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Electromagnetic Compatibility Control Plan
for the
Human Research Facility

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for the
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ACRONYMS AND ABBREVIATIONS

A	Ampere
AC	Alternating Current
AS	Advanced Schottky
dBpT	decibels picoTesla
CE	Conducted Emissions
CMOS	Complimentary Metal Oxide Semiconductor
CS	Conducted Susceptibility
DC	Direct Current
EMC	Electromagnetic Compatibility
EME	Electromagnetic Effects
EMEP	Electromagnetic Effects Panel
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
EXPRESS	Expedite the Processing of Experiments to Space Station
HRF	Human Research Facility
I	current
ICD	Interface Control Document
I/O	Input/Output
ISS	International Space Station
JSC	Johnson Space Center
MPLM	Multi-Purpose Logistics Module
ns	nanoseconds
PRD	Program Requirements Document
PuFF	Pulmonary Function in Flight
RE	Radiated Emissions
SE&I	Systems Engineering and Integration
SIR	Standard Interface Rack
SPUR	Standard Payload Utilization Rack
SSP	Space Station Program
TPS	Task Performance Sheet

1.0 INTRODUCTION

1.1 GENERAL

The Human Research Facility (HRF) is a facility class payload that consists of a suite of generic human life sciences hardware needed to support a multidisciplinary research program that encompasses basic, applied, and operations research. The HRF will include equipment to support research to understand the effects of weightlessness and the space environment on human systems and to develop, where appropriate, methods to counteract these effects to ensure safe and efficient crew operations.

Basic research and clinical investigations from both the intramural and extramural communities, as well as investigations from other federal agencies, and the international community will all be conducted using HRF. All hardware elements to be used during the conduct of human research on the International Space Station (ISS) may not necessarily be included in the HRF racks. The ability to conduct thorough multidisciplinary investigations will depend on the interaction of the HRF with the ISS systems, the Crew Health Care System program, and the Space Station Biological Research Project including the Centrifuge Facility, as well as other hardware provided by the international partners. In addition, the HRF subsystems and experiment packages will be modular in design so that the HRF can be configured to meet many sets of research objectives for the duration of the ISS program.

1.2 PURPOSE

The purpose of this Electromagnetic Interference (EMI) Control Plan is to comply with the requirements to establish a methodology for the HRF to conform to the ISS Electromagnetic Compatibility (EMC) requirements.

1.3 SCOPE

This control plan describes the methods and approaches to be used by HRF designers to insure conformance to the ISS EMC requirements. Design techniques, testing processes, documentation processes, and deliverables to the ISS Payloads Office (0Z3) for Electromagnetic Effects (EME) are presented.

2.0 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

Document Number	Rev.	Document Title
D684-10061-01	H	Product Group-2 (PG-2) Statement of Work
D684-10400-1	Preliminary	Environments Control Plan
LS-71000	A	Program Requirements Document for Human Research Facility
SSP 30238	D	Space Station Electromagnetic Techniques
SSP 57010	B	Pressurized Payloads Generic Payload Verification Plan

NOTE: LS-71000A cites the following requirements:

Document Number	Rev.	Document Title
MIL-STD-1686	C	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment. (Excluding Electrically Initiated Explosive Devices)
SSP 30237	E	Space Station Electromagnetic Emission and Susceptibility Requirements
SSP 30240	C	Space Station Grounding Requirements
SSP 30242	E	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility
SSP 30243	E	Space Station Requirements for Electromagnetic Compatibility
SSP 30245	E	Space Station Electrical Bonding Requirements

2.2 REFERENCE DOCUMENTS

Document Number	Rev.	Document Title
D683-34513	A	SIR Drawer-to-EXPRESS Rack Interface Control Document
MIL-HDBK-263	B	Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment
NSTS 21000-IDD-MDK	B	Middeck Payloads Interface Definition Document for Middeck Accommodations

Document Number	Rev.	Document Title
S683-34511	A	Prime Item Development Specification for the EXPRESS Rack
SSP 41017		Rack to Mini Pressurized Logistics Module Interface Control Document (ICD), Part 1 Rev. D and Part 2 Rev. F
SSP 50431		Space Station Program Requirements for Payloads
SSP 52000-IDD-ERP	A	Expedite the Processing of Experiments to Space Station Rack Payloads Interface Definition Document

2.3 ORDER OF PRECEDENCE

In the event of a conflict between this document and any of the documents referenced in Section 2.1, the documents cited in Section 2.1 shall take precedence.

