Common Instrument Interface (CII) Environmental Guidelines

DRAFT

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Design Goals

- The CII guidelines are provided to increase instrument compatibility with spacecraft so that the maximum number of Missions of Opportunity (MoO) can be realized
- The CII guidelines are designed to allow both the instrument and the spacecraft providers to work independently through the early phases of the applicable design processes
- Final implementation details will still require some resolution between the instrument and the spacecraft once paired in an MoO via the Spacecraft to Instrument ICDs

CII Environment Guidelines

- These guidelines are provided to assure instrument compatibility with the defined environment(s)
- The current set of environmental guidelines are defined for LEO (Low Earth Orbit)
- The environmental guidelines do not yet address quasi-static launch accelerations but we do plan to implement a MAC (Mass Acceleration Curve) approach to same
- We want to engage with the “potential user community” and would appreciate their input to the process of defining the CII guidelines

Key Environment Guidelines

- ## ENV-2 EXPLOSIVE ATMOSPHERE:

  The instrument and assemblies should be designed to operate in the presence of flammable vapors without initiating an explosion or fire

- ## ENV-4 SINUSOIDAL VIBRATION:

  The Instrument should be designed to survive and fulfill its mission after application of launch vehicle-induced transient environments represented by the following sinusoidal vibration design guideline:

Frequency	Displacement or Acceleration Amplitudes	
	Flight Acceptance	Design/Qual/PF
5 -18	8 mm (0.31) DA	12 mm (0.48 in) DA
18-50	5.6 g pk	8 g pk
One sweep: 5 - 50 Hz @ 4 oct/min; except in the freq range 25-35 Hz @1.5 oct/min		

Key Environment Guidelines

- ## ENV-5 RANDOM VIBRATION:

The Instrument should be designed to survive and fulfill its mission after application of launch vehicle-induced transient environments represented by the following random vibration design guideline:

Random Vibration Zone/Assembly	Frequency, Hz	Design, Qual, Protoflight (PF)Level	Flight Acceptance (FA) Level
Instrument	20 20 - 50 50 - 800 800 - 2000 2000 Overall	0.01 g^2/Hz + 2.27 dB/octave 0.02 g^2/Hz - 2.27 dB/octave 0.01 g^2/Hz 5.6 g_{rms}	0.005 g^2/Hz + 2.27 dB/octave 0.01 g2/Hz - 2.27 dB/octave 0.005 g^2/Hz 4.0 g_{rms}

Key Environment Guidelines

- ## ENV-6 ACOUSTIC NOISE:

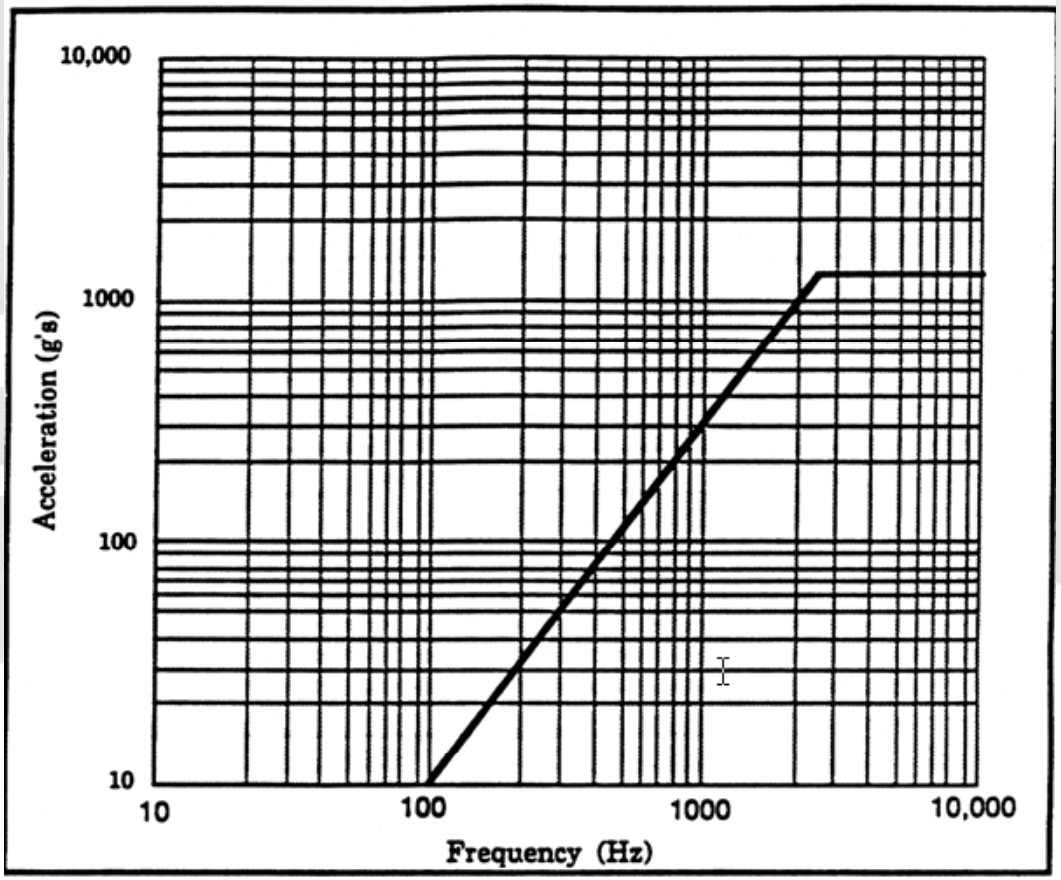
The acoustic noise design guideline for both the instrument and its assemblies is a reverberant random-incidence acoustic field specified in 1/3 octave bands. The acoustic noise spectra are specified in the following table. The design/qual exposure time is 2 minutes; PF/FA exposure time is one minute

