SSP 30237

Space Station Electromagnetic Emission and Susceptibility Requirements

International Space Station

Revision F

17 May 2001

NASDA

National Space Development Agency of Japan

esa

european space agency

Canadian Space Agency

Agence spatiale canadienne

agenzia spaziale italiana
(Italian Space Agency)

National Aeronautics and Space Administration
Space Station Program Office
Johnson Space Center
Houston, Texas

REVISION AND HISTORY PAGE

REV.	DESCRIPTION	PUB. DATE
–	SDR Version	03–07–94
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ERU: /s/ M. Hehn 07/24/01

INTERNATIONAL SPACE STATION PROGRAM

SPACE STATION ELECTROMAGNETIC EMMISION AND SUSCEPTIBILITY REQUIREMENTS

17 MAY 2001

PREFACE

The Space Station Electromagnetic Emission and Susceptibility Requirements for Electromagnetic Compatibility document establishes the requirements for the control of the electromagnetic emission and susceptibility characteristics of electronic, electrical and electromechanical equipment and subsystems designed or procured for use by the International Space Station Alpha Program. The contents of this document are intended to be consistent with the requirements of SSP 30243, Space Station Requirements for Electromagnetic Effects and SSP 41000, System Specification for the Space Station. The Space Station Electromagnetic Emission and Susceptibility Requirements for Electromagnetic Compatibility shall be implemented on all SSP contracts and internal activities. This document is under the control of the Space Station Control Board.

INTERNATIONAL SPACE STATION PROGRAM OFFICE

SPACE STATION ELECTROMAGNETIC EMMISION AND SUSCEPTIBILITY REQUIREMENTS

17 MAY 2001

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INTERNATIONAL SPACE STATION PROGRAM

SPACE STATION ELECTROMAGNETIC EMISSION AND SUSCEPTIBILITY REQUIREMENTS

17 MAY 2001

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ESA Concurrence: Reference SSP 50019 Joint Management Plan and JESA 30000, Section 3, Appendix B. DATE

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SPACE STATION ELECTROMAGNETIC EMISSION AND SUSCEPTIBILITY REQUIREMENTS

17 MAY 2001

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Caveat: Concur with, subject to completion of detailed review and coordination of paragraph 3.2.4.2.2 with NASA.

INTERNATIONAL SPACE STATION PROGRAM

SPACE STATION ELECTROMAGNETIC EMMISION AND SUSCEPTIBILITY REQUIREMENTS

LIST OF CHANGES

17 MAY 2001

All changes to paragraphs, tables, and figures in this document are shown below:

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
000008 R1	6–3–94	Revision B	All
	5–31–96	Revision C	All
	6–12–98	Revision D	All
	9-15-99	Revision E	All
	5–17–01	Revision F	All

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1.0 INTRODUCTION

1.1 PURPOSE

This requirements document establishes the design requirements for the control of the electromagnetic emission and susceptibility characteristics of electronic, electrical and electromechanical equipment and subsystems designed or procured for use by the International Space Station Program. Such equipment and subsystems may be used independently or as an integral part of other subsystems or systems.

1.2 APPLICATION

The requirements of this document are applicable to Space Station electrical and electronic equipment. The applicability of the emission and susceptibility requirements is dependent upon the intended location or installation of the equipment or subsystem. Where deviation from the test level requirements is made based on intended installation and location, the deviation shall be documented and approved by the Electromagnetics Technical Advisory Team. Waiver or deviation shall be submitted per Data Requirement (DR): PC09 (Waiver and Deviations).

1.3 EMISSION AND SUSCEPTIBILITY DESIGNATIONS

The emission and susceptibility requirements in this document and corresponding test methods of SSP 30238 are designated in accordance with an alphanumeric coding system where:

C = Conducted

R = Radiated

E = Emission

L = Leakage

S = Susceptibility.

1.4 PRECEDENCE

SSP 41000 defines the design and performance requirements for the Space Station Program and invokes SSP 30243. SSP 30243 involves this document for electromagnetic emission and susceptibility requirements. In the event of any conflict between SSP 30243 and this document, SSP 30243 shall take precedence.

2.0 DOCUMENTS

The documents in this paragraph, of exact issue shown in the current issue of SSP 50258, are applicable to the extent specified in the referenced paragraphs. Inclusion of applicable documents does not supersede the order of precedence identified in 1.4. The references show where each applicable document is cited in this document.

DOCUMENT NO.	TITLE
SSP 30238 Paragraphs:	Space Station Electromagnetic Techniques 3.1, 3.2, 3.2.2.1.3 and 3.4.1
SSP 30243 Paragraph:	Space Station Requirements for Electromagnetic Compatibility 3.3
SSP 41173 Paragraph:	Space Station Quality Assurance Requirements 4.0

3.0 REQUIREMENTS

3.1 DEFINITION OF ELECTROMAGNETIC EMISSION AND SUSCEPTIBILITY REQUIREMENTS

Electronic, electrical, electromechanical equipment and subsystems emissions and susceptibilities shall comply with these requirements. Testing of the equipment to ensure compliance to the requirements of this document shall be performed using the test methods given in SSP 30238.

3.1.1 SELF–COMPATIBILITY

The Equipment Under Test (EUT), designed in accordance with the Space Station Electromagnetic Compatibility (EMC) requirements, shall not malfunction and performance shall not be degraded during Electromagnetic Inference (EMI) testing.

3.2 EQUIPMENT EMISSION AND SUSCEPTIBILITY LIMITS

This paragraph defines emission and susceptibility test limits for Space Station flight equipment and subsystems, including payloads. General EMI test techniques are contained in SSP 30238. Approval of design procedures and techniques does not relieve the supplier of the responsibility of meeting the emission, and susceptibility test limits. A waiver is required for equipment which cannot meet the emission and susceptibility test requirements. The threshold of susceptibility shall be determined for equipment unable to meet the susceptibility test limits.

3.2.1 CONDUCTED EMISSIONS

Wiring between two or more Orbital Replacement Unit (ORU) shall be exempt from the conducted emission test requirements provided the specific ORUs are tested as a single unit. Wiring external to the group of ORUs tested as a unit shall meet the test limit requirements of this document.

3.2.1.1 CE01, CONDUCTED EMISSIONS

Direct current power, low frequency, 30 hertz (Hz) to 15 kilohertz (kHz).

3.2.1.1.1 APPLICABILITY

CE01 is applicable only for narrowband emissions between 30 Hz and 15 kHz on direct current (dc) leads which obtain power from or provide power to other equipment, distribution panels or subsystems.

3.2.1.1.2 CE01 LIMITS

Electromagnetic emissions shall not appear on dc leads in excess of the following values as shown below. The emission limit shown below is for equipment drawing one amp or less. For equipment drawing more than one amp, the limit, in decibels (dB) as shown in Table 3.2.1.1.2–1 shall be raised by 20 x log I, where I equals the total dc current used by the equipment under test.

TABLE 3.2.1.1.2–1 CE01 EMISSION LIMIT

Frequency	Emissions
30 Hz–200 Hz	110 dB above 1 microampere
200 Hz–15 kHz	Decreasing log linearly with increasing frequency from 110 to 74 dB above 1 microampere

The limits shall be measured with an effective bandwidth not exceeding 100 Hz. See appendix C for exception (Electromagnetic Effects Control Board (EMECB) Tailoring/Interpretation Agreement (TIA)–0025, EMECB TIA–0134, EMECB TIA–0138, EMECB TIA–0155, and EMECB TIA–0159) to this paragraph.

3.2.1.2 CE03, CONDUCTED EMISSIONS

Direct current power leads, 15 kHz to 50 megahertz (MHz).

3.2.1.2.1 APPLICABILITY

CE03 is applicable only for narrowband emissions between 15 kHz and 50 MHz on dc leads which obtain power from other sources or provide power to other equipment, distribution panels or subsystems.

3.2.1.2.2 CE03 LIMITS

Electromagnetic emissions shall not appear on dc power leads in excess of the following values as shown below for narrowband emissions: The limit shown below is for equipment drawing one amp or less. For equipment drawing more than one amp, the limit as shown in Table 3.2.1.2.2–1 shall be raised by 20 x log I, where I equals the total dc current used by the equipment under test. See appendix C for exception (EMECB TIA–0024, EMECB TIA–0025, EMECB TIA–0028, EMECB TIA–0039, EMECB TIA–0043, EMECB TIA–0053, EMECB TIA–0057, EMECB TIA–0064, EMECB TIA–0082, EMECB TIA–0095, EMECB TIA–0098, EMECB TIA–0101, EMECB TIA–0112, EMECB TIA–0114, EMECB TIA–0115, EMECB TIA-0118, EMECB TIA–0123, EMECB TIA–0131, EMECB TIA–0132, EMECB TIA–0134, EMECB TIA–0141, EMECB TIA–0147, EMECB TIA–0153, EMECB TIA–0167, EMECB TIA–0174, EMECB TIA–0176, EMECB TIA–0199, EMEP TIA–0203, EMEP TIA–0206, EMEP TIA–0226, EMEP TIA–0228, EMEP TIA–0244, EMEP TIA–0258, EMEP TIA–0276, and EMEP TIA–0283) to this paragraph.

TABLE 3.2.1.2.2–1 CE03 EMISSION LIMITS

Frequency	Emissions
15 kHz–500 Hz	Decreasing log linearly with increasing frequency from 74 to 45 dB above 1 microampere
500 kHz–50 MHz	45 dB above 1 microampere

3.2.1.3 CE07, CONDUCTED EMISSIONS

Direct current power leads, spikes, time domain.

3.2.1.3.1 APPLICABILITY

CE07 is applicable for dc input power leads.

3.2.1.3.2 CE07 LIMITS

CE07 on and off and mode switching transients shall not exceed the envelope defined by the following values listed in Table 3.2.1.3.2–1. Repetitive on and off and mode switching transients shall not occur more frequently than every 100 milliseconds. See appendix C for exception (EMECB TIA–0014, EMECB TIA–0027, EMECB TIA–0049, EMECB TIA–0050, EMECB TIA–0055, EMECB TIA–0057, EMECB TIA–0072, EMECB TIA–0077, EMECB TIA–0079, EMECB TIA-0095, EMECB TIA-0104, EMECB TIA-0110, EMECB TIA-0111, EMECB TIA-0114, EMECB TIA-0116, EMECB TIA–0124, EMECB TIA–0143, EMECB TIA–0144, EMECB TIA–0155, EMECB TIA–0189, EMECB TIA–0198, EMEP TIA–0200, EMEP TIA–0202, EMEP TIA–0203, EMEP TIA–0228, EMEP TIA–0242, EMEP TIA–0282, and EMEP TIA–0283) to this paragraph.

TABLE 3.2.1.3.2–1 CE07 MODE SWITCHING TRANSIENTS ENVELOPE

Time (Microseconds)	Percentage of Nominal Line Voltage
0.1–10	+ 50 percent
10–50	Decreasing log linearly with increasing time from + 50 percent to + 20 percent
50–1000	Decreasing log linearly with increasing time from + 20 percent to + 5 percent or + 6 volts(V), whichever is greater
1000–10,000	+ 6 percent or + 0.5 V, whichever is greater
10,000–100,000	+ 5 percent or + 0.5 V, whichever is greater

3.2.2 CONDUCTED SUSCEPTIBILITY

3.2.2.1 CS01, CONDUCTED SUSCEPTIBILITY

Direct current power leads, 30 Hz to 50 kHz.

3.2.2.1.1 APPLICABILITY

CS01 is applicable to equipment and subsystems using dc power.

3.2.2.1.2 CS01 LIMITS

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when subjected to electromagnetic energy injected onto its power leads less than or equal to the values as shown in Table 3.2.2.1.2–1. See appendix C for exception (EMECB TIA–0090, EMECB TIA–0145, EMECB TIA–0161, EMECB TIA–0177, EMECB TIA–0178, EMECB TIA–0187, EMECB TIA–0188, and EMEP TIA–0231) to this paragraph.

TABLE 3.2.2.1.2–1 CS01 ELECTROMAGNETIC ENERGY INJECTION

Frequency	Voltage
30 Hz–2 kHz	5 V root mean square (rms) or 10 percent of the supply voltage (E1), whichever is less
2 kHz–50 kHz	Decreasing log linearly with increasing frequency from 5 Vrms, or E1 whichever is less, to either 1 Vrms or 1 percent of the supply voltage, whichever is less

3.2.2.1.3 ALTERNATE CS01 LIMITS

The requirement is also met when the audio power source specified in SSP 30238 adjusted to dissipate 50 Watts in a 0.5 ohm load, cannot develop the required voltage at the EUT power input terminals, and the EUT is not susceptible to the output of the signal source.

3.2.2.2 CS02, CONDUCTED SUSCEPTIBILITY

Direct current power leads, 50 kHz to 50 MHz.

3.2.2.2.1 APPLICABILITY

CS02 is applicable between 50 kHz and 50 MHz for equipment and subsystem dc power leads, including power returns which are not grounded internally to the equipment or subsystem**.**

3.2.2.2.2 CS02 LIMITS

The equipment subsystem shall not exhibit any malfunction, degradation of performance or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when subjected to 1 Vrms from a 50 ohm source. The test signal shall be applied to the equipment power line near the equipment input terminals. The requirement is also met under the following condition: A 1 Watt source of 50 ohms impedance cannot develop the required voltage at the EUT power input terminals, and the EUT is not susceptible to the output of the signal source. See appendix C for exception (EMECB TIA–0023, EMECB TIA–0051, EMECB TIA–0085, EMECB TIA–0110, EMECB TIA–0162, EMECB TIA–00199, EMEP TIA–0214, EMEP TIA–0215, EMEP TIA–0232, EMEP TIA–0253, and EMEP TIA–0293) to this paragraph.

3.2.2.3 CS06, CONDUCTED SUSCEPTIBILITY

Spikes, power leads.

3.2.2.3.1 APPLICABILITY

CS06 is applicable to equipment and subsystem dc power leads, including grounds and returns which are not grounded internally to the equipment or subsystem.

3.2.2.3.2 CS06 LIMITS

The EUT shall not exhibit any malfunction, degradation of performance or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when the test spikes, each having the waveform shown on Figure 3.2.2.3.2–1, are applied sequentially to the dc power input leads. The values of E and t are given below. Each spike shall be superimposed on the powerline voltage waveform. See appendix C for exception (EMECB TIA–0088, EMECB TIA–0119, EMECB TIA–0124, EMECB TIA–0193, EMEP TIA–0204, and EMEP TIA–0242) to this paragraph.

3.2.3 RADIATED EMISSIONS

3.2.3.1 RE02, RADIATED EMISSIONS

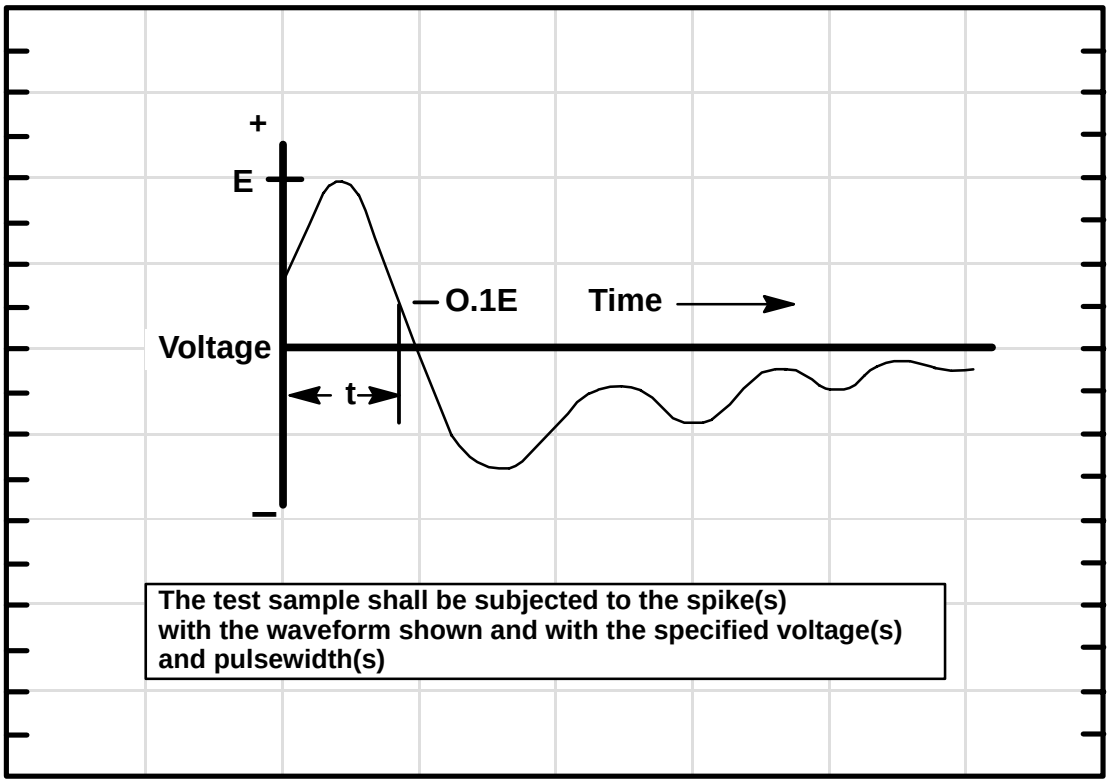
Electric field, 14 kHz to 10 GHz (narrowband), 13.5 to 15.5 GHz.

3.2.3.1.1 APPLICABILITY

RE02 is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, intermediate frequency, power and antenna transmission lines) and interconnecting wiring of the test sample; for narrowband emissions, it applies at the fundamental frequencies and all spurious emissions including harmonics, but does not apply for radiation from antennas. This requirement is applicable for narrowband emissions from 14 kHz to 10 GHz and 13.5 to 15.5 GHz.

3.2.3.1.2 RE02 LIMITS

E–field emissions shall not be radiated in excess of those specified in the following paragraphs. Above 30 MHz, the limits shall be met for both horizontally and vertically polarized waves. Measurement shall be made in the peak detector mode. See appendix C for exception (EMECB TIA–0001, EMECB TIA–0044, EMECB TIA–0048, EMECB TIA–0052, EMECB TIA–0055, EMECB TIA–0057, EMECB TIA–0065, EMECB TIA–0073, EMECB TIA–0074, EMECB TIA–0075, EMECB TIA–0080, EMECB TIA–0095, EMECB TIA–0097, EMECB TIA–0102, EMECB TIA–0103, EMECB TIA–0105, EMECB TIA–0111, EMECB TIA–0133, EMECB TIA–0135, EMECB TIA–0137, EMECB TIA–0138, EMECB TIA–0142, EMECB TIA–0164, EMECB TIA–0165, EMECB TIA–0167, EMECB TIA–0170, EMECB TIA–0171, EMECB TIA–0183, EMECB TIA–0154, EMEP TIA–0160, EMECB TIA–0192, EMEP TIA–0203, EMEP TIA–0207, EMEP TIA–0208, EMEP TIA–0209, EMEP TIA–0212, EMEP TIA–0219, EMEP TIA–0220, EMEP TIA–0227, EMEP TIA–0237, EMEP TIA–0213, EMEP TIA–0229, EMEP TIA–0241, EMEP TIA–0252, EMEP TIA–0254, EMEP TIA–0256, EMEP TIA–0258, EMEP TIA–0261, EMEP TIA–0264, EMEP TIA–0269, EMEP TIA–0270, EMEP TIA–0276, EMEP TIA–0277, EMEP TIA–0283, EMEP TIA–0299, EMEP TIA–0307, EMEP TIA–0314, EMEP TIA–0320, and EMEP TIA–0332) to this paragraph.



SPIKE #1 E = ± Twice the nominal line voltage, t = 10 microseconds ± 20 percent

SPIKE #2 E = ± Twice the nominal line voltage, t = 0.15 microseconds ± 20 percent

FIGURE 3.2.2.3.2–1 CS06 AND RS02 EQUIPMENT LIMIT

3.2.3.1.2.1 NARROWBAND ELECTRIC FIELD EMISSIONS

Narrowband E–field emissions shall not be radiated in excess of the values as shown in Table 3.2.3.1.2.1–1 and in Figure 3.2.3.1.2.1–1 at the required test distance of 1 meter.

TABLE 3.2.3.1.2.1–1 FIELD EMISSION LIMITS

Frequency	Emissions
14 kHz–10 MHz	56 dBμV/m
10 MHz–259 MHz	Increasing log linearly with increasing frequency from 56 to 86 dBμV/m (16dB per decade)
259 MHz–10 GHz	Increasing log linearly with increasing frequency from 46 to 72 dBμV/m (16dB per decade)
13.5–15.5 GHz	72 dBμV/m

3.2.4 RADIATED SUSCEPTIBILITY

3.2.4.1 RS02, RADIATED SUSCEPTIBILITY

Magnetic induction field.

3.2.4.1.1 APPLICABILITY

RS02 is applicable for all equipment and subsystems. These susceptibility signals are electromagnetically coupled into the equipment or subsystem wiring. See appendix C for exception (EMEP TIA–0211, EMEP TIA–0218, and EMEP TIA–0239) to this paragraph.

3.2.4.1.2 RS02 LIMITS

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when subjected sequentially to the test spikes, shown in Figure 3.2.2.3.2–1 each having the waveform with the values of E and t are given below:

— Spike #1 E = ± Twice the nominal line voltage, t = 10 microseconds ± 20 percent

— Spike #2 E = ± Twice the nominal line voltage, t = 0.15 microseconds ± 20 percent.

See appendix C for exception (EMECB TIA–0095, EMECB TIA-0100, EMECB TIA–0116, and EMECB TIA–0155) to this paragraph.

3.2.4.2 RS03, RADIATED SUSCEPTIBILITY

Electric field, 14 kHz to 20 GHz.

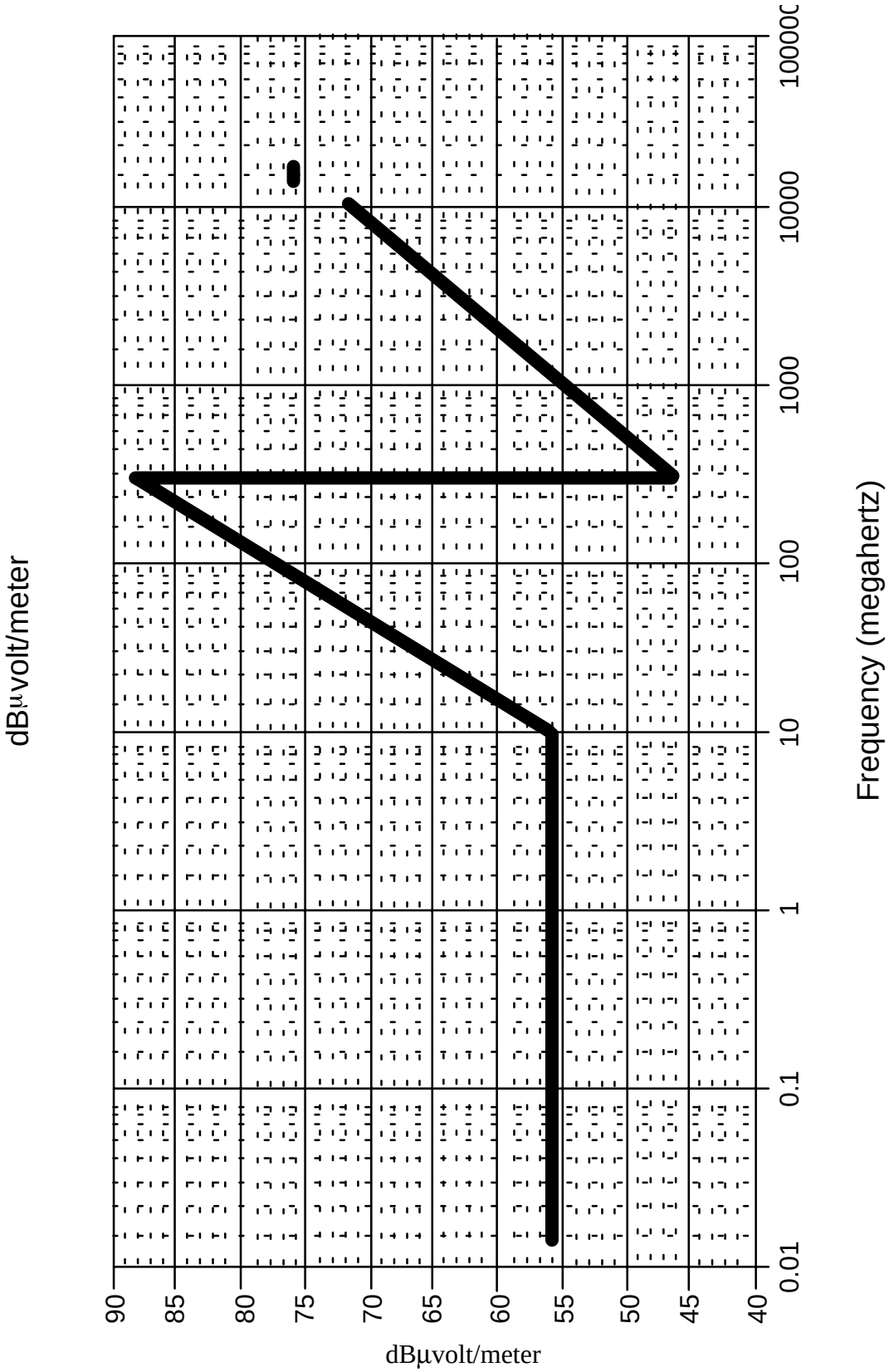


FIGURE 3.2.3.1.2.1–1 ISS EMISSION LIMITS

3.2.4.2.1 APPLICABILITY

RS03 is applicable for all equipment and subsystems between 14 kHz and 20 GHz. Above 10 GHz, this requirement applies only at specific frequencies and amplitudes known to be present at the Space Station. Below 10 GHz, this requirement shall be increased only at specific frequencies and amplitudes known to be present at the International Space Station (ISS). Module shielding effectiveness can be used to limit the levels applied.

3.2.4.2.2 RS03 LIMITS

The EUT shall not exhibit any malfunction, degradation of performance, or deviation, from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when subjected to the radiated electric fields less than or equal to those specified herein. Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves. As a minimum, the levels shown in Table 3.2.4.2.2–1 apply at either the specific frequencies stated or across the ranges stated. See appendix C for exception (EMECB TIA–0005, EMECB TIA–0055, EMECB TIA–0059, EMECB TIA–0062, EMECB TIA–0063, EMECB TIA–0080, EMECB TIA–0083, EMECB TIA–0084, EMECB TIA–0089, EMECB TIA–0095, EMECB TIA–0104, EMECB TIA–0105, EMECB TIA–0108, EMECB TIA–0117, EMECB TIA–0118, EMECB TIA–0119, EMECB TIA–0138, EMECB TIA–0149, EMECB TIA–0151, EMECB TIA–0153, EMECB TIA–0155, EMEP TIA–0158, EMECB TIA–0161, EMECB TIA–0163, EMECB TIA–0168, EMECB TIA–0172, EMECB TIA–0175, EMECB TIA–0183, EMECB TIA–0184, EMECB TIA–0190, EMECB TIA–0199, EMEP TIA–0219, EMEP TIA–0243, EMEP TIA–0250, and EMEP TIA–0255) to this paragraph.

TABLE 3.2.4.2.2–1 RS03 LIMIT LEVELS

Frequency/Range	Radiated Electric Field Level
14 kHz–10 MHz	5 V/m
200 MHz–8 GHz	60 V/m
8 GHz–10 GHz	20 V/m
2.2 GHz	161 V/m
8.5 GHz	79 V/m
13.7 GHz–15.2 GHz	250 V/m

3.2.5 LEAKAGE EMISSIONS

3.2.5.1 LE01, AC POWER USER LEAKAGE CURRENT

3.2.5.1.1 APPLICABILITY

LE01 is applicable for all equipment and subsystems that use alternating current (ac) power.

3.2.5.1.2 LE01 LIMITS

The leakage current for all equipment and subsystems using ac power, as measured between chassis and input power, at the power frequency, shall not exceed 5 milliamperes.

3.3 DOCUMENTATION

Documentation shall be per the requirements of SSP 30243.

3.4 VERIFICATION

3.4.1 TESTING REQUIREMENTS

The test requirements and techniques of SSP 30238 shall be used to determine compliance with the applicable emission and susceptibility test limit requirements of this document. When an EUT susceptibility is noted, the thresholds of susceptibility shall be determined. Equipment that is intended to be operated as a subsystem shall be tested as such to the applicable emission and susceptibility limits whenever practical.

4.0 QUALITY ASSURANCE PROVISIONS

All quality assurance provisions shall be in accordance with the Space Station Program Quality Assurance Program Requirements as specified in SSP 41173.

4.1 RESPONSIBILITY FOR INSPECTION

Unless otherwise specified, the supplier is responsible for the performance of inspection requirements as specified herein. Except as otherwise specified, the supplier may use his own facilities or any other commercial laboratory acceptable to National Aeronautics and Space Administration (NASA) or responsible (International Partner) IP agencies. NASA or IP agencies reserves the right to perform any of the inspections set forth in the requirements document where such inspections are deemed necessary to assure supplies or services conform with prescribed requirements.

APPENDIX A ABBREVIATIONS AND ACRONYMS

A	Ampere
ABIT	Active BIT
ac	alternating current
AM	amplitude modulation
amp	Ampere
ARS	Atmosphere Revitalization System
ASD	Area Smoke Detector
ATC	Air Traffic Control
ATU	Audio Terminal Unit
BCA	Battery Charger Assy
BCDU	Battery Charge/Discharge Unit
BIT	Built–in–Test
BSA	Battery Stowage Assembly
C	Conducted
CBCS	Centerline Berthing Camera System
CBPD	Continuous Blood Pressure Device
CDRA	Carbon Dioxide Removal Assembly
CETA	Crew and Equipment Translation Aid
CI	Configuration Item
CMG	Control Moment Gyro
COTS	Commercial–Off–the–Shelf
CSA–CP	Compound Specific Analyzer–Combustion Products
CWAI	Caution & Warning Associated Indicator
CWR	Collapsible Water Reservoir

dB	decibel
dBm	Decibel relative to one milliwatt
dBmV	Decibel relative to one millivolt
dBV	decibel relative to one volt
dBμA	Decibel relative to one microampere
dBμV/m	Decibel relative to one millivolt per meter
dc	direct current
DCM	Display, Control and Monitoring
DCSU	Direct Current Switching Unit
DDCU	dc–to–dc converter unit
DR	Data Requirement
E	Emission
ECG	Electrocardiogram
ECOMM	Early Communications
ECU	Electronics Control Unit
EMC	Electromagnetic Compatibility
EME	Electromagnetic Effects
EMECB	Electromagnetic Effects Control Board
EMI	Electromagnetic Interference
EMU	Extravehicular Mobility Unit
EPS	Electrical Power System
ESIT	
ESM	Experiment Support Module
EUT	Equipment Under Test
EVA	Extravehicular Activity

FET	Field Effect Transistor
FGB	Functional Cargo Block
FPU	Fluid Pumping Unit
GCM	General Control Module
GFE	Government Furnished Equipment
GHz	Gigahertz
GPRV	Gas Pressure Regulator Valve
HCU	Heater Control Unit
HMS	Health Maintenance System
HST	Hand–held serial terminal
Hz	hertz
IEA	Integrated Equipment Assembly
IMAX	Trademark of the Imax Corporation
IMV	Intermodule Ventilation
IOL	ISS Operations LAN
IP	International Partner
ISS	International Space Station
ITS	Integrated Truss Segment
kHz	kilohertz
KSC	Kennedy Space Center
L	Leakage
LISN	Line Impedance Stabilization Network
m	meter
mA	milliampere
MACE II	Middeck Active Control Experiment II

max.	maximum
mV	millivolt
MBP	multi–body platform
MBS	Mobile Remote Servicer Base System
MBSU	Main Bus Switching Unit
MDA	Motor Drive Assembly
MDAC	McDonnell Douglas Aerospace Company
MDM	Multiplexer/Demultiplexer
MHz	Megahertz
msec	millisecond
NASA	National Aeronautics and Space Administration
NCU	Network Control Unit
NIV	nitrogen isolation valve
nm	nautical mile
OIV	oxygen isolation valve
ORU	Orbital Replaceable Unit
PBA	Portable Breathing Apparatus
PCS	Portable Computer System
PCU	Plasma Contactor Unit
PDB	Power Distribution Box
PDIM	Power/Data Interface Module
PEHG	Payload Ethernet Hub/Gateway
PFCS	Pump and Flow Control Subassembly (TIA–0025)
PFCS	Pump Flow Control System (TIA–0232)
PN	Part Number

PSA	Power Supply Assembly
PV	Photovoltaic
PVCA	Photovoltaic Controller Application
PVR	Photovoltaic Radiator
R	Radiated
RF	Radio Frequency
RGA	Rate Gyro Assembly
RJMC	Rotary Joint Motor Controller
RSA	Russian Space Agency
rms	root mean square
RPCM	Remote Power Controller Module
S	Susceptibility
sec	second
SGANT	Space to Ground Antenna
SGTRC	Space to Ground Transmitter Receiver Controller
SIGI	Space Integrated GPS/INS
SM	Service Module
SMPS	Switch Mode Power Supply
SNR	signal to noise ratio
SPEL	Space Power Electronics Lab
SSBA	Space Station Buffer Amplifier
SSCS	Space to Space Communications System
SSPCM	Solid State Power Controller Module
SSSR	Space to Space Station Radio
SSU	Sequential Shunt Unit

TCCV	Temperature Control Check Valve
TIA	Tailoring/Interpretation Agreement
TEPC	Tissue Equivalent Proportional Counter
TVCIC	Television Camera Interface Converter
μ	Micro
UIA	Umbilical Interface Assembly
USL	U. S. Laboratory
V	Volt
V_{p-p}	Volts peak to peak
VC	Vacuum Cleaner
VES	Vacuum Exhaust System
Vgs	Voltage (gate to source)
V/m	volt per meter
Vrms	Volt root mean square
VRS	Vacuum Resource System
VTS	Video Teleconferencing System
W	Watt
WIS	Wireless Instrumentation System
WMV	Water Modulating Valve

APPENDIX B GLOSSARY

CABLE, ELECTRICAL

Two or more solid or stranded conductors insulated from each other and routed together or enclosed by a common covering; or one conductor enclosed by, but insulated from another conductor or a metallic shield.

EQUIPMENT

Any electrical, electronic, or electromechanical device or collection of devices intended to operate as a single unit and to perform a single function. As used herein, equipment includes but is not limited to the following: receivers; transmitters; transponders; power supplies; hand tools; processors; test apparatus; and test instruments.

SUBSYSTEM

A collection of equipment designed and integrated to perform a single function where in any equipment within the subsystem is not required to function as an individual equipment.

SYSTEM

A collection of equipment, subsystems, skills, and techniques capable of performing or supporting an operational role. A complete system includes related facilities, equipment, subsystems, materials, services, and personnel required for its operation to the degree that it can be considered self sufficient within its operational environment.

WIRE, ELECTRICAL

A single current carrying conductor of one or more strands covered with a suitable insulating material.

APPENDIX C APPROVED TAILORING/INTERPRETATION AGREEMENTS

EMECB TIA–0001

C.3.2.3.1.2 RE02 LIMITS

Exception: Relax RE02 limit for the Battery Charge/Discharge Unit (BCDU) (Configuration Item (CI) 360PG2)/Battery operating system by 2.8 dB from 4.8 MHz to 5.0 MHz, by 0.4 dB at 3.403 MHz, and by 2.0 dB at 12.02 MHz.

Rationale: The BCDU/Battery subsystem will be located on the Integrated Equipment Assembly (IEA) which is part of PG2's Photovoltaic (PV) Module. The PV modules will be launched as part of launch packages PV Modules P6, P4, S6, and S4. The PV module is the primary power system which is controlled by PG2. The only equipment that is located on a PV module that is not controlled by PG2 is PG1's S–band communication equipment and PG1's Multiplexer/Demultiplexer (MDM). The S–band receiver sensitivity performance is required at 1.3775 GHz and the MDM must comply with the SSP 30237 RS03 requirements. The primary power system has been integrated and operating in Rocketdyne's Space Power Electronics Lab (SPEL) facility for many years with no detrimental EMI effects ever attributed to BCDU radiated emissions. System compatibility for the actual flight configuration will be demonstrated during the IEA EMC test.

EMECB TIA–0005

C.3.2.4.2.2 RS03 LIMITS

Exception: PG–3 developed hardware will maintain the tailored RS03 limits as specified in Table TIA–0005–1, as design and test requirements. The components identified in Table TIA–0005–2 will additionally be tested at 60 V/m from 200 MHz to 1 GHz. No additional testing or analysis will be done at frequencies above 1 GHz. Items in Table TIA–0005–3 do not require additional RS03 testing.

Rationale: Based on a technical review by the Prime/MDAC/PG–3 Electromagnetic Effects (EME) teams on January 16, 1997 the recommendation to the program is to accept the above tailoring as this is the most cost effective solution to the situation. Any risk will be mitigated during the Node 1 EMC testing.

TABLE TIA–0005–1 PG3 U.S. LABORATORY (USL) TAILORED RS03 LIMITS

Frequency/Range	Radiated Electric Field Level
14 kHz – 200 MHz	5 V/m
200 MHz – 10 GHz	20 V/m
13.7 GHz – 15.2 GHz	8.5 V/m

TABLE TIA–0005–2 PG3 H/W TO BE TESTED TO HIGHER RS03 LIMITS

CI or Part Number	Nomenclature
FDA001A	Area Smoke Detector
ITCS01A	Pump Package Assembly
EVS003A	Pressure Control Panel
683I23A	Utility Outlet Panel
ITCS12A	Three Way Mix Valve
EVS001A	OIV/NIV
EVS004A	Vent Relief Valve
CDRA01A	CDRA
SSF9665	Avionics Air Assembly
ITCS09A	System Flow Control Assembly
EVS006A	IMV Valve Assembly
SV809114	TCCV Actuator
SSF9619	IMV Fan Assembly
408A40A	General Luminaire Assembly
SSF9664	Inlet ORU

TABLE TIA–0005–3 PG3 FLIGHT 2A H/W NOT APPLICABLE TO HIGHER RS03 TEST

CI or Part Number	Nomenclature	Rationale
RV4SAYSD501E	Resistor, Variable, Comp.	Not Susceptible
ARS36	Valve, 3 way (0.125)	Not Susceptible
408A40C	Remote Power on and off switch	Not Susceptible

EMECB TIA–0014

C.3.2.1.3.2 CE07 LIMITS

Exception: The CE07 requirement of 3.2.1.3, for the Remote Power Controller Module (RPCM) is relaxed for the first 1 microsecond of power initialization from +/– 50 percent to +50 percent to –90 percent.