2.4 REQUIREMENTS TRACEABILITY AND REFERENCES

Table 2.4 highlights the requirements that are addressed by the particular paragraph of this control plan. References to other documents are also shown for additional information and context.

TABLE 2.4. LS-71016 EMC CONTROL PLAN FLOW-UP TO REQUIREMENTS AND REFERENCES

LS-71016	LS-71000

3.0 HUMAN RESEARCH FACILITY ELECTROMAGNETIC COMPATIBILITY PROGRAM AND RESPONSIBILITIES

3.1 MANAGEMENT

The Lockheed Martin HRF Systems Engineering and Integration (SE&I) organization is the primary body responsible for managing the EMC engineering and testing of the payloads and the integrated rack. This control plan provides the management direction to insure adherence of the payloads and integrated rack to the ISS EMC requirements listed in Paragraph 2.1. Responsibilities of SE&I are as follows:

a. Coordinate and review EME engineering analyses of the payloads and integrated rack.

b. Review EME evaluation and certification test results.

c. Coordinate engineering assistance for HRF designers to incorporate EMC engineering techniques into the hardware to insure conformance to the ISS EMC requirements mandated in the HRF Program Requirements Document (PRD), LS-71000.

d. Prepare and maintain the HRF Verification Data Base. The data base shall present wiring and cabling characteristics and routing, analysis methods and models, mechanical and construction details relevant to EMC analyses, test results, and waiver requests.

e. SE&I will coordinate HRF EMC testing performed at the Johnson Space Center (JSC) EMC lab and provide testing information and test results to the ISS Payloads Office (0Z3) for EME in the format provided by the JSC EMC lab process.

f. Provide the ISS Payloads Office (0Z3) for EME with elements of the HRF Verification Data Base. SE&I shall coordinate with the ISS Payloads Office (0Z3) for EME on the HRF Verification Data Base format.

g. Provide the ISS Payloads Office (0Z3) for EME with this control plan and test plans for assessment.

h. Support the HRF Program Design Review, Critical Design Review, Integration Readiness Review, and Design Certification Reviews as needed to present the state of conformance of the HRF to the ISS EMC requirements.

3.2 MILESTONES

SE&I shall coordinate with the schedule of the ISS Payloads Office (0Z3) for EME as follows:

a. Notification of EMC testing for payloads and the integrated rack by SE&I shall be made at least 10 working days prior to the test.

b. Present elements of the current HRF Verification Data Base at least 45 days prior to meetings of the Electromagnetic Effects Panel (EMEP).

c. Submit the updated HRF Verification Data Base 45 days after EMC testing.

4.0 DESCRIPTION OF HUMAN RESEARCH FACILITY

The HRF consists of an Expedite the Processing of Experiments to Space Station (EXPRESS) rack, in which Standard Interface Rack (SIR) drawers are installed. These containers will generally be called payloads[1] in this control plan.

The EXPRESS rack is a prewired unit, containing a 120 Vdc-to-28 Vdc power distribution system; a NTSC/RS-170A analog video system; and the High Rate Data Link, IEEE 802.3 Ethernet, RS-422, and MIL-STD-1553B data communications systems. These services are provided to payloads through data connectors at the rear of the rack. ISS EMC certification of the EXPRESS rack shall be verified by HRF SE&I prior to integration of payloads into the rack.

The HRF will accommodate three types of payloads:

1. Equipment installed in a SIR drawer.
2. Deployable payloads such as the Pulmonary Function in Flight (PuFF) hardware.
3. Stowed payloads, which may be powered after removal from their stowage drawers.

Equipment installed in a SIR drawer receives electric power from a Direct Current (DC) power connector installed in the EXPRESS rack. The deployable payloads may be powered from the rack utility outlet panel, the ISS module utility outlet panels, the user outlet panels, or batteries. Cables connect the deployable payloads to the power and data services. The stowed payloads will obtain power from either the rack utility panel or batteries.