1/3 Octave Band Center Frequency (Hz)	Design/Qual/PF Sound Pressure Levels (dB re 20 µPa)	Flight Acceptance Sound Pressure Levels (dB re 20 µPa)
31.5	122.5	119.5
40	125.5	122.5
50	129.5	126.5
63	131.0	128.0
80	131.5	128.5
100	132.5	129.5
125	133.0	130.0
160	133.0	130.0
200	133.5	130.5
250	134.5	131.5
315	135.5	132.5
400	134.5	131.5
500	131.0	128.0
630	128.0	125.0
800	125.0	122.0
1000	123.0	120.0
1250	121.0	118.0
1600	120.0	117.0
2000	119.5	116.5
2500	119.0	116.0
3150	118.0	115.0
4000	116.5	113.5
5000	114.0	111.0
6300	110.0	107.0
8000	106.0	103.0
10000	103.0	100.0
Overall	**143.8**	**140.8**

Key Environment Guidelines

- ENV-7 PYROSHOCK:

  Pyrotechnic shock design guidelines are defined at the instrument/spacecraft interface in the following figure. The instrument is designed to survive two shocks



Key Environment Guidelines

- ENV-8 ACCELERATIONS:

  The Instrument should be designed to withstand a maximum acceleration of 0.015 g on orbit without permanent degradation of performance

- ENV-11 THERMAL RADIATION:

  The Allowable Flight Temperatures (AFT) for the instrument should not be exceeded during the mission when exposed to the applicable worst case expected thermal radiation levels of the following:

Mission Phase	Solar Flux	Earth Albedo	Earth IR (LW Radiation)
Earth Orbit:	1290 to 1420 W/m^2	0.275 to 0.375	222 to 243 W/m^2

Key Environment Guidelines

- ## ENV-14 MAGNETIC FIELD CONSTRAINTS:

The instrument should be designed with the following magnetic field emissions and susceptibility constraints:

Magnetic Field Emissions
AC Magnetic Field Emissions: The radiated AC magnetic field levels from the instrument shall be limited to 60 dB above 1 pico-Tesla between 20 Hz and 50 kHz using the RE04 test method of MIL-STD-462. The measurement bandwidth shall be 10 Hz between 20 Hz and 200 Hz; 100 Hz between 200 Hz and 20 kHz; and 1 kHz between 20 kHz and 50 kHz.
DC Magnetic Field Emissions: The residual magnetic dipole moment of the instrument shall be less than 0.5 A-m^2.

Magnetic Field Susceptibility
AC Magnetic Field Susceptibility: The instrument shall operate within specification when subjected to an AC magnetic field level of 124 dB above 1 pico-Tesla between 30 Hz and 200 kHz. The RS01 test method of MIL-STD-462 shall be used for measurement.
DC Magnetic Field Susceptibility: The instrument shall operate within specification when subjected to an ambient magnetic field consisting of the earth's field (15 to 50 micro-Tesla), the fields generated by neighboring instruments (3 micro-Tesla maximum), and the field produced by the spacecraft magnetic torquers (1000 micro-Tesla maximum).

Backup Materials

Requirment ID	Function	Guideline
LAUNCH ENVIRONMENT		
ENV-1	LAUNCH PRESSURE PROFILE	The instrument should be designed to withstand a maximum atmospheric pressure decay rate of 30 torr/sec (4 kPa/sec) TBR
ENV-2	EXPLOSIVE ATMOSPHERE	The instrument and assemblies should be designed to operate in the presence of flammable vapors without initiating an explosion or fire
ENV-3	VACUUM	The design pressure for the mission will decrease from 101 kPa (~760 torr) at sea level to 1.3x10-15 kPa (10-14 torr) in space
DYNAMICS		
ENV-4	Sinusoidal Vibration	The Instrument should be designed to survive and fulfill its mission after application of launch vehicle-induced transient environments represented by the following sinusoidal vibration design requirement:

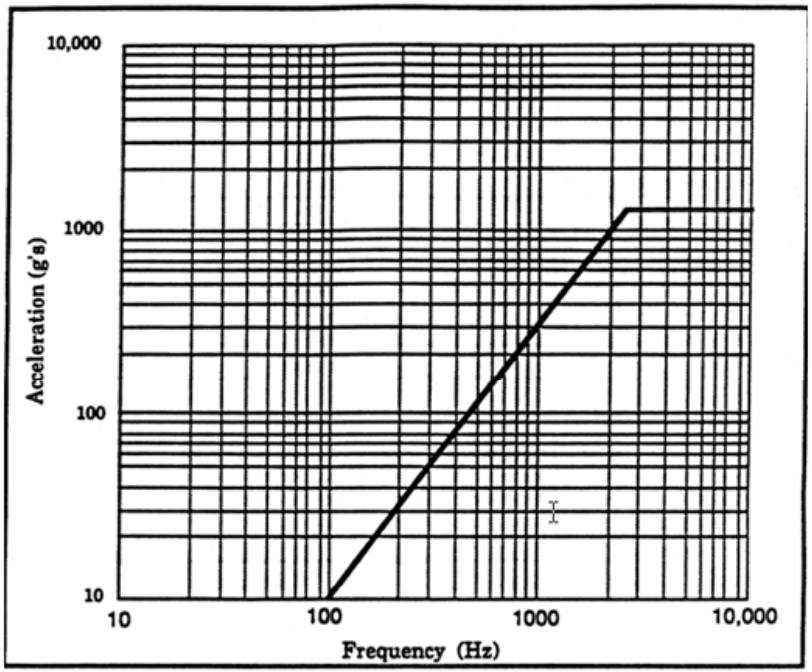
Frequency	Displacement or Acceleration Amplitudes	
	Flight Acceptance	Design/Qual/PF
5 -18	8 mm (0.31) DA	12 mm (0.48 in) DA
18-50	5.6 g pk	8 g pk
One sweep: 5 - 50 Hz @ 4 oct/min; except in the freq range 25-35 Hz @1.5 oct/min		

ENV-5	Random Vibration	The Instrument should be designed to survive and fulfill its mission after application of launch vehicle-induced transient environments represented by the following random vibration design requirement:

Random Vibration Zone/Assembly	Frequency, Hz	Design, Qual, Protoflight (PF)Level	Flight Acceptance (FA) Level
Instrument	20 20 - 50 50 - 800 800 - 2000 2000 Overall	0.01 g^2/Hz + 2.27 dB/octave 0.02 g^2/Hz - 2.27 dB/octave 0.01 g^2/Hz 5.6 g_{rms}	0.005 g^2/Hz + 2.27 dB/octave 0.01 g2/Hz - 2.27 dB/octave 0.005 g^2/Hz 4.0 g_{rms}

ENV-6	Acoustic Noise	The acoustic noise design requirement for both the instrument and its assemblies is a reverberant random-incidence acoustic field specified in 1/3 octave bands. The acoustic noise spectra are specified in the following table. The design/qual exposure time is 2 minutes; PF/FA exposure time is one minute.

1/3 Octave Band Center Frequency (Hz)	Design/Qual/PF Sound Pressure Levels (dB re 20 µPa)	Flight Acceptance Sound Pressure Levels (dB re 20 µPa)
31.5	122.5	119.5
40	125.5	122.5
50	129.5	126.5
63	131.0	128.0
80	131.5	128.5
100	132.5	129.5
125	133.0	130.0
160	133.0	130.0
200	133.5	130.5
250	134.5	131.5
315	135.5	132.5
400	134.5	131.5
500	131.0	128.0
630	128.0	125.0
800	125.0	122.0
1000	123.0	120.0
1250	121.0	118.0
1600	120.0	117.0
2000	119.5	116.5
2500	119.0	116.0
3150	118.0	115.0
4000	116.5	113.5
5000	114.0	111.0
6300	110.0	107.0
8000	106.0	103.0
10000	103.0	100.0
Overall	**143.8**	**140.8**

ENV-7	Pyroshock	Pyrotechnic shock design requirements are defined at the instrument/spacecraft interface in the following Figure. The instrument is designed to survive two shocks. 
ENV-8	Accelerations	The Instrument should be designed to withstand a maximum acceleration of 0.015 g on orbit without permanent degradation of performance.
ENV-9	THERMAL ENVIRONMENT	During ascent, the Instrument should be designed to maintain assembly allowable flight temperatures, within the non-operating temperature range, per Table TBD
ENV-10	CORONA	The test articles should be designed to prevent corona or other forms of electrical breakdown at pressures <1.33 x 10-6 kPa (10-5 torr). RF/high voltage circuitry is subject to multipacting/arcing damage at critical pressure.
ENV-11	THERMAL RADIATION	The Allowable Flight Temperatures (AFT) for the instrument should not be exceeded during the mission when exposed to the applicable worst case expected thermal radiation levels of the following:

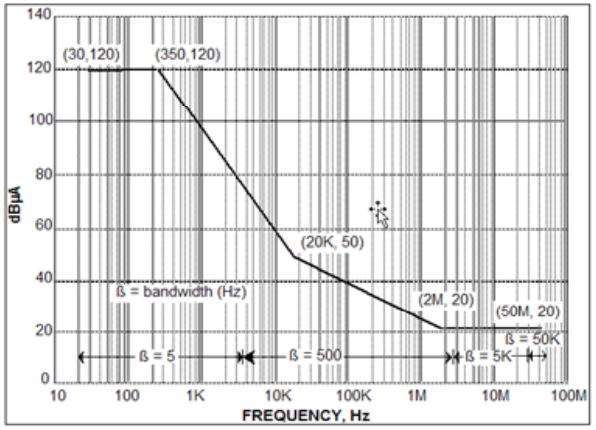
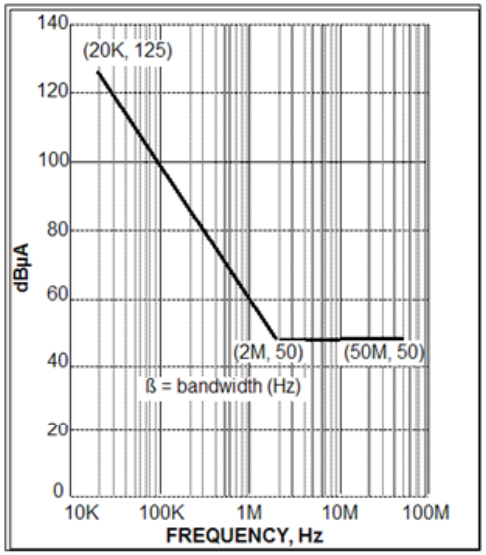
Mission Phase	Solar Flux	Earth Albedo	Earth IR (LW Radiation)
Earth Orbit:	1290 to 1420 W/m^2	0.275 to 0.375	222 to 243 W/m^2