Rationale: When an RPCM is initialized it powers up its internal electronics only and all source power output feeds to downstream loads are zero volts (switch open). However, once one channel is feeding output power to a user load, turning on an adjacent channel to feed another RPCM will result in a common impedance transient being seen by the user load. This transient should not impact user load performance since all Space Station ORUs are required to not be susceptible to SSP 30237, CS06, 10 microseconds transients which are +/– 2 times the line voltage of 120 volts. There is no survivability issue since all loads are required to be immune to a power drop out of 60 microseconds in accordance with SSP 30482, Volume 1.

EMECB TIA–0023

C.3.2.2.2.2 CS02 LIMITS

Exception: The BCDU (CI 360PG2) power control input bus SSP 20327, CS02 requirements are relaxed by 2.5 dB for the frequency range of 26.7 MHz to 28.7 MHz. The requirement of 1 Vrms minus 2.5 dB equals 0.75 Vrms.

Rationale: The dc control power bus was configured in Rocketdyne's SPEL facility per flight drawings (cable lengths, wire twisting, wire shielding/terminations) and routed two inches above a ground plane and bus ripple voltages were measured for various modes of operation. The voltage ripple measured (time domain) at the BCDU control power input port was never greater than 600 mV p–p (0.214 V rms). The ripple at 26 MHz (frequency domain measurement) is much less, around 10 mV. Therefore, there is at least a 10 dB EMI safety margin that exists between the actual threat and the actual susceptibility threshold. Therefore, the source bus current telemetry readings will be in tolerance during all mission scenarios.

EMECB TIA–0024

C.3.2.1.2.2 CE03 LIMITS

Exception: The CE03 limit for the BCDU (CI 360PG2) control power input lines is relaxed by 89 dB at 402 kHz and by 10 dB at 5.84 MHz. The CE03 limit for the BCDU control power output lines is relaxed to the following limit curve:

A. 15 kHz to 300 kHz CE03 limit = 80 dB μA.

B. 300 kHz to 50 MHz CE03 limit is decreased log linearly from 92 dB μA to 55 dB μA.

Rationale: The CE03 limit in SSP 30237 was derived to guarantee 1 Vrms power quality (30 Hz to 30 MHz) for the 52 Amp secondary power bus with an impedance characterized by 120 feet of 4 gauge wire. The dc control bus is a 6 Amp bus with an impedance characterized by 30 feet of 16 gauge wire. Since the control power bus impedance and currents are both less than the secondary system values, the resulting voltage ripple will be less as the data below shows. The dc control power bus was configured in Rocketdyne's SPEL facility per flight drawings (lengths, wire twisting, wire shielding/terminations, inductance of beta gimbal roll rings). The primary power system which provides and uses the dc control power was exercised in all modes of operation while measuring the control bus voltage and current in both time and frequency domains. The measurements were performed at all four control power outputs and at all four control power inputs. All time domain ripple voltages measured were less than 2.0 Volts peak to peak (0.71 Vrms). Therefore even though the CE03 limit was exceeded, a 6 dB EMI safety margin still exists. The control power is routed via twisted shielded wire therefore radiated emissions are controlled to be within RE02 limits except for five frequencies exceeding the limit by less than 3 dB.

EMECB TIA–0025

C.3.2.1.1 CE01 LIMITS, AND
C.3.2.1.2.2 CE03 LIMITS

Exception: The limit of the CE01 requirement for the PG2 Solar Array (CI 250PG2) Motor Drive Assembly (MDA) is relaxed by 2.1 dB at 1.8 kHz. The limit of the CE03 requirement for the PG2 MDA is relaxed by 4.1 dB at 1.12 MHz. This relaxation is for an MDA that is pulling 2.7 Amps.

Rationale: The MDA hardware has very limited usage during the Space Station mission. The MDA's are used to deploy and retract the solar array blankets and to unlatch and latch the blanket boxes. All of the loads external to PG2's PV Module that share the PV Module's secondary power source dc–to–dc converter unit (DDCU) are fed by a separate RPCM than the RPCM that feeds the PV Module's secondary loads MDAs, ECU, Pump and Flow Control Subassembly (PFCS), and Photovoltaic Radiators (PVR). The common impedance between external PV Module loads and internal PV Module loads is small due to the RPCMs being close to the DDCU output. If all other loads were compliant at these two frequencies the resulting ripple on the secondary power bus with the proposed relaxation would still meet power quality requirements.

Calculations:

1.8 kHz V ripple = ((10exp((mda ce01@1.8k)/20))+(10exp(ce01 limit for remaining loads/20)))(1Amp/10exp6 µA)(Z@1.8k, 238lisn)
= ((10exp(102.2 dBµA/20)) + (10exp((dBµA + 20log(52A–2.7A))/20)) (1 Amp/10exp6µA) (0.158 ohms) = 0.368 Vrms

1.1MHz V ripple = ((10exp((mdace03@1.2M)/20)+(10exp(ce03 limit for remaining loads)/20))(1Amp/10exp6 µA)(Zc@1.2m,238lisn)
= ((10exp(57.7 dBµA/20))+(10exp((45.0 dBµA+20log (52A–2.7A))/20))(1Amp/10exp6 µA) (50.0 ohms) = 0.476 Vrms

EMECB TIA–0027

C.3.2.1.3.2 CE07 LIMITS

Exception: The Control Moment Gyro (CMG) (CI 222007A) is allowed to fail the SSP 30237, CE07 requirement for turn off line transient up to –102 volts on a 7.13 microsecond pulse.

Rationale: This unit is in EMC compliance with all other EMC test requirements. It is unlikely that the outage will become the cause of a problem in the integrated system. The CMG is fed from a RPCM type IV which is a current limiting RPCM. This RPCM was not used in the subject test.

EMECB TIA–0028

C.3.2.1.2.2 CE03 LIMITS

Exception: Relax SSP 30237, CE03 specification for the ILC Tech general luminary (CI 408A40A) in the frequency ranges as shown in Table TIA–0028–1.

TABLE TIA–0028–1 ILC TECH GENERAL LUMINARY FREQUENCY RANGES

Frequency Range	Proposed CE03 Amplitude	Current CE03 Amplitude
19.5 kHz to 24.7 kHz	78 dB above 1 microampere	Decreasing log linearly with frequency from 72.3 to 69.9 dB above 1 microampere
37.9 kHz =/– 1 percent	70 dB above 1 microampere	66.3 dB above 1 microampere

Rationale: The calculated safety margin of the induced bus voltage as a result of these emissions to ORU SSP 30237B, CS01 limits and SSP 30482B Volume 1, interface B, spectral voltage power quality exceeds 32 dB for all frequencies. See Tables TIA–0028–2 through TIA–0028–6 for calculations. In accordance with Table TIA–0028–6, 126 ORUs per bus conducting in phase at CE03 limits at 37.9 kHz would be needed to use up the CS01 noise margin. There are on the order of 80 loads per bus in the USL, with less than the Node. The emissions would also add randomly on the bus providing additional margin.

TABLE TIA–0028–2 CALCULATED CONVERSION OF CE03 MEASURED CURRENT TO POWER BUS VOLTAGE

A	B	C	D
Outage Frequency (Hz)	Maximum CE03 Emission (mA)	SSP 30238 LISN Source Impedance (20 µH) Ω	Calculated CE03 Outage Contribution to Interface B Power Bus Voltage (mV)
18.53E+3	6.6	2.3	15.4
24.67E+3	7.5	3.1	23.2
37.91E+3	3.0	4.8	14.2

Column A = Outage Frequency from General Luminaire Test.
Column B = Maximum CE03 Outage at Frequency in Column A.
Column C = 2π * Column A * 20E–6.
Column D = Column B * Column C.

TABLE TIA–0028–3 CALCULATED SAFETY MARGIN TO SSP 30237B CS01 SPECIFICATION LIMIT

A	B	C	D
Outage Frequency (Hz)	Calculated CE03 Outage Contribution to Interface B Power Bus Voltage (mV)	SSP 30237B CS01 Limit (mV)	Safety Margin to SSP 30237B CS01 Specification Limit (dB)
18.53E+3	6.6	2.3	15.4
24.67E+3	7.5	3.1	23.2
37.91E+3	3.0	4.8	14.2

Column A = Outage Frequency from General Luminaire Test.
Column B = Maximum CE03 Outage Contribution from Table TIA–0028–2.
Column C = (5 – 2.861*LOG(Column A/2000))*2000 {CS01 Limit}.
Column D = 20*LOG(Column C/1000) – 20*LOG(Column B/1000).

TABLE TIA–0028–4 CALCULATED SAFETY MARGIN TO SSP 30482B VOLUME 1 INTERFACE B SPECTRAL VOLTAGE POWER QUALITY

A	B	C	D	E
Outage Frequency (Hz)	Calculated CE03 Outage Contribution to Interface B Power Bus Voltage (mV)	SSP 30482B Volume 1 Interface B Spectral Voltage Limit decibel volt (dBV)	(mV)	Safety Margin to SSP 30482B Volume 1 Interface B Spectral Voltage Power (dB)
18.53E+3	15.4	–1.7	821.9	34.6
24.67E+3	23.2	–2.9	712.6	29.7
37.91E+3	14.2	–4.8	575.3	32.1

Column A = Outage Frequency from General Luminaire Test.
Column B = Calculated CE03 Outage Contribution from Table TIA–0028–2.
Column C = –9.966*LOG(Column A/12500) {Interface B Spectral Limit}.
Column D = ALOG(Column C/20)*1000.
Column E = ColumnC–20*LOG(Column B/1000).

TABLE TIA–0028–5 CALCULATED CONVERSION OF CE03 SPECIFICATION LIMIT TO VOLTAGE

A	B	C	D	E
Frequency (Hz)	SSP 30237B CE03 Specification Limit (1 Amp) (dB µA)	(mA)	SSP 30238 LISN Source Impedance (20µ) Ω	Safety Margin to SSP 30482B Volume 1 Interface B Spectral Voltage Power (mV)
18.53E+3	72.4	4.2	2.3	9.7
24.67E+3	70.0	3.2	3.1	9.8
37.91E+3	66.4	2.1	4.8	10.0

Column A = Outage Frequency from General Luminaire Test.

Column B = 110–19.129*LOG(Column A/200) {CE03 Limit}.

Column C = ALOG(ColumnB/20)*0.001.

Column D = 2π * Column A * 20E–6.

Column E = Column C * Column D.

TABLE TIA–0028–6 NUMBER OF ORUs REQUIRED TO USE NOISE MARGIN

A	B	C	D	E	F	G
Outage Frequency (Hz)	Calculated CE03 Outage Contribution to Interface B Power Bus Voltage (mV)	CE03 Outage Contribution from All Lights (6 per Bus–In Phase) (mV)	SSP 30237B CS01 Limit (mV)	Noise Margin (mV)	Conversion of CE03 Specification Limit to Voltage (mV)	# ORUs at CE03 limits to use noise margin (in phase) (# ORUs)
18.53E+3	15.4	92.3	2233.9	2141.5	9.7	221
24.67E+3	23.2	139.5	1878.3	1738.8	9.8	177
37.91E+3	14.2	85.3	1344.4	1259.1	10.0	126

Column A = Outage Frequency from General Luminaire Test.

Column B = Calculated C#03 Outage Contribution from Table 2, Column D.

Column C = Column B * 6.

Column D = (5 – 2.861*LOG(Column A/2000))*1000 {CS01 Limit}.

Column E = Column D – Column C.

Column F = Conversion of CE03 Specification Limit to Voltage from Table TIA–0028–5, Column E.

Column G = Column E / Column F.

EMECB TIA–0039

C.3.2.1.2.2 CE03 LIMITS

Exception: The Payload Ethernet Hub/Gateway (PEHG) (CI 222066A) is allowed to exceed the SSP 30237, CE03 requirement by 2 dB µA at 78 kHz.

Rationale: The high reading is believed to be due to the PEHG power supply switching frequency. The level of noncompliance is believed by MDA to be insignificant, does not warrant the cost and schedule impacts required to push the unit into compliance, and can be accepted.

EMECB TIA–0043

C.3.2.1.2.2 CE03 LIMITS

Exception: The MDM (CI 222002A and 222004A) is relaxed up to 12 dB of the SSP 30237, CE03 requirements at 85 to 95 kHz due to phase relationships.

Rationale: The three component Switch Mode Power Supply (SMPS) power supplies that make up the MDM power supply can have a number of possible phase relationships even though they are frequency locked together. Each phase relationship produces a different emission profile. The maximum profile is up to 12 dB µA above the limit.

EMECB TIA–0044

C.3.2.3.1.2 RE02 LIMITS

Exception: The MDM (CI Nos. 222002A and 222004A) is allowed to exceed the EMC requirements of SSP 30237, RE02 by up to 7 dB in the frequency range of 0.5 to 1.2 MHz.

Rationale: The out of specification condition may be explained by the test interface cable configuration; the cable diameter is nearly 8 inches. This configuration places the wires as much as 10 inches above the ground plane making the cable radiated emissions proportionally higher.

EMECB TIA–0048

C.3.2.3.1.2 RE02 LIMITS

Exception: The Rate Gyro Assembly (RGA) is allowed to exceed the SSP 30237, RE02 specifications by 2.8 dB at 300 MHz.

Rationale: The RGA had previously completed this qualification test without exceedances. A minor modification was required for non–EMI reasons. The RGA was retested after the modification. The modification caused this minor exceedance. This outage will not affect components and there are no receivers at this frequency.

EMECB TIA–0049

C.3.2.1.3.2 CE07 LIMITS

Exception: The Vacuum Cleaner (VC) is allowed to exceed the SSP 30237, Revision C, CE07 specification by –1.88 v at 100 millisecond, +2.49 v at 230 millisecond, –2.15 v at 195 millisecond, and 1.02 v at 245 millisecond.

Rationale: Modification to the VC will impact cost and schedule. The deviation to the CE07 Revision C requirement is well within the limits of the power quality specification thus it should not impact other ISS systems, and it is not felt redesign and associated cost and schedule impacts are warranted.

EMECB TIA–0050

C.3.2.1.3.2 CE07 LIMITS

Exception: The RPCM CE07 requirements are modified as follows:

A. The CE07 voltage limit during the first 2.0 microseconds after power initialization is from +50 percent to –95 percent.

B. The CE07 voltage limit during the period from 3 to 5 microseconds after power initialization is from +60 percent to –50 percent.

Rationale: When the RPCM is energized, power is applied to its housekeeping electronics only. During this process, all RPCM power channels solid state relays are open and no dc voltage is applied to the external loads terminals. However, the CE07 voltage transient generated by the RPCM may appear across the terminals of an adjacent (parallel) RPCM and its subsequent loads. This condition only occurs in the rare case when the emitting RPCM (culprit) is provided power through another series RPCM. Otherwise, both parallel RPCMs are energized together from the same source and no interference occurs. Worst case, this transient should not impact user load performance since all Space Station ORUs are required not to be susceptible to SSP 30237, CS06, 10 microseconds transients which are +/– 2 times the line voltage of 120 volts. There is no survivability issue since all loads are required to be immune to a power drop out of 60 milliseconds in accordance with SSP 30482, Volume 1. Analysis also indicate that any capacitive load greater than 0.1 microFarad will require more than 1 microsecond for its CE07 inrush transient to return to within –50 percent of the dc line voltage.

EMECB TIA–0051

C.3.2.2.2.2 CS02 LIMITS

This TIA has been superceded by EMECB TIA–0085.

EMECB TIA–0052

C.3.2.3.1.2 RE02 LIMITS

Exception: The Heater Control Unit (HCU) (CI M 42070 Q) may exceed the Radiated E–Field (RE02) emission requirements of SSP 30237 by up to 10 dB m V/m maximum in the frequency range of 10 MHz to 25 MHz.

Rationale: The outages should not affect other components of the ISS. There are no receivers present in this frequency range. The EMECB determined that there would be no upsets by the excessive emissions in this frequency range.

EMECB TIA–0053

C.3.2.1.2.2 CE03 LIMITS

Exception: The HCU (CI M 42070 Q) may exceed the conducted emissions (CE03) requirements of SSP 30237 by 10 dB mA at 600 kHz and 2 dB mA at 1.8 MHz.

Rationale: The outages should not affect other components of the ISS. The EMECB concluded there would be no disruptions to other equipment by conducted emissions at these frequencies.

EMECB TIA–0055

C.3.2.1.3.2 CE07 LIMITS,
C.3.2.3.1.2 RE02 LIMITS, AND
C.3.2.4.2.2 RS03 LIMITS

Exception: The early Portable Computer System (PCS) as configured for operation in the battery mode on the ISS is allowed to exceed the SSP 30237, RE02 requirements by up to 0.4 dBμV at 321.38 MHz, 2.9 dBμV at 281.68 MHz, and 0.2 dBμV at 320.86 MHz; CE07 requirements by up to –8.13 V at 5 milliseconds, –20.7 V at 72 milliseconds, 5.4 at 138 milliseconds, and –21.38 V at 302.5 milliseconds, and the RS03 requirements by RS03 1.9 GHz at 54.41 V/m and 2.0 GHz at 56.25 V/m.

Rationale: This commercial–off–the–shelf (COTS) early PCS configuration will be used under benign conditions and will be powered from the Space Shuttle Orbiter or Functional Cargo Block (FGB) only. A TIA will be submitted for the ISS powered COTS PCS configuration for flights after 5A.

EMECB TIA–0057

C.3.2.1.2.2 CE03 LIMITS,
C.3.2.1.3.2 CE07 LIMITS, AND
C.3.2.3.1.2 RE02 LIMITS

Exception: The XHR 150–7 Power Supply is allowed to exceed the EMI requirements of SSP 30237 by the following:

A. CE03: 1.1 dBmA at 61.9 kHz

B. CE07: OFF to ON is DV = 26.6 V at Dt =206 ms (4.9 kHz)

C. RE02: 4.4 dBm V/m at 272.3 MHz

Rationale: The out of specification conducted emissions may be due to input filter capacitors that are charged at the instant that the Power Supply is turned on. The out of specification radiated emission spike may be due to a front printed circuit board having through–hole mounted capacitors instead of surface mounted capacitors. Four EMI testing series have been conducted to test ongoing EMI modifications. Modifications have resulted in significantly lower emissions compared to the original unit. Any further modifications would be contracted to the manufacturer requiring expensive redesign. There are no receivers in this frequency range and the EMECB determined that these emissions would cause no upsets to other equipment.

EMECB TIA–0059

C.3.2.4.2.2 RS03 LIMITS

This TIA has been superceded by EMECB TIA–0059

EMECB TIA–0062

C.3.2.4.2.2 RS03 LIMITS

Exception: The Mobile Remote Servicer Base System (MBS) Video Distribution Unit is allowed to pass the SSP 30237, RS03 requirements at a level 35 V/m in the frequency range of 399 MHz to 417 MHz.

Rationale: It is known that levels above 35 V/m are very unlikely to be experienced in this narrow frequency band, either as a result of ground, station or Orbiter transmissions. The susceptibility noted was a degradation of the signal to noise ratio below the somewhat arbitrary levels that have been established for the design. Persons present during the test had no difficulty reading the display. Whether the artificial vision system could cope with the degraded signal is not known, but this consideration is irrelevant, since operations can be completed without it. There is no hazard involved, and this waiver request is regarded as very low risk. The only known emitter in this frequency range is the Extravehicular Activity (EVA) suit radio.

EMECB TIA–0063

C.3.2.4.2.2 RS03 LIMITS

Exception: The MBS Video Signal Converter is allowed to pass the SSP 30237, RS03 requirements at a level of 20 V/m in the frequency range of 236.8 MHz to 239 MHz.

Rationale: It is known that levels above 20 V/m are very unlikely to be experienced in this narrow band at the relatively low frequencies involved, either as a result of ground, station or Orbiter transmissions. The susceptibility noted was a degradation of the signal to noise ratio below the somewhat arbitrary levels that have been established for the design. Persons present during the test had no difficulty reading the video display. Whether the artificial vision system could cope with the degraded signal is not known, but this consideration is irrelevant, since operations can be completed without it. There is no hazard involved, and this waiver request is regarded as very low risk. There are no ISS emitters at these frequencies.

EMECB TIA–0064

C.3.2.1.2.2 CE03 LIMITS

Exception: The MPLM Power Distribution Box (Part Number (PN) M42010F, CI 658470) may exceed the Conducted Emissions (CE03) requirements of SSP 30237 as follows:

A. 5 dB max at 135 kHz and 9 dB max at 180 kHz, on negative line

B. 15 dB max from 1 MHz to 2.2 MHz, on positive line

Rationale:

A. The deviation is small enough that other hardware will not be affected.

B. Decreased performance characteristics or hardware failure due to susceptibility emissions will not result in a hazard to crew, damage to vehicle, or risk to ISS mission success.

C. Conducted emissions to susceptibility margins are documented in the on going assessment document, D684–10232–01. Implementation of the TIA does not degrade the noise margin required SSP 30243, paragraph 3.2.3.

EMECB TIA–0065

C.3.2.3.1.2 RE02 LIMITS

Exception: The Power Distribution Box may exceed the Radiated E–Field (RE02) emission requirements of SSP 30237 by 5 dB at 190 kHz, from 7 MHz to 9 MHz and around 15 to 16 MHz up to 8 dB m V/m at 45 kHz and at 90 kHz.

Rationale: The outages should not affect other components of the ISS. There are no receivers at these frequencies on ISS. The EMECB agrees there would be no interference caused by these exceedances.

EMECB TIA–0072

C.3.2.1.3.2 CE07 LIMITS

Exception: The Portable Utility Light (PN SEG33107306–301) can exceed the SSP 30237, Revision C, paragraph 3.2.1.3.2 CE07 limits by up to –5.8 V dc at 30.3 kHz.

Rationale: The 5.8 volt spike at 33 microseconds is of a duration of approximately 10 microseconds. ORUs are tested with a 360 volt 10 microsecond CS06 transient. A 30 dB margin exists which meets the system level margin requirement.

EMECB TIA–0073

C.3.2.3.1.2 RE02 LIMITS

Exception: The Temperature Control Check Valve (TCCV) Actuator (PN SV809114) is exempt from testing to the 3.2.3.1.2 RE02 requirements above 1 GHz.

Rationale: The TCCV Actuator is a dc motor which positions a mechanical linkage to set the position of a mechanical air damper. It operates very slowly. The RE02 test data shows no levels above the ambient background between 14 kHz and 1 GHz. The Hamilton Standard EME Control Plan, which was inherited from the Space Station Freedom Program, allowed cessation of the RE02 test after no emissions were detected above ambient background level.

EMECB TIA–0074

C.3.2.3.1.2 RE02 LIMITS

Exception: The Intermodule Ventilation (IMV) Fan Assembly (CI SSF 9619, PN SV809111) is exempt from testing to the 3.1.3.1.2 RE02 requirements above 1 GHz for horizontal polarization or above 200 MHz for vertical polarization.

Rationale: The RE02 test data shows more than 10 dB margin between the measured levels and the SSP 30237, RE02 limits from 14 kHz to 1 GHz. The vertical polarization measurements are the same as the horizontal polarization measurements between 30 MHz and 200 MHz. There is no discernible difference between the measured test and ambient levels above 200 MHz and little discernible difference below 200 MHz. The noise margin in the vertical polarization measurement is sufficient to account for actual horizontal polarization measurements.

EMECB TIA–0075

C.3.2.3.1.2 RE02 LIMITS

Exception: The CCAA Inlet ORU (CI SSF9664, PN SV811840–1) is exempt from testing to the 3.2.3.1.2 RE02 requirements above 1 GHz for horizontal polarization or above 200 MHz for vertical polarization.

Rationale: The RE02 data show greater than 20 dB margin between the measured values and the SSP 30237, RE02 limits above 1 MHz. The margin is greater than 10 dB below 1 MHz except for one spike with approximately 4 dB margin at approximately 120 kHz, however this same spike also appears in the ambient data and is not considered to originate from the CCAA Inlet ORU. The measured values above 80 MHz are not discernibly different from the ambient values. In the 40 to 60 MHz range the measured test data is slightly above the ambient levels although the ambient data shows the same contour features which indicates that the source is not the test article. The only indication of noise from the test article is a slight excess of approximately 8 dB above ambient in the 7 to 9 MHz range which is still approximately 20 dB below the allowed RE02 limits. The noise margin in the vertical polarization measurement is sufficient to account for actual horizontal polarization measurements.

EMECB TIA–0077

C.3.2.1.3.2 CE07 LIMITS

Exception: The IMV Fan Assembly (CI SSF 9619, PN SV80911) meets CE07 waveform without the use of soft start RPCM based on analysis.

Rationale: The voltage trace, SVHSER, Figure 9, plots 1, 2, and 3, was obtained from a test set up that used a fast mercury switch to initiate power to the fan, instead of a soft start RPCM. This voltage trace fails CE07 from approximately 7 to 50 microseconds. The RPCM provides slow turn on. Because of this, input capacitors will charge slowly and will not allow for the severe voltage drop as seen in SVHSER, Figure 9. When RPCM 1 millisecond soft start is considered, this trace does not indicate a CE07 failure. Calculating the soft start response, the voltage descends 4.2 volts below 120 volts, and remains at that level until the soft start is over at 1 millisecond, when the voltage returns to 120 volts. This descent level is within the 6 volts required by CE07.

Analysis results are provided below:

The voltage trace may be modeled by the unit step response of a circuit.

$$f(t) = U(t)h(t) = U(t)60\left(e^{-\alpha t} - e^{-\beta t}\right)$$

where $a = 1 \div \left(70 \times 10^{-6}\right)$ and $b = 1 \div \left(2 \times 10^{-6}\right)$.

For soft start with full turn on within $T = 10^{-3}$ seconds, after any time $\tau = n\Delta\tau$ the response at time t of this circuit to an incremental step incurred within time $\Delta\tau$ at time t is given by:

$$u(t) = \frac{\Delta\tau}{N\Delta\tau} U(t-n\Delta\tau)h(t-n\Delta\tau)$$

where $N\Delta\tau = T$.

The time response to RPCM soft start for t<T is:

$$s(t) = \frac{1}{T}\int_0^t h(t-\tau)d\tau \cong \frac{60}{aT}\left(1-e^{-\alpha t}\right)$$

and for t > T, the response is:

$$s(t) = \frac{1}{T}\int_0^T h(t-\tau)d\tau \cong \frac{60}{\alpha T}\left(e^{-\alpha(t-T)}\right).$$

From these equations the soft start response descends 4.2 volts below 120 volts and remains there until soft start is over at 1 millisecond, when the voltage returns quickly to 120 volts.

EMECB TIA–0079

C.3.2.1.3.2 CE07 LIMITS

Exception: The Area Smoke Detector (CI FDA001A, PNs 2119818–98 and 2119818–99) meets 3.2.1.3.2 CE07 waveform without the use of soft start RPCM by analysis using PSpice.

Rationale: The voltage trace shown in Test Report 96–07490, attachment 6, page 32, was obtained from a test set up that used a fast mercury switch to initiate power to the Area Smoke Detector, instead of a soft start RPCM. This voltage trace fails CE07 from approximately 0.1 to 1.0 microsecond. The outage is at –62.4 volts (–60 volts allowed) at 0.12 microseconds; the entire pulse lasts less than 0.5 microseconds. The RPCM provides slow start/stop which will not allow for the large voltage drop as seen in attachment 6, page 32. When RPCM soft start/stop is considered, this trace does not indicate a CE07 failure.

The following analysis was provided by Allied Signal: ”The CE07 test was done using a mercury switch between the unit under test and the Line Impedance Stabilization Network (LISN). The switch which turns the unit off or on in the Space Station has soft start circuitry, per SSP 30263:002, paragraph 3.7.1.2.3.1, for Type V RPCM. If the soft start circuitry effects are taken into account, the unit would easily comply with the CE07 requirement, but if the mercury switch is used (as in the actual test) the unit input filtering capacitance draws the input line voltage at the LISN down slightly more than allowed. The length of this spike is only 1 microsecond total.

A PSpice analysis was done using the circuit shown in Test Report 96–07490, attachment 6, page 42, Figure 1. The mercury switch was modeled using the PSpice VSWITCH set to change from 10 megohms resistance to .0001 ohms in 1 nanosecond. The resultant spike on the power line at the output of the simulated LISN very closely matches the actual test data shown in Test Report 96–07490, attachment 6, Figure 2. Test Report 96–07490, attachment 6, Figure 3 shows the PSpice power line voltage spike and current spike drawn by the input capacitance. The CE07 limit is plus or minus 50 percent of the line voltage. Fifty percent of 120 volts is 60 volts, so the lower limit is 120 minus 60 volts which is 60 volts. The test voltage got down to about 62 volts below the 120 volts, and the analysis (not including stray inductance and resistance such as that associated with the wire–wound resistors in the actual LISN) shows a maximum dip to about 85 volts below the 120 volts line, (See Test Report 96–07490, attachment 6, Figure 3 for these results. V(47,2) is the voltage at the LISN terminals.) This is the maximum dip possible with these circuit constants and it won't actually occur in the actual testing because of the stray inductance and resistance and the imperfections of the components themselves. Nevertheless, the analytical spike shape and amplitude is very close to that actually obtained, so the model is sufficiently similar to the empirical data. Input current under this condition was over 3A peak (I(RL2)), but the pulse length is only 3 microseconds.

Next, a low on resistance Field Effect Transistor (FET) was chosen as the switch, and the gate to source voltage on the FET was varied linearly from –2 to 10 volts in 1 millisecond. Actually this will turn the FET from completely off (below +3 volts Vgs) to completely on (above +5 volts Vgs) in much less than a millisecond. The RPCM ICD (SSP 30263:002, Revision H), Figure 3.7.1.2.3.1–1, shows the RPCM soft start/stop characteristic, and this shows a minimum rise time of 1 millisecond until the full conductivity of the RPCM soft start switch is obtained.

For the analysis circuit, the actual switching time from essentially no conductivity to 100 percent conductivity (less than 30 milliohms for this transistor) is actually close to one–sixth of a millisecond. The circuit for this analysis is shown in Test Report 96–07490, attachment 6, Figure 4, and the results are shown in 96–07490, attachment 6, Figure 5. This shows the voltage into the unit increasing from 0 to 120 volts in less than 100 microseconds. I(RL2) is the current into the unit, and it is a maximum of 0.22A during the charging, and it stabilizes at around 7 mA. (This is very much less than the 3 A peak of the mercury switch circuit.) The spike seen on the power supply at the output of the LISN (the test measurement point) is approximately 1.2 volts above 120 volts and 0.1 volts below 120 volts. This spike level is almost negligible. The unit would certainly be well within the CE07 specification limits when the soft start circuitry effects are taken into account. The unit, therefore, complies with this requirement."

EMECB TIA–0080

C.3.2.3.1.2 RE02 LIMITS AND
C.3.2.4.2.2 RS03 LIMITS

Exception: The Early Communication (ECOMM) System is allowed to exceed the EMI requirements of SSP 30237 by the following:

A. RE02: 3.4 dBm V/m at 280.33 MHz

B. RS03: 21.99 V/m at 700.60 MHz, 22.81 V/m at 702.80 MHz, 9.12 V/m & 17.22 V/m at 1.051 GHz, and 17.22 V/m at 1.056 GHz.

Rationale: The 3.4 dB μV/m out of specification radiated emission may be due to the ECOMM antenna, with a hat coupler, being operated during the test. The antenna will be mounted outside of the Station once on–orbit. ECOMM system is a criticality 3 item which does not cause loss of life, loss of the Station, or loss of the mission. ECOMM is a fail or safe system, reference Hazard Report Number EC–010 Erroneous Data and Loss of ECOMM. The susceptibility out of specification if results in loss of the ECOMM system will not cause any concern to the crews, Station, or mission. Any modification would have impacted the schedule. A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages.

EMECB TIA–0082

C.3.2.1.2.2 CE03 LIMITS

Exception: The Battery Charger (SEG39122465–301) exceeds the SSP 30237, Revision C, paragraph 3.2.1.2 CE03 limits by 2.1 dBμA at 0.08028 MHz.

Rationale: An assessment of this CE03 outage shows it is so small (2.1 dBμA at 80 kHz) it will not affect the other components of the ISS. All conducted emissions to susceptibility margins are documented in the on going assessment document D684–10232–01. Implementation of this TIA does not degrade the margin required by SSP 30243, paragraph 3.2.3.

EMECB TIA–0083

C.3.2.4.2.2 RS03 LIMITS

Exception: The radiated RS03 electric field specified in 3.2.4.2.2, may be reduced from 5.0 V/m to 2.0 V/m over the frequency range of 48 to 60 MHz when the RPCM temperature sensor is evaluated for RS03 compliance. This tailoring applies to RPCM PNs: R077416, R077417, R077418, R077419, R077420, and R072702.

Note: This TIA shall supersede and replace all changes invoked by TIA–0059.

Rationale: The RPCM temperature sensor is susceptible when the RS03 radiation is coupled onto the external power leads. The temperature sensor's susceptibility is reduced when the external power leads are protected or shielded from the RS03 field. A significant improvement in the temperature sensors immunity is detected when the power cables are moved closer to the ground plane. When RS03 tests are performed on the RPCM, the RPCM electrical connector and cables are exposed to much higher levels of electric field radiation than would occur if the RPCM was tested in situ on Space Station. During the RS03 tests the test article is positioned with its unshielded cables and open connector end exposed to the RS03 irradiating antenna. The RS03 field is measured at the connector interface of the test sample. This test procedure is used to simplify the test setup because replicating the actual RPCM installation bay and enclosed cable trays during RS03 testing is costly and difficult to configure. The RPCM temperature sensor is used before the Thermal Control System becomes active on Flight 4A. A minimum of 48 dB margin exists between the RE02 and RS03 limits. There were no anomalies detected during full scale RS03 tests of Node 1 at Kennedy Space Center (KSC) in May 1998.

EMECB TIA–0084

C.3.2.4.2.2 RS03 LIMITS

Exception: The radiated RS03 electric field specified in 3.2.4.2.2, may be reduced from 60 V/m to 20 V/m over the frequency range of 230 to 270 MHz when the RPCM temperature sensor is evaluated for RS03 compliance. This tailoring applies to RPCM PNs: R077420 and R072702.

Rationale: The RPCM temperature sensor is susceptible when the RS03 radiation is coupled onto the external power leads and into he RPCM connector interface during RS03 testing. When RS03 tests are performed on the RPCM, the RPCM electrical connector and cables are exposed to much higher levels of electric field radiation than would occur if the RPCM was tested in situ on Space Station. During the RS03 tests the test article is positioned with its unshielded cables and open connector end exposed to the RS03 irradiating antenna. The RS03 field is measured at the connector interface of the test sample. This test procedure is used to simplify the test setup because replicating the actual RPCM installation bay and enclosed cable trays during RS03 testing is costly and difficult to configure. The test results indicate that the Radio Frequency (RF) amplifier power to the RS03 irradiating antenna during the susceptible frequencies (235 to 265 MHz) is twice as high as other RS03 test frequencies. This anomaly indicates that multi path interference patterns due to reflections from the shielded enclosure may be present in the region around the test sample. Since the power at the susceptible frequency band is more than the power of other RS03 test frequencies, it is possible that the test sample was exposed to higher levels of irradiation than were detected by the two E–field sensors adjacent to the RPCM. The RPCM temperature sensor is used before the Thermal Control System becomes active on Flight 4A. The only possible source of interference is the Extravehicular Mobility Unit (EMU) radio at a frequency of 259 MHz. This frequency is only used on Flight 2A and then the frequency of the EMU radios changes to another in the the 400 MHz range. The power of this radio operates with 0.25 Watts and will not interfere with the RPCMs. A minimum of 48 dB margin exists between the RE02 and RS03 limits. There were no anomalies detected during full scale RS03 tests of Node 1 at KSC in May 1998.

EMECB TIA–0085

C.3.2.2.2.2 CS02 LIMITS

Exception: The injected CS02 voltage specified in 3.2.2.2.2, may be reduced to the following values when the RPCM temperature sensor is evaluated for CS02 compliance:

CS02 Test Frequencies	Injected CS02 Signal
38 to 44 MHz	0.8 Vrms
44 to 48 MHz	0.6 Vrms
48 to 50 MHz	0.3 Vrms

This tailoring applies to RPCM PNs: R077416, R077417, R077418, R077419, R077420, and R072702. Note: This TIA shall supersede and replace all changes invoked by TIA–0051.

Rationale: The RPCMs are installed only on the secondary power system. The SSP 30482 Power Quality document limits the total steady state voltage on the secondary power bus to 0.1 Vrms for any frequency above 10 MHz. This is 20 dB less than the CS02 requirement of 1 Vrms. It is highly unlikely that the secondary power bus can sustain a steady state narrowband voltage of greater than 0.01 Vrms at frequencies above 40 MHz. This is 40 dB less than the CS02 requirement. This TIA reduces the CS02 test voltage by 2.0 to 10 dB, depending on frequency. This change will not significantly impact the safety margin required for RPCM temperature sensor compatibility. The RPCM temperature sensor is used before the Thermal Control System becomes active on Flight 4A. Between the conducted emissions (CE01 and CE02) and the conducted susceptibilities (CS01 and CS02) the margin is 30 to 40 dB.

EMECB TIA–0088

C.3.2.2.3.2 CS06 LIMITS

Exception: The ECOMM System (consisting of four ECOMM ORUs (190–136110, SEG39130724–301, SEG39130674–301, SEG39130534–301) is allowed to be tested to SSP 30247, paragraph 3.2.2.3.2, for CS06 compliance with only spike #2 (t = 0.15 msec).

Rationale: The CS06 test was not performed for spike #1 because there was concern that the negative voltage swing induced by application of the lower frequency spike would damage the ECOMM transceiver, which is modified COTS equipment. The ECOMM system is a criticality 3 system, the loss of which does not cause loss of life, loss of the Station, or loss of mission. ECOMM is a fail or safe system, reference Hazard Report Number EC–010 Erroneous Data and Loss of ECOMM. If the system susceptibility to such transients results in loss of the ECOMM system, such loss will not jeopardize the crew, Station, or mission. Any modification to meet this requirement would have significantly impacted the schedule.

EMECB TIA–0089

C.3.2.4.2.2 RS03 LIMITS

Exception: The 3.2.4.2.2, RS03 limits for the IMV Fan (CI SSF9619, PN SV809111) are reduced to 52 V/m from 270 to 272 MHz and from 419 to 431 MHz+.