[1]"Payloads" correspond to the definition of equipment found in SSP 50431, Section 4.1.

5.0 ELECTROMAGNETIC COMPATIBILITY TECHNICAL PROGRAM

5.1 IMPLEMENTING REQUIREMENTS

5.1.1 International Space Station Requirements

The EXPRESS Rack Program is responsible for insuring that the EXPRESS Rack conforms to the ISS EMC requirements prior to integration of payloads with the EXPRESS. HRF SE&I shall review the EXPRESS EMC test data to confirm that the ISS requirements have been met; these data shall be included in the HRF Verification Data Base.

The HRF payloads and integrated rack shall conform to the ISS EMC requirements stated in LS-71000. Adherence to these requirements will insure compatibility of the HRF with the ISS.

5.1.2 Space Shuttle Requirements

The HRF is contained in a Multi-Purpose Logistics Module (MPLM) for transport to the ISS in the Orbiter cargo bay; adherence to the Shuttle grounding and bonding requirements (SPP 30245) by the HRF contained within the MPLM and from the MPLM to the cargo bay is the responsibility of launch site personnel.

HRF payloads may be transported in the Orbiter middeck area. Launch site personnel shall be responsible for insuring that payloads meet the Orbiter bonding requirements (NSTS 21000-IDD-MDK). HRF SE&I shall assist launch site personnel as required.

5.2 DESIGN CONSIDERATIONS

5.2.1 Conducted Emissions

The purpose of these requirements is to prevent electronic equipment powered by a common power bus from impressing significant noise energy back onto the bus. Noise on the bus can be conducted into other equipment, affecting the operation of the equipment.

Conducted Emissions (CE)01 and CE03 requirements are dependent on the current that the payload draws from the DC power bus. Figure 5.2.1a shows the emission limits for equipment that draws a maximum current I of 1 Ampere (A). For equipment drawing more than 1 A, the requirement is relaxed by 20 x log I. Emissions measured by this test are steady-state.

Alternately, the CE07 requirement measures noise due to transients produced when switching operational modes of the equipment under test. The amplitude and duration of this transient noise must be within the envelopes shown in Figure 5.2.1b.