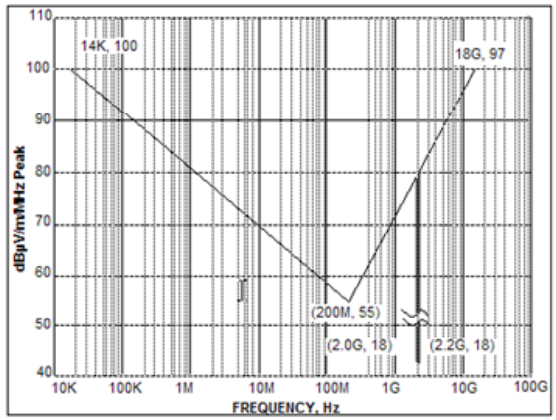
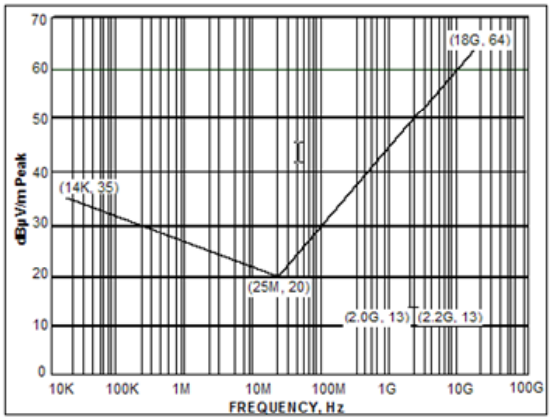
ENV-12	THERMAL RADIATION	The thermal control design should control the Instrument temperatures within the Protoflight levels when exposed to the applicable thermal radiation levels in ENV-11 with a 20% test margin applied to the high levels.
ENV-13	ASSEMBLY TEMPERATURES	Instrument electronic assemblies, where possible, should be designed to operate within specification over the PF temperature range of -20°C to +75°C or AFT + 25°C whichever is more extreme
ENV-14	MAGNETIC FIELD CONSTRAINTS	The instrument should be designed with the following magnetic field emissions and susceptibility constraints:

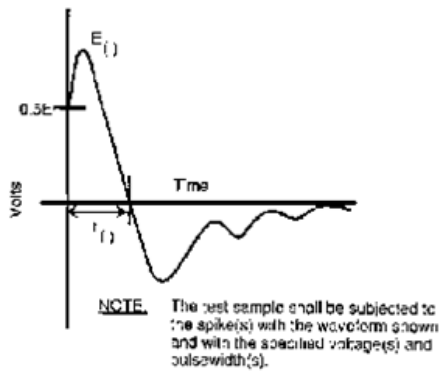
Magnetic Field Emissions
AC Magnetic Field Emissions: The radiated AC magnetic field levels from the instrument shall be limited to 60 dB above 1 pico-Tesla between 20 Hz and 50 kHz using the RE04 test method of MIL-STD-462. The measurement bandwidth shall be 10 Hz between 20 Hz and 200 Hz; 100 Hz between 200 Hz and 20 kHz; and 1 kHz between 20 kHz and 50 kHz.
DC Magnetic Field Emissions: The residual magnetic dipole moment of the instrument shall be less than 0.5 A-m^2.

Magnetic Field Susceptibility
AC Magnetic Field Susceptibility: The instrument shall operate within specification when subjected to an AC magnetic field level of 124 dB above 1 pico-Tesla between 30 Hz and 200 kHz. The RS01 test method of MIL-STD-462 shall be used for measurement.
DC Magnetic Field Susceptibility: The instrument shall operate within specification when subjected to an ambient magnetic field consisting of the earth's field (15 to 50 micro-Tesla), the fields generated by neighboring instruments (3 micro-Tesla maximum), and the field produced by the spacecraft magnetic torquers (1000 micro-Tesla maximum).

ELECTROMAGNETIC COMPATIBILITY (EMC)

ENV-15	Conducted Emissions, Power Leads (CE01/CE03)	Narrowband conducted emissions of the instrument on power and power return leads should be limited to the levels specified in the following when measured in accordance with the CE01 (30 Hz to 20 kHz) and CE03 (20 kHz to 50 MHz) test methods of MIL-STD-462. The measurement bandwidth should be as specified in the following: 
ENV-16	Conducted Emissions, Power Leads (CE01/CE03)	Broadband conducted emissions of the instrument on power and power return leads should be limited to the levels specified in the following over the frequency range of 20 kHz to 50 MHz, when measured in accordance with the CE03 test method of MIL-STD-462. 