Rationale: The SSP 30237, RS03 test limits have at least 6 dB margin built–in, the requested relaxation is using only 1.25 dB of that margin. The only transmitter near these ranges are the Space to Space Communications System (SSCS) internal transmitters at 414.2 or 417.1 MHz, whose output is very low power (0.25 W). No other transmitters are known to operate at or near these frequencies. A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages. There were no anomalies detected during full scale RS03 tests of Node 1 at KSC in May 1998.

EMECB TIA–0090

C.3.2.2.1.2 CS01 LIMITS

Exception: The Metox Generator (PN SV822000–2) is allowed to pass the 3.2.2.1.2, CS01 rms signal requirement between 337 Hz and 482 Hz at a level of 3.2 Vrms.

Rationale: The worst case point is at the EMI filter resonance point of 406 Hz. The power level of the signal to cause the heater overcurrent is at least 20 Watts. To recover from this outage, a crewmember would have to turn the power off and back on and restart the regeneration cycle. The effective input impedance of the Metox Regenerator varies between 0.6 to 1.1 Ohms over the frequency of 337 Hz to 482 Hz.

A review of the Airlock components has been conducted and shows that the Conducted Emissions of the ISS components in the same Airlock rack have a limitation of 0.95 Amps at 300 Hz down to 0.55 Amps at 500 Hz, which leaves adequate margin to prevent a Conducted Susceptibility (CS) interference with the Metox item.

An example based on the worst case THC CE current of 0.95 Amps coupled into the 1.1 Ohm input impedance of the Metox Regenerator yields only 1.05 volts of ripple. The CS01 outage of the Metox item starts at 4.8 volts of ripple at 337 Hz. The EMI margin equal 20 log(4.8 Vrms/1.05 Vrms) = 13.2 dB margin. A safety margin of 6 dB is generally deemed acceptable. Between the Conducted Emissions (CE01 and CE02) and the conducted susceptibilities (CS01 and CS02) the margin is 30 to 40 dB 4.8 volts rms at 337 Hz, 20 Watts, 1.1 Ohm impedance.

4.5 volts rms at 351 Hz, 21.2 Watts

3.7 volts rms at 377 Hz, 20 Watts

3.2 volts rms at 406 Hz, 24 Watts, 0.6 Ohm impedance

3.8 volts rms at 451 Hz, 25.7 Watts

4.9 volts rms at 482 Hz, 28.1 Watts, 0.73 Ohm impedance

The following flag note will be added to the Metox Regenerator ICD, SVHS822000, Revision B: ”Note 40 – The Metal Oxide Regenerator shall function nominally while a 5 volt rms signal between 30 Hz to 2 kHz is injected on the power leads, except the maximum rms signals between 337 Hz and 482 Hz shall be 3.2 Vrms”.

EMECB TIA–0095

C.3.2.1.2.2 CE03 LIMITS,
C.3.2.1.3.2 CE07 LIMITS,
C.3.2.3.1.2 RE02 LIMITS,
C.3.2.4.1.2 RS02 LIMITS, AND
C.3.2.4.2.2 RS03 LIMITS

Exception: The ECOMM FGB Video Teleconferencing System (VTS) consisting of the PNs SED39129333–301, SED39129332–301, 528–20946–1, SED33109713–301, SED16101291–313, SED16102919–301, SED39134112–301, SED39134120–301, and TPS7A9820246, when used on the United States segments only, is allowed to exceed the 3.2.1.2 CE03 requirements by up to 4.2 dB from 350 kHz to 2.1 MHz, the paragraph 3.2.1.3 CE07 requirements by 8.2 V at 105 microseconds, the paragraph 3.2.3.1 RE02 requirements by 5.7 dB at 33.02 MHz, and 4.5 dB at 275.41 MHz, to pass the paragraph 3.2.4.1 RS02 requirements at a level of 5.3 V peak with a 0.15 microsecond spike, and to pass the paragraph 3.2.4.2 RS03 requirements at a level of 0.45 V/m from 14 kHz to 200 MHz and a level of 3.35 V/m from 200 MHz to 1.82 GHz. Exact outages and frequencies are on the continuation sheets. Use on Russian segments requires approval of Russian hardware provider.

Rationale: The ECOMM FGB VTS consisting of the items found in the exception above, with the exception of the dc Power Isolator, have been previously certified for flight on the Orbiter. This system displays exceedances similar to those of the system that has flown on the Orbiter with no ill effect. The ECOMM FGB VTS RE02 outage at 275.41 MHz will not interfere with the Shuttle EMU radio operating at a frequency of 279 MHz. The EMU radio has a half–power bandwidth of 80 kHz. Any noise appearing at the radio antenna terminal outside the pass band of 80 kHz will be attenuated by a factor of two (6 dB) or greater. The outage at 275.41 MHz falls outside this pass band. The CE03 and CE07 emissions are on tertiary power and will not affect the 120 Vdc secondary power bus. The ECOMM system is a criticality 3 item which does not cause loss of life, loss of the Station, or loss of the mission. The ECOMM is a fail or safe system, reference Hazard Report Number EC–010 Erroneous Data and Loss of ECOMM. The loss of ECOMM will not cause any concern to the crews, Station, or mission. Any modification would impact the schedule for delivering ECOMM flight hardware. Approval of this TIA is for use on the US Segment only. Russian Space Agency (RSA) approval is required for use in the FGB.

EMECB TIA–0097

C.3.2.3.1.2 RE02 LIMITS

Exception: The Power Distribution Box (PDB) (CI M42010F PN 658470) may exceed the Radiated E–Field (RE02) emission requirements of 3.2.3.1.2.1 by 7 dB at 190 kHz, 7 MHz, 5.5 MHz, and around 15 to 16 MHz.

Rationale: No receivers are present at 190 kHz, 5.5 MHz and 7 MHz and will not affect other avionics. Soyus–Rassvet is at 14.9 MHz. However shielding effectiveness of MPLM Module is 20 dB (test report MLM–RP–AI–0248) and lowers the emission seen by the receiver at 13 dB below the emission specification. This will not interfere with the Rassvet receiver.

EMECB TIA–0098

C.3.2.1.2.2 CE03 LIMITS

Exception: The Power Distribution Box (CI M42010F, PN 658470) may exceed the Conducted Emissions (CE03) requirement of 3.2.1.2.2 by:

A. 8 dB at 135 kHz

B. 13 dB at 180 kHz

C. 16 dB at 2 MHz

D. 7 dB at 4 to 5 MHz

Rationale: Analysis has shown that the outages should not affect other components of the ISS. The analysis is as follows:

The configuration evaluated was for the MPLM attached to the Nadir port of Node 1 and sharing a common power source with the other Node 1 equipment. While this is a conservative approach, the results show margins of over 20 dB, so additional clarification is unnecessary.

During early assembly flights (including the MPLM first use on Flight 6A) the MPLM is powered via the APCU on the Orbiter. However, during later flights the MPLM will be powered via ISS power sources. In this case, the DDCU will be the secondary power source. The analysis was conducted using the bus impedance model used most recently. This configuration has a RACU feeding an RPCM via 100 feet of #4 twisted wire. It should be noted that the RACU and DDCU output impedance curves are similar.

There is little impact to the lowest EMISM values when the MPLM is included in the analysis. The worst case EMISM for this configuration is over 20 dB. Although the MPLM has some significant emissions (both in magnitude and spectral density), the overall EMISM values are not significantly affected.

EMECB TIA–0100

C.3.2.4.1.2 RS02 LIMITS

Exception: The RS02 test does not apply to RPCM (PNs R077416, R077417, R077418, R077419, R077420, R072702) MIL–STD–1553 data bus cables.

Rationale: The RS02 radiated susceptibility requirement applies to all nonpower cable interfaces of the test article. The MIL–STD–1553 data bus is the only nonpower cable interface to the RPCMs. Performing RS02 tests on the RPCMs to evaluate the MIL–STD–1553 cable interface for susceptibility is unnecessary for the following reasons:

A. MIL–STD–1553 technology is proven by design and is inherently robust to transient EMI environments. The MIL–STD–1553 data bus utilizes transmission parity checking to detect bit errors caused by transients or voltage spikes. Manchester encoding is also utilized by the MIL–STD–1553 data bus to discriminate between signal pulses and unintended transients.

B. The design of the MIL–STD–1553 twinaxial cables and connectors are consistent with MIL–C–17/176–00002 and MIL–C–39029, respectively. Since the MIL–STD–1553 cables, connectors and bus impedance are standardized for all MIL–STD–1553 data transmission lines, spikes induced by RS02 testing should be invariant for all MIL–STD–1553 systems. If the MIL–STD–1553 system is found to be inherently susceptible to RS02, no changes could or would be made to the existing standard.

C. The RS02 test induces common mode voltage spikes onto the MIL–STD–1553 data bus through the standard shielded cable. The shielded MIL–STD–1553 twinaxial cable attenuates the induced RS02 signal by 40 to 60 dB. In addition to the cable shielding effectiveness, the MIL–STD–1553 balanced data bus circuit is immune to common mode signals of +/– 10 volts from dc to 2 MHz.

D. A complete MIL–STD–1553 validation test has been performed on the RPCM in accordance with MIL–HDBK–1553. This test included the verification of the +/– 10 volts common mode noise rejection and Gaussian noise rejection requirements. The MIL–STD–1553 Bus was very stable as demonstrated in MIL–STD–1553 Bus tests as documented in Test Report D684–10265–01.

EMECB TIA–0101

C.3.2.1.2.2 CE03 LIMITS

Exception: The DDCU (Internal and External) (CIs DDCU–EA, DDCU–IA; PNs R076500, R076522) output power leads shall be tested for CE03 emissions with 0.2 micro–Farad feedthrough capacitors connected to each DDCU secondary output power lead. The CE03 conducted emissions requirement between the frequencies of 200 kHz and 1000 kHz shall be relaxed by 12 dB when applied to DDCU output power terminals.

Rationale: The CE03 test requirement (SSP 30238), as it applies to output power leads, does not specify any feedthrough (line–to–ground) capacitors for the output leads. The CE03 qualification test was performed on the DDCU output leads using 0.2 F feedthrough capacitors. Selection of the 0.2 F feedthrough capacitors was somewhat arbitrary - 10 F capacitors would have been unrealistically large and no capacitors would have underrepresented the actual bus capacitance.

MIL–STD–461D has deleted output power leads from all CE03 testing. This is because power supplies are typically designed with low output impedances - the DDCU output impedance is less than 0.3 ohms. Output filter inductors can not be used to reduce emissions without increasing the output impedance. Consequently, large CE03 test feedthrough capacitors compete with the power supply's low impedance output filter capacitor to bypassing noise currents.

Output power lead emissions are generally controlled by power quality specifications. In this case, the DDCU's output voltage emissions are controlled by the DDCU Design Specification (RJ00256) and Secondary Power Quality Document (SSP 30482). The specified limit for DDCU output voltage emissions between 50 kHz and 1 MHz is –12 dBV (0.25 V).

Conducted emissions to susceptibility margins are documented in the on going assessment document D684–10232–01. Implementation of this TIA does not degrade the noise margin required by SSP 30243, paragraph 3.2.3.

EMECB TIA–0102

C.3.2.3.1.2 RE02 LIMITS

Exception: The 3.2.3.1 RE02 radiated emissions requirement for the DDCU (Internal and External) (CIs DDCU–EA, DDCU–IA, PNs R076500, R076522) is relaxed by 7 dB between the frequencies of 80 kHz and 1500 kHz.

Rationale: The RE02 emissions indicated in this TIA are caused by discrete DDCU switching harmonics radiating from the DDCU's power leads. The worst case emissions exceed the RE02 limit by only 6.3 dB. A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages.

The RPCM–6 was designed without common mode cancellation capacitors across the charge pump transformers on each channel. This is because the RPCM–6 has 16 fewer power relay drivers (4 channels) than the RPCM–5 (18 channels) which is a greater CE03 noise source and requires additional common mode suppression. It was calculated that the RPCM–6, because of its fewer relay drivers, did not warrant the extra CE03 suppression components (i.e., common mode cancellation capacitors) on the charge pump transformer, especially since the capacitors are difficult to implement.

Conducted emissions to susceptibility margins are documented in the on going assessment document D684–10232–01. Implementation of this TIA does not degrade the margin required by SSP 30243, paragraph 3.2.3.

EMECB TIA–0103

C.3.2.3.1.2 RE02 LIMITS

Exception: The PCS 1553 setup (PNs SDZ39129262–301, SEZ39129266–301, SDZ39129265–301, SEG39129286–301, SEG39129276–709, SEG39129272–301, SEG39129263–301, SDG39129273–301, and SEZ39129266–301) may exceed the paragraph 3.2.3.1 RE02 limits by 8.5 dB at 265.84 MHz and 2.4 dB at 304.28 MHz.

Rationale: A minimum of 48 dB margin exists between the ISS RE02 and RS03 limits. There are no receivers at these outages so there is still a 39.5 dB margin between the RE02 outages and RS03 limits.

EMECB TIA–0104

C.3.2.1.3.2 CE07 LIMITS AND
C.3.2.4.2.2 RS03 LIMITS

Exception: The PCS Ethernet setup (PNs SDZ39129262–301, SEZ39129266–301, SDZ39129265–301, SEG39129286–301, SEG39129276–709, SDZ39121205–301, SEG39129288–301, SED39126010–301, SEG39129263–301, SDZ39122875–301, SDZ39129269–301, and SDZ39121200–301) is allowed to exceed the 3.2.1.3 CE07 requirements by 12.2 V at 17.0 μsec or 58.8 kHz when switching from on to off and by –20.6 V at 87 μsec or 11.5 kHz when switching from off to on. The SDZ39129262–301 Computer and SDZ39129269–301 Ethernet cards are also allowed to pass the 3.2.4.2, RS03 requirements at 0.65 V/m at 20 MHz, 48.21 V/m at 203.2 MHz, 52.4 V/m at 252.4 MHz, 43.97 V/m at 261 MHz, 51.72 V/m at 285 MHz, 44.27 V/m at 290 MHz, 32 V/m at 296 MHz, 41.8 V/m at 305 MHz, 53.85 V/m at 310 MHz, 58.63 V/m at 333.7 MHz, and 51.36 V/m at 339 MHz. The PCS Ethernet payload setup is only allowed to be used for criticality 3 operations.

Rationale: The PCS is powered from a RPCM Type 5 which has a “soft start” characteristic. This means that the entire 120 Vdc is not applied at once when the power starts but comes in a relatively slow period of 1 millisecond. This allows power cables time to build up to the full 120 Vdc at a rate that precludes the CE07 spikes from forming. The spike on the On to Off CE07 test exceeds the limit by 12.2 V. This will cause no problem to the power system. All of the RS03 outages are within the RS03 safety margins with the exception of the 0.65 V/m at 20 MHz. There are no transmitters on the station at 20 MHz. Risk of nonoperation due to known susceptibilities has been accepted by the equipment provider. The PCS is critical category 3 hardware. Nonoperation due to susceptibility will not impact ISS safety or critical hardware functionality.

EMECB TIA–0105

C.3.2.3.1.2 RE02 LIMITS AND
C.3.2.4.2.2 RS03 LIMITS

Exception: The PCS RS422 payload setup (PNs SDZ39129262–301, SEZ39129266–301, SDZ39129265–301, SEG39129286–301, SEG39129276–709, SEG39129272–301, SEG39129263–301, SDZ39129284–301, SEZ39129266–301, SDZ39121205–301, and SEG39129288–301) may exceed the 3.2.3.1 RE02 limits by 2.6 dB at 0.2179 MHz, 12.6 dB at 2.631 MHz, 0.4 dB at 264.56 MHz, and 1.1 dB at 596.843 MHz. The SDZ39129284–301 RS422 Card is also allowed to pass the 3.2.4.2, RS03 requirements at 44.89 V/m at 225.59 MHz, 45.78 V/m at 230 MHz, 38.16 V/m at 245 MHz, 35.25 V/m at 251.8 MHz, 22.86 V/m at 264 MHz, 19.71 V/m at 273 MHz, 24.47 V/m at 285 MHz, 37.04 V/m at 295 MHz, 37.86 V/m at 310 MHz, 39.64 V/m at 321 MHz, and 45.57 V/m at 341.4 MHz. The PCS RS422 payload setup is only allowed to be used for criticality 3 operations.

Rationale: A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these RE02 outages. RS03 testing of criticality 3 hardware is for on–orbit trouble shooting. Risk of nonoperation due to known susceptibilities has been accepted by the equipment provider. Nonoperation due to susceptibility will not impact ISS safety or critical hardware functionality.

EMECB TIA–0108

C.3.2.4.2.2 RE02 LIMITS

Exception: This tailoring applies to the Compound Specific Analyzer–Combustion Products (CSA–CP) and Sampling Pump, PN SED 46115801 and SED 46115803. The radiated RS03 electric field specified in 3.2.4.2 may be reduced from 60 V/m to the following for the specified frequencies:

CSA–CP: 261 MHz - 27 V/m, 270 MHz - 33 V/m, 340 MHz - 33 V/m, 346 MHz - 47 V/m, 364 MHz - 36 V/m, 450 MHz - 29 V/m, 472 MHz to 580 MHz - 18 V/m, 622 MHz to 760 MHz - 15 V/m, 775 MHz to 1 GHz. - 20 V/m. Sampling Pump: 556 to 570 MHz – 40.8 V/m; 670 MHz at 52.02 V/m.

Rationale: The CSA–CP and Sampling Pump are susceptible to RS03 radiation at the frequencies and levels specified the reduced power levels are acceptable for this hardware due to the following considerations:

The failure mechanism for the Sampling Pump is that it is tripped off by the radiation at the frequencies specified. Instrument operation (pump running) was accomplished by cycling the power switch, which restored the instrument to operation. The Sampling Pump is sometimes used with the CSA–CP to take active samples of gas (it provides a quicker response than the CSA–CP alone). Tripping off the Sampling Pump by EMI does not significantly affect the usage since power can be cycled easily. In addition the CSA–CP can operate without the Sampling Pump and still provide the necessary detection capability. The effect on the CSA–CP would decrease the instrument response to a specific gas. For small deviations, the effect would be too small to be of concern. For large deviations, cross correlation between the sensors would provide adequate information to ensure proper use of the data. The Sampling Pump is classified critical category 3 hardware. It is only used in a contingency situation (combustion event) which will be infrequent in nature (maybe once every 3 months).

For the CSA–CP the maximum acceptable HCN and HCL sensor deviation (pass or fail tolerance) during RS03 testing is +/– 1 ppm and +/– 25 ppm for CO. A worst case sensor error of -30 ppm was seen for the HCN sensor, –10 for the HCL sensor and -90 for the CO sensor, all at different frequencies. This has the effect of biasing the instrument low, so that if it is exposed to a specific gas, for example CO, the instrument would give a reading lower than anticipated. The values for the sensors varied from the maximum acceptable deviation to the values listed at the frequencies where the attached table shows deviations. The CSA–CP was classified critical category 3 by the ISS Program direction to CHECS (Crew Health Care Systems). The Government Furnished Equipment (GFE) Assurance Panel, based on the operational usage, has reclassified the CSA–CP as critical category 1SR. There are two uses of the CSA–CP: continuous monitoring for CO and use during a contingency combustion event. For continuous monitoring, the CSA–CP is still considered critical category 3 hardware. However, for combustion events, it is classified as critical category 1SR. Combustion events will probably occur once every two to three months. The critical use of the CSA–CP is when, after the combustion event occurs, it is used to monitor gases present for the next several hours, up to 48 hours (estimated maximum time). This is the only time this unit would be used in a critical function as designated by the GFE Assurance Panel. The extremely low usage of the CSA–CP as a critical category 1 item; coupled with analysis that shows there is over 10 dB of safety margin from known emissions at the susceptible frequencies demonstrates that this equipment is acceptable for use with respect to EME. A minimum of 48 dB margin exists between the RE02 and RS03 limits.

EMECB TIA–0110

C.3.2.1.3.2 CE03 LIMITS AND
C.3.2.2.2 CE07 LIMITS

Exception: The Diagnostic Caddy (PN SEG33108814–301) is allowed to exceed the 3.2.2.2 CE03 limits by up 4.4 dB from 4.692 MHz to 5.006 MHz by 4.8 dB at 1.1 MHz and to exceed the 3.2.1.3.2 CE07 limits by 10.2 Volts at 27 microseconds.

Rationale: For CE03 the outages will not affect the other components of the ISS. Conducted emissions to susceptibility margins will be incorporated in the next update to the conducted emissions assessment document D684–010232–01. Implementation of this TIA does not degrade the margin required by SSP 30245, paragraph 3.2.3. The 27 Volt spike at 27 microseconds is of a duration of less than 10 microseconds. ORUs are tested with a 360 volt, 10 microsecond CS06 transient. 30 dB of margin exists which meets the system level margin requirement.

EMECB TIA–0111

C.3.2.1.3.2 CE07 LIMITS AND
C.3.2.3.1.2 RE02 LIMITS

Exception: The Electronic Still Camera system consisting of SCSI Cable, PN 528–21008–2; ESC–II Color Camera, SED33105837–306; 28 Vdc Converter, PN SEG39129950–301; 50 mm lens, PN 235384; Calluna 520 MB Hard Drive, PN SED33105832–304; SCSI Cable, PN 528–21008–1; SCSI Card, PN SED33107706–302; and ESC Power Adapter Cable, PN SEG33111365–301, when used on the US segments only, is allowed to exceed the 3.2.3.1.2 RE02 limits by 1.5 dB at 360.24 MHz, 11.3 dB at 440.43 MHz and 0.1 dB at 520.6 MHz. The system is also allowed to exceed the 3.2.1.3.2 CE07 requirements for 28 Vdc power by –0.52 Vdc at 3.7 millisecond Use on Russian segments requires approval of Russian hardware provider.

Rationale: For the RE02 exception a minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages. For CE07 the outage is very small and there will be no problem in allowing this –0.52 Vdc exception. Approval of this TIA is for use on the US Segment only. RSA approval is required for use in the FGB.

EMECB TIA–0112

C.3.2.1.2.2 CE03 LIMITS

Exception: The CE03 conducted emissions requirement specified in 3.2.1.2 shall be relaxed by 3 dB (from 45 to 48 dBμA) for the case when the RPCM–6 (CI RPC6EA, RPC6IA; PN R077420) is operating with all of its power relay channels in the open position.

Rationale: The RPCM–6 was out of specification by less than 3 dB at only one frequency (1 MHz). This is probably due to common mode emissions from the RPCM–6 relay driver circuits.

The RPCM–6 was designed without common mode cancellation capacitors across the change pump transformers on each channel. This is because the RPCM–6 has sixteen fewer power relay drivers (4 channels) than the RPCM–5 (18 channels) which is a greater CE03 noise source and requires additional common mode suppression. It was calculated that the RPCM–6, because of its fewer relay drivers, did not warrant the extra CE03 suppression components (i.e., common mode cancellation capacitors) on the charge pump transformer, especially since the capacitors are difficult to implement.

Conducted emissions to susceptibility margins are documented in the on going assessment document D684–10232–01. Implementation of this TIA does not degrade the margin required by SSP 30243, paragraph 3.2.3.

EMECB TIA–0114

C.3.2.1.2.2 CE03 LIMITS AND
C.3.2.1.3.2 CE07 LIMITS

Exception: The High Rate Modem (CI 222017A, PN 01–P337000U001) is allowed to exceed the 3.2.1.2.2 CE03 limits by 3 dB on the high voltage line at 230 kHz and by 7 dB on the supply line and 14 dB on the return line at 243.98 kHz, the 5th harmonic of the power converter. The High Rate Modem is also allowed to exceed the 3.2.1.3.2 CE07 limits by 6 volts during the 0.1 millisecond to 10 millisecond time period.

Rationale: For the CE03 exceedance conducted emissions to susceptibility margins are documented in the on going assessment document D684–10232–01. Implementation of this TIA does not degrade the margin of SSP 30243, paragraph 3.2.3. For CE07 the High Rate Modem is supplied power through a RPCM with slow turn on characteristics. The RPCM can not turn on the High Rate Modem on as fast as this test does. This exceedance can not occur in flight.

EMECB TIA–0115

C.3.2.1.2.2 CE03 LIMITS

Exception: 1) The Assembly Contingency Baseband Signal Processor (CI 222013A, PN 01–P35390T001) is allowed to exceed the 3.2.1.2.2 CE03 limits on the 120 V high voltage line at:

A. 55 kHz by 0.7 dB

B. 166 kHz by 1.4 dB

C. 276 kHz by 2.1 dB

D. 12.16 MHz by 2.5 dB

2) The Assembly Contingency Baseband Signal Processor (CI 222013A, PN 01– P35390T001) is allowed to exceed the 3.2.1.2.2 CE03 limits on the 120 V return voltage line at:

A. 55 kHz by 1.7 dB

B. 276 kHz by 3.1 dB

C. 11.91 MHz by 4.5 dB

Rationale: For the CE03 exceedance conducted emissions to susceptibility margins are documented in the on going assessment document D684–10232–01. Implementation of this TIA does not degrade the margin of SSP 30243, paragraph 3.2.3.

EMECB TIA–0116

C.3.2.1.3.2 CE07 LIMITS AND
C.3.2.4.1.2 RS02 LIMITS

Exception:

A. The High Rate Frame Mux (CI 222021A, PN 01– P23400N001) is allowed to exceed the 3.2.1.3 CE07 limits for heater turn on by 1.0 volts at 48 msec and by 2.0 volts at 54 millisecond

B. The High Rate Frame Mux (CI 222021A, PN 01– P23400N001) is allowed to be susceptible to transients greater than 190 volts and to negative transients with magnitudes greater than or equal to 230 Volts.

Rationale: For the CE07 exceedance conducted emissions to susceptibility margins are documented in the on going assessment document D684–10232–01. Implementation of this TIA does not degrade the margin of SSP 30243, paragraph 3.2.3.

The RS02 susceptibility test transient activity causes the monitored bit error rate to exceed the defined qualification limit. In the integrated system, the data bus errors can be expected to be detected by the parity check and corrected by programmed word–repeat. RS02 transients of this magnitude (190 Volts generated B Field) will be unusual. The volt–time product of the transient is estimated to be 399 μV–sec, 18 dB below the CS06 level. The energy content is 17 dB below the CS06 test level. The peak level of 27 V over the nominal bus voltage is nearly 19 dB below the peak CS06 level, assuring adequate margins on the power bus.

EMECB TIA–0117

C.3.2.4.2.2 RS03 LIMITS

Exception: The RS03 radiated susceptibility requirement for the Area Smoke Detector (CI FDA001A, PN 2119818–98) specified in 3.2.4.2 shall be relaxed over the frequency range of 208 to 486 MHz as follows:

RS03 susceptibility thresholds for vertically polarized antenna in normal (Passive Built–in–Test (BIT)) mode test frequency range (MHz) susceptibility threshold level (V/m)

224	229	50*
361	361	58
370	370	58
382	400	58

RS03 susceptibility thresholds for vertically polarized antenna in Active BIT (ABIT) mode test frequency range (MHz) susceptibility threshold level (V/m)

211	211	45*
223	231	43
331	331	55
340	346	45
351	362	45
365	376	35
381	381	45
391	400	34

RS03 susceptibility thresholds for horizontally polarized antenna in normal (Passive BIT) mode test frequency range (MHz) susceptibility threshold level (V/m)

220	224	50*
311	311	58
346	395	28
395	408	24
415	439	34
455	460	58
472	476	52

RS03 susceptibility thresholds for horizontally polarized antenna in ABIT mode test frequency range (MHz) susceptibility threshold level (V/m)

208	208	58*
213	216	38
216	227	55
231	231	58
331	335	48
338	349	32
350	410	15
416	438	24
452	486	58

*sensor readings available

Rationale: The actual value of the two analog Area Smoke Detector (ASD) sensor readings (percent scatter and percent obscuration) were recorded for four of the 28 anomalies noted, and presented in the report with the low and high limits of the acceptable range of the sensor. A recent change expanded the acceptable ranges of sensor output in the flight software. Presented below are the values of the sensor outputs for the four anomalies recorded, the acceptable range of outputs per the current flight software, and the limits used in the test report (in parenthesis).

Case 1:	Passive BIT mode, vertical polarization	Lo Limit (report)	Measured	Hi Limit (report) Units
	Scatter	-0.500 (-0.500)	-0.208	(+0.500) Volts
	Obscuration	+0.000 (3.000)	+0.112	+4.600 (+4.500) Volts

Note: This reading would not be considered anomalous by the current flight software

Case 2:	Active BIT mode, vertical polarization	Lo Limit (report)	Measured	Hi Limit (report) Units
	Scatter	+1.400 (+1.800)	+4.958	+4.600 (+4.200) Volts
	Obscuration	-4.500 (-5.500)	-4.204	-3.600 (-3.500) Volts
Case 3:	Passive BIT mode, horizontal polarization	Lo Limit (report)	Measured	Hi Limit (report) Units
	Scatter	-0.500 (-0.500)	+0.942	(+0.500) Volts
	Obscuration	+0.000 (3.000)	+1.726	+4.600 (+4.500) Volts

Note: This obscuration reading would not be considered anomalous by the current flight software.

Case 4:	Active BIT mode, horizontal polarization	Lo Limit (report)	Measured	Hi Limit (report) Units
	Scatter	+1.400 (+1.800)	+4.729	+4.600 (+4.200) Volts
	Obscuration	-4.500 (-5.500)	-4.136	-3.600 (-3.500) Volts

A software review evaluated the flight software response to these four cases for three operating conditions of the ASD:

A. Passive BIT (Note that the ASD normally operates in Passive BIT at 1 Hz unless Active BIT is in progress). This evaluation assumes two successive readings at this voltage.

B. Active BIT Phase 1 (LASER off and LED on)

C. Active BIT Phase 2 (both LASER and LED off)

The ASD test report does not make a distinction between Active BIT Phase 1 and Phase 2. Note that Active BIT occurs for the following conditions: (1) Upon receipt of a Begin Monitoring Command, (2) Upon receipt of a Perform BIT Command, (3) If the Passive BIT determines that the Scatter Voltage is greater than or equal to the Scatter Threshold for two consecutive reads, and (4) If 24 hours of monitoring has lapsed since an Active BIT has been performed.

Case 1:	Passive BIT mode	A	B	C
	Scatter of -0.208	ok	N/A	N/A
	Obscuration of +0.112	ok	N/A	N/A

Case 2:	Active BIT mode	A	B	C
	Scatter of +4.958	N/A	BIT failed	BIT failed
	Obscuration of -4.204	N/A	ok	ok
Case 3:	Passive Bit mode	A	B	C
	Scatter of +0.942	ok	N/A	N/A
	Obscuration of +1.726	ok	N/A	N/A
Case 4:	Active BIT mode	A	B	C
	Scatter of +4.729	N/A	BIT failed	BIT failed
	Obscuration of -4.136	N/A	ok	ok

Although the ASD flight software would generate a Caution message for the conditions listed as ”ASD failed” and ”BIT failed”, it would not generate a false alarm, or inhibit an alarm in subsequent use.

There are six ISS RF transmitters in the frequency range of 208 to 486 MHz. Only three of these operate at frequencies where ASD susceptibilities were identified, and require further consideration.

Transmitter	Frequency(s) (MHz)
(1) USOS:SSCS EMU (mobile antenna)	414.2, 417.1
(2) USOS:SSCS ISS Radio (antennas on USL, ITS P1)	414.2, 417.1
(3) RSOS:KL–108 (Television) – (antennas on SM, FGB)	463

A comparison of these transmitter frequencies to each of the four tested sets of operating modes and antenna polarizations results in the following set of susceptibility thresholds:

	Passive BIT		Active BIT	
	Vertical	Horizontal	Vertical	Horizontal
(1) USOS:SSCS (at 414.2 MHz)	pass	34 V/m	pass	pass
(2) USOS:SSCS (at 417.1 MHz)	pass	34 V/m	pass	24 V/m
(3) RSOS:KL–108 (at 463 MHz)	pass	pass	pass	58 V/m

Using the currently best available data to calculate the field strength from the associated antennas at the worst case distance assumed, the transmitters are shown to be well under the susceptibility thresholds demonstrated during test.

Transmitter	Frequency(s) (MHz)	Worst case distance from ASD (meters)	Resultant Field Strength at the ASD (V/m)
SSCS EMU	414.2, 417.1	0.5 m	4.112
SSCS ISS Radio	414.2, 417.1	1.0 m	3.073
KL–108A (FGB)	463	9.0 m	1.431

(KL–108A SM antennas will be further from Node 1 than FGB, so the FGB is a worst case)

The ASD must also be compared to the profile of known ground based RF transmitters. Presented below are the frequencies of known transmitters in the range of 200 to 500 MHz. The second column gives the resultant field strength at the ISS altitude of 200 nm. The margins to ASD Susceptibility thresholds are calculated for vertical antenna polarization, both normal and BIT modes.

			Passive BIT Mode					
			Vertical Polarization			Horizontal Polarization		
Frequency	Field Strength		ASD Threshold		Margin	ASD Threshold		Margin
(MHz)	(V/m)	(dB)	(V/m)	(dB)	(dB)	(V/m)	(dB)	(dB)
204.86	0.51	-5.9	60	35.6	41.4	60	35.6	41.4
208.18	0.80	-1.9	60	35.6	37.5	60	35.6	37.5
211.55	1.29	2.2	60	35.6	33.4	60	35.6	33.4
214.98	1.29	2.2	60	35.6	33.4	60	35.6	33.4
218.47	0.51	-5.9	60	35.6	41.4	60	35.6	41.4
365.47	0.51	-5.9	60	35.6	41.4	28	28.9	34.8
371.39	0.52	-5.7	60	35.6	41.3	28	28.9	34.7
377.41	2.10	6.4	60	35.6	29.1	28	28.9	22.5
402.48	2.10	6.4	60	35.6	29.1	24	27.6	21.2
409.01	2.80	8.9	60	35.6	26.6	60	35.6	26.6
415.64	6.74	16.6	60	35.6	19.0	60	35.6	19.0
415.64	18.88	25.5	60	35.6	10.0	34	30.6	5.1
422.38	23.92	27.6	60	35.6	8.0	34	30.6	3.1
429.22	11.19	21.0	60	35.6	14.6	34	30.6	9.7
436.18	10.99	20.8	60	35.6	14.7	34	30.6	9.8
443.25	10.64	20.5	60	35.6	15.0	60	35.6	15.0
457.74	4.13	12.3	60	35.6	23.2	58	35.3	23.0
465.16	0.51	-5.9	60	35.6	41.4	60	35.6	41.4

Listed below is the same information for Active BIT mode.

Active BIT Mode

			Vertical Polarization			Horizontal Polarization		
Frequency	Field Strength		ASD Threshold		Margin	ASD Threshold		Margin
(MHz)	(V/m)	(dB)	(V/m)	(dB)	(dB)	(V/m)	(dB)	(dB)
204.86	0.51	-5.9	60	35.6	41.4	60	35.6	41.4
208.18	0.80	-1.9	60	35.6	37.5	58	35.3	37.2
211.55	1.29	2.2	45	33.1	30.9	60	35.6	33.4
214.98	1.29	2.2	60	35.6	33.4	38	31.6	29.4
218.47	0.51	-5.9	60	35.6	41.4	55	34.8	40.7
365.47	0.51	-5.9	60	35.6	41.4	15	23.5	29.4
371.39	0.52	-5.7	35	30.9	36.6	15	23.5	29.3
377.41	2.10	6.4	60	35.6	29.1	15	23.5	17.1
402.48	2.10	6.4	60	35.6	29.1	15	23.5	17.1
409.01	2.80	8.9	60	35.6	26.6	15	23.5	14.6
415.64	6.74	16.6	60	35.6	19.0	60	35.6	19.0
415.64	18.88	25.5	60	35.6	10.0	60	35.6	10.0
422.38	23.92	27.6	60	35.6	8.0	24	27.6	0.03
429.22	11.18	21.0	60	35.6	14.6	24	27.6	6.6
436.18	10.99	20.8	60	35.6	14.7	24	27.6	6.8
443.25	10.63	20.5	60	35.6	15.0	24	27.6	7.1
457.74	4.13	12.3	60	35.6	23.2	60	35.6	23.2
465.16	0.51	-5.9	60	35.6	41.4	58	35.3	41.1

These calculations confirm positive margins for these ground based transmitters. There is one transmitter at 422.375 MHz with a very low margin of 0.03 dB for horizontal polarization in BIT mode. However, the probability of upset due to this one transmitter is low. First, the Active BIT mode is used about once per day and the ISS can be expected to be over the offending antenna only about once a month. The expected rate of upsets (ABIT occurring over the antenna) is about once in 100 years. Second, the offending antenna is not transmitting to or tracking the ISS. However, for completeness, we address this low upset probability by recommending the following operational workaround: in case an ASD ABIT anomaly is observed, wait ten minutes (so the ground transmitter is no longer in line of sight) and repeat the BIT. The crew could also be briefed as to the location of the potentially offending marginal ground transmitters, so anomalies caused by them are not unexpected.

EMECB TIA–0118

C.3.2.1.2.2 CE03 LIMITS AND
C.3.2.4.2.2 RS03 LIMITS

Exception: The IMAX light, ballast, battery charger, battery, microphones, and recorder (PNs ACC0035–1, ACC0023–1, ACC0051, ACC0038, ACC0039, ACC0033) are allowed to exceed the 3.2.1.2.2 CE03 requirements as follows:

A. Charger/Battery combination +1.7 dB at 12.31 MHz on the return line, +4.6 dB at 214 kHz and 3.1 dB at 12.1 MHz on the hot line

B. Charger/Recorder Combination +2.9 dB at 10.81 MHz

C. The IMAX is allowed to exceed the 3.2.4.2.1, RS03 requirements as follows:

D. Charger/Battery combination 4.05 V/m at 25.7 MHz and 23.8 V/m at 200 to 316 MHz

E. Charger/Recorder combination 25.01 V/m at 230 MHz, 14.73 V/m at 250 MHz, 21.02 V/m at 275 MHz, 20.42.V/m at 300 MHz, 28.82 V/m at 326 MHz, 26.6 V/m at 433.6 MHz, and 27.1 V/m at 450 MHz

The RS03 tests were limited to a maximum of 30 V/m.

Rationale: The transient and steady state emissions are sufficiently low that they are not expected to interfere with other systems. The conducted emissions outages are sufficiently small that no interference is expected with other systems. Conducted emissions to susceptibility margins are documented in the on going assessment document D684–10232–01. Implementation of this TIA does not degrade the noise margin required by SSP 30243, paragraph 3.2.3.

