

# ***JEO Spacecraft Environmental Interactions Summary***

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**For Planning and Discussion Purposes Only**

# **Summary**

- **Useful References**
- **Conclusion**

## *Summary*

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# USEFUL INTERNET SITES FOR SPACE ENVIRONMENT EFFECTS

<a href="http://see.msfc.nasa.gov/">http://see.msfc.nasa.gov/</a>	MSFC SEE Homepage
<a href="http://crsp3.nrl.navy.mil/">http://crsp3.nrl.navy.mil/</a>	CREME96 Homepage
<a href="http://sat-nd.com/#FAILURES">http://sat-nd.com/#FAILURES</a>	Recent Satellite Outages and Failures
<a href="http://standards.nasa.gov/">http://standards.nasa.gov/</a>	NASA TECHNICAL STANDARDS PROGRAM
<a href="http://engineer.jpl.nasa.gov/standards.html">http://engineer.jpl.nasa.gov/standards.html</a>	Space Engineering Standards (JPL)
<a href="http://www.swpc.noaa.gov/">http://www.swpc.noaa.gov/</a>	Today's Space Weather
<a href="http://spaceweather.com/">http://spaceweather.com/</a>	The NASA Space Weather Bureau
<a href="http://www.ngdc.noaa.gov/">http://www.ngdc.noaa.gov/</a>	National Geophysical Data Center
<a href="http://geomag.usgs.gov/">http://geomag.usgs.gov/</a>	USGS Geomagnetism Program
<a href="http://www.ngdc.noaa.gov/geomag/">http://www.ngdc.noaa.gov/geomag/</a>	Geomagnetic Field Models
<a href="http://www.ngdc.noaa.gov/IAGA/vmod/igrf.html">http://www.ngdc.noaa.gov/IAGA/vmod/igrf.html</a>	International Geomagnetic Reference Field
<a href="http://portal.cssdp.ca:8080/ssdp/jsp/logon.jsp">http://portal.cssdp.ca:8080/ssdp/jsp/logon.jsp</a>	Canadian Space Data Data
<a href="http://www.meteorblog.com/">http://www.meteorblog.com/</a>	Meteor Showers
<a href="http://www.astro.ufl.edu/~oliver/xyz/">http://www.astro.ufl.edu/~oliver/xyz/</a>	METEM Model FTP Site (Prof. John Oliver)
<a href="http://www.imo.net/index.html">http://www.imo.net/index.html</a>	International Meteor Organization Index
<a href="http://www.orbitaldebris.jsc.nasa.gov/">http://www.orbitaldebris.jsc.nasa.gov/</a>	Debris Models
<a href="http://www.geo.mtu.edu/weather/aurora/">http://www.geo.mtu.edu/weather/aurora/</a>	The Aurora
<a href="http://www.ngdc.noaa.gov/dmsp/">http://www.ngdc.noaa.gov/dmsp/</a>	DMSP Auroral Photos (Latest Aurora)
<a href="http://www.ngdc.noaa.gov/stp/GOES/goes.html">http://www.ngdc.noaa.gov/stp/GOES/goes.html</a>	GOES Daily Satellite Data (Geosynchronous)
<a href="http://nssdc.gsfc.nasa.gov/cd-rom/cd-rom.html">http://nssdc.gsfc.nasa.gov/cd-rom/cd-rom.html</a>	NSSDC CD Catalog of Space Data
<a href="http://hubblesite.org/newscenter/">http://hubblesite.org/newscenter/</a>	HST Pictures
<a href="http://www.nasa.gov/home/index.html">http://www.nasa.gov/home/index.html</a>	NASA Space Link Educational Data Base
<a href="http://www.jpl.nasa.gov/">http://www.jpl.nasa.gov/</a>	JPL Homepage
<a href="http://www.cmf.nrl.navy.mil/clementine/">http://www.cmf.nrl.navy.mil/clementine/</a>	NRL Clementine Site
<a href="http://umbra.nascom.nasa.gov/spd/">http://umbra.nascom.nasa.gov/spd/</a>	NASA Space Physics--Mission Descriptions
<a href="http://www.cambridge.org/catalogue/catalogue.asp?isbn=9780521607568">http://www.cambridge.org/catalogue/catalogue.asp?isbn=9780521607568</a>	My Spacecraft-Environment Interactions Book

*Summary*

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# **Conclusion**

## **Conclusions**

- **WHY DO WE CARE?**
  - ENVIRONMENTAL EFFECTS ARE POTENTIALLY EXPENSIVE PROBLEMS
  - THERE ARE STILL MANY UNKNOWNS
  - PROPER DESIGN WILL LIMIT PROBLEMS
- **WHAT CAN WE DO?**
  - DESIGN: EVALUATE THE MISSION DESIGN USING AN INTEGRATED APPROACH
  - BUILD: REQUIRE ADEQUATE TESTING (RECOMMEND ENGINEERING TEST MODEL!)
  - FLIGHT: DURING FLIGHT, EVALUATE EFFECTIVENESS OF MITIGATION METHODOLOGY
  - POST FLIGHT: USE DATA TO UPDATE MODELS