ENV-20	Radiated Emissions, E-Fields (RE02)	Instrument assemblies should not radiate electric fields in excess of the levels presented in the following (broadband) and (narrowband), when measured according to the RE02 test method of MIL-STD-462 over the frequency range of 14 kHz to 18 GHz. The narrowband measurement bandwidth should be 500 Hz between 14 kHz and 2.5 MHz, 5 kHz between 2.5 MHz and 30 MHz, 50 kHz between 30 MHz and 1 GHz, and 100 kHz between 1 GHz and 18 GHz.  Radiated Broadband Limits For Electric Field Emissions.  Radiated Narrowband Limits for Electric Field Emissions
ENV-21	Conducted Susceptibility, Power Line Ripple	Differential Voltage Ripple Test. The assembly components connected to the power bus should operate nominally under the following bus conditions of sine wave voltage ripple added to any dc voltage: Power Bus: 3 V p-p with frequency 30 Hz to 400 MHz

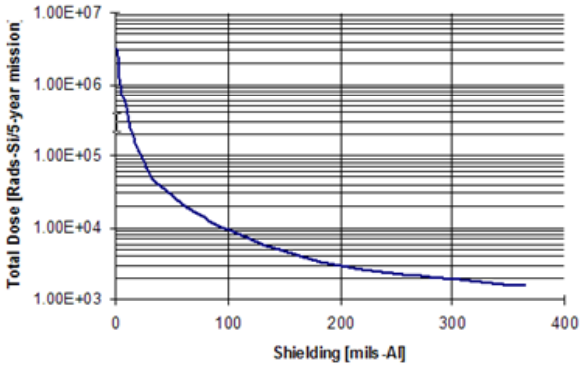
ENV-22	Conducted Susceptibility, Power Line Transient Tests.	The assembly should operate within specification when the input power leads are subjected to the power line transients illustrated in the following figure and table. Positive and negative spikes having a peak voltage equal to the steady-state input power bus voltage and a pulse width of 10 u-sec should be applied to each input power lead using the CS06 test method of MIL-STD-462.  Transient Polarity | DC Line Voltage | Repetition Rate | Duration Positive Transient | 28 Volts | 60 pulses/sec | 5 Minutes Negative Transient | 28 Volts | 60 pulses/sec | 5 Minutes
ENV-23	Radiated Susceptibility, Electric Field (RS03).	The component/instrument should not exhibit any undesirable response, malfunction or performance degradation beyond the tolerances allowed by its specification when it is subjected to the following radiated electric field strengths using the RS03 test method of MIL-STD-462: • 2 V/m between 14 kHz and 2 GHz • 10 V/m between 2 GHz and 18 GHz, except at the following spacecraft transmitter frequencies: • 20 V/m at 2.2875 GHz +/- 2 MHz • 20 V/m at 8.16 GHz +/- 100 MHz

RADIATION

ENV-25	Total Ionizing Dose (TID) Radiation Environment	The instrument should be designed to operate within specification during and after exposure to the Total Ionizing Dose radiation environment of Table 4-6 over the three year mission life. The TID of Table contains no margin or uncertainty factors. The TID vs shielding thickness curve for an aluminum, spherical shell shield exposed to these fluences is given in the following figure:
ENV-26	Total Ionizing Dose (TID) Radiation Environment	A Radiation Design Margin (RDM) for a given electronic part (with respect to a given radiation environment) is defined as the ratio of that part's capability (with respect to that environment and its circuit application) to the environment level at the part's location. The hardware should be designed so as to provide all parts an RDM of two (2) or greater.

Shield Thickness [mils-Al]	Total Ionizing Dose (Rads-Si)	Shield Thickness [mils-Al]	Total Ionizing Dose (Rads-Si)
1	3.26E+06	117	7.23E+03
3	1.92E+06	146	4.95E+03
4	1.24E+06	182	3.45E+03
6	8.62E+05	219	2.63E+03
7	6.30E+05	255	2.21E+03
9	4.79E+05	292	1.95E+03
10	3.76E+05	365	1.58E+03
12	3.00E+05	437	1.39E+03
13	2.44E+05	510	1.21E+03
15	2.00E+05	583	1.08E+03
29	5.98E+04	656	9.82E+02
44	3.28E+04	729	8.90E+02
58	2.18E+04	875	7.49E+02
73	1.57E+04	1167	5.67E+02
87	1.18E+04	1458	4.50E+02