The radiated susceptibility affects only the IMAX system, which is a noncritical item.

The IMAX system is GFE, has only a dc power interface with the Space Station and is not essential or critical for station operations.

EMECB TIA–0119

C.3.2.2.3.2 CS06 LIMITS AND
C.3.2.4.2.2 RS03 LIMITS

Exception: The Portable Breathing Apparatus (PBA) (PN 33105020–301) is allowed to pass the 3.2.2.3.2, CS06 requirements of a 0.15 microsecond spike at a level of 17.63 volts for a positive spike and 18.49 volts for a negative spike instead of the required 20 volt spike.

The PBA is allowed to pass the 3.2.4.2.2, RS03 requirements at the following levels:

TABLE TIA–0119–1 PBA SPIKE EXCEPTION

Frequency	Threshold Level in V/m(1)	Frequency	Threshold Level in V/m(1)
20 MHz	1.19	200–250 MHz	18
25–33 MHz	1.85	275 MHz	12.59
40 MHz	0.72	300–325 MHz	18.32
45 MHz	4.22	350 MHz	6.57
		400 MHz	24.39
50.48–50.8 MHz	3.84	450 MHz	9.97
55 MHz	1.68	500–700 MHz	13.94
60.58 MHz	3.92	750–1000 MHz	23.16
65.65 MHz	4.39	1.1–1.2 GHz	48.99
68.99 MHz	4.4	1.3–1.4 GHz	22.4
70 MHz	2.23	1.5 GHz	54.22
70.24 MHz	4.16	1.632 GHz	27.88
75.89–76.45 MHz	3.88	1.7 GHz	48.38
80.3–80.52 MHz	4.21	1.8 GHz	15.32
85.84 MHz	3.61	1.9 GHz	47.22
90–90.13 MHz	4.01	2–3.1 GHz	11.31
107.95–198 MHz	2.48	3.4–7.8 GHz	32.89

Note:
(1) Threshold Level in V/m is the level at which harmonic distortion starts to exceed the acceptable tolerance.

Rationale: The hardware providing the communications function in the item is criticality 3. It plugs into the Audio Terminal Unit (ATU) which is also criticality 3.

The communications system will not be used during emergency egress since the crew cannot be plugged into the ATU and egress an element. The communications system will be used during a toxic clean up, but is not required for a toxic clean up to be performed.

The radiated susceptibility data was collected. There was no damage to the equipment and the only failure was the creation of harmonic distortion. It was impossible to run the test with a crewmember participating and providing feedback. Unfortunately due to the subjective nature of the results, it is difficult to assess acceptable levels of distortion for intelligible communication. Since the communication feature is noncritical and the headset hardware was not damaged by the test, the item is not recommended for redesign and the headset will be accepted as is.

EMECB TIA–0123

C.3.2.1.2.2 CE03 LIMITS

Exception: The Gas Pressure Regulator Valve (GPRV), part of the Nitrogen Tank Assembly (End Item Number 222078A, PN 3750262), is allowed to exceed the 3.2.1.2.2 CE03 limit by 4.4 dB at 1.262 MHz and 0.6 dB at 1.065 MHz on its 120 V high line and by 4.0 dB at 1.273 MHz and 0.8 dB at 1.065 MHz on its 120 V return line.

Rationale: The AC appearing on the powerline due to the CE03 exceedance is well below the voltage susceptibility limit of the powerline. The other equipment sharing the power bus with the GPRV will not be affected by the additional AC resulting from this exceedance.

Conducted emissions to susceptibility margins are documented in the ongoing Electrical Power System (EPS) assessment document D684–10232–01. Implementation of this TIA does not violate the EMI 10 dB safety margin required by SSP 30243, paragraph 3.2.3.

EMECB TIA–0124

C.3.2.1.3.2 CE07 LIMITS AND
C.3.2.2.3.2 CS06 LIMITS

Exception:

A. The RJMC (End Item number 222926A) is allowed to exceed the 3.2.1.3.2 CE07 limits for inrush transients below 1.0 microsecond duration.

B. The Rotary Joint Motor Controller (RJMC) (End Item number 222926A) is allowed to exceed the 3.2.2.3.2, requirements by being susceptible to 10 microsecond transients of 92 volts magnitude on its input power leads.

Rationale:

A. The RJMC is supplied power through an RPCM. The Type 5 RPCM can not turn on the RJMC as fast as the CE07 test turns on the RJMC. This exceedance will not occur in flight.

B. The Lockheed EMC test engineer reports that in response to the 240 volt CS06 pulses; an apparent motor dithering appears. This subjective pass or fail criteria is too severe. The ultimate pass or fail criteria for the RJMC is that no motor rotation occurs. There is no change in motor position or state in response to the 240 volt CS06 pulses. Therefore, the RJMC does not have a functional upset in response to the CS06 pulses.

EMECB TIA–0131

C.3.2.1.2.2 CE03 LIMITS

Exception: The CE03 conducted emissions requirement specified in 3.2.1.2, shall be relaxed by 2 dB (from 65 to 67 dBμA) for the DCSU (PN R072610) primary power leads only. This tailored requirement shall apply to DCSU emissions between the frequency of 500 kHz and 1.0 MHz.

(The CE03 emissions limit for the DCSU primary power leads is 20 dB above the CE03 limit for a 1 ampere device as defined in 3.2.1.2. This is because the DCSU primary power switching system is characterized as a 10 ampere power system device or "user".)

Rationale: The CE03 emissions limit for the DCSU is 15 dB less than the DDCU emission requirement and 20 dB less than the BCDU emissions requirement. The DDCU and BCDU emission limits above 500 kHz are 80 dBμA and 85 dBμA, respectively. The DCSU emissions will not threaten the susceptibility of any other device on the primary power system because these devices (ORUs) are designed to be immune to emissions from the DDCU, BCDS and SSU. All other ORUs connected to the primary power distribution system have CE03 emission limits that are at least 15 dB greater than the DCSU. Since these ORUs are compatible with each other, it is a mute point whether they will be compatible with DCSU emissions. It is unreasonable and costly to design the DCSU to CE03 emission limits that are unnecessarily stringent when compared to the other primary power system users on the same power cable. Also, it could be debated whether the relaxation of the CE03 limit in 3.2.1.2.2, is intended for all devices that 'use or draw' greater than 1 ampere, even if the current is power system throughput.

As a measure of compatibility between the Space Station primary power hardware, all EPS hardware meets the conducted susceptibility requirements of 3.2.2.2.2. Conducted emissions to susceptibility margins are documented in the on going assessment document D684–10232–01. Implementation of this TIA does not degrade the margin required by SSP 30243, paragraph 3.2.3.

EMECB TIA–0132

C.3.2.1.2.2 CE03 LIMITS

Exception: The CE03 conducted emissions requirement specified in 3.2.1.2, shall be relaxed by 8 dB for the DCSU (CI 370PG2, PN R072610) 120 volt Controller Power Output leads only. This tailored requirement shall apply to DCSU emissions between the frequency of 90 and 100 kHz.

Rationale: The DCSU 120 V Controller Power Output is a dedicated power supply output for the MDM. No other load is connected to this terminal.

The amplitude of DCSU emission outage indicated above is 2 milliamperes (65.6 dBμA) at 95 kHz. This differential mode current was measured into a load that accurately simulated MDM impedance during CE03 testing. The impedance of the simulated MDM load was less than 30 ohms at the 95 kHz. The induced voltage across the MDM input terminals calculates to be less than 0.1 Vrms at 95 kHz. Since the MDM is compliant with CS02, this is greater than 20 dB margin.

This CE03 exceedance occurs only at the fundamental switching frequency (approximately 95 kHz) of the DCSU's 120 V Controller Power Output. All other CE03 emissions measured from DCSU 120 V Controller Power Output meet the CE03 limit with 15 dB margin.

Conducted emissions to susceptibility margins are documented in the on going assessment document D684–10232–01. Implementation of this TIA does not degrade the margin required by SSP 30243, paragraph 3.2.3.

EMECB TIA–0133

C.3.2.3.1.2 RE02 LIMITS

Exception: The RE02 radiated emissions requirement specified in 3.2.3.1, shall be relaxed by 2 dB (from 56 to 58 dBA) when applied to the DCSU (CI 370PG2, PN R072610). This tailored requirement shall apply to DCSU radiated emissions between the frequency of 4.0 and 5.0 MHz.

Rationale: The DCSU is out of specification with respect to RE02 by less than 2 dB. The frequency band of this noncompliance is between 4.1 and 4.4 MHz. A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages.

EMECB TIA–0134

C.3.2.1.1.2 CE01 LIMITS AND
C.3.2.1.2.2 CE03 LIMITS

Exception: The Water Modulating Valve (WMV) (CI M51100F), which consists of a valve and electronics box (PNs 6012.10.AA and 6012.11.AA) is allowed to exceed the 3.2.1.1.2 CE01 and 3.2.1.2.2 CE03 limits by 21 dB from 10 kHz to 50 kHz and 25 dB from 50 kHz to 100 kHz.

Rationale: The ISS does not require limits for 28 volt supplied equipment. The paragraph quoted above is relevant to units supplied from the 120 Volt bus. However, the PDB does not provide any filtering to units, so in effect all noise will be transmitted to the main power bus (120 Vdc).

Although the levels of the WMV are higher than the dBμA limit, the Alenia analysis of the total emissions towards the source (i.e. the rest of the Station) show the MPLM to have at least 20 dB margin with respect to the required susceptibility limit, as shown in Figure TIA–0134-1.

Conducted emissions to susceptibility margins are documented in the on going EPS assessment document D684–10232–01. Implementation of this TIA does not degrade the EMI Safety margin required by SSP 30243, paragraph 3.2.3.

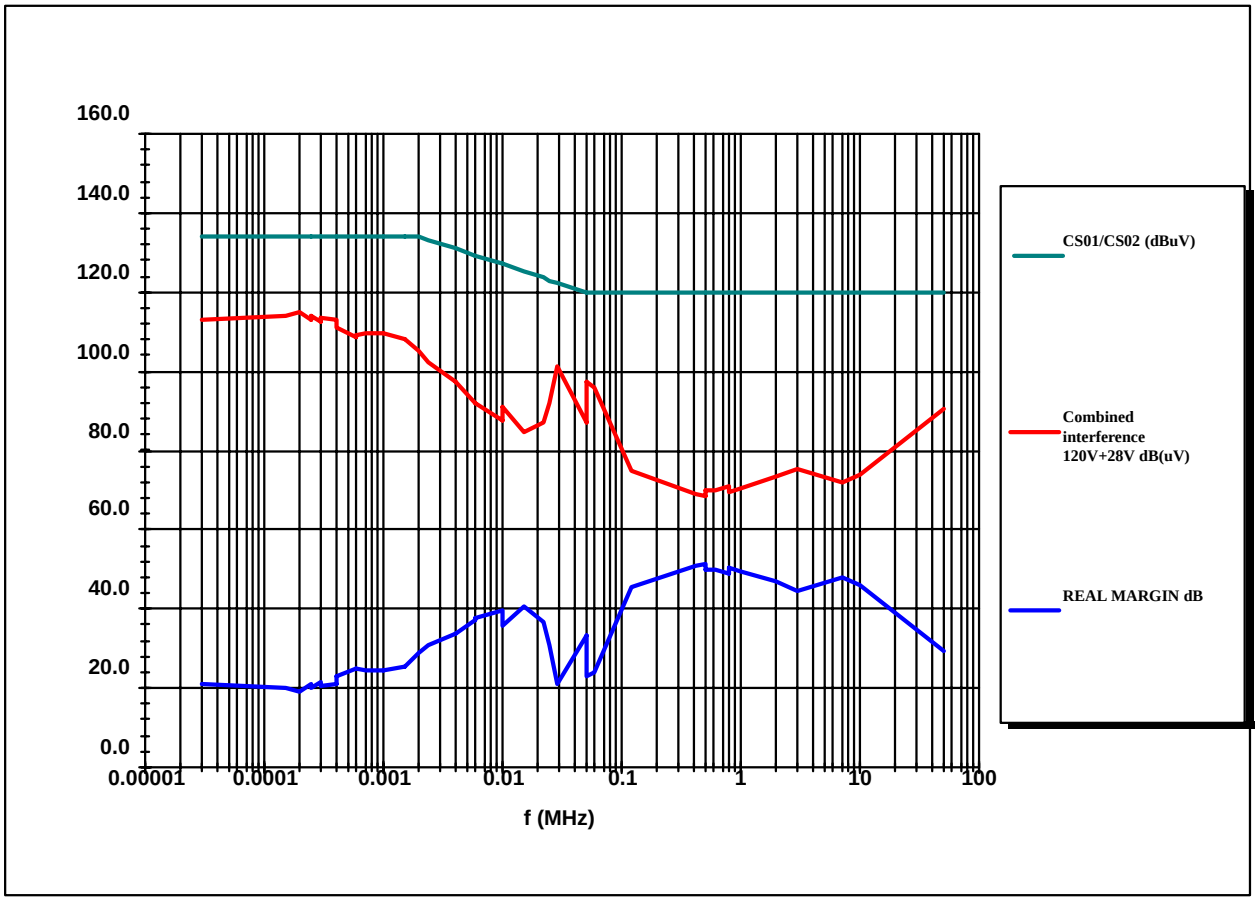


FIGURE TIA–0134–1 MPLM SUSCEPTIBILITY MARGIN

EMECB TIA–0135

C.3.2.3.1.2 RE02 LIMITS

Exception: The WMV (CI M51100F), which consists of a valve and electronics box (PNs 6012.10.AA and 6012.11.AA) and Delta Pressure Sensor (DPS) (CI M51130F, PN 6061.10.AA) is allowed to exceed the 3.2.3.1.2, by up to 5 dB from 20 kHz to 30 kHz.

Rationale: This is a marginal exceedance of the ISS requirement and the Alenia analysis, as shown in Figure TIA–0135–1, shows a significant margin with respect to the RS E–field susceptibility limit.

The analysis considers the level of E–field expected at the Node entrance, being the closest module to the MPLM. Field strengths from those units exceeding the unit level requirement have been combined (using a square root summation) and the field roll off factor has been computed using appropriate far field and near field factors across the complete frequency range.

A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages.

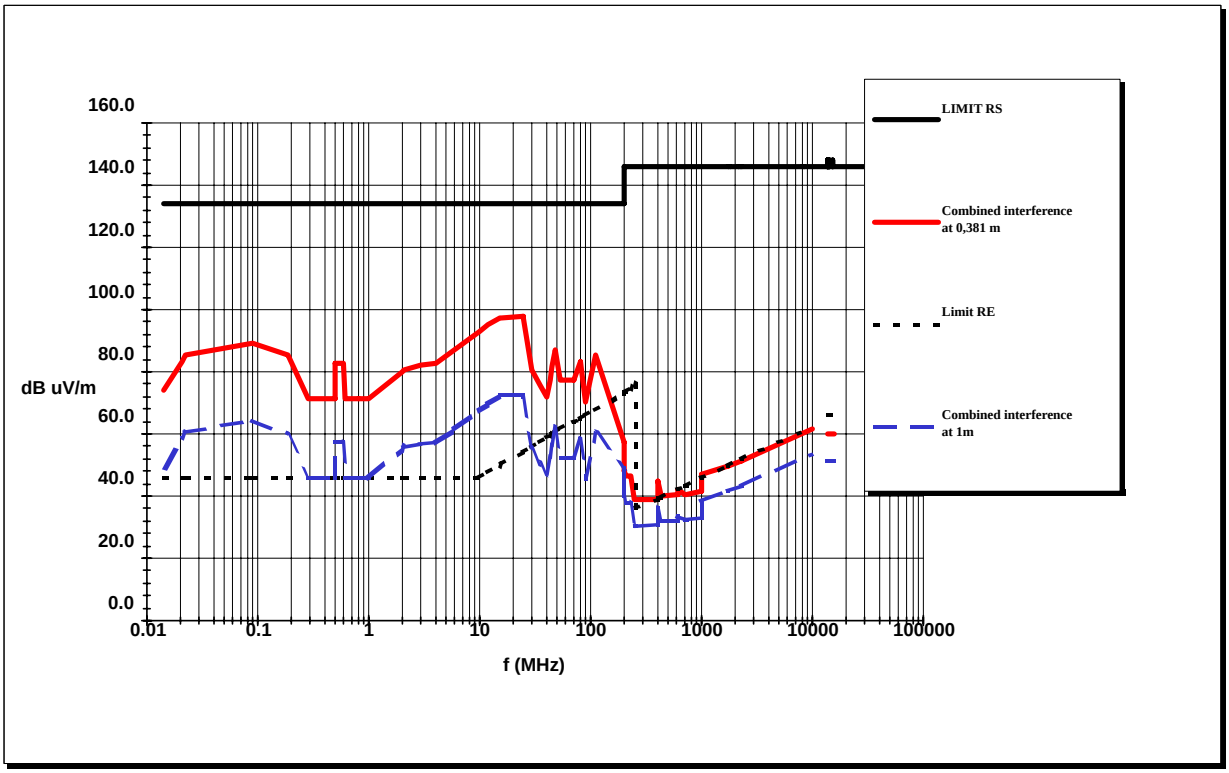


FIGURE TIA–0135–1 RS E–FIELD SUSCEPTIBILITY LIMIT

EMECB TIA–0137

C.3.2.3.1.2 RE02 LIMITS

Exception: The ISS Operations LAN (IOL) (PN SEZ39129738–303) and data cable (PN SED39129317–301) are allowed to exceed the RE02 electric field requirements specified in 3.2.3.1.2, by the amount shown below.

TABLE TIA–0137–1 RE02 ELECTRIC FIELD EXCEPTIONS

Narrowband radiated emission, RE02 configuration 1 (using IOL dipole antenna)		
Frequency (MHz)	Emission (dBμV/m)	Delta
265.84	47.8	1.7
Narrowband radiated emission, RE02 configuration 2 (using IOL linear antenna)		
Frequency (MHz)	Emission (dBμV/m)	Delta
265.84	49.9	3.8

Rationale: These emissions are minimal and will not affect other equipment. A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages. The closest receivers are at 259.7 and 279 MHz.

EMECB TIA–0138

C.3.2.1.1.2 CE01 LIMITS,
C.3.2.3.1.2 RE02 LIMITS, AND
C.3.2.4.2.2 RS03 LIMITS

Exception: The Space to Space Station Radio (SSSR) (PN SED16102482–301) is allowed to exceed the 3.2.1.1.2, limits by 2 dB at 3.023 kHz and 1 dB at 2.525 kHz. It is also allowed to exceed the 3.2.3.1.2 RE02 requirements by up to 4.0 dB from 259 MHz to 287 MHz. The 3.2.4.2.2, RS03 requirements may be relaxed by the margins shown in Table TIA–0138–1.

TABLE TIA–0138–1 SSSR RS03 LIMIT EXCEPTIONS (PAGE 1 OF 2)

Low Frequency, Low Power		
Susceptibility Band	Threshold of Susceptibility	Relaxation Margin
137.8 MHz–140 MHz	2.73 V/m	2.27 V/m
206.8 MHz–225 MHz	4.22 V/m	55.78 V/m
231.54 MHz–246.3 MHz	46.41 V/m	13.59 V/m
248.8 MHz–260 MHz	38.3 V/m	21.7 V/m
266 MHz–275 MHz	43.87 V/m	16.13 V/m
276.56 MHz–300 MHz	40.61 V/m	19.39 V/m
371 MHz–375 MHz	7.06 V/m	52.94 V/m
403.88 MHz–413.12 MHz	41.08 V/m	18.92 V/m
420 MHz–425 MHz	47.77 V/m	12.23 V/m
425 MHz–450 MHz	49.56 V/m	10.44 V/m
High Frequency, Low Power		
Susceptibility Band	Threshold of Susceptibility	Relaxation Margin
138.72 MHz–140 MHz	2.71 V/m	2.29 V/m
208.12 MHz–210 MHz	8.94 V/m	51.06 V/m
211.90 MHz– 215.90 MHz	45.25 V/m	14.75 V/m
217 MHz– 220 MHz	57.49 V/m	2.51 V/m
221.70 MHz– 230 MHz	57.63 V/m	2.37 V/m
230 MHz– 235 MHz	38.56 V/m	21.44 V/m
250 MHz–251 MHz	30.07 V/m	29.93 V/m
251 MHz–257 MHz	33.86 V/m	26.14 V/m
272 MHz–275 MHz	46.41 V/m	13.59 V/m
275 MHz– 290 MHz	48.32 V/m	11.68 V/m
293 MHz– 300 MHz	44.48 V/m	15.52 V/m

TABLE TIA–0138–1 SSSR RS03 LIMIT EXCEPTIONS (PAGE 2 OF 2)

High Frequency, Low Power		
373 MHz–382 MHz	33.20 V/m	26.80 V/m
406 MHz–415.7 MHz	41.08 V/m	18.92 V/m
415.7 MHz–416 MHz	15.64 V/m	44.36 V/m
420 MHz–425 MHz	43.82 V/m	16.18 V/m
425 MHz–445 MHz	43.72 V/m	16.28 V/m
446.1 MHz–450 MHz	36.24 V/m	23.76 V/m
475.5 MHz–480 MHz	12.93 V/m	47.07 V/m

Rationale:

A. CE01: For the conducted emissions exceedances (worst case exceedance of 2.0 dB at 0.003023 MHz), conducted emissions to susceptibility margins are documented in the ongoing assessment document D684–10232–01. Implementation of this TIA does not degrade the conducted noise margin of SSP 30243, paragraph 3.2.3.

B. RE02: Radiated Emission exceedances occur at eight frequencies between 259 MHz and 287 MHz. A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages.

C. RS03: The SSSR susceptibility mode begins with audio distortion. As the interference level increases, the radio will eventually lose lock. When the interference is removed, the radio regains lock without requiring crew intervention. No Shuttle or ISS transmitters other than those associated with the SSSR system exist in SSSR susceptibility bands. Only one ground transmitter (Research Radar at Aerocibo, Puerto Rico) operates in SSSR susceptibility band. However, the margin between SSSR threshold of susceptibility and transmitter maximum field level is 6 dB. Additionally, interference from the Aerocibo transmitter, although not likely, would last no more than 5 seconds, and the MTBF would be approximately 93 days.

EMECB TIA–0141

C.3.2.1.2.2 CE03 LIMITS

Exception: This tailoring applies to Sequential Shunt Unit (SSU) (PN RE1806–01/0003). The CE03 limits specified in 3.2.1.2.2, may be increased from 87 dBA and 78 dBA to 93.9 dBA in the frequencies ranges 10 kHz to 30 kHz and from 72 dBA and 61 dBA to 75 dBA in the frequencies ranges 60 kHz to 200 kHz.

Rationale:

A sample of the SSU ripple test data is shown in Figure TIA–0141–1. The SSU EMI test data shown in Figure TIA–0141–1 denotes that virtually all of the failed conducted emission points in the frequency range 10 kHz to 200 kHz were no more than 13.7 dB above the specification. The worst case condition was analyzed.

The ripple analysis in Figure TIA–0141–2 shows the delta margin between the required interface A specification and the calculated ripple. The ripple analysis shown in Figure TIA–0141–2 infers that the functional performance of the ORUs (DCSU–DDCU–RPCM, ECU, BCDU and MBSU) that are being integrated with the SSU will not be degraded. The ripple analysis in Figure TIA–0141–2 infers that a minimum of 20 dB margin is achieved.

Emissions of the nominal 20 kHz SSU operation can be observed at harmonically related frequencies of 20.7, 62, 103, 125, and 145 kilohertz. The 20.7 kHz emission is out by 14.1 dB and 12.9 dB in heavy and light modes respectively. These emissions result from the normal operation of the SSU and have been suppressed to the extent practical within size and weight restrictions. The present EMI string filters represent a large proportion of the existing weight and power dissipation of the SSU, and further suppression, although technically possible, would result in additional weight and size penalties.

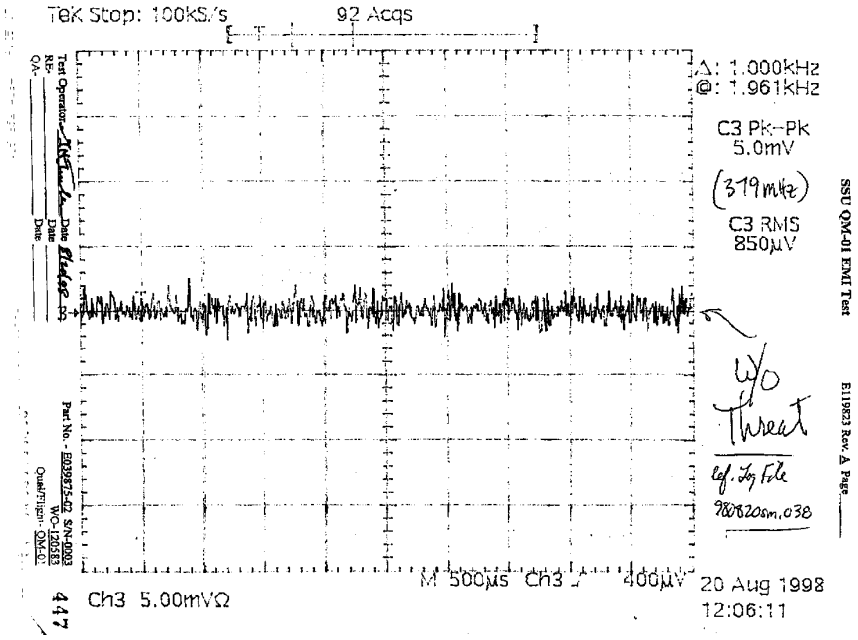


FIGURE TIA–0141–1 SSU RIPPLE TEST DATA

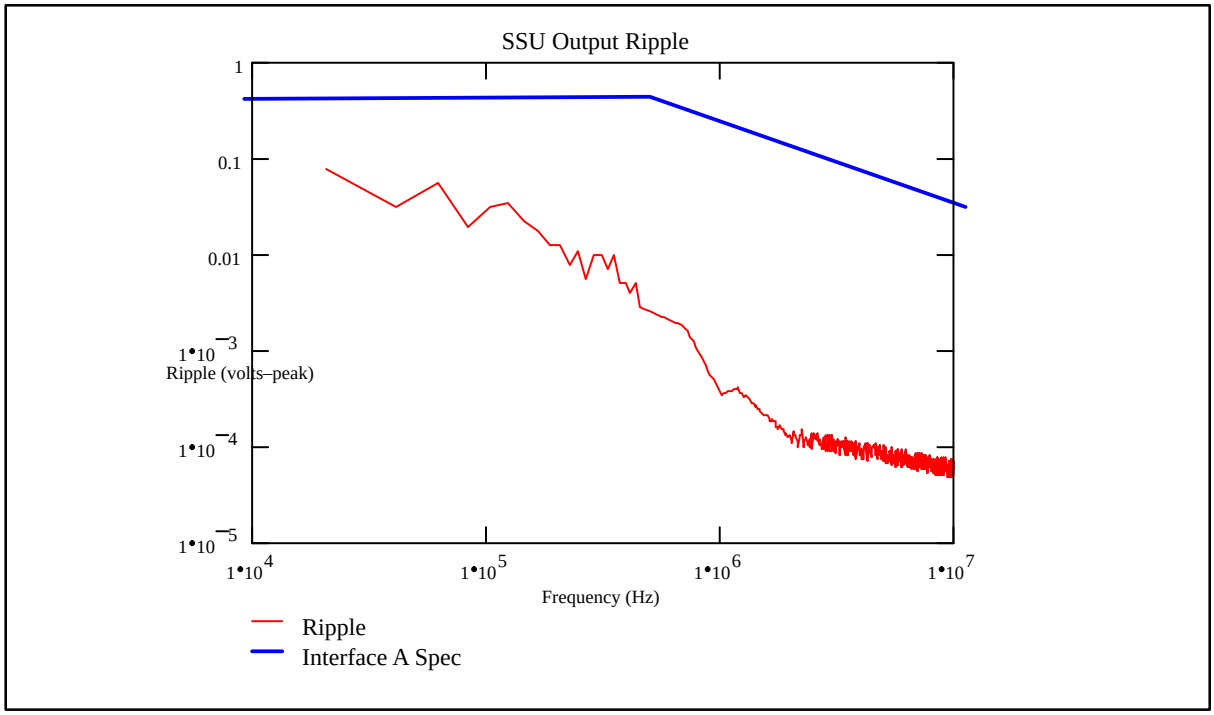


FIGURE TIA–0141–2 SSU OUTPUT RIPPLE

Conducted emissions on the positive or negative primary power output bus that exceed the specification by small amounts, the worst being 5.1 dB above specification at 104 kHz, (fifth harmonic). The highest emission frequency, which exceeded the specification, was at 168 kHz, with a level 0.4 dB above the allowed value. Again, these are all harmonically related emissions due to the normal operation of the SSU at 20 kHz, and in no way interfere with the operation of the SSU itself or impacting on system operation and performance.

EMECB TIA–0142

C.3.2.3.1.2 RE02 LIMITS

Exception: This tailoring applies to SSU (PN RE1806–01/0003). The RE02 limits specified in 3.2.3.1.2, may be increased:

A. From 56 dBμV/m to 70 dBμV/m in the frequencies ranges 14 kHz to 60 kHz.

B. From 56 dBμV/m to 70 dBμV/m in the frequencies ranges 200 kHz to 600 kHz.

Rationale: The SSU EMI test data shown denote that virtually all of the failed radiated emission points in the frequency ranges 200 kHz to 600 kHz were no more than 13 dB above the specification. The worst case condition was analyzed (below). The analysis and assessment infers that the ORUs (DCSU–DDCU–RPCM, ECU, BCDU and MBSU), that are being integrated with the SSU, will maintain the minimum -85.0 dB susceptibility margin which provides more isolation than the calculated specification susceptibility level (-77.9 dB). Thus, the SSU RE that exceeds the specification limit will not impact on the system performance and will comply with systems level EMC requirement.

Assessment and Analysis

A quick analysis was performed based on the test data and the specification limit and is shown in Table TIA–0142–1.

TABLE TIA–0142–1 ASSESSMENT ANALYSIS

	Frequency	Specification Limit	SSU Data	Delta above the Limit	Ambient
RE	21.0 kHz	56 dBµV/m	69 dBµV/m	13 dB	23 dBµV/m
		0.63 mV/m	2.81 mV/m		
RS	21.0 kHz	5 V/m	5 V/m (complied)		
Susceptibility Margin	21.0 kHz	-77.9 dB	-65.0 dB		

Discussion:

Radiated emission recorded at 21 kHz, which represents the fundamental operating frequency of the SSU pulse width modulation regulator. The two worst being at the 14th and 15th harmonic with emissions of 9.1 dB and 9 dB above specification respectively. These are due to the normal operation of the SSU, and in no way interfere with the operation of the SSU itself or impacting on other interfacing ORUs. A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages.

EMECB TIA–0143

C.3.2.1.3.2 CE07 LIMITS

Exception: The Crew and Equipment Translation Aid (CETA) Luminaire heater (CI 222070A, PN 1F03046–1) is permitted to exceed the 3.2.1.3.2 CE07 limits by + 5 Volts and - 50 Volts.

Rationale: The CETA heater receives power through a Type V RPCM. The RPCM delivers a power turn on and turn off with a controlled voltage ramp. This exceedance will not occur in flight.

EMECB TIA–0144

C.3.2.1.3.2 CE07 LIMITS

Exception: The Video Camera Luminaire heater (CI 222073A, PN 1F01194–1) is permitted to exceed the 3.2.1.3.2 CE07 limits by + 5 Volts and - 50 Volts for a switching transient between 0.1 and 10 microseconds.

Rationale: This unit receives power through a Type V RPCM. The RPCM delivers a power turn on and turn off with a controlled voltage ramp. This exceedance will not occur in flight.

EMECB TIA–0145

C.3.2.2.1.2 CS01 LIMITS

Exception: The Space to Ground Transmitter Receiver Controller (SGTRC) (CI 222035A, PN 1F1160–1) is permitted to be susceptible to the 3.2.2.1.2, CS01 requirements in the frequency range of 60 to 2000 Hz peaking at 500 Hz. The SGTRC PIDs functional requirement of a susceptibility response of 0.2 percent amplitude modulation (AM) shall be allowed to be exceeded by an additional 2 percent AM for a total susceptibility response of 2.2 percent AM.

Rationale: Formal analyses (Goddard Space Flight Center letters SES–450–98202 of 20 February 1998 and SES–450–60105 of 18 February 1998) show the impact of the incidental CS01 generated AM produces negligible degradation to the autotrack pointing error budget. The autotrack scale factor has a defined pointing error budget to accommodate modulator temperature variability, off pointing angle and user axis ratio. The CS01 generated AM produces an autotrack scale factor error that falls within this error budget. The unit qualification pass or fail criteria used was overly conservative when evaluated in terms of system performance.

EMECB TIA–0147

C.3.2.1.2.2 CE03 LIMITS

Exception: The Cold Cathode Transducer (CI 220007A, PN 220F01083) is allowed to exceed the CE03 levels of SSP 30237 on its 28 Vdc power input by 2 dB at 28.6 kHz and by up to 12 dB from 200 kHz to 900 kHz.

Rationale: The Cold Cathode Transducer receives its 28 Vdc input power from the Load Control Assembly which also provides power for another Cold Cathode Transducer, Pirani Gauge Transducers, and several stepper motor drivers to monitor and control the Vacuum Exhaust System and Vacuum Resource System. The power supply in the Load Control Assembly will provide ample capacity to isolate this low energy ripple noise from the 120 Vdc secondary power system. As an alternative corrective action, a capacitive connector filter insert was tested. The 10,000 picofarad capacitance reduced the ripple well below the limits. However, mechanical alterations to the connector and to the filter insert to allow the connector to fully seat were not practical. The capacitance in the Load Control Assembly power source far exceeds this amount and will provide the necessary isolation. Most of the harmonic spikes between 200 kHz and 900 kHz are less than 5 dB above the limit; only two spikes are 10 dB or more above the limit. The CE03 noise drops rapidly above 1 MHz and provides 30 dB or greater margin above 2 MHz.

EMECB TIA–0149

C.3.2.4.2.2 RS03 LIMITS

Exception: The Pirani Gauge Transducer (CI 220008A, PN 220F01084) is allowed to meet its RS03 requirements at the following combinations of frequencies and reduced levels: 2.9 V/m at 27 to 35 MHz, 4.5 V/m at 35 to 43 MHz, 4.9 V/m at 43 to 47 MHz.

Rationale: These Pirani Gauge Transducers monitor the pressure in the exhaust lines for the Vacuum Exhaust System (VES) and the Vacuum Resource System (VRS). They cover the pressure range of 20 Torr to 0.0001 Torr. The pressure readings are used to indicate when the line pressure is low enough to connect a payload to one of these systems from one of the Payload Rack locations, to monitor payload vacuum dumps for abnormal levels, and to detect low level leakage from cabin atmosphere via the VES and VRS. (Primary monitoring for cabin atmosphere leakage is performed by the Atmosphere Revitalization System (ARS).) Their failure modes are criticality 3 except for leakage (mechanical failure) through the gauge which is criticality 2R. The failures under RS03 testing were readings outside the nominal error tolerances. These failures would not affect normal operations since only the gross pressure levels in the vacuum exhaust lines are used and not precise readings. (Note: This TIA covers only the Pirani Gauge Transducers for the VES and VRS.) There are no transmitters at these frequencies. The closest transmitter frequencies are SOYUZ Rassvet at 14.962 and 18.06 MHz.

EMECB TIA–0151

C.3.2.4.2.2 RS03 LIMITS

Exception: The IMAX3D camera, magazine, video display assembly, left hand grip, and right hand grip (PNs 880001, 700101, 820101, 830101, 830201) are allowed to exceed the 3.2.4.2.1, RS03 requirements as follows:

8.96 V/m from 294.8 to 320 MHz, 2.97 V/m from 591.46 to 650 MHz, 10.07 V/m from 650.00 to 680 MHz, and 20.59 V/m from 768.70 to 770 MHz.

The RS03 tests were limited to a maximum of 30 V/m

Rationale: The radiated susceptibility affects only the IMAX3D camera system, which is a noncritical item.

At 294.8 MHz the camera frame rate displayed by the Camera Video Display Assembly changed. It is unclear whether the frame rate actually changed or the displayed value changed without affecting the frame rate. At all other frequencies, the Camera Video Display Assembly image was distorted. Such distortion will not affect the image recorded on film but could make camera focusing difficult. If the video gets distorted whereby the camera can not be focused, the Optical Viewfinder is used. This view finder does not rely on any electronic components (not affected by electrical fields).

The IMAX3D camera system is GFE, has no power interface with the Space Station, and is not essential or critical for station operations.

The equipment provider has accepted risk of IMAX3D malfunction due to radiated fields on–orbit.

EMECB TIA–0153

C.3.2.1.2.2 CE03 LIMITS AND
C.3.2.4.2.2 RS03 LIMITS

Exception: This tailoring applies to the HMS Defibrillator, PN SJG42103750–302.

The radiated RS03 electric field specified in 3.2.4.2, may be reduced from 5 V/m to the following levels for the specified frequencies: 4.26 V/m from 27.5 to 30.0 MHz, 4.15 V/m from 33.2 to 35.0 MHz, 3.07 V/m from 52 to 60.0 MHz, 4.37 V/m from 91.5 to 96.0 MHz.

The radiated RS03 electric field specified in 3.2.4.2, may be reduced from 60 V/m to the following levels for the specified frequencies: 33.62 V/m from 200 to 225 MHz, 45.99 V/m from 225 to 250 MHz, 27.81 V/m from 250 to 275 MHz, 14.59 V/m from 275 to 300 MHz, 32.45 V/m from 300 to 325 MHz, 30.07 V/m from 325 to 400 MHz, 50.54 V/m from 409.64 to 430 MHz, 42.97 V/m from 430 to 450 MHz, 52.44 V/m from 467.8 to 485 MHz, 32.15 V/m from 505 to 525 MHz, 26.16 V/m from 545 to 600 MHz, and 36.15 V/m from 661 to 675 MHz.

Rationale: RS03: The HMS Defibrillator is susceptible to RS03 radiation at the frequencies and levels specified. During testing, the HMS Defibrillator exhibited various off nominal characteristics described below. Reference the data sheet for specific frequencies involved.

