an EMCTP appropriate to level of demonstration of compliance possible at the element level. The test program shall be documented in the system or element level general acceptance or checkout plan to the extent that demonstration of compliance with this specification can be verified during normal vehicle checkout activity. A separate EMCTP test plan shall be prepared and submitted to the procuring activity describing the methods planned for verification of requirements of this specification which cannot be accomplished in conjunction with normal end item checkout activity.

System and element level test planning shall provide the necessary data for margin verification (i.e., test or analysis) of each EMI critical equipment or function prior to the program milestone or event in which the equipment or function becomes EMI critical. The following elements, a through r, shall be used as guides in the preparation of EMCTP system and element level test plans.

- a. Methods to be used to select critical circuits to be monitored for compliance to the degradation criteria and safety margin.
- b. Procedures used for developing failure criteria and limits.
- c. Test conditions and procedures for all electronic and electrical equipment installed in or associated with the system and the sequence for operations during tests, including switching.
- d. Implementation and application of test procedures which shall include modes of operation and monitoring points for each subsystem and equipment.
- e. Use of approved results from laboratory interference tests on subsystems and equipment.

- f. Flight test program (manned systems only).
- g. Methods and procedures for data readout and analysis.
- h. Means of testing design adequacy of vehicle electrification (static electricity) and lightning protection.
- i. Means of simulating and testing electroexplosive subsystems and devices.
- j. Demonstration of the approval safety margin for electroexplosive devices, and for systems whose degradation affects safety-of-flight or mission success.
- k. Electrical power voltage limits, and methods for monitoring AC and DC power buses to assure that voltages are within the proper limits.
- l. Test locations and descriptions of arrangements for simulating operational performance in cases where actual operation is impractical.
- m. Adjustments and settings of variable controls such as audio gain, video gain, sensitivity, squelch settings, et cetera.
- n. Details concerning frequency ranges, channels and combinations to be specifically tested such as image frequencies, intermediate frequencies, local oscillator, and transmitter fundamental and harmonically related frequencies. Subsystem susceptibility frequencies identified during laboratory testing shall be included.
- o. Personnel required, Government, contractor, and vendor.
- p. Calibration schedules and description of unique EMC instrumentation for measuring electrical, video, and mechanical outputs of equipments and subsystems to be monitored during the testing including applicable safety margins.
- q. Means of simulating signal inputs such as Doppler, radar altimeter, et cetera.
- r. Evaluation and degradation criteria for each subsystem and equipment.

4.3 (DELETED)

4.3.1 (Deleted)

4.3.1.1 (Deleted)

4.3.2 (Deleted)

4.3.3 (Deleted)

4.3.4 (Deleted)

4.3.5 (Deleted)

4.4 (DELETED)

4.4.1 (Deleted)

4.4.2 (Deleted)

4.4.3 (Deleted)

4.4.4 (Deleted)

4.4.5 (Deleted)

4.4.6 (Deleted)

4.4.7 (Deleted)

4.4.8 (Deleted)

4.4.9 (Deleted)

4.4.10 (Deleted)

4.5 (DELETED)

4.5.1 (Deleted)

4.5.2 (Deleted)

4.6 (DELETED)

4.7 (DELETED)

4.8 (DELETED)

4.9 (DELETED)

THIS PAGE INTENTIONALLY LEFT BLANK

5.0 PREPARATION FOR DELIVERY

5.1 NOT APPLICABLE

This section is not applicable to this specification.

THIS PAGE INTENTIONALLY LEFT BLANK

6.0 NOTES

6.1 (DELETED)

6.2 DEFINITIONS

6.2.1 Electromagnetic Compatibility

The capability of systems and all associated subsystems/equipments to perform with required effectiveness, and without degradation, in the total electromagnetic environment encountered during accomplishment of the assigned mission.

6.2.2 Electromagnetic Environment

The composite of electromagnetic energy, including man made and natural sources, to which a system or subsystem/equipment will be exposed in performing its mission. When defined, the environment will be for a particular time and place.

6.2.3 Electromagnetic Interference

Any electrical or electronic disturbance, phenomenon, signal, or emission (man made or natural) which causes undesirable responses, unacceptable responses, malfunctions, degradation of performance, or premature and undesired location, detection or discovery by enemy forces, except deliberately generated interference.

6.2.4 Malfunction

A failure of a system or associated subsystem/equipment due to electromagnetic interference or susceptibility that results in a flight safety situation, a mission abort, or failure to accomplish mission.

6.2.5 Receiver Area Noise Level

The receiver area electrical noise level at a particular frequency is that receiver output obtained with all controls at standard settings, all other subsystems/equipments turned off, and the receiver antenna connected.

6.2.6 Subsystem

A subsystem is a major functional element of a system, usually consisting of several equipments that are essential to the operational completeness of the subsystem/system. Examples are airframe, propulsion, guidance, navigation, and communication.

6.2.7 System

A composite of equipments, skills and techniques capable of performing and supporting an operational role. A complete system includes related facilities, equipment, material,

services, and personnel required for its operation to the degree that it can be considered a self-sufficient unit in its operational or support environment. A system may be aerospace, ground, or ship oriented.