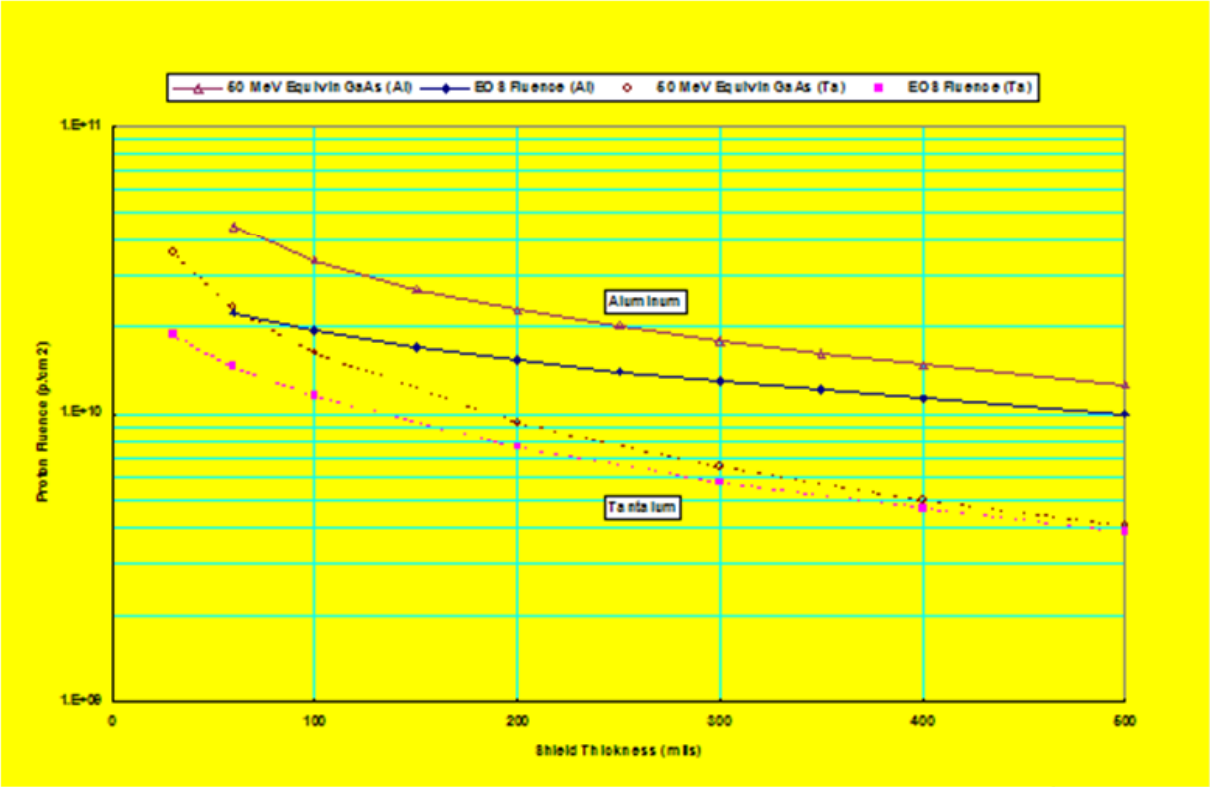
Mission Total Ionizing Dose



ENV-27	Displacement Damage Effects	Prediction of proton-induced displacement damage to sensitive electronic parts should be based on the differential proton fluence in the following table and the integral proton fluence in the following figure. An RDM of 2 should be applied to this fluence.

Surface Incident Energy (MeV)	Surface Incident Fluence (p/sqcm*MeV)	Emerging Energy (MeV)	Particles Emerging Behind Tantalum Spheres			Aluminum Spheres
			30 mils-Ta (p/sqcm*MeV*5-yr)	150 mils-Ta (p/sqcm*MeV*5-yr)	500 mils-Ta (p/sqcm*MeV*5-yr)	100 mils-Al (p/sqcm*MeV*5-yr)
4.00E-02	1.33E+13	1.30E-01	-	2.83E+07	5.11E+06	2.03E+07
7.00E-02	1.03E+13	1.60E-01	1.49E+08	2.52E+07	4.56E+06	2.17E+07
1.00E-01	7.64E+12	2.00E-01	1.33E+08	2.25E+07	4.06E+06	2.33E+07
5.00E-01	5.05E+11	4.00E-01	9.39E+07	1.59E+07	2.87E+06	3.09E+07
1.00E+00	8.22E+11	5.00E-01	8.37E+07	1.42E+07	2.56E+06	3.50E+07
2.00E+00	1.15E+10	6.30E-01	7.68E+07	1.30E+07	2.35E+06	3.98E+07
3.00E+00	5.64E+09	7.90E-01	7.61E+07	1.29E+07	2.33E+06	4.51E+07
4.00E+00	3.80E+09	1.00E+00	7.90E+07	1.34E+07	2.42E+06	5.20E+07
5.00E+00	2.54E+09	2.00E+00	9.44E+07	1.75E+07	3.16E+06	8.22E+07
6.00E+00	1.64E+09	3.98E+00	1.40E+08	2.59E+07	4.68E+06	1.35E+08
8.00E+00	1.28E+09	5.01E+00	1.62E+08	3.00E+07	5.42E+06	1.54E+08
1.00E+01	1.05E+09	6.31E+00	1.65E+08	3.49E+07	6.31E+06	1.75E+08
2.00E+01	5.19E+08	7.94E+00	1.74E+08	4.09E+07	7.39E+06	2.08E+08
3.00E+01	3.47E+08	1.00E+01	2.00E+08	4.81E+07	8.68E+06	1.94E+08
4.00E+01	2.62E+08	2.00E+01	2.12E+08	5.98E+07	1.43E+07	2.20E+08
5.00E+01	2.03E+08	3.98E+01	1.65E+08	6.99E+07	1.78E+07	1.76E+08
6.00E+01	1.61E+08	5.01E+01	1.41E+08	6.45E+07	1.96E+07	1.44E+08
8.00E+01	1.00E+08	6.31E+01	1.01E+08	5.80E+07	2.05E+07	1.07E+08
1.00E+02	6.80E+07	7.94E+01	7.15E+07	4.57E+07	1.84E+07	7.37E+07
2.00E+02	1.72E+07	1.00E+02	5.04E+07	3.43E+07	1.75E+07	5.16E+07
3.00E+02	5.97E+06	2.00E+02	1.34E+07	1.07E+07	7.19E+06	1.34E+07
4.00E+02	2.20E+06	3.98E+02	1.80E+06	1.30E+06	8.92E+05	1.68E+06
5.00E+02	8.51E+05	5.01E+02	4.30E+05	1.50E+05	8.60E+04	2.85E+05
6.00E+02	3.65E+04	6.31E+02	3.73E+04	3.77E+04	3.78E+04	3.76E+04
8.00E+02	3.83E+04	7.94E+02	3.82E+04	3.79E+04	3.76E+04	3.81E+04
1.00E+03	3.70E+04	1.00E+03	3.63E+04	3.52E+04	3.44E+04	3.59E+04
2.00E+03	2.57E+04	2.00E+03	2.52E+04	2.39E+04	2.28E+04	2.43E+04
3.00E+03	1.72E+04	3.98E+03	1.17E+04	1.08E+04	1.02E+04	1.12E+04
4.00E+03	1.22E+04	5.01E+03	8.85E+03	8.28E+03	7.77E+03	8.46E+03
5.00E+03	9.16E+03	6.31E+03	6.45E+03	6.02E+03	5.65E+03	6.17E+03
8.00E+03	4.93E+03	7.94E+03	4.76E+03	4.41E+03	3.98E+03	4.56E+03
1.00E+04	3.61E+03	1.00E+04	-	-	-	-