The HMS Defibrillator is allowed the following exceedances to conducted emissions CE03 requirements specified in 3.2.1.2, at the specified frequencies: 4.5 dB at 90.65 kHz (return lead), 4.2 dB at 92.14 kHz (hot lead), 3.9 dB at 93.64 kHz (hot lead), and 1.8 dB at 95.17 kHz (hot lead).

- General Control Module (GCM) Data Error

The GCM controls the functions of the PDIM. This error indicates that the GCM has locked up. In the event of lockup, the PDIM is automatically dropped into a lower output voltage mode for battery charging. This event is detectable on the ground as a loss of battery status data and general health and status data of the interface. Reset of the GCM is easily accomplished manually on–orbit via a reset button or can be commanded from the ground. Loss of the PDIM functions does not prohibit use of the defibrillator for patient treatment, only the ability to power the defibrillator from vehicle power and relay information to the ground. Removing the amplitude modulation of the EMI signal returned GCM function at 27.46 MHz but had no effect above 200 MHz.

- Error Message ”Status 51”

This error message is normally displayed during defibrillator self testing to indicate a failure of the 2.5 V reference voltage from the power supply board. However, the display message was removed by removing amplitude modulation from the EMI signal. Most likely, the EMI was causing the reference sensor to falsely indicate a problem with the reference voltage since the monitored signals indicated the defibrillator continued to function (i.e. no loss of ECG signal or pacer output) while the message was displayed.

- Error Message ”Pace Fault”

This error message is normally displayed when the defibrillator detects a problem with a monitoring signal (VMON) during pacing. In this case, the display message was removed by removing amplitude modulation at the lower frequencies (84.5 and 91.5 MHz) but not at the higher frequencies (greater than 400 MHz). Since the monitored signals indicated the defibrillator continued to function (i.e. no loss of ECG signal or pacer output) while the message was displayed, the message was most likely a false indication.

- Error Message ”Status 11”, ”Set Clock”

These error messages indicate a problem with the real–time clock of the defibrillator. When these messages are displayed, the defibrillator is not functioning (i.e. there is loss of signal and output). The situation is corrected by switching the defibrillator off and removing the battery (to reset the internal clock). This was a problem at the 60 V/m level for various frequencies in the 200 MHz to 225 MHz and the 300 MHz to 400 MHz range.

- Control Module or Defibrillator Error

This indicates that there was a problem with the Defibrillator, with the GCM, or both which caused a loss of ECG signal or loss of pacing output or both. This was a problem at the 60 V/m level for various frequencies in the 225 MHz to 505 MHz range. The GCM and defibrillator can both be reset as described above to restore function.

A minimum of 48 dB margin exists between the RE02 and RS03 limits.

The COTS defibrillator would require significant modifications to meet the RS03 requirements in SSP 30237. However, the high margins between known radiated emission levels and defibrillator susceptibility at the given frequencies indicate that these problems would not occur on–orbit. Given its extremely low expected usage, the HMS Defibrillator is acceptable for use on ISS with regard to EME.

CE03: The CE03 emission exceedances are very small and are unlikely to cause any problems with other circuits. Conducted emissions to susceptibility margins are documented in the on going assessment document D684–10232–01. Implementation of this TIA does not degrade the EMI Safety margin required by SSP 30243, paragraph 3.2.3.

The last two susceptibility effects are the only ones where operation is affected and crew intervention is required to reset the defibrillator. Ten Shuttle transmitters exist in these susceptibility bands, however, you would have to go EVA and be within 1.2 m to experience required field levels to cause susceptibility. Ten ground transmitters also exist in these susceptibility bands. However, greater than 11 dB margin exists between transmitter levels and what is necessary to upset the defibrillator.

EMECB TIA–0154

C.3.2.3.1.2 RE02 LIMITS

Exception: This tailoring applies to LCD Video Monitors (CI 306305, PN 832281–501). The radiated emission RE02 specified in 3.2.3.1 may be increased by 35 dB over the 15 kHz to 350 kHz frequency range, 3dB over the 12 MHz to 25 MHz range, 9.1 dB over the 299 MHz to 400 MHz range, 6 dB over the 400 MHz to 450 MHz range.

Rationale: A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers under 100 MHz. The closest receivers are in the upper limits at frequencies of 420, 414.2, and 417.1 MHz. The monitors are used in the USL and the Cupola.

During the test, the monitors were temporarily wrapped in a shield and did not exceed the limits, with the exception of one spike (about 5 dB) at 300 MHz vertical. This shield cannot be used for operational purposes as it covers the monitor display.

Also, the 16 kHz field is a near field measurement and should fall off at a rate of $1/r^2$. The 92 micro dB volts/meter field at 14 kHz equals 40 millivolts/meter and would drive a current of 60 microamperes or 35 dB microamperes if it is perfectly coupled into a nearby wiring bundle. This is well below the 10 dB limit allowed for power wiring of 45 dB above 1 microampere.

EMECB TIA–0155

C.3.2.1.1.2 CE01 LIMITS,
C.3.2.1.3.2 CE07 LIMITS,
C.3.2.4.1.2 RS02 LIMITS AND
C.3.2.4.2.2 RS03 LIMITS

Exception: The Power Supply Assembly (PSA) (PN SEG39128211–301) is allowed to pass the SSP 30237 requirements with following exceptions:

A. CE01: paragraph 3.2.1.1.2, The limits for CE01 emissions may be relaxed by 9.1 dB (µA) at 496 Hz.

B. CE07: paragraph 3.2.1.3.2, Apply the turn on and turn off transient voltage limits defined in SSP 30237D instead of SSP 30237C.

C. RS02: paragraph 3.2.4.1.2, The PSA is allowed to pass the RS02 requirements with a spike level of 131 volts.

D. RS03: paragraph 3.2.4.2.2, The PSA is allowed to pass the RS03 requirements at levels of 3.51 V/m from 26.73 MHz to 30.0 MHz, 3.94 V/m from 53.5 MHz to 200.0 MHz; and 44.74 V/m from to 335.8 MHz to 1.0 GHz.

Rationale:

A. CE01: There was only one exceedance during the CE01 test. At 496 Hz, the PSA emissions exceeded the CE01 limits defined in SSP 30237C, paragraph 3.2.1.1.2, by 9.1 dB (µA). However, these limits apply only to equipment drawing 1 A or less. At the time of the CE01 test, the PSA was drawing approximately 1.64 A, so that the actual limit at 496 Hz should have been higher by (20 log 1.64) = 4.3 dB (µA). Thus, the PSA actually exceeded the CE01 limit by only (9.1 - 4.3) = 4.8 dB (µA). Furthermore, this exceedance represents a worst case condition that appears only when both EMU output channels are on and both EMUs are operating at full power. All other configurations tested, including the operation of two Orlan suits simultaneously, yield lower levels of emissions. The PSA operates in these configurations during pre–EVA and post–EVA activities only. Conducted emissions to susceptibility margins are documented in the ongoing EPS assessment document D684–10232–01. Implementation of this TIA does not degrade the EMI safety margin required by SSP 30243, paragraph 3.2.3.

B. CE07 voltage limits: During CE07 testing of the PSA, switching transients were measured that deviated up to 3.4 percent from the 120 Vdc nominal input voltage. These levels exceeded the 0.5 percent limit defined in SSP 30237C, paragraph 3.2.1.3.2, under which the unit was tested in 1997. Since that time, however, SSP 30237D has been released. This current revision relaxes the limit from 0.5 to 5 percent, so that the PSA now meets the requirement. Conducted emissions to susceptibility margins are documented in the ongoing EPS assessment document D684–10232–01. Implementation of this TIA does not degrade the EMI safety margin required by SSP 30243, paragraph 3.2.3.

C. RS02: The PSA exhibited susceptibility to a voltage spike that could spuriously raise the dc power input voltage to 251 V, which is 131 V above the 120 Vdc nominal input voltage. As a result, the Orlan output channels of the PSA shut down, as they are designed to do when overvoltage conditions are detected. A manual reset of the unit restored proper operation.

SSP 30482B, Volume 1, CDCN #002, states that the maximum abnormal transient voltage that can appear on the EPS (interface C) is 200 V. This voltage is below the level at which the PSA exhibits susceptibility, so that the shutdown observed during RS02 will not normally occur. Even if a shutdown does occur, the PSA places itself in a fail safe mode which can easily be reset by a crewmember after the transient spike goes away. By this means, the unit complies with SSP 30482A, Volume 2, paragraph 3.1.1.2, that requires equipment to “be restorable to its full specified performance when the EPS is restored to normal operating conditions.”

D. RS03: At all susceptible frequencies except 335.8 MHz, the only unexpected performance in the PSA was an increase in the EMU output ripple voltage, which ranged from 0.55 to 0.85 Vp–p.

The Servicing and Performance Checkout Equipment (SPCE)/Extravehicular Mobility Unit (EMU) ICD, ICD–4–0075–0C–0, allows EMU output ripple voltage to be as high as 1.5 Vp–p; therefore, the susceptibility to the PSA will not cause any damage or unexpected behavior in the EMUs. At 335.8 MHz, the PSA display went blank, but the EMU and Orlan output voltages were still within specifications. A manual reset of the unit restored proper operation of the display. If a failure of this nature occurs on–orbit, the PSA can easily be reset by a crewmember after the interference goes away. By this means, the unit complies with SSP 30482A, Volume 2, paragraph 3.1.1.2, that requires equipment to "be restorable to its full specified performance when the EPS is restored to normal operating conditions." Even if proper operation of the display cannot be restored, however, the Umbilical Interface Assembly (UIA), which is also located in the airlock, has meters that display the same information.

A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages.

EMEP TIA–0158

C.3.2.4.2.2 RS03 LIMITS

Exemption: The Rotational Hand Controller (PN 830381–551) and Translational Hand Controller (PN 830382–551) radiated RS03 electric field specified in 3.2.4.2.2, may be reduced from 60 V/m to 12 V/m over the frequency range of 200 to 340 MHz for RHC and THC acceptance. The effectivity for this TIA is for RWS operations in the USL only. RWS operations in the Cupola will be reflected in a new change.

Rationale: In the frequency range of issue, five ground based transmitters exist that transmit at levels lower than 19 dB below the RWS threshold of susceptibility. Six on–orbit transmitters also exist in the same frequency range but the transmit levels are at levels more than 10 dB below the RWS threshold of susceptibility. Additionally, of these six transmitters, three only operate during Shuttle landing operations and three will no longer be operational once the Space to Space Communications System becomes operational. The RWS hand controller failure mode at the threshold of susceptibility is cross check error. This error would result in a safing of the RWS, which would prevent any motion of the SSRMS. As field levels increase, the hand controllers could output signals capable of causing uncommanded motion. A minimum of 10 dB exists between the RWS threshold of susceptibility and the known RF environment.

EMECB TIA–0159

C.3.2.1.1.2 CE01 LIMITS

Exception: The DAQCard 6533 Data Acquisition Card (PN 777315–01) is part of the Logic Analyzer Kit. Although the PCS and associated power supply, and cables are not part of the Logic Analyzer Kit, they must be used in conjunction with it. They include the PCS 760XD (PN SDZ39129262–301), DC Power Cable (PN SEG39129263–301), 120 VDC Power Supply (PN SEG39129272–301), and UOP Power Cable (PN SEZ39129260–303). The Logic Analyzer Kit is allowed to exceed the 3.2.1.2 CE03 limits, of 45 dB by 9.3 dB at 6.18 MHz, 1.5 dB at 6.13 MHz, 1.6 dB at 7.945 MHz. The Logic Analyzer Kit is also allowed to exceed the 3.2.3 RE02 limits, of 56 dBμV/m by 19.3 dB between 24.35 kHz and 73.67 kHz, 6.6 dB between 1.121 MHz and 6.126 MHz, and the requirement of 48.3 dBμV/m by 1.4 dB at 358.51 MHz.

Rationale: For CE03 the outages will not affect the other components of the ISS. Implementation of this TIA does not degrade the margin required by SSP 30243, paragraph 3.2.3. Conducted emissions to susceptibility margins are documented in the ongoing assessment document D684–10232–01. The 24.35 kHz to 1.121 MHz radiated emissions are in frequency ranges that are not used by any ISS receivers. The closest receivers to 358.51 MHz are at 217 and 414.2 MHz. A minimum margin of 48 dB exists between the RE02 and RS03 limits.

EMECB TIA–0160

C.3.2.3.1.2 RE02 LIMITS

Exemptions:

E. The Personal Computer System baseline setup (PN SDZ39129262–301) may exceed the RE02 limits by 10 dB at the frequency range of 250 to 350 MHz.

F. The PCS RS–232, DAQ–700 (configuration 1) setup (PN SDZ39129262–301 SN 1101, SEG46117035–301, SEG46116864–301) may exceed the RE02 limits by 10 dB in the frequency range of 250 to 350 MHz and 5 dB in the frequency range of 450 to 550 MHz.

G. The PCS Ethernet (configuration 2) setup (PN SDZ39129262–301, SEG46116862–301) may exceed the RE02 limits by 10 dB at the frequency range of 250 to 350 MHz and 5 dB in the frequency range of 400 to 500 MHz.

H. The PCS Hard Drive (configuration 3) setup (PN SDZ39129262–301, SEG46115541–301) may exceed the RE02 limits by 10 dB in the frequency range of 250 to 350 MHz.

The HRF Personal Computer System baseline setup is not allowed to be operated in the NASDA segment until NASDA approval is received.

Rationale: The items which were EMI tested (RS–232, Ethernet, Hard Drive, and DAQ–700) require the use of the IBM Thinkpad 760XD. The IBM Thinkpad 760XD accounts for the failure of the RE02 limits in the 250 to 350 MHz frequency range. During the testing of configuration 1 (RS–232 and DAQ 700) the EMI results have two additional spikes that do not exceed 5 dB at the frequency range of 450 to 550 MHz. During the testing of configuration 2 (Ethernet) the EMI results also have two additional, but even smaller, spikes in the 400 to 500 MHz range. During the testing of configuration 3 (Hard Drive) the EMI results have the same failure as the stand–alone laptop, thus not providing additional emissions. It is believed that, in comparison to the stand alone laptop, the additional HRF configurations that exceeded the RE02 limits are relatively small.

A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages.

EMECB TIA–0161

C.3.2.2.1.2 CS01 LIMITS AND
C.3.2.4.2.2 RS03 LIMITS

Exception: The Battery Stowage Assembly (BSA) (PN SEG39128213–301) and the Battery Charger Assembly (BCA) Module (PN SEG39128256–301) are allowed to pass the SSP 30237 requirements with the following exceptions:

A. CS01: Paragraph 3.2.2.1. The BCA Module is allowed to pass the CS01 requirements at levels of 0.46 Vrms from 280 Hz to 600 Hz, 0.83 Vrms from 600 Hz to 4 kHz and 0.57 Vrms from 4 kHz to 20 kHz.

B. RS03: Paragraph 3.2.4.2. The BSA and BCA Module are allowed to pass the RS03 requirements at levels of 22.2 V/m from 201 MHz to 1 GHz.

Rationale:

A. CS01: At all susceptible frequencies the only unexpected performance in the BCA Module was an increase in charge current, which ranged from +0.4 amps to +0.8 amps. All of the EVA related batteries require from 4 to 20 hours of charge time. A momentary increase in charge current during susceptibility does not damage any hardware but changes the required charge time. At no time did the BCA Module stop charging.

   Conducted emissions to susceptibility margins are documented in the on going EPS assessment document D684–10232–01. Implementation of this TIA does not degrade the EMI Safety margin required in SSP 30243, paragraph 3.2.3.

B. RS03: At all susceptible frequencies the only unexpected performance in the BSA and the BCA Module was an increase or decrease in the BCA Module charge current, which ranged from –0.7 amps to +0.5 amps. All of the EVA related batteries require from 4 to 20 hours of charge time. A momentary increase or decrease in the charge current during

susceptibility does not damage any hardware but changes the required charge time. At no time did the BCA Module stop charging.
The BSA and BCA Module were not susceptible at any known radio frequencies except 457.735 MHz. The transmission level at 457.735 MHz is 4.1285 V/m. The susceptibility level of the BSA and BCA Module at 457.735 MHz was 33.4 V/m. This provides a margin of 18.2 dB at this frequency.

A minimum of 48 dB margin exists between the RE02 and RS03 limits.

C. A response was received from JSC–EP stating that the susceptibility to these transients does not pose a safety issue. The worst case event would be a premature charge termination. However, as previously noted, the BCA Module did not terminate the charge for either the CS01 or the RS03 transients.

EMECB TIA–0162

C.3.2.2.2.2 CS02 LIMITS

Exception: The injected CS02 voltage specified in 3.2.2.2.2 may be reduced to the following values when the DCSU temperature sensor is evaluated for CS02 compliance:

CS02 Test Frequencies	Injected CS02 Voltage
17.0 MHz to 19.0 MHz	0.5 Vrms

Rationale:

A. The DCSU is equipped with two baseplate temperature sensors. Only one baseplate temperature measurement exceeded the lower limit and by less than 5 degrees Celsius over a narrow susceptibility bandwidth (1 MHz).

B. The Photovoltaic Controller Application (PVCA) software samples the temperature sensors once every second and reports the measurement to the higher tier every tenth sample. The PVCA software does not perform any closed loop control or FDIR functionality based on these temperature measurements. The PVCA software does perform a Caution & Warning Associated Indicator (CWAI) check on this data. The CWAI flag is set only if the temperature measurement exceeds -45 degrees or +170 degrees Celsius for three consecutive samples.

C. In situ common mode conducted emissions data from the primary input leads of the DDCU External unit (R076522–61), indicates primary bus noise of less than 40 dBμA (100 μA) at 10 MHz to 20 MHz when measured with 100 percent secondary load (50A). During the CS02 tests on the DCSU, the primary input terminals of the DCSU are subjected to CS02 currents of 90 dBμA at the susceptible frequencies. The temperature sensor threshold of susceptibility was determined to be 84 dBμA. A safety margin of greater than 40 dB exists.

EMECB TIA–0163

C.3.2.4.2.2 RS03 LIMITS

Exception: The RS03 radiated field intensity specified in 3.2.4.2.2, may be reduced to the following values when the DCSU baseplate temperature sensors are evaluated for RS03 compliance:

TABLE TIA–0163–1 RS03 MODIFIED RADIATED FIELD INTENSITY

RS03 Test Frequencies	RS03 Field Intensity	Antenna Polarization
85 MHz to 90 MHz	3 V/m	Vertical
95 MHz to 110 MHz	2 V/m	Horizontal

Rationale: The PVCA software samples the temperature sensors once every second and reports the measurement to the higher tier every tenth sample. The PVCA software does not perform any closed loop control or FDIR functionality based on these temperature measurements. The PVCA software does perform a CWAI check on this data. The CWAI flag is set only if the temperature measurement exceeds -45 degrees or +170 degrees Celsius for three consecutive samples.

In addition to the above rational, the RS03 test procedure exposed the DCSU electrical connectors and interface cables to electric field radiation levels which are considerably higher than would normally occur if tested in situ on Space Station. RS03 tests were performed using unshielded cables exposed to the transmit antenna. This test procedure was used to simplify the test setup because replicating the actual DCSU installation bay and enclosed cable trays would be too costly. The DCSU's temperature sensors will not likely be susceptible to the required RS03 radiation level (5 V/m) if the test configuration is modified to represent the actual Space Station's worst case installation.

EMECB TIA–0164

C.3.2.3.1.2 RE02 LIMITS

Exception: RE02: This tailoring applies to ISS OCA Router System PN SEG46116924–301. The radiated RE02 electric field are specified in 3.2.3.1.2, and the failures are listed below.

TABLE TIA–0164–1 RE02 NARROWBAND RADIATED EMISSION

Freq. (MHz)	Emission (dBμV/m)	Delta
265.84	56.4	10.3
298.47	57.3	10.3
319.32	52.1	4.7
331.35	49.1	1.4

Rationale: A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages. The closest receivers are at 259.7 and 279 MHz.

EMECB TIA–0165

C.3.2.3.1.2 RE02 LIMITS

Exception: The RE02 radiated emissions requirement specified in 3.2.3.1 shall be relaxed by 10 dB for emissions between the frequencies of 80 kHz and 2.2 MHz when applied to the DDCU–I (R076500), DDCU–E (R076522), and DDCU–HP (R076672).

Rationale: The RE02 emission outages indicated in this TIA are caused by discrete DDCU switching harmonics radiating from the DDCU external power leads. These worst case emissions exceed the RE02 limit by less than 10 dB. A margin of greater than 40 dB exists between the RE02 and RS03 limits. There are no receivers at these outages.

EMECB TIA–0166

C.3.2.3.1.2 RE02 LIMITS

Exception: The Space to Ground Antenna (SGANT) (CI 222016A, PN 10033190–1) is allowed to exceed the 3.2.3.1.2 RE02 requirements by 28 dB from 1 MHz to 7 MHz. The SGANT is permitted to not follow the SSP 30240, paragraph 3.2.2.7, requirement by not terminating the harness shield at both ends. The SGANT is allowed to not meet the SSP 30245, paragraph 3.2.1.2.1, Class R Bonding requirement at the titanium interfaces.

Rationale:

A. Currently there are no intended receiver systems in the noted frequency band, hence low level signals would impose no impact on RF systems

B. An emission level of 80 dBμV is 54 dB below the radiated susceptibility RS03 test level of 5 V/m in that frequency band. This level of incident field would not impose any threat to ORUs qualified to that RS03 level.

C. The data busses and power busses near to the SGANT that would be illuminated by the out of specification field have been thoroughly tested in both laboratory and installed vehicle environments. Neither have shown any susceptibility in the frequency range noted at fields much greater than those noted.

D. Assuming the SGANT emissions to be a plane wave, the field intensity would decrease as 1/r, hence a 25 meter sphere would be considered as potentially illuminated by this field. The systems and ORUs within this sphere comprise the PV Module P6 assembly, all of which have been successfully tested at field strengths significantly higher than those noted.

E. The SGANT passed the RS03 tests.

EMECB TIA–0167

C.3.2.1.2.2 CE03 LIMITS

Exception: The Ku–Band Receiver PN SEG46116703–301 and the Ku Power Supply PN SEG46116711–301 shall be permitted to exceed the 3.2.1.2.2 CE03 requirement by 4.9 dB at 192 kHz when powered as a system. The units shall comply with all other conducted noise requirements as compared to the levels in SSP 30237, Revision C.

Rationale: Conducted emissions to susceptibility margins are documented in the on going EPS assessment document D684–10232–01. Implementation of this TIA does not degrade the EMI safety margin required by paragraph 3.2.3 of SSP 30243.

EMECB TIA–0168

C.3.2.4.2.2 RS03 LIMITS

Exception: Agreement is to allow the relaxation of 3.2.4.2.2, RS03 limit to 50 V/m for the Space Integrated GPS/INS (SIGI) Receiver hardware (PN 34204010–002) in the following bands: 205.11 MHz to 206 MHz, 217.35 MHz to 300 MHz, and 331.74 MHz to 400 MHz.

Rationale: The SIGI receiver was retested and no failure occurred. It is suspected that the failure is seen when low signal to noise ratio (SNR) values are available from the GPS satellites in view. The unit failed when 2 of the 4 satellites being tracked were providing a SNR below 40 dB and 1 providing a SNR below 35 dB. The SIGI requires at least four satellites with SNRs greater than 35 dB in order to output a position solution and at least four satellites with SNRs greater than 40 dB in order to output an attitude solution. Therefore, the failure occurred during below specification satellite coverage conditions. During the retest which passed, all satellites in view output a SNR greater than 40 dB (i.e. above specifications).

There are no ISS or SSP transmitters operational on–orbit in these frequency bands. There exists 27.5 dB of margin between the SIGI threshold of susceptibility and the ground based transmitters present in these bands.

EMECB TIA–0170

C.3.2.3.1.2 RE02 LIMITS

Exception: The Blood Pressure/12 Lead Electrocardiogram (BP/ECG) (PN SED46115812–301) may exceed 3.2.3.1 RE02 limits by 6.9 dB at 285.79 MHz, 6.8 dB at 288.1 MHz, 0.3 dB at 305.26 MHz, 8.5 dB at 325.02 MHz, 4.0 dB at 335.1 MHz, and 2.0 dB at 344.94 MHz.

Rationale: A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages.

EMECB TIA–0171

C.3.2.3.1.2 RE02 LIMITS

Exception: Agreement is to allow the relaxation of 3.2.3.1 RE02 limit for the Space Integrated GPS/INS (SIGI) Receiver hardware (PN 34204010–002) and the SIGI firmware load cable assembly (PN SEF20100208–301) in the following bands: 277.19 MHz by 4 dB, 300.4 MHz by 2.1 dB, and 543.69 MHz by 5.6 dB.

Rationale: The SIGI receiver exceedances occurred during the "off nominal" configuration of reloading firmware into the three internal SIGI processors over the flight pigtail cable. This loading process takes about 5 minutes per processor and therefore poses very minimal time exposure to these levels. The firmware load will occur only a couple of times during the lifetime of the system. The SIGI passed all RE02 testing in its configuration for nominal operation, i.e. load port capped.

There are no ISS or SSP receivers operational on–orbit in these frequency bands.

EMECB TIA–0172

C.3.2.4.2.2 RS03 LIMITS

Exception: The UIA, PN SEG39128214–301, is allowed to pass the 3.2.4.2.2 RS03 requirements at levels as low as 3.77 V/m 6.5 MHz, and levels as low as 29.02 V/m from 220 MHz to 530 MHz.

Rationale: The UIA, located in the Crew Lock, provides connections that provide power for EMU and/or Orlan spacesuits during pre–EVA checkout. This power is generated by the PSA, which is located in the Equipment Lock. The voltages and currents from the PSA are measured inside the UIA, and the measurements are transmitted to an MDM.

At the susceptible frequencies, the measurements reported to the MDM were outside their expected values. However, only the measurements were in error. The actual voltages and currents delivered to the suits were not affected. Furthermore, when the test field was removed, the measurements reported to the MDM returned to their specified levels. No user intervention was required to restore proper operation to the UIA.

If a failure of this nature occurs on–orbit, such that the measurements reported to the MDM appear to be erroneous, the correct voltage and current levels can be obtained from the PSA, which has panel meters that display the same information.

The UIA is criticality 2R equipment. A spare UIA is carried aboard the ISS.

A minimum of 48 dB margin exists between the RE02 and RS03 limits.

EMECB TIA–0174

C.3.2.1.2.2 CE03 LIMITS

Exception: The TDRSS Transponder (CI 222011A, PN 10039397–1) is allowed to exceed the 3.2.1.2.2 CE03 requirements at 250 kHz by 2 dB on the high power side and 10 dB on the low power side.

Rationale: The added 250 kHz powerline circuit activity will not result in an interference condition. Conducted emissions to susceptibility margins are documented in the on going assessment document D684–10232–01.

EMECB TIA–0175

C.3.4.4.2.2 RS03 LIMITS

Exception: The DCSU (CI 370PG2, PN R0726410) radiated RS03 electric field specified in 3.2.4.2.2, may be reduced from 60 V/m to 10 V/m over the frequency range of 200 to 350 MHz when the DCSU temperature sensors are evaluated for RS03 compliance.

Rationale: The DCSU temperature sensors are susceptible when the RS03 radiation is coupled onto its external power leads and into the DCSU connector interface during RS03 testing. When RS03 tests are performed on the DCSU, the DCSU's electrical connectors and cables are exposed to much higher levels of electric field radiation than would otherwise occur if the DCSU was irradiated in situ on Space Station. During the RS03 tests the DCSU is positioned on a flat table with its unshielded cables and open connector housing exposed to the RS03 irradiating antenna. The RS03 field is measured at the connector interface panel of the test sample. The RS03 test procedure is used as a simplified test setup (i.e., exposed connector plate) because replicating the actual DCSU installation onto enclosed cable trays during RS03 testing is costly and difficult to configure. The DCSU temperature sensors are significantly less susceptible to the 60 V/m RS03 radiation between 200 and 350 MHz when the DCSU connectors and cables are protected by the shielded cable tray and connector housing on the IEA. RS03 tests performed on a DCSU installed onto the IEA Test Report - RD97–687, 10/97 indicate that the DCSU temperature sensors are not susceptible at 30 V/m.

All known transmitters between 200 and 350 MHz are 20 dB less than the 10 V/m RS03 tailoring requested by this TIA.

EMECB TIA–0176

C.3.2.1.2.2 CE03 LIMITS

Exception: This tailoring applies to SSU (CI 220PG2, PN RE1806–01/0003). The CE03 limits specified in 3.2.1.2.2, may be increased: From 95.7 dBμA and 109 dBμA to 96 dBμA and 111.5 in the frequencies ranges 20 kHz to 170 kHz.

Rationale: The SSU EMI test data shown below denotes that virtually all of the failed conducted emission points in the frequency range 20 kHz to 170 kHz were no more than 2.98 dB above the specification. The worst case condition was analyzed in TIA–0141 and is also applicable to this TIA. The ripple analysis shown below infers that the functional performance of the ORUs (DCSU–DDCU–RPCM, ECU, BCDU and MBSU), that are being integrated with the SSU will not be degraded. The ripple analysis below infers that a minimum of 20 dB margin is achieved.

A sample of the SSU ripple test data is shown in Figure TIA–0141–1.

The ripple analysis in Figure TIA–0141–2 shows the delta margin between the required interface A specification and the calculated ripple.

Emissions of the nominal 20 kHz SSU operation can be observed at harmonically related frequencies of 20.7, 62, 103, 125, and 145 kHz. The 20.7 kHz emission is out average by 2.98 dB in heavy and light modes respectively. These emissions result from the normal operation of the SSU and have been suppressed to the extent practical within size and weight restrictions. The present EMI string filters represent a large proportion of the existing weight and power dissipation of the SSU, and further suppression, although technically possible, would result in additional weight and size penalties.

Conducted emissions on the positive or negative primary power output bus that exceed the specification by small amounts, the worst being 2.98 dB above specification at 104 kHz, (fifth harmonic). The highest emission frequency, which exceeded the specification, was at 165.6 kHz, with a level 0.3 dB above the allowed value. Again these are all harmonically related emissions due to the normal operation of the SSU at 20 kHz, and in no way interfere with the operation of the SSU itself or impacting on system operation and performance.

EMECB TIA–0177

C.3.2.2.1.2 CS01 LIMITS

Exception: For the DCSU (CI 370PG2, PN R072610–11), in the frequency ranges of 400 to 700 Hz, the CS01 voltage requirement specified in 3.2.2.1, may not exceed 1.5 Vrms when the DCSU Control Power Input voltage is less than 80 Vdc and 3 Vrms when the DCSU Control Power Input voltage is less than 90 Vdc.

Rationale: The integrated interfacing ORUs to the DCSU input power channels are SSU and BCDU. The DCSU meets the 5 Vrms CS01 requirement when the CS01 is applied to the SSU power input channel. The BCDU noise ripple measurement performed on a worst case system control power bus configuration (SAR E40028, 4/1/99) indicates less than 100 mVrms spectrum between 400 to 700 Hz. This noise ripple environment verifies that greater than a 20 dB safety margin exists between systems control power noise and the CS01 test signal of 1.5 Vrms.

EMECB TIA–0178

C.3.2.2.1.2 CS01 LIMITS

Exception: When evaluating the measurement accuracy (susceptibility) of the DCSU bidirectional current sensors in accordance with the CS01 requirements specified in 3.2.2.1, the applied CS01 current between 7 kHz and 30 kHz through each primary power channel shall be limited to the following values:

Current Sensor Locations	Applied CS01 Current
Primary Channels 1 and 6	3.0 A_{RMS}
Primary Channels 2, 3, 4 and 5	1.5 A_{RMS}.

This tailored CS01 requirement applies only for evaluating current sensors within the DCSU and may not be used to reduce the CS01 signal during the evaluation of other DCSU functions.

Rationale: Conducted emissions on the primary power bus are generated from the following sources:

Power System Equipment	Test Report (Data Source)	CE03 Emissions (Maximum)	Amperes (RMS)
SSU	RD97–681–11–V2 and TIA–176	112 dBµA	400 mA
BCDU and Battery	Loral SSB000923	94 dBµA	50 mA
DDCU	RD97–681–05–V2	88 dBµA	25 mA
ARCU	ETD–MD4–B01078	86 dBµA	20 mA
DCSU/MBSU	RD97–681–07–V2	66 dBµA	2 mA

The total RMS noise current on the primary power bus does not exceed 500 mA between 1 and 100 kHz. The total emission will not be greater than 500 mA if all of the equipment emits its maximum specified CE03 emissions. The total emissions from all primary power equipment (from qualification test data) verifies that a greater than 10 dB safety margin exists between primary power bus and the tailored CS01 test signal of 3.0/1.5 A_{RMS} used to evaluate the DCSU current sensors. The DDCU transfer function above 5 kHz is greater than 20 dB. Test data indicates that noise and ripple on the primary power distribution system will not cause current sensor susceptibilities.

EMECB TIA–0183

C.3.2.3.1.2 RS03 LIMITS

Exception: The General Luminaire Assembly (GLA) (PN 219003, CI Number 408A40A) is not required to be tested for 3.2.3.1.2 RE02 radiated emissions or 3.2.4.2.2 RS03 radiated susceptibility requirements above 1 GHz.

Rationale:

A. RE02: The GLA is a fluorescent lamp including a ballast, control, and power supply. The electronics in the power supply include a dc inverter operating at approximately 19 kHz. (TIA–0028 addressed minor CE03 exceedances from this power supply.) Examination of the RE02 data submitted shows no signals above the ambient background at frequencies above 30 MHz, and the worst case emission above 1 MHz showed over 20 dB margin to the required level.

B. RS03: No susceptibility was noted even when tested at the supplementary level of 60 V/m up to 1 GHz. During early testing, the only noted effect was a brightening of the fluorescent tube in the 200 to 250 MHz range when the tube was parallel to the applied field. (Note that the length of the tube with its conductive column of plasma is approximately a quarter wavelength at these frequencies and that these type tubes are used informally as RF field indicators at these and lower field strengths.) This problem was corrected by remounting the GLA to provide grounding simulating its as installed configuration and changing the antenna orientation instead of the GLA orientation for orthogonal polarizations. Since no susceptibility was noted, especially in the most sensitive frequency range and up to 60 V/m field strength, it is unlikely that any radiated susceptibility exists at lower field strengths at higher frequencies.

EMECB TIA–0184

C.3.2.4.2.2 RS03 LIMITS

Exception: The 3.2.4.2.2 RS03 radiated electric field strength level of 5 V/m will apply to the thermostats (CIs 222007A, 222201A, 222052A, and 222080A, PNs 1F97596 and 1F97597) in the frequency range of 200 MHz to 410 MHz, a reduction from the required 60 V/m.

Rationale: The Thermostat radiated susceptibility occurred at a few discrete frequencies between 200 MHz and 410 MHz. Further investigation revealed no Space Station transmitters on future flights in the 200 to 260 MHz frequency range. Radio interference from ground transmitters would be limited by the 4 to 5 minute line of sight transit time for the Space Station in Low Earth Orbit. Thermal events occur on a relatively slow time scale. A modest delay of 5 minutes to power up the heaters is unlikely to cause the failure of heater dependant devices (as cooling in a space environment is limited to thermal radiation and conduction).

EMECB TIA–0187

C.3.2.2.1.2 CS01 LIMITS

Exception: When testing the DCSU (CI DCSU–EA, PN R02610–11) Control Power Input terminals for CS01 susceptibility, the amplitude of the applied CS01 voltage specified in 3.2.2.1, shall be reduced from 5.0 Vrms to 3.0 Vrms between the CS01 test frequencies of 450 to 750 Hz.

Rationale: Noise and ripple measurements performed on a worst case system control power bus configuration (SAR E40028, 4/1/99) indicates less the 100 mVrms spectrum between 450 to 750 Hz. This measurement verifies that greater than a 20 dB safety margin exists between system control power noise and the CS01 test signal of 3.0 Vrms.

The tailoring in this request is similar to approved TIA #177 where the applied CS01 signal is reduced to 3.0 Vrms between 400 and 700 Hz.

EMECB TIA–0188

C.3.2.2.1.2 CS01 LIMITS

Exception: When performing audio susceptibility testing on the MBSU (PN R072591) Auxiliary Control power input terminals, the amplitude of the applied CS01 voltage specified in 3.2.2.1 shall be reduced from 5.0 Vrms to 3.0 Vrms between the CS01 test frequencies of 450 to 750 Hz.

Rationale: Noise and ripple measurements performed on a worst case system power bus configuration (SPEL ESIT Phase 1C, ETD–MD4–S00912V1) indicates noise voltages and currents of less than 100 mV and 100 mA (RMS) between 450 to 750 Hz. This measurement verifies that greater than a 20 dB safety margin exists between system power noise and the CS01 test signal of 3.0 Vrms.

The tailoring in this request is similar to approved TIA 187, where the applied CS01 signal is also reduced to 3.0 Vrms between 450 and 750 Hz.

EMECB TIA–0189

C.3.2.1.3.2 CE07 LIMITS

Exception: The listed affected valves and assemblies are allowed to exceed the CE07 requirement by the emission of a single burst of transient pulses during the period of 200 to 2000 microseconds after an ENABLE command is sent to a powered valve, where the burst of transient pulses do not exceed +35 volts peak or 40 volts peak to peak with a pulse repetition interval of 3 to 4 microseconds and a pulse width of 0.4 to 0.6 microseconds full width half maximum.

The affected items are (name, part number, CI number):

System Flow Control Assembly	2353190–1–1	ITCS09A
Rack Flow Control Assembly	2353180–1–1	ITCS08A
Intermodule Vent Valve	2353024–1–1	EVS006A
Vent/Relief Valve Assembly	2353026–1–1	EVS004A
Carbon Dioxide Removal Assembly	2352630–1–1	CDRA01A
Loop Crossover Assembly	2353198–1–1	ITCS10A
3 way Mix Valve	2365504–1–1	ITCS12A

The above include the following valves individually or in assemblies:

2357110–2–1	Intermodule Vent Valve
2357120–2–1	Flow Control Valve
2357130–2–1	CDRA Valve
2357140–2–1	Shutoff Valve
2357170–2–1	Loop Crossover Assembly Valve
2357530–2–1	Vent/Relief Isolation Valve
2357540–2–1	Vent/Relief Control Valve
2357590–2–1	3 way Mix Valve

Rationale: The transient bursts are not always emitted, but they will not cause problems to other items on the shared power bus when they are. The total energy contained in the burst is small (approximately 700 microjoules per burst) and is largely in frequencies above 200 kHz. The CS06 requirement is to withstand pulses of up to 240 volts which is over 18 dB higher than the values observed during the testing and over 16 dB higher than the requested exception maximum. The CS02 requirement is to withstand 1 volt from a 50 ohm source or 1 Watt of power, which is substantially more power than in these bursts. Also, the power buses contain substantial dissipative loading for high frequency noise through capacitance in ORUs including RPCMs as well as distributed capacitance and inductance in cabling.