6.2.8 Unaccepted Response

An unacceptable response is an abnormality in the required operation or output of a subsystem/equipment due to electromagnetic interference which cannot be designated a malfunction but which is detrimental to system performance.

6.2.8.1

For equipment providing aural output, such as interphone (except communication receivers), an unacceptable response is an undesired output greater than 1.125 microwatts. Unacceptable response for communication receivers is an undesired output that exceeds the receiver area noise level with receiver unsquelched. With the receiver squelched to the point where the area noise level is just nondetectable, there shall be no signal generated by other subsystems/equipments that cause the receiver to break squelch.

6.2.9 Undesirable Response

A recognizable interruption of normal output of a subsystem which cannot be designated as an unacceptable response or malfunction and which is considered tolerable by the procuring activity.

6.3 (DELETED)

APPENDIX A
ARCHIVED DEVIATIONS/WAIVERS

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A

ARCHIVED DEVIATIONS/WAIVERS

1.0 PURPOSE AND SCOPE

The purpose of this Appendix is to retain those Deviations/Waivers rescinded as a result of the STS 51-L accident and retired due to expiration of effectivity.

1.1 RESCINDED DEVIATIONS/WAIVERS

The Deviations/Waivers contained in this section were approved prior to STS 51-L. Any of these Deviations/Waivers that apply to future *Space Shuttle (SS)* missions must be resubmitted with appropriate rationale for SSP approval and reinstatement.

THIS PAGE INTENTIONALLY LEFT BLANK

**RESCINDED DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS
CONTAINED IN THIS DOCUMENT**

1. REQUIREMENT: Paragraph 3.2.3 Degradation Criteria, specifies that degradation criteria shall be established by the contractor for each subsystem/equipment after consultation with the procuring activity. These criteria shall be used to define and evaluate malfunctions, unacceptable and undesirable responses. When available, the results of subsystem/equipment laboratory interference tests shall be used in establishing or defining the criteria. When error budgets are established, the portion allocated to EMC shall be included as part of the degradation criteria.

WAIVER: The requirement for a verification demonstration of the 6dB safety margin as related to the SRB rate gyro assemblies is waived for STS-3 and subs.

AUTHORITY: Level I PRCBD H20755, dated 3/16/82; Level II PRCBD S40019R3, dated 8/26/87.

THIS PAGE INTENTIONALLY LEFT BLANK

1.2 RETIRED DEVIATIONS/WAIVERS

The Deviations/Waivers contained in this section have been removed from the list of active Deviations/Waivers because of expiration of effectivity.

THIS PAGE INTENTIONALLY LEFT BLANK

**RETIRED DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS
CONTAINED IN THIS DOCUMENT**

4. **REQUIREMENT:** Paragraph 3.2.8, Bonding and Grounding, specifies bonding and grounding provisions for the system shall be in accordance with MIL-B-5087.

SPECIFIC

REQUIREMENT: MIL-B-5087, Paragraph 3.3.6 Class S Bonding (Static Charge), specifies all isolated conducting items (except antennas) having any linear dimension greater than 3 inches, which are external to the vehicle, carry fluids in motion, or otherwise are subject to frictional charging, shall have a mechanically secure connection to the vehicle structure. The resistance of the connection shall be less than 1 ohm when dry.

WAIVER: The above requirement is waived for STS-26 only as related to the Pole Crew Escape System (PCES) mounting bracket attached to the OV-103 Orbiter structure.

AUTHORITY: Level II PRCBDs S66950D, dated 9/10/88 and S00125B, dated 4/11/90.

5. **REQUIREMENT:** Paragraph 3.2.8 Bonding and Grounding. Electrical bonding shall be in accordance with MIL-B-5087 in all areas, except in the area of lightning protection where the requirements of NSTS 07636 shall apply.

SPECIFIED

REQUIREMENT: MIL-B-5087, Paragraph 3.3.6, Class S bonding (static charge). All isolated conducting items (except antennas) having any linear dimension greater than 3 inches, which are external to the vehicle, carry fluids in motion, or otherwise are subject to frictional charging, shall have a mechanically secure connection to the vehicle structure. The resistance of the connection shall be less than 1 OHM when dry.

WAIVER: The above requirement is waived for the installed TCS blanket which does not contain a grounding grid of conductive threads and, therefore, does not meet established grounding (EMI) requirements. This is a one time waiver for use on STS-43 (OV-104).

RATIONALE: The installed TCS blanket is considered an acceptable risk. The blanket in question is in the payload bay in an area

**RETIRED DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS
CONTAINED IN THIS DOCUMENT – Concluded**

around the aft right crew compartment viewing window. The only wire harnesses in this area are associated with overhead docking spotlight, P/N MC 434-0066-0002, and the forward payload bay floodlight, P/N MC 434-0062-0033, both of which are assigned a FMEA/CIL Criticality of 2R3.

EFFECTIVITY: OV-104, Flt 9

AUTHORITY: Level II PRCBD S052494, dated 7/19/91.