## **Integrated Approach to Mission Design**

### **DESIGN PROCEDURES**

- 1) Identify Requirements Based on Trajectory, Instruments, and Unique Mission Constraints
- 2) Rate the Environments versus the Interactions
- 3) Identify the Design Trade-Offs for the Most Critical Environment/Interaction Concerns
- 4) Establish Weight, Cost, Complexity Criteria
- 5) Optimize Combinations of Design Choices
- 6) Evaluate Resulting Designs

## Summary

# Integrated Approach to Environment Mitigation

## STEP 1 ENVIRONMENTS VS INTERACTIONS

### INTERACTIONS

ENVIRONMENTS	INTERACTIONS									
	CUMULATIVE RAD EFFECTS	SINGLE EVENT UPSETS	LATCH-UP	SURFACE CHARGING/WAKES	INTERNAL CHARGING	POWER LOSS	VxB	SURFACE DAMAGE	CONTAMINATION	PARTICLE IMPACTS
NEUTRAL ATMOSPHERE										
E,B FIELDS										
ULTRAVIOLET RADIATION										
INFRARED RADIATION										
SOLAR WIND PLASMA										
IONOSPHERIC PLASMA										
AURORA PLASMA										
TRAPPED RADIATION										
GALACTIC COSMIC RAY										
SOLAR PROTON EVENTS										
METEOROIDS										
DEBRIS										
Legend:	X = Major Effect		E,e = Europa							
	X = Observable Effect		P,p = Pluto Express							
			S,s = Solar Probe							

Legend:  
 X = Major Effect  
 X = Observable Effect  
 S,s = Solar Probe

DESIGN OPTIONS

	COST	WEIGHT	POWER	COMPLEXITY	RELIABILITY	AVAILABILITY	USABILITY	SPECIAL ISSUES (FIPS)
SHIELDING	3	3	2	3	3	3	3	3
POSITIONING	2	1	1	3	1	2	3	3
MATERIAL PROPERTIES	3	2		2	2	3	1	3
ELECTRONIC PARTS	2			2	3	2	3	
CIRCUIT/SYSTEM DESIGN	3	2	3	3	3	2		3
GROUNDING	2		2	3	2		2	
TRAJECTORY	1		2	2	2			3
OPERATIONAL PROCEDURES	3		1	2	2		3	3
CONSTRUCTION METHODS	1		2	3	2		1	2

## FACTORS

	COST	WEIGHT	POWER	COMPLEXITY	RELIABILITY	AVAILABILITY	USABILITY	SPECIAL ISSUES (FIPS)
SHIELDING	3	3	2	3	3	3	3	3
POSITIONING	2	1	1	3	1	2	3	3
MATERIAL PROPERTIES	3	2		2	2	3	1	3
ELECTRONIC PARTS	2			2	3	2	3	
CIRCUIT/SYSTEM DESIGN	3	2	3	3	3	2		3
GROUNDING	2		2	3	2		2	
TRAJECTORY	1		2	2	2			3
OPERATIONAL PROCEDURES	3		1	2	2		3	3
CONSTRUCTION METHODS	1		2	3	2		1	2

## STEP 2 INTERACTIONS VS DESIGN OPTIONS

### DESIGN OPTIONS

Legend:  
 3 = Major Effect  
 2 = Observable Effect  
 1 = Minor Effect

INTERACTIONS

	CUMULATIVE RAD EFFECTS	SINGLE EVENT UPSETS	LATCH-UP	SURFACE CHARGING/WAKES	INTERNAL CHARGING	POWER LOSS	VxB	SURFACE DAMAGE	CONTAMINATION	PARTICLE IMPACTS
SHIELDING	3	3	2	3	3	3	3	3	1	
POSITIONING	2	1		3	3			2	2	
MATERIAL PROPERTIES	2	1		3	3			2	2	
ELECTRONIC PARTS	3	3	3	1	3	3	3	2	3	
CIRCUIT/SYSTEM DESIGN	3	2	3	2	3	3	3	2	3	
GROUNDING	2			3	3			2	2	
TRAJECTORY	3	3	3	1	3	3	3	2	3	
OPERATIONAL PROCEDURES	3	3	3	1	3	3	3	2	3	
CONSTRUCTION METHODS	3	3	3	1	3			1	3	

## STEP 3 DESIGN OPTIONS VS FACTORS

### DESIGN OPTIONS

INTERACTIONS

*Summary*

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## ***Things That Can Go Bump in the Night ...***

**"AND WHAT, OH WISE ONE, SHOULD WE DO ... ?"**

**CONCENTRATE ON EARLY DETECTION, PREVENTION, AND MITIGATION**

- **TEST, TEST, TEST, TEST, TEST, TEST,.....**
- **TRUST BUT....INSPECT AND VERIFY—IN PERSON IS BEST!!!**
- **UTILIZE YOUR MISSION ASSURANCE, RELIABILITY, SAFETY, AND QUALITY ASSURANCE PERSONNEL**

**AND FINALLY:**

- **GARLIC CLOVES SHOULD BE INCLUDED ON ALL INTERPLANETARY SPACECRAFT (JUST IN CASE)**