EMECB TIA–0190

C.3.2.4.2.2 RS03 LIMITS

Exception: The Fluid Pumping Unit (FPU), (PN SEG39128310–301) is allowed to pass the requirements of SSP 30237C, paragraph 3.2.4.2.2, with the following exceptions:

RS03: Paragraph 3.2.4.2.2. The FPU is allowed to pass the RS03 requirements at the following levels:

A. 3.3 V/m in the range 42.72 MHz to 56.38 MHz

B. 31.2 V/m in the range 222.266 MHz to 278.15 MHz

C. 27.8 V/m in the range 361.86 MHz to 558.00 MHz.

Rationale: The FPU is criticality 2R equipment; a spare FPU is flown aboard the Space Station.

The flow meter display provides an indication of the total amount of water transferred between a Collapsible Water Reservoir (CWR) and the Extravehicular Mobility Unit (EMU) during an EMU water tank refill. This display provides extra information only, and is not required in order to determine the progress of a refill. Instead, pressure gauges located on the FPU and on the EMU's Display, Control, and Monitoring (DCM) system are the instruments used by the crew to determine when a refill is complete.

The over temperature indicator on the FPU is used to indicate a pump temperature that has exceeded 150 F. This indicator applies to the temperature of the pump itself, and not to the temperature of the water being pumped. The only known on–orbit transmitter close to this frequency is at 279 MHz. This is the old EMU frequency and the EMU's have been moved to 414 and 417 MHz. The 279 MHz frequency has been relegated for use as STS Air Traffic Control (ATC) which is only used during Shuttle landings. Based on a detailed analysis of the environment, there is a margin of 14 dB from ground based transmitters and the FPU has a 10 dB margin with respect to on–board transmitters (including the ATC) based on its location.

Rationale:

A. Currently there are no intended receiver systems in the noted frequency band, hence low level signals would impose no impact on RF systems

B. An emission level of 80 dBμV is 54 dB below the radiated susceptibility RS03 test level of 5 V/m in that frequency band. This level of incident field would not impose any threat to ORUs qualified to that RS03 level.

C. The data busses and power busses near to the SGANT that would be illuminated by the out of specification field have been thoroughly tested in both laboratory and installed vehicle environments. Neither have shown any susceptibility in the frequency range noted at fields much greater than those noted.

D. Assuming the SGANT emissions to be a plane wave, the field intensity would decrease as 1/r, hence a 25 meter sphere would be considered as potentially illuminated by this field. The systems and ORUs within this sphere comprise the P6 assembly, all of which have been successfully tested at field strengths significantly higher than those noted.

E. The SGANT passed the RS03 tests.

EMECB TIA–0192

C.3.2.3.1.2 RE02 LIMITS

Exception: The ARIS Controller (PN 683–61566, no CI number) is allowed to exceed the RE02 radiated emissions limits of 3.2.3.1.2 at the frequencies and levels listed in Table TIA–0192–1.

TABLE TIA–0192–1 ARIS CONTROLLER RADIATED EMISSION LIMITS

Freq. MHz	Exceedance dB	Freq. MHz	Exceedance dB	Freq. MHz	Exceedance dB
268	22	380	7	516	5
284	15	396	12	532	8
300	19	404	12	548	5

TABLE TIA–0192–1 ARIS CONTROLLER RADIATED EMISSION LIMITS

Freq. MHz	Exceedance dB	Freq. MHz	Exceedance dB	Freq. MHz	Exceedance dB
316	6	436	8	580	3
332	8	452	12	620	2
348	2	484	8	780	2
364	6	500	4		

Rationale: The requested allowance levels were derived by raising the highest measured exceedance level to the second higher whole decibel at each frequency. The frequencies are harmonically related at multiples of 8 MHz; the other harmonics did not exceed the limits. The measured levels were taken on the ARIS Controller with its cables attached and arranged for RE02 measurements along the front of the groundplane in accordance with SSP 30238. However, in practice, the ARIS is installed inside a composite or aluminum Rack (normally inside a composite ISPR) with the cables routed in various directions to connect with power, MIL–STD–1553B data buses, and the ARIS actuators. Therefore, this test configuration enhances the amount of radiated emissions, and the emissions in actual use are expected to be somewhat lower as a result of cable routing, loads on the cables, and shielding by the Rack structures, other ARIS components, and experiment packages. The power line connection is filtered and prevents excessive radiation of these signals via the power line which connects to outside the Rack. There are no intentional receivers at these frequencies on the ISS. The highest measured emissions level has a margin of over 88 dB with respect to the 60 V/m RS03 level. The total power emitted by all twenty frequencies exceeding the allowed level is less than 0.6 microwatts. Approved for use in USL only.

EMECB TIA–0193

C.3.2.2.3.2 CS06 LIMITS

Exception: This tailoring applies to the HMS Defibrillator (PN SJG42103750–303). The Conducted Susceptibility requirements (CS06) specified in 3.2.2.3.2 may be reduced from 240 volts to 150 volts for the 10 microsecond pulses (10 pps) placed on the power leads (positive and negative pulses).

Rationale: The HMS Defibrillator is susceptible to the 240 volt, 10 microsecond pulses (10 pps) applied to the power leads during CS06 testing. The susceptibility effect observed is that the Power/Data Interface Module (PDIM) attached to the modified COTS defibrillator ceases to provide power to the defibrillator when the pulses are applied. The reason is that the 240 volt pulses exceed the maximum voltage input of the 120 to 28 Volt DDCU in the PDIM and additional voltage clamping was not part of the original design. The problem was observed to be temporary, with PDIM power output returning when the voltage level of the pulses is reduced to 150 volts. The problem was not observed when the 240 volt, 0.15 microsecond pulses were applied to the power leads.

Even though the PDIM loses output power while the 10 microsecond pulses are applied to the power leads, the defibrillator is still operable because of a battery installed in the defibrillator that provides auxiliary power. Modifications that would allow the PDIM to meet the CS06 requirements would have significant cost and schedule impacts. The PDIM is used to charge the batteries and not for operation. Transients of the level and frequency required to interrupt charging and eventually impact operation have not been seen in available test data and are not expected per existing power system analyses. Existing transient analyses in the EME verification reports completed to date show a minimum 11 dB margin with respect to the upset threshold of the PDIM. This information has been briefed to and concurred with by the Safety Working Group and the HMS community.

EMECB TIA–0198

C.3.2.1.3.2 CE07 LIMITS

Exception: The O2/N2 Latching Motor Valve (Carleton PN B41395, Boeing ED 683–16419, CI 683L21A) is allowed to exceed the 60 volt (50 percent) CE07 transient limit of 3.2.1.3.2 for the time interval 0.1 to 10 microseconds by up to 20 volts.

Rationale: The O2/N2 Latching Motor Valve is supplied power via a current limiting RPCM with soft start characteristics which will suppress this transient to within the allowed CE07 requirements. Carleton Technologies also had a test performed using a power supply with a 1 millisecond risetime limit to emulate the RPCM soft start characteristics which showed that the transient was effectively suppressed. The transient only occurs at turn on (power application) and not during valve operations. The corresponding CS06 requirement for susceptibity to conducted transients is for 240 volts from the nominal power voltage of 120 volts.

EMECB TIA–0199

C.3.2.1.2.2 CE03
C.3.2.2.2.2 CS02 AND
C.3.2.4.2.2 RS03 LIMITS

Exception: The Pressure Transducer (Sentran Part Number 200002, Boeing ED 683–19356, CI ARS28, a Pirani Gauge vacuum pressure transducer) is allowed to meet the requirements with these exceptions:

3.2.1.2.2 CE03 – The Pressure Transducer is allowed to exceed the 45 dBµA conducted emissions limit by 8 dB between 1.2 MHz and 1.5 MHz on the return power line.

3.2.2.2.2 CS02 – The Pressure Transducer is allowed to meet the CS02 requirements with test signal levels reduced to 0.7 Vrms from 1.0 Vrms for 30.0 MHz to 38.5 MHz on the supply power line, and reduced to 0.4 Vrms from 1.0 Vrms for 2.05 MHz to 42.2 MHz on the return power line.

3.2.4.2.2 RS03 – The Pressure Transducer is allowed to meet the RS03 requirements with the test signal levels reduced to 2.5 V/m from 5.0 V/m over the frequency range of 68.5 MHz to 70.5 MHz.

Rationale:

CE03 – The requested exception will allow an increase of noise emissions on the return power lines from the requirement level of 178 microamps to a peak of 447 microamps in the narrow medium frequency range of 1.2 to 1.5 MHz. The additional noise, which occurs only on the return power line is equivalent to that allowed for 2.5 additional ORUs. This is an insignificant amount of noise when compared with the total allowed on the bus. In addition, the noise is restricted to a narrow range of frequencies above 1 MHz where the filtering available from other ORUs will provide additional reduction at the bus level. This item is fed from an MDM LA–3 SDO card channel.

CS02 and RS03 – The use of this item is to make rough level measurements of the vacuum pressure in the carbon dioxide vent line to ensure that the pressure is low enough for the CDRA to vent adsorbed carbon dioxide and to check for excessive leakage of module atmosphere through the carbon dioxide vent line. To perform these functions, the pressure is checked for a reading in the approximate range of 0.2 to 1.0 Torr (the gauge reads up to 20 Torr.) If the reading is above the expected range, maintenance checks are scheduled to check for the sources of the excess leakage. The exact range may be adjusted in software based on experience and has already been changed to reflect CDRA functional test data. The failures recorded during the EMI tests for CS02 and RS03 were that the “signal” and “range” outputs were more than 30 millivolts from their expected readings. The “range” output only has two nominal values of 1.0 and 4.0 volts to indicate which scale factor to use to interpret the “signal” voltage output; a 30 millivolt variation in the “range” output has no effect on the use of this device. The 30 millivolt variation in the “signal” output, under the test conditions, equates to approximately a 6 percent error in the pressure reading. The overall pressure reading accuracy is specified as + or – 10 percent. A change of only 6 percent in the reading, even in addition to the 10 percent tolerance allowed, would have, at most, no effect other than flagging the ground or orbital crew to perform a maintenance check. Under most conditions, there would be no noticeable effect. Based on actual on–orbit experience, the software limits for the expected pressure range would be set based on actual experience and could accommodate an offset in the actual output caused in part by susceptibility to conducted or radiated noise. There are no internal transmitters onboard the ISS in the susceptible frequency ranges. In addition, the module provides well in excess of 10 dB shielding effectiveness from external ambient emissions in this frequency range where only 6 dB is required.

EMEP TIA–0200

C.3.2.1.3.2 CE07 LIMITS

Exception: The Tissue Equivalent Proportional Counter (TEPC) Spectrometer (PN SEG16103076–301) is allowed to exceed the 3.2.1.2.2 CE07 limits as follows: The first condition (28 Vdc power) are two pulses, one exceeding the requirement of +/– 12 VDC by – 5.8 VDC at 17.5 microsecond and the second exceeding the requirement of +/– 5.6 VDC by 2.2 VDC at 85 microseconds.

The second condition (120 Vdc Power) is a burst of pulses on the 120 Vdc power line. These pulses are as shown in Table TIA–0200–1.

TABLE TIA–0200–1 TEPC SPECTROMETER CE07 LIMITS

No.	Limit (VDC)	Exceedance (VDC)	Time (microseconds)
1	+/– 18	–17.6	132
2	+/– 17	–3.6	142
3	+/– 17	–2.4	144
4	+/– 16	–2.1	168
5	+/– 15	–5.6	221

Rationale: These switch transients are of small energy. The pulses of the first condition have a small magnitude over specification limits. Worst case excess is 20 percent of the line voltage and occurs only once per switch actuation. The pulses of the second condition occur more frequently and of higher amplitude than the first, but the pulses are of very short duration. Average pulse width is a few microseconds. In addition, the operational scenario for TEPC calls for the switch to be operated infrequently. It is a radiation monitoring instrument which is normally left on. A worst case scenario for TEPC is a weekly occurrence of switching it off for relocation throughout the ISS. It would not be switched off for a simple reorientation, such as turning it to a new direction. Turning it off only needs to take place when the unit is being moved to a new location. Thus as a matter of routine, TEPC may not be powered down, and back up, for several weeks at a time. The pulses seen are in the 10 microsecond duration range and have a minimum of 20 dB of margin with respect to CS06 levels.

EMEP TIA–0202

C.3.2.1.2.2 CE03 LIMITS,
C.3.2.1.3.2 CE07 LIMITS AND
C.3.2.3.1.2 RE02 LIMITS

Exception: The CDRA, (CI CDRA01A, PN 2352630–1–1) is allowed to exceed the 60 volt transient limit for CE07 of 3.2.1.3.2 by up to 30 volts during the period of 0.1 to 2.0 microseconds after power application on the Selector Valve and Heater Controller power inputs.

Rationale: The CE07 testing for the CDRA was performed using a fast mercury switch instead of an RPCM or an RPCM emulator for power application. The installations in the USL and Node 3 (or future HAB module) will use RPCMs with a “soft turn on” characteristic which limits current for up to one millisecond. Modeling of the input circuitry for the two affected CDRA power inputs performed by Allied Signal using PSpice and documented in the test report shows that a very moderate current limiting capability would suppress these power application transients below the allowed 60 volt limit. The models showed the transients being constrained within the 60 volt limits with a 0.01 millisecond ramp up time. For the 1.0 millisecond RPCM ramp up time the models showed less than 1 volt transient response. This is consistent with the short duration (less than 1.1 microseconds) of the single negative transient pulses observed.

EMEP TIA–0203

C.3.2.1.2.2 CE03 LIMITS

Exemption: The Middeck Active Control Experiment II (MACE II) consists of two configurations. The first includes the
ESM, (PN MACE–1–930),
HST w/umbilical, (PN MACE–1–929),
MBP Primary Intermediate Node, (PN MACE–1–913–P),
MBP Secondary Intermediate Node, (PN MACE–1–913–S),
MBP Primary Outer Strut, (PN MACE–1–925–PO),
MBP Secondary Inner Strut, (PN MACE–1–925–SI),
MBP Secondary Outer Strut, (PN MACE–1–925–SO),
MBP Active Strut, (PN MACE–1–926),
Reaction Wheel Assembly with umbilical, (PN MACE–1–915),
Primary Gimbal, (PN MACE–1–920–P),
Secondary Gimbal, (PN MACE–1–920–S), (PN MACE–2–923–SO), and
Laser Pointer, (PN MACE–1–927–3).
Configuration 2 adds these (PNs:
Payload Flexible Appendage Primary Inner, (PN MACE–2–923–PI) and
Payload Flexible Appendage Secondary Inner, (PN MACE–2–923–SI).

The Exceptions are as follows:

A. MACE II, in configuration 1, exceeded the 3.2.1.1.2 CE03 limits of 52.4 dB microamperes by 9.9 dB at 0.2039 MHz, of 49.9 dB microamperes by 1.8 dB at 0.2751 MHz, of 46.7 dB microamperes by 0.2 dB at 0.4059 MHz, of 52.2 dB microamperes by 11.3 dB at 0.2027 MHz, and of 49.9 dB microamperes by 2.0 dB at 0.2751 MHz.

B. MACE II, in configuration 1, exceeded the 3.2.1.3.2 CE07 limits, by +13.4 VDC at 24.8 microseconds, where the limit is +/– 9.2 VDC and by –12.66 VDC at 143.008 microseconds, where the limit is +/– 5.7 VDC.

C. MACE II, in configuration 1, 3.2.3.1.2 RE02 limits of 46 dB microvolts/meter by 5.0 dB at 260.76 MHz, of 46.3 dB microvolts/meter by 0.8 dB at 270.59 MHz, of 46.6 dB microvolts/meter by 1.3 dB at 272.77 MHz, of 45.5 dB microvolts/meter by 10.1 dB at 280.78 MHz, of 47.9 dB microvolts/meter by 1.6 dB at 340.53 MHz, of 48.3 dB microvolts/meter by 4.3 dB at 360.82 MHz, and of 49.7 dB microvolts/meter by 1.8 dB at 440.43 MHz.

D. MACE II, in configuration 2, exceeded the 3.3.1.1.2, CE03 limits of 51.4 dB microamperes by 10.1 dB at 0.2022 MHz and of 50 dB microamperes by 1.8 dB at 0.2729 MHz on the return lead. On the hot lead the MACE II exceeded the CE03 limits of 52.5 microamperes by 11.1 dB at 0.2006 MHz and of 50 microamperes by 2.3 dB at 0.2729 MHz.

E. MACE II, in configuration 2, exceeded the 3.2.1.3.2 CE07 limits, by +11.48 VDC at 33.25 microseconds, where the limit is +/– 7.5 VDC, by –8.91 VDC at 48.00 microseconds, where the limit is +/– 5.6 VDC and by –12.93 VDC at 137.25 microseconds, where the limit is +/– 5.9 VDC.

F. MACE II, in configuration 2, exceeded the 3.2.3.1.2 RE02 limits of 56 dB microvolts/meter by 5.1 dB at 9.962 MHz and of 56.1 dB microvolts/meter by 0.2 dB at 10.19 MHz. MACE also exceeded the RE02 limit of 46 dB microvolts/meter by 6.2 dB at 260.76 MHz, of 46.3 dB microvolts/meter by 2.7 dB at 272.77 MHz, of 46.5 dB microvolts/meter by 5.6 dB at 280.78 MHz, of 48.5 dB microvolts/meter by 3.2 dB at 320.86 MHz, of 47.9 dB microvolts/meter by 2.6 dB at 340.53 MHz, of 48.3 dB microvolts/meter by 6.6 dB at 360.82 MHz, of 49.1 dB microvolts/meter by 0.8 dB at 400.57 MHz, and of 49.4 dB microvolts/meter by 2.4 dB at 420.37 MHz.

Rationale: The SSPCM (Solid State Power Controller Module) provides 30 dB of isolation with respect to the emissions outages and the secondary power bus. The power supply is close to the MACE II and therefore the CE07 exceedances will be mitigated by its regulation. There is greater than 100 dB of margin with respect ot RS03 for the RE02 outage frequencies of concern. The closest known receivers are at 342, 367, 400, 414, 417, 420, and 463 MHz. The RE02 outages do not represent a threat to those receivers.

EMEP–TIA–0204

C.3.2.2.3.2 CS06 LIMITS

Exemption: The 3.2.2.3.2 CS06 Powerline Conducted Susceptibility interference voltage of 240 volts is to be reduced to 100 volts for (Television Camera Interface Converter) TVCIC EMC compliance. The test pulses have the effect of producing white pixels during the pulse on time. The required CS06 pulse train is a series of 240 volt conducted susceptibility transients that is superimposed onto the 120 DC input power. The television interference disappears when the 240 volt interference transient pulse train is reduced to 100 volts peak. Apart from the pulse induced white pixels, there is no other interference effect. The effect of the CS06 produced interference is sufficiently minor to warrant qualification as is.

TVCIC PN 10033211–501
External Camera Group 10033194–501
Video Subsystem Spec. 10032305

Rationale: If it is assumed that powerline transients that exceed 100 volts are noncontinuous single event occurrences, then the observed interference will be infrequent enough to disregard. During the repetitive transients of the CS06 qualification test, the interference effects appeared relatively minor and are unlikely to compromise the equipment performance. The unit was tested to the full threat level with no damage.

EMEP TIA–0206

C.3.2.1.2.2 CE03 LIMITS

Exemption: When evaluating the Electronic Control Unit's (ECU) power input leads for conducted emissions, the CE03 limit specified in 3.2.1.2 shall be relaxed by 12 dB for conducted emissions between 170 and 1200 kHz.

Conducted emissions from the ECU's input power leads (secondary power input) exceed the CE03 limits at the following frequencies shown in Table TIA–0206–1.

TABLE TIA–0206–1 ECU INPUT POWER CONDUCTED EMISSIONS

Frequency	CE03 Limit	Measured Emission	Exceeds Limit by	ECU Operating Conditions
171 kHz	63.8 dBµA	74.4 dBµA	10.6 dB	BGA motor in stall mode
682 kHz	55.0 dBµA	57.6 dBµA	2.6 dB	BGA motor in stall mode
764 kHz	55.0 dBµA	63.7 dBµA	8.7 dB	BGA motor in stall mode
770 kHz	55.0 dBµA	61.6 dBµA	6.6 dB	BGA motor in stall mode
802 kHz	55.0 dBµA	56.5 dBµA	1.5 dB	BGA motor in stall mode
849 kHz	55.0 dBµA	59.1 dBµA	4.1 dB	BGA motor in stall mode
1140 kHz	55.0 dBµA	65.3 dBµA	10.3 dB	MDA motor operating
1150 kHz	55.0 dBµA	66.3 dBµA	11.3 dB	MDA motor operating

Rationale: The emissions identified by this TIA exceed the CE03 limit during the following ECU operating conditions:

A. CE03 emissions measured when the BGA motor is the operating in the stall mode (maximum mechanical resistance).

B. CE03 emissions measured when the SAW MDA motor is operating.

The emissions during condition 1 occur because the BGA motor is fully loaded and not permitted to rotate. This condition simulates the stress induced by a mechanically stalled BGA motor and is not a normal operating mode. The out of tolerance CE03 emissions during condition 1 are below 1 MHz. The emissions during condition 2 are caused by the MDA motor, which is fed 120 VDC EPS secondary power through the ECU. The out of tolerance emissions during condition 2 are between 1 MHz and 1.2 MHz only. The MDA motors operate only when the PV Array is deployed or retracted. The ECU is compliant with CE03 when the MDA motors are not energized. Emissions from the MDA exceeded the CE03 limit during MDA Qualification testing and TIA 0025 (Approved February 2, 1997) was generated to reconcile its noncompliance. These MDA emissions are responsible for the ECU noncompliance above 1 MHz. For the worst of these emissions, if a worst case bus impedance of 1 Ohm was used the equivalent ripple voltage would be 5.2 millivolts. This would still result in 46 dB of margin with respect to CS02.

EMEP TIA–0207

C.3.2.3.1.2 RE02 LIMITS

Exception: The 3.2.3.1.2 RE02 limit of 46.7 dB microvolts/meter for the Continuous Blood Pressure Device (CBPD) (PN SEG46115090–301) is relaxed by 0.1 dB at 288.1 MHz.

Rationale: The actual deviation measured is the smallest increment possible for this test and it occurred only at a single point in the frequency range. Any design changes to correct the slight deviation will likely have effects on other CBPD test results and could also cause additional EMI problems. Approval of exception for the RE02 requirement will avoid costly hardware redesign and associated schedule impacts. Furthermore, the exception will preclude any additional risk to other hardware, systems or the CBPD.

A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages.

EMEP TIA–0208

C.3.2.3.1.2 RE02 LIMITS

Exemption: When evaluating the Electronics Control Unit for RE02 radiated emissions in accordance with 3.2.3.1, the RE02 emissions limit shall be relaxed by 10 dB for frequencies between 4.4 and 9.4 MHz.

Rationale: The radiated emissions identified by this TIA are caused primarily when the ECU is operating with the BGA motor in the stall mode (maximum mechanical resistance). The emissions during this occur because the BGA motor is fully loaded and not permitted to rotate. This condition simulates the stress induced by a mechanically stalled BGA motor and is not a normal operating mode.

The radiated emissions exceed the RE02 limit by only 2 dB when the BGA motor is allowed to rotate without any external mechanical load (nominal unloaded condition). A 77 dB margin exists between RS03 and RE02 at these frequencies. There are no intentional receivers at these RE02 exceedances.

EMEP TIA–0209

C.3.2.3.1.2 RE02 LIMITS

Exemption: The Wireless Instrumentation System (WIS) Network Control Unit (NCU) (PN SEG16102890) RE02 limits from 3.2.3.1.2 may be increased as follows:

A. From 54 dB microvolts/meter to 57 dB microvolts/meter in the frequencies range of 800 to 812 MHz

B. From 54.5 dB microvolts/meter to 62 dB microvolts/meter in the frequencies range of 856 to 865 MHz.

Rationale: The NCU RE02 test data shown in Table TIA–0209–1 shows that all of the failed radiated emission points in the frequency ranges of concern were no more than 7 dB above the specification. The worst case conditions were evaluated against the RS03 requirements for equipment at those frequencies. The analysis and assessment infers that any ORU that meets the 60 v/m RS03 requirement will maintain a minimum –94 dB safety margin with respect to the NCU emissions of concern. Thus, the NCU emissions that exceeds the limit will not impact the system performance and will comply with systems level EMC requirements.

TABLE TIA–0209–1 WIS NCU TEST DATA AND SPECIFICATION LIMITS

	Frequency	Specification Limit	NCU data	Delta above the limit
RE02	803.1 MHz	54.05 dB µV/m	56.68 dB µV/m	2.63 dB
	861.9 MHz	54.56 dB µV/m	61.48 dB µV/m	6.92 dB
RE03	803.1 MHz	60 V/m (155.6 dB µV/m)		
	861.9 MHz	60 V/m (155.6 dB µV/m)		
Susceptibility Margin	803.1 MHz	98.9 dB		
	861.9 MHz	94.1 dB		

Discussion: A quick analysis was performed based on the test data and the specification limit. A minimum of 94 dB margin exists between the NCU RE02 measurement and RS03 limits in the frequency ranges of concern. At these frequencies, there are no known receivers outside the Wireless Instrumentation System and no known RS03 susceptibilities in other equipment.

EMEP TIA–0211

C.3.2.4.1.1 RS02 APPLICABILITY

Exception: The 3.2.4.1.1 RS02 test does not apply to the DDCUs (PNs R076500–81, R076522–61, R076672; CIs DDCU–EA, DDCU–EA PCA, DDCU–IA) MIL–STD–1553 data bus cables. This exempts MIL–STD–1553 data bus cables only, and not other cabling for which RS02 may be applicable.

Rationale: The RS02 radiated susceptibility requirement applies to all nonpower cable interfaces of the test article. The 1553 data bus is the only nonpower cable interface to the DDCU–E. Performing RS02 tests on the DDCUs to evaluate the 1553 cable interface for susceptibility is unnecessary for the following reasons:

A. MIL–STD–1553 technology is proven by design and is inherently robust to transient EMI environments. The 1553 data bus utilizes transmission parity checking to detect bit errors caused by transients or voltage spikes. Manchester encoding is also utilized by the 1553 data bus to discriminate between signal pulses and unintended transients.

B. The design of the MIL–STD–1553 twinaxial cables and connectors are consistent with MIL–C–17/176–00002 and MIL–C–39029, respectively. Since the 1553 cables, connectors, and bus impedance are standardized for all 1553 data transmission lines, spikes induced by RS02 testing should be invariant for all 1553 systems. If the 1553 system is found to be inherently susceptible to RS02, no changes could or would be made to the existing standard.

C. The RS02 test induces common mode voltage spikes onto the 1553 data bus through the standard shielded cable. The shielded 1553 twinaxial cable attenuates the induced RS02 signal by 40 to 60 dB. In addition to the cable shielding effectiveness, the 1553 balanced data bus circuit is immune to common mode signals of +/– 10 volts from DC to 2 MHz. A complete 1553 validation test has been or will be performed on the DDCUs in accordance with MIL–HDBK–1553. This test included the verification of the +/– 10 volts common mode noise rejection and Gaussian noise rejection requirements. The 1553 bus was very stable as demonstrated in 1553 bus tests as documented in test report, D684–10265–01.

EMEP TIA–0212

C.3.2.3.1.2 RE02 LIMITS

Exception: The DAT PASS1000 Kit (PN SEG33111767–301, –303) is allowed to pass the 3.2.3.1.2.1 RE02 requirements with the following exceptions:

TABLE TIA–0212–1 DAT PASS1000 KIT EXCEPTIONS

Frequency in MHz	Requirement (dBuV/m)	Outage (dBuV/m)	Delta (dB)
203.24	43.9	44.2	0.3
265.84	45.7	52.9	7.2
272.77	45.9	54.5	8.6
331.88	47.2	48.1	0.9

Rationale: The outages are not within 5 MHz of any ISS or STS receiver frequencies. The exceedances are low enough and there is sufficient separation that there will be no interference with any ISS or STS receivers.

EMECB TIA–0213

C.3.2.3.1.2 RE02 LIMITS

Exception: The ARIS Controller (PN 683–61566) is allowed to exceed the RE02 radiated emissions limits of 3.2.3.1.2 at the frequencies and levels listed:

Frequencies (MHz)	Exceedance (dB)	Frequencies (MHz)	Exceedance (dB)	Frequencies (MHz)	Exceedance (dB)
268	22	380	7	516	5
284	15	396	12	532	8
300	19	404	12	548	5
316	6	436	8	580	3
332	8	452	12	620	2
348	2	484	8	780	2
364	6	500	4	N/A	N/A

Rationale: The requested allowance levels were derived by raising the highest measured exceedance level to the second higher whole decibel at each frequency. The frequencies are harmonically related at multiples of 8 MHz; the other harmonics did not exceed the limits. The measured levels were taken on the ARIS Controller with its cables attached and arranged for RE02 measurements along the front of the groundplane in accordance with SSP 30238. However, in practice, the ARIS is installed inside a composite or aluminum rack (normally inside a composite ISPR) with the cables routed in various directions to connect with power, MIL–STD–1553 data buses, and the ARIS actuators. Therefore, this test configuration enhances the amount of radiated emissions, and the emissions in actual use are expected to be somewhat lower as a result of cable routing, loads on the cables, and shielding by the rack structures, other ARIS components, and experiment packages. The power line connection is filtered and prevents excessive radiation of these signals via the power line which connects to outside the rack. There are no intentional receivers at these frequencies on the ISS. The highest measured emissions level has a margin of over 88 dB with respect to the 60 V/m RS03 level in SSP 30237. The total power emitted by all twenty frequencies exceeding the allowed level is less than 0.6 microwatts. Approved for use on US and ESA segments only.

EMEP TIA–0214

C.3.2.2.1 CS02 LIMITS

Exemption: When evaluating the measurement accuracy (susceptibility) of the Electronic Control Unit (ECU) (CI 320PG–2, PN R072341) SAW–Side current sensor in accordance with the CS02 susceptibility requirements specified in 3.2.2.2, the injected CS02 signal between the frequency range of 1.4 and 5.6 MHz shall be reduced from 1 Vrms to 0.5 Vrms.

This tailored CS02 requirement applies only for evaluating the ECU SAW–Side current sensor and does not authorize the reduction or tailoring of the CS02 signal when other ECU functions are evaluated for CS02 susceptibility.

Rationale: The SAW–Side current sensor is operational only when the PV Array is deployed or retracted. This sensor monitors current to the PV Mast Deployment Motor and PV Blanket Box Motors when secondary power is applied. The current sensor measurement data is transmitted by the ECU's 1553 data bus interface for space station down link information only. The SAW–Side current sensor data is not used by the ECU or other PV Array systems for internal decision making, processing, or autonomous functions.

After Flight 12A

The ECU is connected to a dedicated secondary power bus after Flight 12A that consists of the DDCU, RPCM–1, and PFCS.

The ECU terminals are connected 5.8 feet from the DDCU output power terminal, which is referenced to chassis ground at the DDCU. This load configuration remains fixed after Flight 12A.

The worst case emissions from the DDCU output (1 to 10 MHz) were measured at 50 mVrms (EID–03772).

The maximum measured CE03 emissions (1 to 10 MHz) from the RPCM–1 and PFCS leads are less than 0.2 mA (46 dB microamperes).

The RPCM–1 and PFCS emissions are converted to voltage using the equation:

$$v = (i^2 |Z_1| |Z_2|)^{1/2},$$

where $|Z_1|$ is the impedance of the line to chassis 10 microFarad test capacitor in series with the 2 meter CE03 test leads and $|Z_2|$ is a conservative estimate of the line to chassis impedance of the power line without the CE03 test capacitor. Substituting reasonably conservative values for $|Z_1|$ and $|Z_2|$ at the highest frequency (10 MHz) yields the following voltage:

$$v = (0.0002^2 \times 10\ \Omega \times 300\ \Omega)^{1/2} = 10 \text{ mVrms}.$$

EMEP TIA–0215

C.3.2.2.1 CS02 LIMITS

Exception: When evaluating the measurement accuracy (susceptibility) of the ECU (CI 320PG2, PN R072341) BGA Motor current sensor in accordance with the CS02 susceptibility requirements specified in 3.2.2.2, the injected CS02 signal between the frequency range of 750 and 1100 kHz shall be reduced from 1 Vrms to 0.24 Vrms. In addition, the injected CS02 signal onto the negative input power lead between the frequency range of 120 and 220 kHz shall be reduced to 0.16 Vrms.

This tailored CS02 requirement applies only for evaluating the ECU's BGA Motor current sensor and does not authorize the reduction or tailoring of the CS02 signal when other ECU functions are evaluated for CS02 susceptibility.

Rationale: The BGA Motor current sensor output data is not utilized by the ECU or other PV Array systems for internal functions, autonomous decision making or other processing. The current sensor measurement data is transmitted by the ECU's 1553 data bus interface for space station down link information only. The ECU does not utilize the BGA Motor current sensor to calculate the PV Array position or BGA movement, however these parameters can be used to validate the accuracy of the BGA current sensor.

After Flight 12A

After Flight 12A, the ECU is connected to a dedicated secondary power bus that consists of the DDCU, RPCM–1, and PFCS. The ECU terminals are connected 5.8 feet from the DDCU output power terminal, which is referenced to chassis ground at the DDCU. This load configuration remains fixed after Flight 12A.

The worst case system noise voltage between 100 and 240 kHz on the dedicated secondary power bus to the ECU is 20 mVrms. This is verified by line to chassis measurements performed on both negative and positive leads at the ECU terminus of the fully configured secondary power bus in accordance with SPEL Action Request SAR E40109 and documented results in EID–03659. This noise voltage is also corroborated by worst case DDCU emission measurements (100 to 240 kHz) documented in EID–03772.

Post Flight 12A system configuration measurements (EID–03659) indicate that 18 dB margin exists between the power line noise voltage at the ECU input terminals and the tailored CS02 test signal of 160 mVrms between 100 and 240 kHz.

The worst case system noise voltage between 700 and 1200 kHz on the dedicated secondary power bus to the ECU is 20 mVrms. This is verified by line to chassis measurements performed on both negative and positive leads at the ECU terminus of the fully configured secondary power bus in accordance with SPEL Action Request SAR E40109 and results documented in EID–03659. This noise voltage is also corroborated by DDCU emission measurements (700 to 1200 kHz) documented in EID–03772, performed on similar loads to the dedicated ECU secondary (10 amperes). The DDCU is the largest noise source on the post Flight 12A configured power bus.

Post Flight 12A system configuration measurements (EID–03659) indicate that greater than 20 dB margin exists between the power line noise voltage at the ECU input terminals and the tailored CS02 test signal of 240 mVrms between 750 and 1100 kHz.

Prior to Flight 12A

In addition to emissions generated by equipment on the Post Flight 12A configured power bus discussed above, noise is also generated by temporary loads on the output of a SPDA extension to the ITS Z1. The shortest cable length between these temporary loads and the ECU connection is 83 feet. The Z1–SPDA power line extension and loads are removed from the ECU power bus after Flight 12A.

To evaluate the worst case emissions that the temporary SPDA loads will induce on the power bus at the ECU connection, voltage emission measurements were performed on the pre Flight 12A configured power bus in accordance with SPEL Action Request, SAR E40111. The measurements were performed over the ECU current sensor's susceptible range (120 to 220 kHz and 750 to 1100 kHz). The test results are documented in EID–03659. The noise voltage was measured at both the positive and negative power line connections to the ECU while a 0.5 Vrms signal was injected on the positive and negative load terminals of the SPDA, 83 cable feet from the ECU connection. The DDCU, PFCS and RPCM emissions were also present and operating during this measurement as required for the pre Flight 12A configuration. The injected 0.5 Vrms signal was selected to represent the worst case SPDA load emissions because: 1) it is the maximum RMS ripple and noise voltage specified by the Power Quality Requirements (SSP 30482) at Interfaces B&C, and 2) the CS02 injected test signal (1 Vrms) specified was derived from the knowledge that the anticipated threat from emissions was 6 dB less.

The tests indicate that the worst case system noise voltage between 750 and 1100 kHz, measured at the ECU terminals on the pre Flight 12A configured secondary power bus, is 50 mVrms. This result indicates 14 dB margin exists between the amplitude of the tailored CS02 test signal (0.24 Vrms) and the worst case secondary power system noise voltage measured at the ECU input terminals.

The tests indicate that the worst case system noise voltage between 120 and 220 kHz, measured at the ECU terminals on the pre Flight 12A configured secondary power bus, is 60 mV at 120 kHz, 80 mV at 220 kHz, and 70 mV at 154 kHz, the frequency of maximum susceptibility. If the amplitude contour of immunity is considered over the bandwidth of susceptibility, the minimum margin is 7 dB at 154 kHz. Based on this result, at least 7 dB margin exists between the amplitude of the tailored CS02 test signal of 0.16 Vrms and the worst case secondary power system noise voltage measured at the ECU input terminals.

This result of the secondary power system noise measurements (SAR E40111 and SAR 40109) are documented in EID–03659.

Since all the safety margins in this TIA are based solely on test data, the safety margin requirement is 6 dB, and it is shown better in all cases, even with very conservative test data.

In particular, the 500 mVrms noise that as injected to represent the temporary loads on the SPDA extension was far too high relative to the actual noise as measured on the PC175 Power Quality Test at KSC (see Figures T1–1 and T1–2 in ETD MA4–S01139, RL01313 – 175 Power Quality Test Report, released March 17, 1999). Because the actual noise from this test at the measurement location of concern is within a 150 mV peak to peak envelope, corresponding to 54 mVrms, the injected noise during the SPEL test (SAR E40111) was nine times higher than necessary. We determine margins relative to the more realistic 54 mVrms noise via the following arguments.

Superimposing our injected 500 mVrms noise level increased the 20 mVrms noise of the dedicated secondary power bus by:

A. 30 mVrms in the 750 to 1100 kHz range (increasing the dedicated secondary power bus noise level up to 50 mVrms).

B. 40 to 60 mVrms in the 120 to 220 kHz range (increasing the dedicated secondary power bus noise level up to 60 to 80 mVrms).

These 30, 40, and 60 mVrms increases equal 6 percent, 8 percent, and 12 percent of the injected 500 mV level.