Total Differential Fluence of Trapped Protons, Galactic Cosmic Ray Protons and Solar Flare Protons
EOS Common Spacecraft: I=98 deg, h=705km

ENV-27	Displacement Damage Effects (continued)	 Integral Proton Fluence with 50 MeV Equivalent in GaAs

ENV-28	Single Event Effects (SEE) Radiation Environment.	The instrument should be designed to operate as defined below when exposed to Galactic Cosmic Ray and small solar flare protons specified and the trapped proton/electron peak flux environment specified in the following tables. The integral Galactic Cosmic Ray Linear Energy Transfer (LET) spectrum is provided in Figure 4-10. The required operational capabilities and associated design requirements are as follows: 1) Temporary loss of function or loss of data is permitted, provided that the loss does not compromise instrument health and full performance can be recovered rapidly. 2) To minimize loss of data, normal operation and function should be restored via internal correction methods without external intervention. 3) Irreversible actions should not be permitted. The hardware design should have no parts which experience radiation induced latch-up to an effective LET of 75 MeV/mg/cm2 and a fluence of 107 ions/cm2.

Surface Incident Energy (MeV)	Surface Incident Fluence (p/sqcm*MeV)	Emerging Energy (MeV)	Particles Emerging Behind Tantalum Spheres			Aluminum Spheres
			30 mils-Ta (p/sqcm*MeV*5-yr)	150 mils-Ta (p/sqcm*MeV*5-yr)	500 mils-Ta (p/sqcm*MeV*5-yr)	100 mils-Al (p/sqcm*MeV*5-yr)
4.00E-02	1.33E+13	1.30E-01	-	2.83E+07	5.11E+06	2.03E+07
7.00E-02	1.03E+13	1.60E-01	1.49E+08	2.52E+07	4.56E+06	2.17E+07
1.00E-01	7.64E+12	2.00E-01	1.33E+08	2.25E+07	4.06E+06	2.33E+07
5.00E-01	5.05E+11	4.00E-01	9.39E+07	1.59E+07	2.87E+06	3.09E+07
1.00E+00	8.22E+11	5.00E-01	8.37E+07	1.42E+07	2.56E+06	3.50E+07
2.00E+00	1.15E+10	6.30E-01	7.68E+07	1.30E+07	2.35E+06	3.98E+07
3.00E+00	5.64E+09	7.90E-01	7.61E+07	1.29E+07	2.33E+06	4.51E+07
4.00E+00	3.80E+09	1.00E+00	7.90E+07	1.34E+07	2.42E+06	5.20E+07
5.00E+00	2.54E+09	2.00E+00	9.44E+07	1.75E+07	3.16E+06	8.22E+07
6.00E+00	1.64E+09	3.98E+00	1.40E+08	2.59E+07	4.68E+06	1.35E+08
8.00E+00	1.28E+09	5.01E+00	1.62E+08	3.00E+07	5.42E+06	1.54E+08
1.00E+01	1.05E+09	6.31E+00	1.65E+08	3.49E+07	6.31E+06	1.75E+08
2.00E+01	5.19E+08	7.94E+00	1.74E+08	4.09E+07	7.39E+06	2.08E+08
3.00E+01	3.47E+08	1.00E+01	2.00E+08	4.81E+07	8.68E+06	1.94E+08
4.00E+01	2.62E+08	2.00E+01	2.12E+08	5.98E+07	1.43E+07	2.20E+08
5.00E+01	2.03E+08	3.98E+01	1.65E+08	6.99E+07	1.78E+07	1.76E+08
6.00E+01	1.61E+08	5.01E+01	1.41E+08	6.45E+07	1.96E+07	1.44E+08
8.00E+01	1.00E+08	6.31E+01	1.01E+08	5.80E+07	2.05E+07	1.07E+08
1.00E+02	6.80E+07	7.94E+01	7.15E+07	4.57E+07	1.84E+07	7.37E+07
2.00E+02	1.72E+07	1.00E+02	5.04E+07	3.43E+07	1.75E+07	5.16E+07
3.00E+02	5.97E+06	2.00E+02	1.34E+07	1.07E+07	7.19E+06	1.34E+07
4.00E+02	2.20E+06	3.98E+02	1.80E+06	1.30E+06	8.92E+05	1.68E+06
5.00E+02	8.51E+05	5.01E+02	4.30E+05	1.50E+05	8.60E+04	2.85E+05
6.00E+02	3.65E+04	6.31E+02	3.73E+04	3.77E+04	3.78E+04	3.76E+04
8.00E+02	3.83E+04	7.94E+02	3.82E+04	3.79E+04	3.76E+04	3.81E+04
1.00E+03	3.70E+04	1.00E+03	3.63E+04	3.52E+04	3.44E+04	3.59E+04
2.00E+03	2.57E+04	2.00E+03	2.52E+04	2.39E+04	2.28E+04	2.43E+04
3.00E+03	1.72E+04	3.98E+03	1.17E+04	1.08E+04	1.02E+04	1.12E+04
4.00E+03	1.22E+04	5.01E+03	8.85E+03	8.28E+03	7.77E+03	8.46E+03
5.00E+03	9.16E+03	6.31E+03	6.45E+03	6.02E+03	5.65E+03	6.17E+03
8.00E+03	4.93E+03	7.94E+03	4.76E+03	4.41E+03	3.98E+03	4.56E+03
1.00E+04	3.61E+03	1.00E+04	-	-	-	-