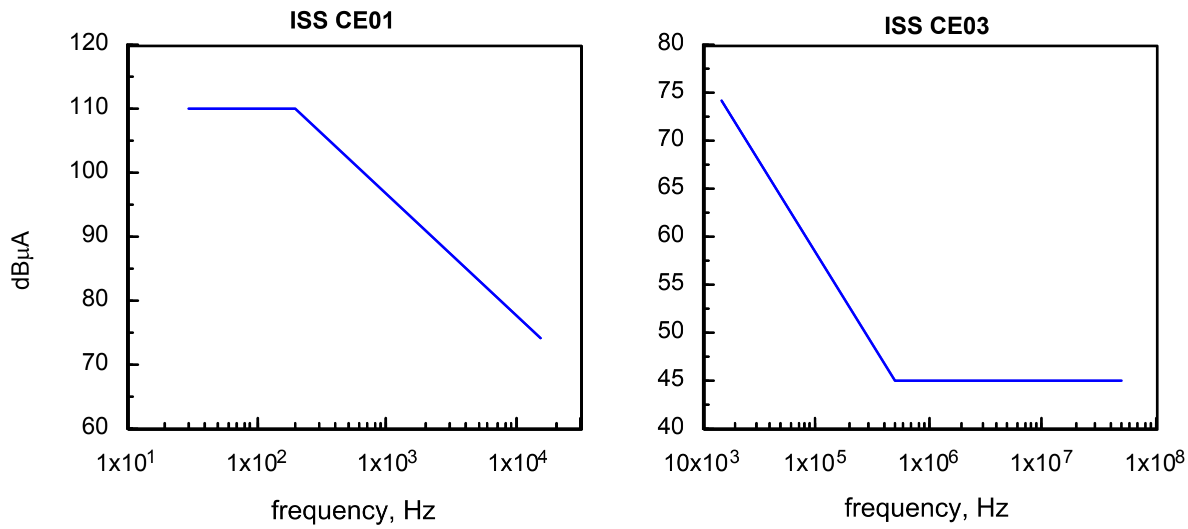

Figure 5.2.1a. CE Requirements, SSP 30237

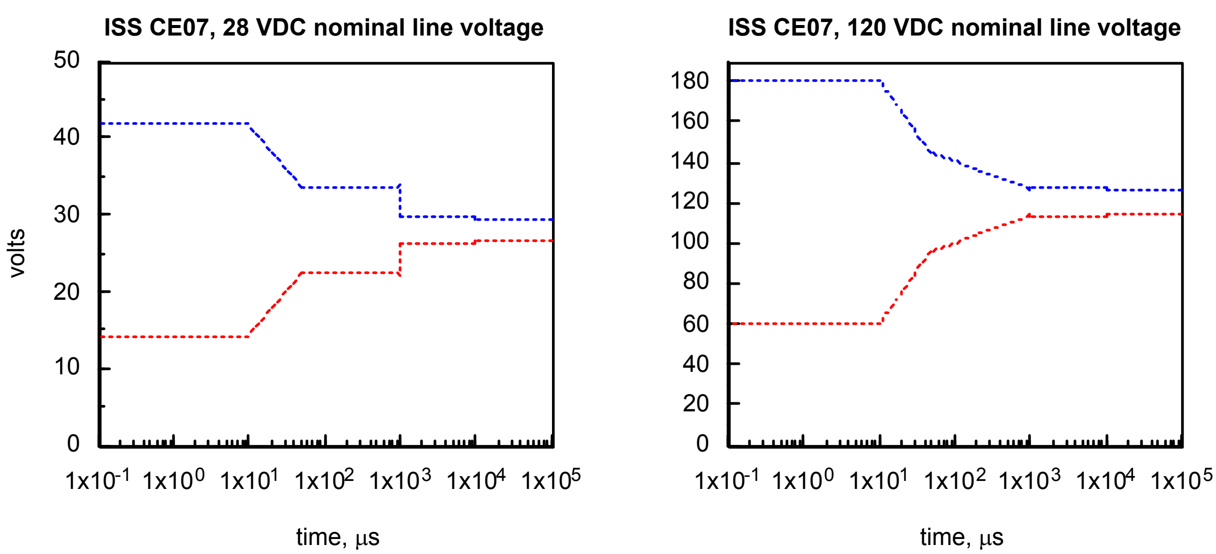

Figure 5.2.1b. CE Requirements, SSP 30237

Correctly installing an EMI power line filter in a payload will dramatically reduce these CE. Since the SIR drawer power connectors do not have in-line filters, a separate EMI filter will have to be connected between the connector and the power supply. It is important to mount a power line filter as close as possible to the drawer connector. The recommended technique is to enclose the EMI filter and drawer connector within a continuous-bonded metal housing known as a doghouse; feedthrough capacitors mounted in the housing supply filtered DC power to the drawer power supply.

EMI test data for the EXPRESS rack, the payloads, and the integrated rack shall be included in the HRF Verification Data Base. CE prevention design techniques shall be documented in the HRF Verification Data Base.

5.2.2 Conducted Susceptibility

Noise energy is impressed upon the power leads in the Conducted Susceptibility (CS)01, CS02, and CS06 tests to assess the equipment's ability to operate with noise superimposed on DC power. Again, an EMI filter is effective in preventing the noise from entering into the payload's power supply.

EMI test data for the EXPRESS rack, the payloads, and the integrated rack shall be included in the HRF Verification Data Base. CS hardening techniques shall be documented in the HRF Verification Data Base.

5.2.3 Radiated Emissions

5.2.3.1 Electric Field Emissions

The Radiated Emissions (RE) 02 test measures the electric field emissions of the equipment under test. These emissions radiate from apertures in the equipment's enclosure, and from external cabling. EMI conductive gaskets should be installed in the seams created by enclosure access panels. Where possible, holes and cutouts in the enclosure should be covered with a screen or honeycomb, which is multi-point bonded along its periphery to the enclosure; clean metal-to-metal contacts are essential.

For reduced radiation and susceptibility, cables attached to the drawer's front panel connectors should be shielded with a dense weave braid or a foil shield. At the connector, bond the shield to a metallic connector backshell. Do not connect the shield to a connector pin; this will prevent shield noise currents from entering the interior of the enclosure. Avoid bonding the shield with a pigtail connection; this type of connection does not provide a good RF bond.