Using these percentages to superimpose the more realistic 54 mV noise level produces the following noise levels on the dedicated secondary power bus:

A. 23 mVrms from 750 to 1100 kHz,

B. 24 to 26 mVrms from 120 to 220 kHz.

These noise levels result in more realistic safety margins of:

A. 20 dB from 750 to 1100 kHz,

16 dB from 120 to 220 kHz,

even with the tailored CS02 levels described in this TIA.

Summary

The tailored CS02 levels over the frequency ranges described in this TIA meet the 6 dB margin required for test data.

After Flight 12A :

Based on worst case SPEL tests (EID–03659), there is an 18 dB margin between 120 and 220 kHz, and a 20 dB margin between 750 and 1100 kHz.

Prior to Flight 12A:

Based on worst case SPEL test data (EID–03659), there is a 7 dB margin between 120 and 220 kHz, and a 14 dB margin between 750 and 1100 kHz.

EMEP TIA–0218

C.3.2.4.1.1 RS02 APPLICABILITY

Exemption: The 3.2.4.1.1 RS02 test does not apply to the DCSU (PN R072610–11; CI DCSU) MIL–STD–1553 data bus cables. This exempts MIL–STD–1553 data bus cables only, and not other cabling for which RS02 may be applicable.

Rationale: The RS02 radiated susceptibility requirement applies to all nonpower cable interfaces of the test article. The 1553 data bus is the only nonpower cable interface to the DCSU. Performing RS02 tests on the DCSU to evaluate the 1553 cable interface for susceptibility is unnecessary for the following reasons:

MIL–STD–1553 technology is proven by design and is inherently robust to transient EMI environments. The 1553 data bus utilizes transmission parity checking to detect bit errors caused by transients or voltage spikes. Manchester encoding is also utilized by the 1553 data bus to discriminate between signal pulses and unintended transients.

The design of the MIL–STD–1553 twinaxial cables and connectors are consistent with MIL–C–17/176–00002 and MIL–C–39029, respectively. Since the 1553 cables, connectors and bus impedance are standardized for all 1553 data transmission lines, spikes induced by RS02 testing are invariant for all 1553 systems.

The RS02 test induces common mode voltage spikes onto the 1553 data bus through the standard shielded cable. The shielded 1553 twinaxial cable attenuates the induced RS02 signal by 40 to 60 dB. In addition to the cable shielding effectiveness, the 1553 balanced data bus circuit is immune to common mode signals of +/– 10 volts from DC to 2 MHz.

A complete 1553 validation test has been or will be performed on the DCSUs in accordance with MIL–HDBK–1553. This test included the verification of the +/– 10 volts common mode noise rejection and Gaussian noise rejection requirements. The 1553 Bus was very stable as demonstrated in 1553 Bus tests as documented in test report D684–10265–01.

EMEP TIA–0219

C.3.2.3.1.2 RE02 LIMITS AND
C.3.2.4.2.2 RS03 LIMITS

Exception: The Space Station Buffer Amplifier (SSBA) (Astro PN 51612–0411) EMI qualification testing is accepted for use on the Mobile Transporter (CI 222201A) with A) 3.2.3.1.2 RE02 emission limits and B) 3.2.4.2.2 RS03 E–field levels shown below:

A. RE02 Limits: 14 kHz to 10 MHz: 54 dB microvolts/meter; 10 MHz to 700 MHz: increasing log linearly 54 to 99 dB microvolts/meter; 700 MHz to 10 GHz: 111 dB microvolts/meter; 13.9 GHz: 41 dB microvolts/meter and 14.3 GHz to 15.0 GHz: 52 dB microvolts/meter

B. RS03 Levels: SSP 30237C levels except 200 MHz to 10 GHz: 20 V/m and 13.7 GHz–14.8 GHz: 3 V/m

Rationale: Because the SSBA is a digital repeater and uses a standard MIL–STD 1553 transceiver chip set (UTMC model UT63M125 using 5 and 15 volts) it is reasonably expected the unit EMC performance to reflect that of other equipment that employs this chip set. While there are no qualification test results that confirm Radiated Emission compliance, the frequency range of radiated emission qualification test limits where the Space Station requirements deviate from the SSBA qualification testing are well beyond the range of frequencies that this chip set has been known to produce emissions in other applications. The effects of electromagnetic environment susceptibility on the SSBA was evaluated by mathematical model. The study addressed the electromagnetic coupling to the SSBA input by way of the Trailing Umbilical Cable. The impinging field used the RS03 EMC test requirement defined field intensity and frequency limits. The impinging field was taken to be a plane in several orientations with respect to the umbilical transmission line. The calculation showed that the peak differential field induced SSBA terminal voltage was a few microvolts, which is many orders of magnitude below the data bus threshold of interference (200 mV inband).

EMEP TIA–0220

C.3.2.3.1.2 RE02 LIMITS

Exemption: The H–Reflex hardware (PN McGAMRU–041, 042, 043, 044, DAQ700, DP–ATA/4–CE) may exceed the SSP 30237, Revision D, paragraph 3.2.3.1.2 RE02 limits of 56 dB microvolts/meter by 3 dB in the frequency range of 0.7 to 3 MHz.

The H–Reflex hardware will not be required to undergo radiated susceptability testing (RS03). Conducted emissions and susceptibility testing is not required, as the H–Reflex hardware is battery powered.

This TIA is approved for use on the USL only. It will not be used in other segments.

Rationale:

Issue 1: An isolation amplifier in the H–Reflex Hardware creates the narrowband emissions that are out of RE02 specification. The amplifier being used was chosen because it is a very specialized, high grade, medical quality amplifier. In addition, since this amplifier has flown before (STS–78), the design of the circuitry is proven to provide the data quality required by the hardware. To change now would imply a new circuit board, new certification testing, and would cause many months of delays. The total anticipated usage time for this hardware on the ISS is approximately 6 hours per increment.

Issue 2: The hardware in question has been determined to be criticality 3 (criticality assessment in signature cycle). Therefore, any failures resulting from radiated susceptability will affect the science gathered by this particular experiment only. The hardware has a history of performing in noisy EMI environments (on the ground and in flight) without any difficulty. It is believed that the cost of performing the radiated testing outweighs the potential benefit gained by this test. The hardware provider will accept the risk associated with not performing this testing. A 77 dB margin exists between RS03 and RE02 at these frequencies. There are no intentional receivers at these RE02 exceedances.

EMEP TIA–0226

C.3.2.1.2 CE03 LIMITS

Exemption: When evaluating the Plasma Contactor Unit (PCU) (CI 270PG2, PN R078480) power input leads for conducted emissions, the CE03 limit specified in 3.2.1.2 shall be relaxed from the limit of 45 dB microamperes by 3.5 dB for conducted emissions between 1 to 2 MHz.

Rationale: The PCU conducted emission outages identified by this TIA exceed the SSP 30237, CE03 limit by less than 3.5 dB. The PCU receives secondary power from two dedicated RPCM–V output channels. The PCU emissions are greater than 6 dB below the RPCM–V approved CE limit line and are a fraction of the total noise budget for the secondary power system. As a result adequate safety margins exist.

EMEP TIA–0227

C.3.2.3.1.2 RE02 LIMITS

Exemption: The EXPRESS Rack 8/2 ((PN 683–46052–002, CEI 683P78A, PEI 683P79A) is allowed to exceed the RE02 limits by the amounts indicated at the listed frequency ranges; the excess ambient levels are attributed to the EXPRESS Rack 8/2: 80 to 100 kHz by 10 dB above the 56 dB microvolt/meter requirement, 250 to 275 kHz by 7 dB above the 56 dB microvolt/meter requirement, 375 to 400 kHz by 4 dB above the 56 dB microvolt/meter requirement, 1.5 to 5.0 MHz by 20 dB above the 56 dB microvolt/meter requirement, 6.7 to 10 MHz by 25 dB above the 56 dB microvolt/meter requirement, and 10 to 25 MHz by 25 dB above the requirement, which rises from 56 dB microvolt/meter at 10 MHz to 64.5 dB microvolt/meter at 25 MHz. This is approved for use on US segments only, and is not to be used on JEM or Columbus until approved by NASDA and ESA.

Rationale: In the 1.5 to 25 MHz range, most exceedances were 10 dB or less over the limits; the exception levels were chosen to accommodate the highest levels which were approximately 5 percent of the number of exceedances measured. The emissions below 500 kHz and in the 12 to 18 MHz range have the Solid State Power Converter Module (SSPCM) as the likely culprit based on the SSPCM RE02 test data. The frequencies where the ambient was above the limits include the 1.6 to 5 MHz range where peaks of 20 dB above the 56 dB microvolt/meter were reached in the 1.6 to 2.0 MHz range, a few minor points in the 5 to 9.3 MHz range of less than 1 dB above the limit, and the 9.3 to 12.9 MHz range where the ambient exceeded the limit by as much as 7.5 dB but was usually less than 4 dB above the limit. In the 1.5 to 2.5 MHz range, the ambient emissions seem to be the dominant contributor. In the 2.5 to 5.0 MHz range the ambient also seems to be the dominant contributor except for a small number of frequencies where the Rack emissions appear to push the overall level as much as 6 dB above the ambient level. The Rack is the clearly dominant source above 6.7 MHz.

None of the measured emissions appears to be on or very near a known ISS receiver frequency. The closest ISS receivers appear to be Soyuz Rassvet channels 17V14 at 14.962 MHz (FM) and 17V15 at 18.06 MHz (FM). The nearest measured emissions by the EXPRESS Rack 8/2 within 1 MHz of either frequency were: 14.3 MHz at 5.3 dB above 59.3 dB microvolt/meter limit, 14.7 MHz at 9.0 dB above 59.6 dB microvolt/meter limit, 15.7 MHz at 3.9 dB above 60.2 dB microvolt/meter limit, 15.9 MHz at 3.8 dB above 60.3 dB microvolt/meter limit, 17.1 MHz at 1.2 dB above 60.9 dB microvolt/meter limit, 17.3 MHz at 2.2 dB above 61.0 dB microvolt/meter, and 17.5 MHz at 1.4 dB above 61.2 dB microvolt/meter. Normally, the bandpass of HF receivers is much less than 100 kHz and typically less than 20 kHz. Also, the EXPRESS Racks will be located inside the modules where the hulls will provide significant (40 dB or more) of shielding effectiveness in these frequency ranges to external antennae. Even with the tailoring of the requirement more than 58 dB of margin exists between RS03 and RE02 at these frequencies.

EMEP TIA–0228

C.3.2.1.2.2 CE03 AND
C.3.2.1.3.2 CE07 LIMITS

Exemption: The camcorder system (PNs SED33111493–301, SED33111490–301, DSR–PD1P, DSR–PD1, SED33111485–301, and SED33111491–301) is allowed to exceed the 3.2.1.3 CE07 requirements of +/– 14 Volts by 10.7 Volts at approximately 5 microseconds and +/– 11 Volts by 6.2 Volts at approximately 17 microseconds.

The camcorder (PN DSR–PD1) powered by the AVIU (PN SED33111493–301) is allowed to exceed the 3.2.1.3 CE03 requirements of 69.3 dB microamperes by 1.3 dB at 53.53 kHz. This CE03 exception is against the 120 VDC input.

Rationale: The CE07 test is for use on a 120 Volts system. The US segments are powered by 120 Volts. SSP 50094 does not have a CE07 requirement for its 28 Volt system therefore there is no reason to test the 28 Volt power supply for CE07. Use in the FGB and Russian segments will require approval from RSA.

The CE03 outage is insignificant and should have no effect on EME.

EMEP TIA–0229

C.3.2.3.1.2 RE02 LIMITS

Exemption: The camcorder (PN SED33111485–301) is allowed to exceed the 3.2.3.1 RE02 requirements of 46 dBµV by 6.5 dB at 259.93 MHz, of 49.5 dBµV at 1.5 dB at 425.81 MHz, of 49.9 dBµV at 5.1 dB at 451.19 MHz, and of 50 dBµV at 0.5 dB at 459.98 MHz.

Rationale: A minimum of 64.9 dB margin exists between the RE02 and RS03 limits. These outages are insignificant and should cause no EME concerns.

EMEP TIA–0231

C.3.2.2.1.1 CS01 LIMITS

Exemption: The Pump Flow Control System (PFCS) (CI 380PG2, PN PFCS/10000) CS01 injected noise signal specified in 3.2.2.1 may be reduced from 3.717 Vrms to 1.7 Vrms at 17.8 kHz when the PFCS is evaluated for CS01 compliance.

Rationale: The measured noise on the power bus where the PFCS is located was obtained during MEIT PCM 175 testing (test point 10). The voltage ripple on the power bus 120 VDC line was measured to be 20 mV rms. The noise on the return is expected to be less than that measured on the power line because the return is grounded to structure approximately 8 feet away at the DDCU. However, even if the ripple on the return is equal to the ripple measured on the power line a margin of 38 dB exists.

EMEP TIA–0232

C.3.2.2.1 CS02 LIMITS

Exemption: The Pump Flow Control System (PFCS) (CI 380PG2, PN PFCS/10000) 120 VDC power return leads are not required to be tested to the CS02 requirements specified in 3.2.2.2.

Rationale: The test configuration of the CS02 testing performed was flight representative. CS02 allows for differential injection which would alleviate the need for a test on the return. While differential injection was not performed the intent of this type of test was met. The flight configuration of the PFCS has the return grounded to structure approximately 8 feet away from the PFCS. The actual test configuration used was representative of the flight configuration. Because of the local grounding nearby significant amounts of noise are not expected at the return of the PFCS.

EMEP TIA–0237

C.3.2.3.1.2 RE02

Exemption: The IVA Power Tool Charger Kit (PN SEG33111376–301), while charging the IVA 12 Volt NiMH Battery, is allowed to pass the 3.2.3.1.2 RE02 requirement at the following levels: For frequencies from 0.05503 to 0.6743 MHz, the maximum radiated emissions delta exceedancew will be 8.2 dB.

Approved for use on US segment only.

Rationale: The radiated emissions measurements that were obtained from test RE02 conducted as specified in SSP 30238, paragraphs 3.2.3 contained exceedances at frequency ranges that will not effect the operation or performance of any equipment onboard the Space Station module. There is 77 dB margin between the RE02 and RS03 at these frequencies.

EMEP TIA–0239

C.3.2.4.1.1 RS02 APPLICABILITY

Exemption: The 3.2.4.1.1, RS02 test does not apply to the PCU (PN R078480, CI 270PG2) MIL–STD–1553 data bus cables. This exempts MIL–STD–1553 data bus cables only, and not other cabling in which the RS02 requirement may be applicable.

Rationale: The RS02 radiated susceptibility requirement applies to all nonpower cable interfaces of the test article. The 1553 data bus is the only nonpower cable interface to the PCU. Performing RS02 tests on the PCU to evaluate the 1553 cable interface for susceptibility is unnecessary for the following reasons:

MIL–STD–1553 technology is proven by design and is inherently robust to transient EMI environments. The 1553 data bus utilizes transmission parity checking to detect bit errors caused by transients or voltage spikes. Manchester encoding is also utilized by the 1553 data bus to discriminate between signal pulses and unintended transients.

The design of the MIL–STD–1553 twinaxial cables and connectors are consistent with MIL–C–17/176–00002 and MIL–C–39029, respectively. Since the 1553 cables, connectors and bus impedance are standardized for all 1553 data transmission lines, spikes induced by RS02 testing should be invariant for all 1553 systems. If the 1553 system is found to be inherently susceptible to RS02, no changes could or would be made to the existing standard.

The RS02 test induces common mode voltage spikes onto the 1553 data bus through the standard shielded cable. The shielded 1553 twinaxial cable attenuates the induced RS02 signal by 40 to 60 dB. In addition to the cable shielding effectiveness, the 1553 balanced data bus circuit is immune to common mode signals of +/– 10 volts from DC to 2 MHz.

A complete 1553 validation test has been or will be performed on the PCU in accordance with MIL–HDBK–1553. This test included the verification of the +/– 10 volts common mode noise rejection and Gaussian noise rejection requirements. The 1553 bus was very stable as demonstrated in 1553 bus tests as documented in test report D684–10265–01.

EMEP TIA–0241

C.3.2.3.1.2 RE02 LIMITS

Exemption: The Bar Code Reader (BCR) (PN 90021080) is allowed to pass the 3.2.1.2 RE02 requirements at the following levels:

FREQUENCIES (MHz)	Exceedance (dB)
0.02435 to 0.5593	0.1 dB
228.5	5.3
326.07	0.7
358.51	6.7
457.03	4.9

This TIA is approved for use on US segments only.

Rationale: The configuration for this test had the BCR terminal communicating with a PCS 760XD laptop computer via a RF wireless communication link. Test data was taken under conditions where the BCR and the PCS 760XD laptop computer were in the EMI test chamber operating over the wireless communications link, then the PCS was placed in the EMI chamber alone. Comparison of the EMI test results obtained from the PCS operating alone, then operating with the BCR terminal in a wireless communications link, indicate that the exceedances are due primarily to the PCS, as noted in Table TIA–0241–1. They are not of sufficient magnitude to cause problems. The closest receivers in the frequency ranges of concern are at 463 MHz (Toru and SM–TV–1 & 2).

TABLE TIA–0241–1 EXCEEDANCE CHART

Frequencies (MHz)	Maximum Radiated Emissions Delta Exceedances (dBμV)	
	RF Link	PCS 760XD Only
0.02435 to 0.5593	40.6	40.5
228.5	6.0	0.7
326.07	1.7	1.0
358.51	6.7	0.0
457.03	4.9	0.0

EMEP TIA–0242

C.3.2.1.3.2 CE03 LIMITS AND
C.3.2.2.3.2 CS06 LIMITS

Exception:

1. The Television Camera Interface Converter (TVCIC) (CI 222024A, PN 10033211–501) is allowed to pass the 3.2.2.3.2 CS06 conducted interference 10 microsecond pulse limits with an interruption of power for the duration of the interfering pulse.

2. The TVCIC is allowed to pass the 3.2.1.3.2 CE07 conducted emissions requirements at levels and times as shown in Table TIA–0242–1.

TABLE TIA–0242–1 CE07 MEASURED DATA, LOCKHEED 2–22–2000 TVCIC

	Limit (Volts)	Pulse–width (µsec)	Pulse Peak (Volts)	Amplitude (Volts)
120 volt main, turn on	29	40	+50	–85
120 volt main, turn off	60	<1	+8	–1.0
Heater, turn on	42.3	22	+65	–82.4
Heater, turn off	60	<1	+4	–0.2
Light, turn on	60	1.7	+30	–70.0
Light, turn off	60	<1	0	–0.5

Rationale:

1. An interruption of 28 volt heater power will have negligible functional effect as long as the interruption time remains similar to the transient duration.

2. The TVCIC is a RPCM power supplied unit. Therefore, power switch on is a voltage controlled ramp up making the CE07 test results irrelevant for this particular application.

If it is assumed that powerline transients that exceed 100 volts are noncontinuous, single event occurrences, then the observed interference will be infrequent enough to disregard. During the repetitive transients of the CS06 qualification test, the interference effects appeared relatively minor and are unlikely to compromise the equipment performance. The unit was tested to the full threat level with no damage.

EMEP TIA–0243

C.3.2.4.2.2 RS03 LIMITS

Exemption: The Centerline Berthing Camera System (CBCS) (PN SIG33112636–301) is allowed to pass the 3.3.2.4.2 RS03 requirements at the following levels:

TABLE TIA–0243–1 CBCS RS03 LIMIT EXCEPTIONS

Frequencies (MHz)	Measured Results (V/m)
200	28.4
210	13.0
220	22.0

Rationale: The configuration for this test was where the Camera Assembly CCD was in line of sight of the radiating antenna. During normal operations the camera CCD will be positioned within an inch of the center of the hatch window facing out. Also for planned CBCS operations, which are berthing operations the space station will not be occupied, all personnel will be onboard the orbiter, therefore the possibility for experiment operations or other space station operations will be minimized. Within the range of susceptible frequencies the CBCS was found to consistently provide usable video with interference of no more than 13.0 V/m. There are no ISS transmitters at the susceptible frequencies nor any known ground transmitters that could affect the CBCS.

EMEP TIA–0244

C.3.2.1.2.2 CE03 LIMITS

Exception: The output power leads of the DC to DC Converter Units (Internal, External and Heat Pipe) (CIs DDCU–IA, DDCU–EA and DDCU–HP; PNs R076500, R076522 and R079903) shall be tested for CE03 emissions with 0.2 micro–Farad feedthrough capacitors connected to each DDCU secondary output power lead. The CE03 conducted emissions requirement between the frequencies of 200 kHz and 1200 kHz shall be relaxed by 12 dB when applied to DDCU output power terminals.

When evaluating the DDCU–IA, DDCU–EA and DDCU–HP (PNs R076500, R076522 and R079903) output power leads for conducted emissions, the CE03 limit specified in 3.2.1.2, shall be relaxed by 12 dB for conducted emissions between the frequencies of 200 kHz and 1.2 MHz. This Tailoring/Interpretation Agreement replaces TIA–0101.

Rationale: The outages are not within 5 MHz of any ISS or STS receiver frequencies. The excedances are low enough and there is sufficient separation that there will be no interference with any ISS or STS receivers.

EMEP TIA–0250

C.3.2.4.2.2 RS03 APPLICABILITY

Exemption: The Beta Gimbal Assembly Motor Drive Assembly (MDA) temperature sensor (PN Analog Devices AD590) is allowed to pass the 3.2.4.2.2, RS03 requirements at a level of 30 V/m at 205 MHz.

Rationale: The susceptibility threshold of the MDA temperature sensor was found to be 30 V/m at 205 MHz. There are no electromagnetic emitters on the station or on the shuttle that operate at or near 205 MHz. During testing there was no indication of system malfunction or degradation.

EMEP TIA–0252

C.3.2.3.1.2 RE02 LIMITS

Exemption: The Cycle Ergometer with Vibration Isolation and Stabilization (CEVIS) Cycle Ergometer, (PN SEG46115811–302), Display Control Panel, (PN SEG46117191–301), and Display Cable Assembly, (PN WLSJ320227–301) are allowed to exceed the 3.2.3.1.2 RE02 Limits by of 56 dBμV/m by 4.3 dB at 38.14 kHz.

Rationale: There are no ISS receivers at 38.14 kHz.

EMEP TIA–0253

C.3.2.2.2.2 CS02 LIMITS

Exemption: The injected CS02 threat voltage specified in 3.2.2.2.2, may be reduced to the following values when the MBSU temperature sensor is evaluated for CS02 compliance:

Requirement	CS02 Test Frequencies	Injected CS02 Voltage
1 Vrms	20.0 MHz to 30.0 MHz	0.5 Vrms

Rationale: To avoid susceptibilities, this TIA reduces the injected CS02 voltage levels on the MBSU by 6 dB, from 1 Vrms down to 0.5 Vrms, over the frequency range of 20 to 30 MHz. The dominating frequency of power bus ripple is at 80 kHz, at the switching frequency of the DDCUs. The 20 to 30 MHz frequency range of the reduced CS02 levels is some 250 times higher.

Between 20 and 30 MHz, the maximum ripple at the MBSU is below 20 mVrms, as shown by ripple measurements documented in ETD–MD4–S01064V2, SPEL ESIT Phase III Test Report for Primary/Secondary Noise and Ripple Test, dated May 20, 1998. Comparing this maximum 20 mVrms measured ripple with the measured 500 mVrms susceptibility level yields 28 dB margins at the system level, bettering the 6 dB requirement.

Additionally, the PVCA software samples the temperature sensors once every second and reports the measurement to the higher tier every tenth sample. The PVCA software does not perform any closed loop control or FDIR functionality based on these temperature measurements. The PVCA software does perform a Caution & Warning Associated Indicator (CWAI) check on these data resulting in a CWAI flag only if the temperature measurement exceeds –45 or +170 degrees Celsius for three consecutive samples.

EMEP TIA–0254

C.3.2.3.1.2 RE02 LIMITS

Exemption: The RE02 radiated emissions requirement specified in 3.2.3.1, shall be relaxed by 6 dB (from 56 to 62 dBμV/m when applied to the MBSU (PN R072591)). This tailored requirement shall apply to MBSU radiated emissions between the frequency of 4.25 and 5.25 MHz.

Rationale: This TIA documents the MBSU out of limit RE02 radiated emissions over the frequency range of 4.25 to 5.25 MHz. However, there are no intended visiting vehicle or ISS receiver systems in this frequency range, and the peak out of limit level is at least 48 dB below the 5 V/m RS03 radiated susceptibility level. Therefore the required system level safety margins are maintained.

EMEP TIA–0255

C.3.2.4.2.2 RS03 LIMITS

Exception: When evaluating the MBSU temperature sensor for RS03 compliance, the radiated RS03 electric field, specified in 3.2.4.2.2, may be reduced from 60 V/m to 15 V/m over the frequency range of 240 to 350 MHz. When evaluating the MBSU temperature sensor for RS03 compliance between 360 to 500 MHz, the RS03 electric field may be reduced from 60 V/m to 30 V/m.

Rationale: To avoid susceptibilities, this TIA reduces MBSU RS03 levels in two frequency ranges from 240 to 350 MHz and from 360 to 500 MHz.

Over the first frequency range (240 to 350 MHz), to avoid susceptibilities, the RS03 level was reduced by 12 dB, from 60 to 15 V/m. Even with this reduced level, the required system level safety margins were preserved. Transmitters are not currently planned for use in the 240 to 350 MHz range on–orbit. However, there is the potential for old Shuttle EVA transmitters to be operated at 259.7, 279, and 296.8 MHz in the event the new EMU radios are not ready. However, sufficient system margin exists at these frequencies with respect to these transmitters in the event they are used.

Over the second frequency range (360 to 500 MHz), to avoid susceptibilities, the RS03 level was reduced by 6 dB, from 60 to 30 V/m. At the system level, the minimum margins within this frequency range for ORUs passing their full 60 V/m RS03 levels are 13 dB relative to ground based transmitters, and 15 dB relative to on–orbit transmitters. This translates to safety margin shortfalls of 3 and 1 dB, respectively, at the 30 V/m level.

Note that to reduce costs, a simplified but worst case test setup was used for this MBSU test, wherein the interface cables and front connector panel were directly exposed to the radiated fields. In the on–orbit configuration, shielded cable trays and connector housings protect the MBSU interfacing cables and connectors and decrease incident EM field coupling by at least 6 dB, thus overcoming the margin shortfalls and meeting the 10 dB safety margin requirement.

DCSUs and MBSUs are physically and functionally similar. Both employ identical temperature measurement designs and are installed within the Integrated Equipment Assembly (IEA) and the S0 Truss Segment, respectively. As installed, the DCSU and MBSU outside interfaces are similar. The similar construction of the IEA and S0 provide comparable EM shielding to both the DCSU and MBSU. In 1997, EME tests were conducted on the IEA in Denver, Colorado, that demonstrated IEA compliance with the full 60 V/m RS03 level over the complete frequency range of interest (360 to 500 MHz), as documented in RD97–687, *EMC Test Plan IEA Test Report*, dated November 5, 1997.

Based on this precedent, the MBSUs, as installed within S0 and operating on–orbit, will comply with the full 60 V/m RS03 requirement.

Additionally, the PVCA software samples the temperature sensors once every second and reports the measurement to the higher tier every tenth sample. The PVCA software does not perform any closed loop control or FDIR functionality based on these temperature measurements. The PVCA software does perform a Caution & Warning Associated Indicator (CWAI) check on these data resulting in a CWAI flag only if the temperature measurement exceeds –45 or +170 degrees Celsius for three consecutive samples.

EMEP TIA–0256

C.3.2.3.1.2 RE02 LIMITS

Exemption: The RE02 radiated emissions requirement specified in 3.2.3.1, shall be relaxed by 6 dB for emissions between the frequencies of 2.2 MHz and 10.0 MHz when applied to the DDCU–I (CI DDCU–IA, PN R076500), DDCU–E (CI DDCU–EA, PN R076522) and DDCU–HP (CI DDCU–HPA, PN R076672).

Rationale: The RE02 emission outages indicated in this TIA are caused by DDCU switching noise radiating from the DDCU external power leads. These worst case emissions exceed the RE02 limit by less than 6 dB. A margin of greater than 40 dB exists between the RE02 and RS03 limits. There are no intended visiting vehicles or ISS receivers systems within the frequency range of these outages.

These exceedances were measured during RE02 qualification retests that were ordered after modifications to the DDCU power switch snubber circuits and output rectifier diodes. There is 77 dB margin between the RE02 and RS03 at these frequencies.

EMEP TIA–0258

C.3.2.1.3.2 CE07 AND
C.3.2.3.1.2 RE02 LIMITS

Exemption: The B Bolt Bus Controller (BBC) (CI 222064A, PN 1F45012–1) is allowed to exceed the 3.2.3.1.2 RE02 limits of 56 dBuV/m by 1 dB at 10 MHz. The BBC is also allowed to exceed the 3.2.1.3.2 CE07 limits by 3 volts at 80 μsecs and 5 volts at 160 μsecs.

Rationale: The coupled powerline interference is unlikely to affect any of the equipment that shares the power source at this time.

The radiated emission out of specification margin is small enough to be considered within the repeatability margin of the test setup.

The CE07 requirement is not relevant to actual application since an RPCM provides a power source controlled voltage ramp up.

EMEP TIA–0261

C.3.2.3.1.2 RE02 LIMITS

Exemption: The tailoring would apply to the Portable Fan Assembly (PFA) GFE (PN 96M68020–1). The PFA may exceed 3.2.3.1.2 RE02 requirements in the vertical polarization by 2.9 dB at 46.15 MHz, 0.4 dB at 68.25 MHz, and 1.6 dB at 300 MHz. The PFA may exceed RE02 requirements in the horizontal polarization by 0.8 dB at 68.25 MHz, 5.5 dB at 69.95 MHz, 1.3 dB at 276 MHz, and 5.5 dB at 300 MHz.

Rationale: The radiated emission outages occur in frequency bands where no receivers exist and therefore will not impact the ISS operations.

EMEP TIA–0264

C.3.2.3.1.2 RE02 LIMITS

Exception: The Portable Computer System (PCS) (series 760 computers) with Timex Adapter Assembly (PN SEG12100477–801), COSS Audio/Video Cable (PN SEG12100475–301), and Timex Watch Assembly (PN SEG12100476–801) are allowed to pass the 3.2.3.1.2 RE02 requirements, having a maximum peak of 18.8 dBµV above the specified limit at the frequency levels listed in Table TIA–0264–1.

TABLE TIA–0264–1 RE02 LIMIT EXCEEDANCES (PCS, COSS AUDIO/VIDEO CABLE, AND TIMEX WATCH ASSEMBLY

Peak Number	Frequency (MHz)	Emission (dBµV)	Delta Exceedance (dB)
1	0.02435	72.5	16.5
2	0.05069	74.2	18.2
3	0.07367	58.6	2.6

Rationale: TPS 7l0020109 removed the COSS Hardware from the PCS Laptop and performed the test to compare the data. The results of the test were very similar to the first test. Many of the failures occurred at the same point. The PCS computer has already received waivers for these failures. Based on the test results, the deviation of the PCS should not affect other hardware.

Corrective measures, which could significantly improve the EMI emission, will have major cost impacts to the PCS program.

EMEP TIA–0269

C.3.2.3.1.2 RE02 LIMITS

Exception: The Empty Rack Configuration, consisting of the HRF Flight Rack 1 (PN SEG46117298–301) and the EXPRESS Laptop (PN SDZ39129262–301), may exceed the RE02 requirements of 3.2.3.1, by the frequency levels shown in Table TIA–0269–1.

TABLE TIA–0269–1 RE02 LIMIT EXCEEDANCES (EMPTY RACK CONFIGURATION) (PAGE 1 OF 1)

Comments RE02	RE02 Frequency	Measured Intensity	Standard Intensity	Standard Peak	Exceedance Delta	Average Delta	Median Delta
	(MHz)	(dBμVm)	(dBμVm)	(dB)	(dB)	(dB)	(dB)
Empty Rack, Laptop, Antenna located center	0.02435	71.4	56	3	15.40	8.13	7.60
Empty Rack, Laptop, Antenna located left	0.02453	65.5	56	3	9.50	8.13	7.60
Empty Rack, Laptop, Antenna located center	0.05222	75.5	56	3	19.50	8.13	7.60
Empty Rack, Laptop, Antenna located left	0.05222	63.6	56	3	7.60	8.13	7.60
Empty Rack, Laptop, Antenna located center	0.06157	57.5	56	3	1.50	8.13	7.60
Empty Rack, Laptop, Antenna located center	0.07367	58.3	56	3	2.30	8.13	7.60
Empty Rack, Laptop, Antenna located right	0.2628	57.1	56	3	1.10	8.13	7.60
Empty Rack, Laptop, Antenna located left	10.66	60.9	56.5	3	4.40	5.20	4.40
Empty Rack, Laptop, Antenna located left	13.34	60.3	58.6	3	1.70	5.20	4.40
Empty Rack, Laptop, Antenna located left	14.27	61.1	59.2	3	1.90	5.20	4.40
Empty Rack, Laptop, Antenna located left	14.70	67.0	59.5	3	7.50	5.20	4.40
Empty Rack, Laptop, Antenna located left	15.72	69.0	60.1	3	8.90	5.20	4.40
Empty Rack, Laptop, Antenna located left	15.96	70.6	60.3	3	10.30	5.20	4.40
Empty Rack, Laptop, Antenna located center	16.08	64.7	60.3	3	4.40	5.20	4.40
Empty Rack, Laptop, Antenna located left	17.20	63.4	60.9	3	2.50	5.20	4.40

Rationale: With this configuration, both the Rack and EXPRESS Laptops are activated and placed in their respective operational modes. Rack Health and Status functions are active. However, no subrack payloads (instruments) are activated.

Fifteen exceedances were measured for the HRF Flight Rack 1 configured as empty with a laptop. Possible reasons for these exceedances are the Solid State Power Controller Module (SSPCM) DDCUs. The empty rack avionics had exceedances in stand alone box level tests (reference MDH–SS–SSPCM–0058).

Since the HRF Flight Rack 1 hardware has been built, it would not be reasonable to impose modification(s) to the flight hardware. A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages.

These exceptions to requirements in SSP 57000, paragraph 3.2.4.4, and SSP 57200, do not impose any operational constraints.

EMEP TIA–0270

C.3.2.3.1.2 RE02 LIMITS

Exemption: The HRF Flight Rack 1 in a Full Rack Configuration consists of the following hardware.

Equipment	Part Number
HRF Flight Rack 1	SEG46117298–303
HRF Workstation	SEG46114189–301
Ultrasound	SEG46114550–301
GASMAP Calibration Module	SEG46116916–801
GASMAP Analyzer	901000–001
EXPRESS Laptop	SDZ39129262–301
4PU Stowage Drawer	SED46105631–302
8PU Stowage Drawer	SED46111138–302
Cooling Storage Drawers	SEG46117144–301

The RE02 requirement for the HRF Flight Rack 1 (Full Rack Configuration) specified in 3.2.3.1, shall be relaxed over the frequency range of 0.08848 MHz to 0.2685 MHz as shown in Table TIA–0270–1.

TABLE TIA–0270–1 RE02 LIMIT EXCEEDANCES (FULL RACK CONFIGURATION) (PAGE 1 OF 1)

Comments RE02	RE02 Frequency	Measured Intensity	Standard Intensity	Standard Peak	Exceedance Delta	Average Delta	Median Delta
	(MHz)	(dBμVm)	(dBμVm)	(dB)	(dB)	(dB)	(dB)
Full Rack, Antenna located center	0.02435	71.8	56	15.8	3	5.69	1.00
Full Rack, Antenna located center	0.03071	57.0	56	1.0	3	5.69	1.00
Full Rack, Antenna located center	0.04882	56.9	56	0.9	3	5.69	1.00
Full Rack, Antenna located center	0.05222	75.7	56	19.7	3	5.69	1.00
Full Rack, Antenna located center	0.06157	56.1	56	0.1	3	5.69	1.00
Full Rack, Antenna located center	0.07312	58.2	56	2.2	3	5.69	1.00
Full Rack, Antenna located right	0.27	56.1	56	0.1	3	5.69	1.00
Full Rack, Antenna located center	10.04	72.4	56	16.4	3	10.25	10.30
Full Rack, Antenna located center	10.82	60.7	56.7	4.0	3	10.25	10.30
Full Rack, Antenna located center	15.96	64.8	60.3	4.5	3	10.25	10.30
Full Rack, Antenna located center	19.97	78.4	62.3	16.1	3	10.25	10.30
Full Rack, Antenna located left	260.14	47.5	46	1.5	3	1.50	1.50

Rationale: Full Configuration: Rack and EXPRESS Laptops are activated and placed in respective operational modes. Rack Health and Status and subrack payloads are activated and placed in their respective operational modes. The HRF Monitor interfaces with the Workstation payload. However, no wand is used with the Ultrasound Payload. GASMAP and CSD and all their drawers are on. Sources of high voltage in the rack are the GASMAP, ULTRASOUND, Workstation, and Laptop Power Converter.

These exceedances are due to a combination of the Solid State Power Controller Module (SSPCM) DDCUs, its instruments, and the EXPRESS Laptop (GFE hardware).

Since the HRF Flight Rack 1 hardware has been built, it would not be reasonable to impose modification(s) to the flight hardware. A minimum of 48 dB margin exists between the RE02 and RS03 limits. There are no receivers at these outages.

These exceptions to requirements in SSP 57000, paragraph 3.2.4.4, and SSP 57200 do not impose any operational constraints.

Issue 3: All the payload instruments were located on the testing bench and not physically located within the rack. EXPRESS made some changes to the racks electrical components since the full test was performed. The Moratta Valve control circuitry and the 8–2 Rack were modified before their EMI/EMC testing. EXPRESS reported good results. Also HRF made some changes to the acoustic abatement, mechanical components, and software. In addition, the HRF Configuration Control Board recently approved the upgrade of the Ultrasound and Workstation instruments in the rack. The instrument engineers will rerun these boxes for EMI and EMC and provide before and after data to ensure that the new boxes are no worse than the old boxes.

EMEP TIA–0276

C.3.2.1.2.2 CE03 AND
C.3.2.3.1.2 RE02 LIMITS

Exemption: The Medium Rate Communications Outage Recorder (MCOR) hardware including the updated external fan (PN SEG46117296–301) is allowed to pass the SSP 30237, Revision C, paragraph 3.2.1.2.2 CE03 limits and the SSP 30237, Revision C, paragraph 3.2.3.1.2 RE02 at the frequencies and levels listed in Table TIA–0276–1.