Trapped Proton (E≥5 MeV) Flux	6.4×10^3 particles/cm^{2}sec
Trapped Electron (E≥0.5 MeV) Flux	3.2×10^5 particles/cm^{2}sec

Trapped, Peak Proton and Electron Fluxes

ENV-29	solar flare event	The instrument should be designed to survive the solar flare event specified in the following table without permanent degradation or damage and to operate within specification after the event. If necessary, external intervention is allowed to restore functionality.

Energy (MeV)	Flux (Particles/cm^{2}sec)	Total Event Integral Fluence (Particles/cm^2)
> 10	1.1E+06	3.4E+09
>30	2.6E+05	1.8E+09
>60	8.0E+04	6.4E+08
>100	-	1.5E+08

The total event integral fluence is accumulated within a time interval of a few hours to two days.

Solar Flare Proton Peak Fluxes and Associated Total Event Integral Fluences (Instrument Survival)

ELECTROSTATIC DISCHARGE		
ENV-31	External Potential Difference	The voltage between any instrument surface area greater than 0.5 cm2 and instrument structure should be less than or equal to 200 volts, when exposed to a 5 nA/cm2 flux level of electrons with 20 keV energy
ENV-32	Electrostatic Discharge Susceptibility	The instrument should not be susceptible to a 6 mJ arc discharge (13 kV from 70 pF capacitor or equivalent) applied at a distance of 25 cm from the exterior surface of the instrument
ENV-36	Internal Charging	Metallic elements, including wires, unused conductors of cable, connectors, circuit board traces, and spot shields greater than 3 cm2 in area or 25 cm in length should have a conductive path to ground of less than 108 Ohms when measured in air and less than 1012 Ohms when measured in vacuum. Flight hardware that is shielded from the external radiation environment by >0.32 cm (125 mils) of aluminum (or equivalent) need not be grounded.
SOLID PARTICLE ENVIRONMENTS		
ENV-37	Micrometeoroids	The following table should be used as the design level fluence (nominal levels, no margin, omnidirectional fluence) for the Instrument mission micrometeoroid environment (cumulative)

Particle mass, M (grams)	Omnidirectional Fluence (particles/m^2 of mass > M)	
	Micrometeoroids	Artificial Space Debris
1.0E−12	1.0E+04	2.3E+06
1.0E−10	1.9E−03	5.0E+04
1.0E−08	3.6E−02	1.1E−03
1.0E−06	1.4E−01	2.3E−01
1.0E−05	1.4E−00	3.4E 00
1.0E−04	9.9E−02	5.0E−01
1.0E−03	5.7E−03	7.3E−02
1.0E−02	2.9E−04	1.1E−02
1.0E−01	1.4E−05	1.6E−03
1.0E 00	6.7E−08	2.7E−04
1.0E+01	-	6.9E−05
1.0E+02	-	3.1E−05

For micrometeoroids: average particle density = 2.5 g cm^{-3}
mean penetration speed = 19 km s^{-1}

For artificial space debris: particle density = 2.5 to 3.0 g cm^{-3}
mean penetration speed = 7 to 10 km s^{-1}

ENV-38	Artificial Space Debris	The above table should be used as thedesign level fluence (nominal levels, no margin, omindirectional fluence) for the Instrument mission artificial space debris environment (cumulative)