However, the prewired EXPRESS rack data connectors that mate with the SIR drawer rear panels will restrict the payload designers' ability to apply these EMC techniques; these connectors are already wired such that the rack cable shields are brought into the payload on a connector pin. The payload front panel data umbilical, too, makes provisions for bringing cable shields into the payload interior by way of connector pins. Routing the payload interior shielded wiring along the metallic enclosure walls will minimize the loop area from which shield noise currents can radiate. Ferrite sleeves can be installed on the shield pins to attenuate shield noise currents as they enter the payload.

EMI test data for the EXPRESS rack, the payloads, and the integrated rack shall be included in the HRF Verification Data Base. Cable and shield construction and installation descriptions shall be provided. Bandwidth control techniques for signal cables shall be described. Apertures in enclosures shall be documented, and EMI gasket installations shall be noted.

5.2.3.2 Magnetic Field Emissions

5.2.3.2.1 Alternating Current Emissions

The HRF PRD requirement for Alternating Current (AC) magnetic emissions testing, Figure 5.2.3.2.1, applies to the integrated rack. Wiring installations in the rack and payloads will be examined for current carrying loops. The HRF Verification Data Base shall be documented accordingly.

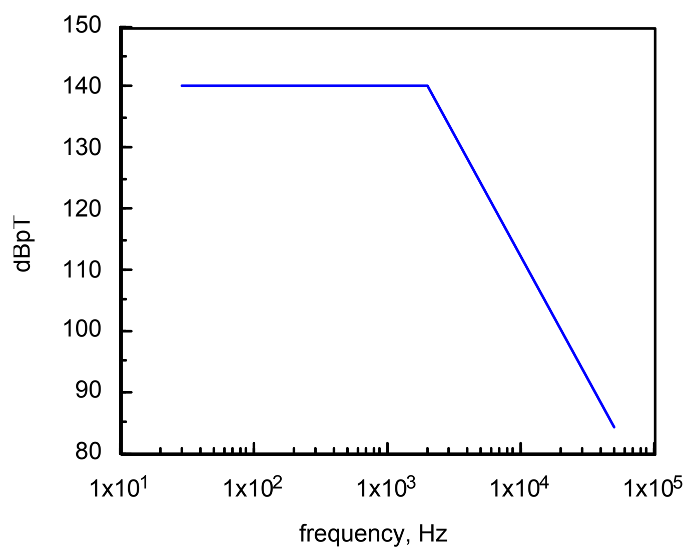

Figure 5.2.3.2.1. AC Magnetic Emissions Requirement, LS-71000

5.2.3.2.2 Direct Current Emissions

A 170 dBpT DC magnetic field limit is levied on the payloads as well as the integrated rack by the PRD. Techniques for minimizing this field are routing DC power supply lines and associated returns as close together as possible, and enclosing permanent magnets in high mu-metal shields when possible.

Payload designs shall be reviewed for potential DC magnetic field sources and described in the HRF Verification Data Base.

5.2.4 Radiated Susceptibility

The Radiated Susceptibility (RS) 02 test assesses the equipment's ability to operate when transient noise is electromagnetically coupled into external cabling. Techniques to harden the equipment include proper termination of the cable shields and using filtered connectors on the drawer front panel. Again, the shields have to be terminated to metallic connector backshells; the shield has to make metallic contact around its periphery to the connector.

The RS03 test assesses the equipment's ability to operate when immersed in a constant electric field. This test is performed for the frequency range shown in Figure 5.2.4; the amplitude of the field is higher at frequencies where high powered RF emitters could potentially operate. Hardening of the equipment to these fields is achieved by proper termination of the cable shields and minimizing enclosure apertures.