TABLE TIA–0276–1 RE02 LIMITS (MCOR HARDWARE) (PAGE 1 OF 3)

MCOR Hardware and Fan without Enclosure			
CE03, 15 kHz to 50 MHz Return Lead			
Peak Number	Frequency (MHz)	Emission (dBμVm)	Delta (dB)
1	0.1651	56.3	2.2
MCOR Hardware and Fan with Enclosure (Engineering Evaluation)			
CE03, 15 kHz to 50 MHz Return Lead			
Peak Number	Frequency (MHz)	Emission (dBμVm)	Delta (dB)

TABLE TIA–0276–1 RE02 LIMITS (MCOR HARDWARE) (PAGE 2 OF 3)

1	0.1638	59.2	5.0
MCOR Hardware and Fan without Enclosure			
CE03, 15 kHz to 50 MHz Hot Lead			
Peak Number	Frequency (MHz)	Emission (dBµVm)	Delta (dB)
1	0.1651	56.7	2.6
MCOR Hardware and Fan with Enclosure (Engineering Evaluation)			
CE03, 15 kHz to 50 MHz Hot Lead			
Peak Number	Frequency (MHz)	Emission (dBµVm)	Delta (dB)
1	0.1638	60.1	5.9
MCOR Hardware and Fan without Enclosure			
RE02, 200 MHz to 1 GHz			
Peak Number	Frequency (MHz)	Emission (dBµVm)	Delta (dB)
1	266.27	54.7	8.6
2	273.21	53.4	7.1
3	289.02	47	0.3
4	320.35	53.7	6.2
5	336.72	52.1	4.3
6	340.53	48.4	0.5
7	352.79	49.7	1.6
8	360.24	49.3	1.0
9	400.57	50.3	1.2
10	480.38	61.3	11.0
11	520.6	62	11.1
12	530.74	52.6	1.5
13	540.21	52.2	1.0
14	560.56	63.6	12.2
15	580.74	61.2	9.5
16	600.69	52.6	0.7
17	640.59	55.3	2.9
18	679.85	57.6	4.8
19	720.36	54	0.8
20	839.24	60.4	6.1
21	879.3	59.2	4.6

TABLE TIA–0276–1 RE02 LIMITS (MCOR HARDWARE) (PAGE 3 OF 3)

22	960.6	57.8	2.5
MCOR Hardware and Fan with Enclosure (Engineering Evaluation)			
RE02, 200 MHz to 1 GHz			
Peak Number	Frequency (MHz)	Emission (dBµVm)	Delta (dB)
1	266.27	50.1	4.0
2	320.86	47.6	0.1

Rationale: The MCOR hardware's final configuration will be in an aluminum enclosure with the same physical dimensions as the mockup box used during the engineering evaluation test (TPS 7L0020114). The drawings used to build the mockup are 683–50672 (box) and 683–50671 (faceplate cover). This setup with the mockup enclosure simulates the MCOR's final operating configuration. The RE02 data is significantly improved when the hardware is in the enclosure. The data obtained in TPS 7L0020106 (no enclosure) does not accurately demonstrate the EMI signature of the hardware because of the invalidity of the hardware test configuration.

EMEP TIA–0277

C.3.2.3.1.2 RE02 LIMITS

Exemption: The Mass Access Computer Equipment (MACE) Assembly (PN SEG 46117354–301, SEG46117354–303, SEG46117494–301, SEG46117495–301, SEG46117493–301), with the Portable Computer System (PCS) (series 760 computers) is allowed to pass the 3.2.3.1 RE02 requirement. It has a maximum peak of 18.4 dBµV above the specified limit at the frequency levels listed in Tables TIA–0277–1 through TIA–0277–4. In addition, a 0.016 inches copper screen, covering both fans for safety considerations, does not contribute to additional exceedances.

TABLE TIA–0277–1 PCS LAPTOP

RE02, 14 kHz to 25 MHz			
Peak Number	Frequency (MHz)	Emission (dBµVm)	Delta (dB)
1	0.02435	74.3	18.3
2	0.04919	57.5	1.5
3	0.05222	74.2	18.2
4	0.07367	60.7	4.7

TABLE TIA–0277–2 PCS LAPTOP AND MACE

RE02, 14 kHz to 25 MHz			
Peak Number	Frequency (MHz)	Emission (dBµVm)	Delta (dB)
1	0.02435	74.4	18.4
2	0.04882	57.2	1.2
3	0.05262	71.1	15.1
4	0.07367	60.5	4.5

TABLE TIA–0277–3 PCS LAPTOP

RE02, 200 MHz to 1 GHz			
Peak Number	Frequency (MHz)	Emission (dBµVm)	Delta (dB)
1	675.49	53.3	0.5

TABLE TIA–0277–4 PCS LAPTOP AND MACE

RE02, 200 MHz to 1 GHz			
Peak Number	Frequency (MHz)	Emission (dBµVm)	Delta (dB)
1	261.1	48.2	2.2
2	266.27	48.2	2.1
3	294.18	48.5	1.6
4	326.59	52.7	5.1
5	457.03	53.8	3.8
6	675.49	53.2	0.4

Rationale: TPS 7L0020115 (configuration 1) removed the MACE Assembly from the PCS Laptop and performed the test to compare the data. The results of the test were very similar to the first test. Many of the failures occurred at the same point. The PCS computer has already received waivers to the first test for these failures. Based on the test results, the deviation should not affect other hardware.

The copper fan screen (PN SDG46117500–001) is bonded to the MACE chassis by four screws on each fan. This should not contribute to RE or CE emissions.

Corrective measures, which could significantly improve the EMI emission, will have major cost impacts.

EMEP TIA–0282

C.3.2.1.3.2 CE07 LIMITS

Exemption: The ISS Food Warmer (PN SED39114053–309) is allowed to pass the CE07 turnon line transient envelope requirement in SSP 30237, Revision E, paragraph 3.2.1.3.2, with the following exceptions listed in Table TIA–0282–1.

TABLE TIA–0282–1 CE07 LIMIT EXCEEDANCES (PAGE 1 OF 1)

Time (μ secs)	Exceedances (volts)
5.7	–1.0
35.7	15.5
153.0	–1.5
156.0	1.5
201.7	–1.5
208.7	–2.7
217.7	–21.5
337.0	–5.2
341.0	5.9
345.0	–1.5
384.0	–10.2
388.0	2.1
404.0	0.9
415.0	–7.1
418.0	2.8
430.0	12.1
435.0	5.2
441.0	–5.2
452.0	3.1
489.0	–15.2
572.0	3.8
593.0	–17.1
598.0	4.6
604.0	–1.5

Rationale: The actual testing values do not critically exceed the CE07 envelope requirement. Envelope exceedances are attributed to the internal contact points of the ISS Food Warmer Switch. Power transients for the current ISS Food Warmer switch are consistent and reliable. The ISS Food Warmer switch was an existing piece of hardware used for the Shuttle Orbiter In–Flight Food Warmer and MIR Configuration Food Warmer. This hardware has already been flown. Redesign of the power switch would significantly impact project cost and schedule.

EMEP TIA–0283

C.3.2.1.2.2 CE03
C.3.2.1.3.2 CE07 AND
C.3.2.3.1.2 RE02 LIMITS

Exemption: The SMPA/Charger Kit (PN SJG33111349–303), while powering the Fluke scopemeter and charging a Makita battery, and being powered from the US Segments, is allowed to pass the 3.2.3.1.2 RE02 requirements at the following levels:

FREQUENCIES (MHz)	MAXIMUM RADIATED EMISSIONS DELTA EXCEEDANCES (dB)
0.04 to 0.4241	20.0
0.5 to 0.9876	15.5
1.28 to 5.517	10.8

The SMPA/Charger Kit, while powering the Fluke scopemeter, and being powered from the US Segments, is allowed to pass the 3.2.3.1.2 RE02 requirements at the following levels:

FREQUENCIES (MHz)	MAXIMUM RADIATED EMISSIONS DELTA EXCEEDANCES (dB)
0.043 to 0.47	16.0

The SMPA/Charger Kit, while powering the Fluke scopemeter and charging a Makita battery, and being powered from the US Segments, is allowed to pass the 3.2.1.2.2 CE03 requirements at the following levels:

FREQUENCIES (MHz)	MAXIMUM RADIATED EMISSIONS DELTA EXCEEDANCES (dB)
5.653 Vdc Return Lead	5.2
5.699 Vdc Hot Lead	2.5

The SMPA/Charger Kit, while powering the Fluke scopemeter and charging a Makita battery, and being powered from the US Segments, is allowed to pass the 3.2.1.3.2 CE07 requirements by –24.4 V at 2.5 µs and by –16.6 V at 40.0 µs.

The SMPA/Charger Kit, while powering the Fluke scopemeter, and being powered from the US Segments, is allowed to pass the 3.2.1.3.2 CE07 requirement ”off to on” by –16.2 V at 19.5 µs.

Rationale: The radiated emissions measurements that were obtained from test RE02 conducted as specified in SSP 30238, paragraph 3.2.3, contained exceedances at frequency ranges that will not affect the operation or performance of any equipment onboard the Space Station module. There is a 73 dB margin between the RE02 and RS03 requirements at these frequencies.

The narrowband conducted emissions measurements that were obtained from test CE03 as specified in SSP 30238, paragraph. 3.2.1.2.1, contained exceedances at two frequencies that will not affect the operation or performance of any equipment onboard the Space Station module.

The SMPA/BC does not critically exceed the required Time Domain Transient Test (CE07) envelope. The exceedances are attributed to the automatic internal power switch and the internal power routing to the Fluke 105B Scopemeter and Makita battery charging circuit.

Since this is a criticality 3 piece of equipment, NASA EC5 accepts the risk that the kit may have to be turned off (temporarily or permanently) if interference with other equipment is noted. The SMPA/Charger Kit is approved for use on US elements only.

EMEP TIA–0293

C.3.2.2.2.2 CS02 LIMITS

Exception: The Video Tape Recorder (PN 683–51020, CI Number 683138A) is allowed to pass CS02 at 5.0 Vrms for 30 Hz to 339 Hz, 4.0 Vrms for 340 Hz to 500 Hz, 3.5 Vrms for 501 Hz to 700 Hz, 3.0 Vrms for 701 to 1300 Hz, 2.8 Vrms for 1301 Hz to 3800 Hz, 3.0 Vrms for 3801 Hz to 4500 Hz, 3.5 Vrms for 4501 Hz to 5300 Hz, and the standard CS02 curve above 5300 Hz.

Rationale: The VTR passed CS02 testing functionally at the standard levels. A subsequent component failure led to evaluation of electrical stress factors for components in the failed circuit. Although CS02 testing did not cause the component failure, R1 and R3 on schematic drawing 683–51059 (120 Vdc power input) were found to be overstressed with respect to their derated levels of 0.6 Watts per ISS design guidelines at some portions of the standard CS02 test curve. The CS02 limits for the VTR are being reduced to avoid component overstress instead of malfunction. The expected noise ripple on the power bus is less than 1 Vrms. The VTR is a criticality 3 item.

EMEP TIA–0299

C.3.2.3.1.2 RE02 LIMITS

Exception: The Portable Digital Notepad Assembly, TouchPad, Notebook Speakers, and RIO player all configured with the IBM ThinkPad 760D are allowed to pass the 3.2.3 requirements, having a maximum peak of 42.4 dBμV above the specified limit at the frequency levels listed in Table TIA–0299–1 through TIA–0299–11.

TABLE TIA–0299–1 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 1 OF 3)

Digital Notepad and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)
1	0.01805	47.2	2.8	1	0.01805	45.9	1.5
2	0.02453	76	32.2	2	0.02453	76.7	32.9

TABLE TIA–0299–1 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 2 OF 3)

Digital Notepad and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)
3	0.03188	50.8	7.5	3	0.03164	47.9	4.6
4	0.03901	58.1	15.2	4	0.03872	53.3	10.4
5	0.04882	57.4	15.0	5	0.04919	59.6	17.2
6	0.05628	84.6	42.4	6	0.05628	79.5	37.3
7	0.06785	61	19.2	7	0.06391	51.2	9.3
8	0.07367	64.9	23.3	8	0.06735	58.3	16.5
9	0.0812	50.3	8.9	9	0.07312	64.4	22.8
10	0.09501	53.4	12.3	10	0.08059	46	4.6
11	0.09789	53.5	12.4	11	0.09501	48.4	7.3
12	0.1009	45.9	4.9	12	0.09789	46.1	15.0
13	0.1128	53.2	12.4	13	0.1009	46.8	5.8
14	0.1216	56	15.4	14	0.112	46.1	5.3
15	0.133	49.5	9.1	15	0.1216	46	5.4
16	0.1511	54.8	14.6	16	0.133	45.9	5.5
17	0.169	60.8	20.8	17	0.1466	50.6	10.4
18	0.1863	46.6	6.8	18	0.169	56.3	16.3
19	0.1948	46.4	6.7	19	0.1863	41.9	2.1
20	0.2196	50.9	11.5	20	0.1948	45.6	5.9
21	0.2438	44.1	4.9	21	0.2196	51.7	12.3
22	0.2687	50.1	11.1	22	0.2687	51.1	12.1
23	0.2811	46.9	8.0	23	0.2811	42.7	3.8
24	0.294	42.5	3.6	24	0.3144	47.2	8.5
25	0.3029	40.4	1.6	25	0.3652	38.6	0.2
26	0.3168	45.6	6.9	26	0.3906	39.5	1.2
27	0.3414	41.2	2.6	27	0.437	40.9	2.8
28	0.3906	40.5	2.2	28	0.4639	41.5	3.6
29	0.4403	39.7	1.7	29	0.4852	40.1	2.3
30	0.4605	40.1	2.1	30	0.5113	43.2	5.5
31	0.4852	43.5	5.7	31	0.5593	42.3	4.7
32	0.5113	41.3	3.6	32	0.6073	38	0.6
33	0.5593	41.6	4.0	33	0.6496	37.9	0.6
34	0.6028	37.7	0.3	34	0.7544	40.4	3.4
35	0.6496	41.9	4.6	35	0.807	40	3.2
36	0.7544	37.9	0.9	36	1.002	38.5	2.1

TABLE TIA–0299–1 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 3 OF 3)

Digital Notepad and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)
37	0.807	42.6	5.8	37	1.048	37.9	1.6
38	0.896	37.3	0.7	38	1.097	36.6	0.4
39	0.9729	43.3	6.8	39	1.156	36.8	0.7
40	1.13	40.3	4.1	40	1.332	40.7	4.9
41	1.293	40.7	4.8	41	1.582	37.8	2.3
42	1.352	40.3	4.5	42	1.893	37.2	2.1
43	1.524	43	7.4	43	6.36	39.7	7.0
44	2.01	43.2	8.2	44	12.47	36.2	4.9
45	5.236	51.8	18.7				
46	8.905	42.5	10.5				
47	10.66	45.6	13.9				
48	14.7	35.9	4.9				

TABLE TIA–0299–2 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 1 OF 2)

Digital Notepad and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Broadband							
Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)
1	0.02363	123.0	15.5	1	0.02381	123.6	16.1
2	0.03212	108.5	2.5	2	0.0362	106.2	0.7
3	0.03758	109.4	4.1	3	0.0373	107.6	2.3
4	.05545	132.2	28.7	4	0.05545	127.1	23.6
5	0.07258	117.5	15.3	5	0.07204	114.9	12.7
6	0.09572	104.8	3.9	6	0.09716	104.3	3.5
7	0.169	102.5	4.3	7	6.4087	86.3	5.2
8	0.8762	90.6	0.1	8	12.47	83.0	5.0
9	1.147	90.6	1.4				
10	1.342	89.9	1.4				
11	1.57	91.3	3.6				
12	2.056	90.7	4.2				
13	5.355	95.2	13.2				

TABLE TIA–0299–2 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 2 OF 2)

Digital Notepad and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Broadband							
Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)
14	9.039	89.9	10.4				
15	10.58	88.8	10.0				

TABLE TIA–0299–3 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 1 OF 2)

Speakers and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)
1	0.02435	75.8	32.0	1	0.01805	45.9	1.5
2	0.03164	45.2	1.9	2	0.02453	76.7	32.9
3	0.03872	52.5	9.6	3	0.03164	47.9	4.6
4	0.04919	58.4	16.0	4	0.03872	53.3	10.4
5	0.0567	77.6	35.5	5	0.04919	59.6	17.2
6	0.07367	62.9	21.3	6	0.05628	79.5	37.3
7	0.08059	43.4	2.0	7	0.06391	51.2	9.3
8	0.0943	44.7	3.6	8	0.06735	58.3	16.5
9	0.09789	54.7	13.6	9	0.07312	64.4	22.8
10	0.1003	46.1	5.1	10	0.08059	46.0	4.6
11	0.1079	42.3	1.4	11	0.09501	48.4	7.3
12	0.1128	44.8	4.0	12	0.09789	46.1	15
13	0.1216	45.8	5.2	13	0.1009	46.8	5.8
14	0.135	41.8	1.4	14	0.112	46.1	5.3
15	0.1466	49.9	9.7	15	0.1216	46.0	5.4
16	0.169	54.6	14.6	16	0.133	45.9	5.5
17	0.1863	40.6	0.8	17	0.1466	50.6	10.4
18	0.1948	44.7	5.0	18	0.169	56.3	16.3
19	0.2179	50.9	11.4	19	0.1863	41.9	2.1
20	0.2667	50	11.0	20	0.1948	45.6	5.9
21	0.279	40.4	1.4	21	0.2196	51.7	12.3
22	0.3168	46.3	7.6	22	0.2687	51.1	12.1
23	0.3652	38.5	0.1	23	0.2811	42.7	3.8
24	0.3906	38.6	0.3	24	0.3144	47.2	8.5

TABLE TIA–0299–3 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 2 OF 2)

Speakers and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)
25	0.4403	40.5	2.5	25	0.3652	38.6	0.2
26	0.4639	43.2	5.3	26	0.3906	39.5	1.2
27	0.5113	42.2	4.5	27	0.437	40.9	2.8
28	0.5635	42	4.5	28	0.4639	41.5	3.6
29	0.7106	38.3	1.2	29	0.4852	40.1	2.3
30	0.7322	38.3	1.3	30	0.5113	43.2	5.5
31	0.7544	40	3.0	31	0.5593	42.3	4.7
32	0.807	38.4	1.6	32	0.6073	38	0.6
33	0.9302	38.3	1.8	33	0.6496	37.9	0.6
34	1.041	38.3	2.0	34	0.7544	40.4	3.4
35	1.097	37.7	1.5	35	0.807	40	3.2
36	1.218	36.4	0.4	36	1.002	38.5	2.1
37	1.274	36.4	0.5	37	1.048	37.9	1.6
38	1.393	36.3	0.6	38	1.097	36.6	0.4
39	1.457	37.5	1.9	39	1.156	36.8	0.7
40	1.655	36.6	1.2	40	1.332	40.7	4.9
41	1.824	36.4	1.2	41	1.582	37.8	2.3
42	2.025	36.4	1.4	42	1.893	37.2	2.1
43	6.172	38	5.2	43	6.36	39.7	7.0
44	11.83	41.7	10.3	44	12.47	36.2	4.9

TABLE TIA–0299–4 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 1 OF 2)

Speakers and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Broadband							
Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)
1	0.02381	122.7	15.2	1	0.02381	123.6	16.1
2	0.0373	106.0	0.7	2	0.0362	106.2	0.7
3	0.05586	125.2	21.8	3	0.0373	107.6	2.3
4	0.07258	113.1	10.9	4	0.05545	127.1	23.6
5	0.09716	104.3	3.5	5	0.07204	114.9	12.7
6	6.172	82.6	1.3	6	0.09716	104.3	3.5

TABLE TIA–0299–4 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 2 OF 2)

Speakers and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Broadband							
Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)
7	11.83	92.0	13.8	7	6.408	86.3	5.2
				8	12.47	83	5.0

TABLE TIA–0299–5 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 1 OF 1)

Speakers and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)
1	226.72	45.8	1.1	1	226.72	45.7	1.0
2	228.92	54.0	9.3	2	228.92	54.8	10.1
3	237.93	45.1	0.1	3	326.59	54.6	7.5
4	266.27	47.1	1.4				
5	457.03	52.5	3.1				

TABLE TIA–0299–6 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 1 OF 3)

Touchpad and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)
1	0.01819	47.2	2.8	1	0.01805	45.9	1.5
2	0.02435	75.4	31.6	2	0.02453	76.7	32.9
3	0.03236	50.9	7.6	3	0.03164	47.9	4.6
4	0.03872	58.2	15.3	4	0.03872	53.3	10.4
5	0.04599	65.7	23.1	5	0.04919	59.6	17.2
6	0.04882	58.6	16.2	6	0.05628	79.5	37.3
7	0.05628	84.6	42.4	7	0.06391	51.2	9.3
8	0.06735	60.1	18.3	8	0.06735	58.3	16.5
9	0.07367	63.7	22.1	9	0.07312	64.4	22.8
10	0.0812	49.6	8.2	10	0.08059	46.0	4.6
11	0.09221	42.5	1.3	11	0.09501	48.4	7.3

TABLE TIA–0299–6 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 2 OF 3)

Touchpad and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)
12	0.09501	53.1	12.0	12	0.09789	46.1	15.0
13	0.09789	54.7	13.6	13	0.1009	46.8	5.8
14	0.1009	45.3	4.3	14	0.112	46.1	5.3
15	0.1128	53.4	12.6	15	0.1216	46.0	5.4
16	0.1234	46.6	6.0	16	0.133	45.9	5.5
17	0.1371	55.6	15.5	17	0.1466	50.6	10.4
18	0.1499	54.7	14.5	18	0.169	56.3	16.3
19	0.1677	60.8	20.8	19	0.1863	41.9	2.1
20	0.1863	46.5	6.7	20	0.1948	45.6	5.9
21	0.1948	44.8	5.1	21	0.2196	51.7	12.3
22	0.2007	42.2	2.6	22	0.2687	51.1	12.1
23	0.2196	50.5	11.1	23	0.2811	42.7	3.8
24	0.2297	50.5	11.2	24	0.3144	47.2	8.5
25	0.2687	50.7	11.7	25	0.3652	38.6	0.2
26	0.2811	46.8	1.9	26	0.3906	39.5	1.2
27	0.3052	44.8	6.0	27	0.437	40.9	2.8
28	0.3192	47.9	9.2	28	0.4639	41.5	3.6
29	0.3363	41.2	2.6	29	0.4852	40.1	2.3
30	0.3906	39.0	0.7	30	0.5113	43.2	5.5
31	0.4116	45.4	7.2	31	0.5593	42.3	4.7
32	0.4241	39.4	1.0	32	0.6073	38.0	0.6
33	0.4403	41.7	3.7	33	0.6496	37.9	0.6
34	0.4639	40.4	2.5	34	0.7544	40.4	3.4
35	0.5113	42.5	4.8	35	0.807	40.0	3.2
36	0.5635	42.0	4.5	36	1.002	38.5	2.1
37	0.5938	43.2	5.8	37	1.048	37.9	1.6
38	0.6594	42.7	5.5	38	1.097	36.6	0.4
39	0.6845	41.8	4.6	39	1.156	36.8	0.7
40	0.7544	39.7	2.7	40	1.332	40.7	4.9
41	0.7773	37.2	0.3	41	1.582	37.8	2.3
42	0.8009	40.0	3.2	42	1.893	37.2	2.1
43	0.844	40.5	3.8	43	6.36	39.7	7.0
44	0.8762	43.0	6.3	44	12.47	36.2	4.9
45	0.9729	40.9	4.4				

TABLE TIA–0299–6 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 3 OF 3)

Touchpad and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)
46	1.173	41.2	5.1				
47	1.283	41.8	5.9				
48	1.582	42.7	7.2				
49	1.98	43.3	8.3				
50	2.04	42.9	7.9				
51	2.553	35.3	0.8				
52	4.786	35.5	2.2				
53	5.601	38.4	5.5				
54	5.858	45.1	12.2				
55	9.107	44.5	12.5				
56	11.31	44.3	12.8				
57	12.19	36.2	4.8				

TABLE TIA–0299–7 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 1 OF 1)

Touchpad and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Broadband							
Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)
1	0.02381	122.6	15.1	1	0.02381	123.6	16.1
2	0.04565	118.5	14.1	2	0.0362	106.2	0.7
3	0.05586	132.2	28.8	3	0.0373	107.6	2.3
4	0.09644	105.3	4.4	4	0.05545	127.1	23.6
5	0.1703	102.0	3.8	5	0.07204	114.9	12.7
6	1.088	89.9	0.4	6	0.09716	104.3	3.5
7	1.274	89.3	0.6	7	6.408	86.3	5.2
8	1.98	90.9	4.2	8	12.47	83.0	5.0
9	5.902	92.4	10.9				
10	9.039	92.6	13.1				
11	11.15	92.0	13.5				
12	12.28	83.1	5.0				

TABLE TIA–0299–8 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 1 OF 1)

Touchpad and Laptop				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)
1	228.92	46.1	1.4	1	226.72	45.7	1.0
2	326.07	52.3	5.2	2	228.92	54.8	10.1
3	456.29	49.6	0.3	3	326.59	54.6	7.5

TABLE TIA–0299–9 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 1 OF 3)

All Devices (Including RIO)				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)
1	0.01453	47.5	2.6	1	0.01805	45.9	1.5
2	0.01805	48.8	4.4	2	0.02453	76.7	32.9
3	0.02453	74.4	30.6	3	0.03164	47.9	4.6
4	0.03212	49.0	5.7	4	0.03872	53.3	10.4
5	0.03901	56.1	13.2	5	0.04919	59.6	17.2
6	0.04267	47.1	4.4	6	0.05628	79.5	37.3
7	0.04599	52.2	9.6	7	0.06391	51.2	9.3
8	0.04882	57.5	15.1	8	0.06735	58.3	16.5
9	0.05069	54.6	12.2	9	0.07312	64.4	22.8
10	0.05628	81.8	39.6	10	0.08059	46.0	4.6
11	0.06836	53.8	12.0	11	0.09501	48.4	7.3
12	0.07312	62.2	20.6	12	0.09789	46.1	15
13	0.08059	47.3	5.9	13	0.1009	46.8	5.8
14	0.09084	47.8	6.6	14	0.112	46.1	5.3
15	0.09572	55.1	14.0	15	0.1216	46.0	5.4
16	0.09789	53.5	12.4	16	0.133	45.9	5.5
17	0.1063	50.9	10.0	17	0.1466	50.6	10.4
18	0.112	51.6	10.8	18	0.169	56.3	16.3
19	0.134	48.1	7.7	19	0.1863	41.9	2.1
20	0.1511	53.1	12.9	20	0.1948	45.6	5.9
21	0.169	58.5	18.5	21	0.2196	51.7	12.3
22	0.1863	47.2	7.4	22	0.2687	51.1	12.1
23	0.1992	45.3	5.7	23	0.2811	42.7	3.8

TABLE TIA–0299–9 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 2 OF 3)

All Devices (Including RIO)				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBµV/m)	Exceedence (dB)
24	0.2196	49.3	9.9	24	0.3144	47.2	8.5
25	0.2366	39.9	0.6	25	0.3652	38.6	0.2
26	0.2457	41.4	2.2	26	0.3906	39.5	1.2
27	0.2687	48.9	9.9	27	0.437	40.9	2.8
28	0.2811	45.1	6.2	28	0.4639	41.5	3.6
29	0.3052	43.5	4.7	29	0.4852	40.1	2.3
30	0.3168	44.9	6.2	30	0.5113	43.2	5.5
31	0.3363	40.8	2.2	31	0.5593	42.3	4.7
32	0.3518	42.5	4.0	32	0.6073	38.0	0.6
33	0.437	39.2	1.1	33	0.6496	37.9	0.6
34	0.4605	44.7	6.7	34	0.7544	40.4	3.4
35	0.4709	44.0	6.1	35	0.807	40.0	3.2
36	0.5	39.8	2.0	36	1.002	38.5	2.1
37	0.5113	42.2	4.5	37	1.048	37.9	1.6
38	0.5348	43.6	5.9	38	1.097	36.6	0.4
39	0.6073	41.2	3.8	39	1.156	36.8	0.7
40	0.6693	43.1	5.9	40	1.332	40.7	4.9
41	0.7	44.8	7.7	41	1.582	37.8	2.3
42	0.807	40.8	4.0	42	1.893	37.2	2.1
43	0.8696	44.4	7.7	43	6.36	39.7	7.0
44	0.9372	45.0	8.5	44	12.47	36.2	4.9
45	0.9802	42.4	6.0				
46	1.048	43.3	7.0				
47	1.113	44.1	7.9				
48	1.182	45.1	9.0				
49	1.293	44.9	9.0				
50	1.393	45.4	9.7				
51	1.457	45	9.4				
52	1.68	49	13.6				
53	1.865	47	11.9				
54	2.102	47.6	12.7				
55	4.895	59	25.8				
56	9.039	42	10.0				

TABLE TIA–0299–9 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 3 OF 3)

All Devices (Including RIO)				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)
57	10.58	43.5	11.8				
58	12.1	34.7	3.3				

TABLE TIA–0299–10 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 1 OF 1)

All Devices (Including RIO)				Laptop Only			
RE02 14 kHz to 25 MHz Broadband							
Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)
1	0.02381	121.6	14.1	1	0.02381	123.6	16.1
2	0.0314	107.5	1.3	2	0.0362	106.2	0.7
3	0.03284	106.1	0.2	3	0.0373	107.6	2.3
4	0.03786	108.3	3.0	4	0.05545	127.1	23.6
5	0.0567	130.0	26.6	5	0.07204	114.9	12.7
6	0.09572	107.7	6.8	6	0.09716	104.3	3.5
7	0.169	101.4	3.2	7	6.408	86.3	5.2
8	0.6845	92.4	0.7	8	12.47	83.0	5.0
9	0.7715	93.4	2.3				
10	0.9656	94.3	4.3				
11	1.209	94.7	5.7				
12	1.302	93.0	4.4				
13	1.501	94.2	6.2				
14	1.655	94.4	6.9				
15	2.025	94.6	8.0				
16	2.478	89.3	3.7				
17	4.859	103.9	21.5				
18	9.107	89.8	10.3				
19	10.66	90.9	12.2				
20	12.01	84.3	6.1				

TABLE TIA–0299–11 RE02 RADIATED EMISSION EXCEEDANCES (PAGE 1 OF 1)

All Devices (Including RIO)				Laptop Only			
RE02 14 kHz to 25 MHz Narrowband							
Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)	Peaks	Frequency (MHz)	Emission (dBμV/m)	Exceedence (dB)
1	60.07	36.7	0.9	1	40.56	33.7	0.5
2	63.54	37.3	1.1	2	81.02	41.7	3.9
3	80.68	38.0	0.2	3	146.76	44.5	2.7
4	180.64	43.8	0.6	4	149.53	43.3	1.4
				5	158.15	44.7	2.4

Rationale: TPS 7L0020188 also conducts a test of only the IBM Thinkpad 760D laptop. The results of the test showed that the laptop was responsible for the majority of the exceedances and that most of the exceedances are below the specifications listed in 3.2.3.1.2.1 for USL only. The crew preference items are COTS hardware and corrective measures will have major cost impacts. The emission exceedances from the crew preference items will not interfere with any other ISS operations.

EMEP TIA–0307

C.3.2.3.1.2 RE02 LIMITS

Exception: The Clio Personal Data Assistant (PDA) (PN SEG12100596–801) when utilized with the Clio Battery Pouch Assembly (PN SEG12100600–301), PCMCIA Adapter Assembly (PN SEZ33113155–801), and Calluna Card Assembly (PN SEG12100478–801) are allowed to pass the paragraph 3.2.3.1.2 requirements, having a maximum peak of 18.4 dBμV above the specified limit at the frequency levels listed in Tables TIA–0307–1 through TIA–0307–3.

TABLE TIA–0307–1 RE02 LIMIT EXCEEDANCES

Clio PDA with Serial Cable to Laptop (Laptop Outside of Chamber)			
Peaks	Frequency (MHz)	Emission (dBμV/m)	Delta
1	0.04668	69.7	13.7
2	0.1391	60.3	4.3
3	282.14	51.4	4.8
4	506.56	54.9	4.2

TABLE TIA–0307–2 RE02 LIMIT EXCEEDANCES

Clio PDA Only			
Peaks	Frequency (MHz)	Emission (dBμV/m)	Delta
1	0.04774	68.5	12.5
2	0.1423	57.6	1.6
3	282.14	48.5	1.9

TABLE TIA–0307–3 RE02 LIMIT EXCEEDANCES

Clio PDA With Calluna Card and PMCIA Adapter			
Peaks	Frequency (MHz)	Emission (dBμV/m)	Delta
1	0.04739	68.8	12.8
2	281.23	52	5.5
3	320.86	64.5	17.0
4	341.08	48.8	0.9
5	356.21	53.3	5.1
6	381.1	53.2	4.5
7	401.22	67.5	18.4
8	403.16	55.5	6.4
9	481.16	58.5	8.1
10	498.48	52.8	2.2
11	521.43	58.5	7.6
12	561.46	52.3	0.8
13	679.85	53.9	1.1

Rationale: The Clio PDA is modified COTS hardware and any modifications will have major cost impacts. The PCMCIA Adapter Assembly and Calluna Card Assembly have been previously certified for use with the Station Support Computer. The design and fabrication of the Clio Battery Pouch Assembly is based exclusively on the previously certified Battery Pouch Assembly (PN SEG16103510–301) with the exception of a 2.0 amp fuse replacing the previous 0.25 amp fuse. The Battery Pouch Assembly (PN SEG16103510–301) experienced no exceedances during EMI testing (Reference TPS 3G0020046). A potential exists for the Clio PDA to degrade the performance of the WVS. The chance is slight considering the Clio PDA is used for IVA and the WVS is used for EVA. If, however, interference from the Clio PDA is observed on the WVS, the Clio PDA should be either turned off or moved away from the windows. In 2002, the WVS is expected to become a spread spectrum receiver that is inherently immune to this type of narrowband interference.

EMEP TIA–0314

C.3.2.3.1.2 RE02 LIMITS

Exception: The Jazz PC Speakers Assembly (PN SEG12100594–303), which consists of the Jazz PC Speakers Assembly (PN SEG12100594–301) receiving power from an IBM Thinkpad 760XD via the PS/2 Power Cable Assembly (PN SEG12100603–801), is allowed to pass the 3.2.3 requirements, having a maximum peak of 16.8 dBµV above the specified limit at the frequency levels listed in Table TIA–0314–1.

TABLE TIA–0314–1 RE02 RADIATED EMISSIONS EXCEEDANCES

Jazz PC Speakers Assembly (PN SEG 12100594–303) (Consists of the Jazz PC Speakers Assembly (PN SEG 12100594–301), PS/2 Power Cable Assembly (PN SEG 12100603–801), and IBM Thinkpad 760XD Laptop Computer)			
Peaks	Frequency (MHz)	Emission (dBµV/m)	Delta
1	0.02435	72.8	16.8
2	0.05107	67.9	11.9
3	0.07367	59.5	3.5

Rationale: The Jazz PC Speakers Assembly (PN SEG12100594–303) is an additional configuration of the Jazz PC Speakers Assembly (PN SEG12100594–301). It receives power from the IBM Thinkpad 760XD via the PS/2 Power Cable Assembly (PN SEG12100603–801) instead of the alkaline batteries used by the –301 configuration (two AA alkaline batteries). These items are modified COTS hardware and any modifications will have major cost impacts.

EMEP TIA–0320

C.3.2.3.1.2 RE02 LIMITS

Exception: The Clio PDA (PN SEG12100596–801) and Clio Battery Pouch Assembly (PN SEG12100600–301), when configured with the PC Card 7401 (PN SEZ39129739–303) or the Flashcard (PN SDZ39131200–301), are allowed to pass the 3.2.3 requirements, having a maximum peak of 33.9 dBuV above the specified limit at the frequency levels listed in Table TIA–0320–1 through TIA–0320–3.

TABLE TIA–0320–1 RE02 RADIATED EMISSIONS EXCEEDANCES

Clio PDA WITH PC CARD 7401 (3 dB Attenuation Added) (IBM Thinkpad 760 XD also in chamber) 0.014 to 25 MHz			
Peaks	Frequency (MHz)	Emission (dBµV/m)	Delta
1	0.04633	88.7	32.7
2	0.0929	63.8	7.8
3	0.1391	64.9	8.9

TABLE TIA–0320–2 RE02 RADIATED EMISSIONS EXCEEDANCES

Clio PDA WITH PC CARD 7401 (IBM Thinkpad 760XD also in chamber) 200 MHz to 1000 MHz			
Peaks	Frequency (MHz)	Emission (dBμV/m)	Delta
1	281.68	51.5	5.0
2	564.18	52.2	0.7

TABLE TIA–0320–3 RE02 RADIATED EMISSIONS EXCEEDANCES

Clio PDA WITH FLASHCARD 0.014 to 25 MHz			
Peaks	Frequency (MHz)	Emission (dBμV/m)	Delta
1	0.04739	89.9	33.9
2	0.09501	65.3	9.3
3	0.1423	66.4	10.4

Rationale: The Clio PDA, Clio Battery, PC Card 7401, and Flashcard are modified COTS hardware and any modifications will have major cost impacts. The Clio PDA has been approved for USOS use per EMEP TIA #307b when utilized with the Clio Battery Pouch Assembly, PCMCIA Adapter, and Calluna Card Assembly (Reference TPS 7L0020252 and EMEP TIA–0307b). Approval of this TIA would allow the Clio to use the PC Card 7401 to communicate with a 760XD Laptop Thinkpad as well as store data using the SAN disk Flashcard. The PC Card 7401 (RF LAN Card) has been previously certified for ISS use under GCAR 3135. The SAN disk Flashcard has been previously certified for ISS use under GCAR 3547. This is internally installed equipment. There are no receivers at these frequencies.

EMEP TIA–0332

C.3.2.3.1.2 RE02 LIMITS

Exception: The Sony DSR–PD100A Camcorder (PN SEZ16103293–301) when used in battery operated mode is allowed to exceed the 3.2.3.1 requirements of 48.3 dBμV/m by 0.1 dBμV/m at 392.29 MHz, 48.8 dBμV/m by 2.4 dBμV/m at 419.69 MHz, and 49.4 dBμV/m by 0.6 dBμV/m at 459.24 MHz.

Rationale: These outages are insignificant and they should cause no EME concerns. There are no ISS receivers at these frequencies.