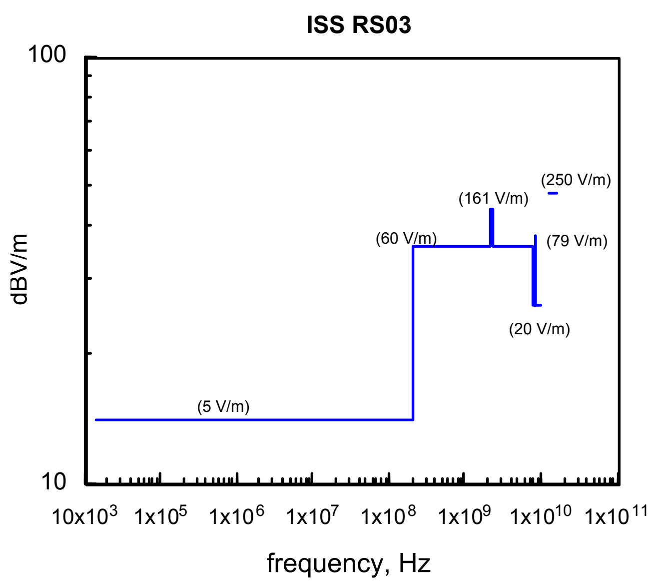

Figure 5.2.4. Radiated Susceptibility Requirements, SSP 30237

Test signal modulation shall be specified in the test plans for payloads and the integrated rack. Wiring installation, shielding, and enclosure fabrication information shall be included in the HRF Verification Data Base, as well as susceptibility test data.

5.2.5 Leakage Emissions

Only DC power is used by the HRF; this test is not applicable.

5.2.6 Electrostatic Discharge

Adherence to these requirements will minimize immediate damage and latent defects in Electrostatic Discharge (ESD) sensitive electronic equipment. ESD testing is not specifically required by the PRD; hence, analysis of the ESD susceptibility of the HRF is sufficient[2].

Designers should be aware of a manufacturer's ESD data for components. If a single component in any piece of equipment is determined to be ESD-sensitive, the equipment is considered to be ESD sensitive and must be labeled as such. The entire piece of equipment must be handled in an ESD-safe manner.

Several ESD protective measures are recommended to harden the equipment. ESD-protected line drivers and receivers should be used for circuits connected to the payloads' front panel connectors. Filtered connectors protect input electronics from ESD potentials applied to the connector pins. EMI gaskets should be installed in the seams in enclosures.

An inventory of all electronic components shall be conducted to determine which parts are ESD sensitive and their respective sensitivity classifications documented. Likely ESD entry points into the equipment shall be identified. Protective conductive connector caps shall be used whenever an external cable is not connected to a front panel connector. Labeling of payloads containing ESD sensitive parts shall conform with the MIL-STD-1686 requirements. ESD protection measures for handling, assembling, and transporting ESD-sensitive payloads shall be developed along the guidelines of MIL-HDBK-263. The ESD analyses and mitigation techniques shall be documented in the HRF Verification Data Base.

5.2.7 Electrical Bonding

Bonding of the metallic structural parts of the HRF to the module will maintain an approximate equipotential among the parts. SIR drawers are automatically bonded to the EXPRESS rack via two pins in the power connector. Bonding of the EXPRESS rack to the module is accomplished by fastening the rack corner post to the module structure.

[2]See MIL-STD-1686C

Analyses shall be performed to verify that bond faying surfaces provide the required low-impedance path from the payloads to the module. Connections between payload front panel connectors and external cable backshells shall be analyzed for low-impedance bonds. Deployable payloads shall be bonded to the HRF via an interconnecting cable or fastened directly to the module structure, as demonstrated by analysis. The HRF Verification Data Base shall include these bonding analyses.

5.2.8 Electrical Grounding

Equipment such as the HRF is required to follow the single point ground concept – only one connection from the conditioned power to structure is allowed.

A review of the EXPRESS rack power supply and payload grounding layout will be performed to confirm that a single point ground will exist. A grounding analysis shall be included in the HRF Verification Data Base.

5.2.9 Cable and Wire Design

These requirements ensure that cabling is constructed so that electromagnetic coupling among circuits is minimized, radiation from the circuits is minimized, and external fields coupling energy to the circuits is minimized.

Wire bundle and harness design and installation in the pre-wired EXPRESS rack are the responsibility of the Standard Payload Utilization Rack (SPUR) program. HRF SE&I shall review the EXPRESS wiring and document the layout in the HRF Verification Data Base with reference to the ISS wiring requirements. Wiring and cabling within payloads shall adhere to the classification, separation, and shield grounding requirements of the table found in SSP 30242. Cabling connected to the payloads' front panel connectors and any other wiring external to a deployable payload shall be analyzed and classified according to the table in SSP 30242. Based on the signal characteristics of the circuits, such as frequency and load impedances, shield terminations and wire types shall be used according to the table; schematics and wire lists shall document the design. Analyses of the wiring and associated shielding shall be included in the HRF Verification Data Base.

5.2.10 Corona

Large electric potentials can potentially create electric discharges, which can radiate substantial broadband noise. High voltage power supplies are a typical source of these potentials.

No specific test is mandated to insure the prevention of corona. However, analysis of the HRF shall be performed to verify that any high electric potentials that are conducive to the formation of corona will not exist or will be managed to prevent the formation of corona. Analyses shall be documented in the HRF Verification Data Base.

5.3 GENERAL ELECTROMAGNETIC COMPATIBILITY DESIGN GUIDELINES

DC Power Input

- Place EMI power line filters in doghouses to reduce CE from SIR drawer payloads; install feed-through capacitors in doghouse wall to route filtered DC to circuitry. (Filters and capacitors are available from Schaffner EMC, Inc., Spectrum Control, Inc., and Capcon, Inc.)

Printed Circuit Board

- Use minimum clock frequency and maximum rise/fall times necessary to minimize Radiated Emissions (RE).
- Minimize the length of reset lines.
- Minimize the distance between front panel connectors and the associated input/output circuitry.
- Multilayer circuit boards generally produce less RE than do single layer boards.
- When multiple printed circuit boards are required, installing the boards into a multilayer backplane will keep cabling to a minimum.
- Components should be grouped according to operating speed as well as function into zones on the PCB. Keep faster components in the center of the board, slower components toward the edge of the board.
- Use Surface Mount Devices whenever possible. These packages have low lead inductance providing high resonant frequencies; ground bounce is also reduced.
- Never route periodic signals near random signals such as Input/Output (I/O) and data lines.
- Minimize loop areas between signal traces and return traces.
- Locate decoupling capacitors as close to the integrated circuit as possible.
- Use planar decoupling capacitors for pin grid array packages. (Circuit Components, Inc., makes the Micro/Q decoupling capacitor for pin grid array packages.)

Components

- Choose integrated circuits with center-package ground leads rather than end-package ground leads. Center ground leads have 1/3 the inductance of end leads.
- Different logic families will produce different amounts of RE, dependent on the rise and fall times; as the rise and fall times become smaller, the circuit's RE generally increase. Harmonics of the pulse waveform can radiate efficiently from typical circuit board trace lengths. For comparison, Advanced Schottky (AS) logic has a rise time of 2 ns and the Complimentary Metal Oxide Semiconductor (CMOS) logic rise time is approximately 10 ns. The maximum rise time is always recommended to reduce RE.

- Controlled slew rate line drivers are recommended for driving signal lines connected to the payload front panel; radiated emission bandwidth is reduced from these devices as compared to ordinary line drivers. (The LTC1483 RS485 Low EMI Transceiver by Linear Technology is a representative line driver, with a minimum risetime of 150 ns.)
- Circuitry connected to payload panel connectors can be ESD hardened by selecting devices incorporating ESD protection. (The LT1137A RS232 Transceiver by Linear Technology is a representative device, with ESD protection to 15 kV.)

Cables and Connectors

- Restrict the bandwidth on external cables to the signal bandwidth by using filtered connectors or ferrite beads on the connector's signal wires. (Typical ferrites can be obtained from Fair-Rite Products, Inc.; AMP, Inc., makes a line of filtered connectors called the Quiet Line.)
- Installing EMI backshells on connectors is highly recommended. (Glenair, Inc., and Jerrick Connecting Devices, Inc., are representative manufacturers of EMI backshells and connectors.)
- Choose cable shields with high density woven strands. For a low RF impedance bond from the shield to the connector backshell, attach the entire circumference of the shield to the connector backshell. (The G-Spring Backshell and Crimp Ring Backshell from Glenair are typical products for making such a circumferential bond.)
- Avoid using pigtails to bond cable shields to the backshell.
- Terminate both ends of the cable shield to structure; shields bonded to the EMI backshell are automatically terminated to structure.
- To harden the payload to ESD and EMI, filtered panel connectors will attenuate high frequency noise on the signal conductors. Hardening of nonfiltered connectors can be accomplished by inserting planar capacitor arrays onto the connector pins. (A typical array is the mDisc EMI Filter Wafer, produced by TRW, Inc.) ESD suppression arrays too, can be installed onto connector pins to provide ESD hardening. (The Pulse Guard Suppressor by G&H Technology, Inc., will clamp ESD transients.).

Enclosure

- Route internal wiring away from enclosure seams and apertures wherever possible.
- Gaps between the enclosure's doors or panels and the enclosure chassis are prime locations for installing conductive EMI gaskets and fingerstock. Gaskets inserted between the connector and enclosure wall are also effective in reducing RE and increasing radiated susceptibility. (Schlegel Corp., Chomerics, Inc., and Tecknit are among many manufacturers of EMI gaskets.)

- Where gaskets or fingerstock cannot be used in gaps and seams of the enclosure, the spacing of the mating screws should be minimized. Screw spacing tradeoffs between RE prevention (for EMC) and maintainability (for human factors) need to be made for doors and panels that are to be opened for access to the payload interior.
- Holes in the enclosure wall can behave as efficient aperture antennas. A metallic mesh or screen covering the aperture will greatly attenuate the energy passing through it. Make complete perimeter bonds on all screens covering apertures; bonding only the corners of the screen creates slot antennas along the length of the screen. (Screens are available from manufacturers such as Tecknit.)

This list is not definitive. But, if the above guidelines are followed, the major sources of EMI will be reduced. The equipment will be less susceptible to both itself and external noise sources.

5.4 ELECTROMAGNETIC COMPATIBILITY ENGINEERING RESOURCES

EMC engineering assistance can be coordinated through the SE&I contact. Additionally, the JSC ISS EMC Testing Facility personnel can provide EMC engineering expertise to designers.

5.5 COMMERCIAL-OFF-THE-SHELF EQUIPMENT

Vendors of commercial off-the-shelf equipment and subcontractors shall adhere to the EMC and ESD requirements listed in Paragraph 2.0 of this document. In their analyses, HRF designers shall use any available EMC test data provided by vendors.

6.0 TESTING PROGRAM

6.1 TEST FACILITIES

EMC testing shall be performed at an EMC test lab capable of meeting the EMC requirement test levels stated in SSP 30237. A representative EMC lab is located in Building 14 at the NASA JSC; contact the ISS EMC Functional Area Manager to arrange testing.

ESD testing is not required unless directed by a payload's PRD.

6.2 PROTOTYPE TESTING

HRF designers are encouraged to verify the EMC prediction analyses of their payloads by performing EMC evaluation tests. These should be performed on prototypes as early in the design cycle as possible. These initial tests will provide baseline emission and susceptibility levels from which problem areas can be addressed. Further EMC engineering will be incorporated into the designs to bring the prototypes into compliance. The prototypes will be retested to verify improvement.

6.3 CERTIFICATION TESTING

6.3.1 Payloads

HRF stowed or deployed payloads shall be tested individually or in combination with supporting equipment required to achieve the payload's function.

6.3.2 Subrack Payloads

HRF subrack payloads shall be evaluated for EMC prior to integration into the rack.

6.3.3 Integrated Rack

The HRF integrated rack shall be tested as a single unit. This test will be performed when all individual subrack payloads manifested are available.

6.4 TEST PLAN

Prior to scheduling certification testing, test plans for payloads and the integrated rack shall be submitted to the EMEP for approval.

Designers shall obtain a Task Performance Sheet (TPS) from the EMC lab prior to scheduling testing. The operation and configuration, including supplementary equipment, of the equipment to be tested shall be described in the TPS. The TPS shall be reviewed and approved by the EMC lab test engineer prior to testing.

6.5 TEST REPORT

Results of the testing based upon the test plans shall be submitted to the EMEP. The report shall conform to the format produced during the JSC EMC testing. Test results shall also be included in the HRF Verification Data Base.

7.0 CONTROL PLAN REVISIONS

Maintenance of this Control Plan is the responsibility of the HRF SE&I organization. Revisions of this Control Plan shall be submitted to the EMEP for approval.

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