Appendix I
Expanded Worst-Case Geosynchronous Earth Environments Descriptions

The worst-case geosynchronous environment descriptions in Table I-1 are actually several measured environments that caused large spacecraft charging events. They come from documented measured data as referenced and are presented in a form that can be used in a double Maxwellian fit in a charging code such as Nascap-2k. Note: in Table I-1, Tav, Trms, and the ATS-6 two-Maxwellian parameters are averaged over all angles. The SCATHA two-Maxwellian parameters are for fluxes parallel and perpendicular to the magnetic field.

There are three environments (one from Applied Technology Satellite 6 [ATS-6] and two from the Spacecraft Charging at High Altitudes Satellite [SCATHA]), each of which caused large potentials on the respective satellites. Thus, persons wishing to evaluate a satellite design more carefully could make three runs using all three environmental descriptions. In this manner, the design of a satellite could be checked more thoroughly for charging effects in various worst-case environments.

Other attempts at worst-case Earth geosynchronous environments are presented in Table 2-1 (Section 2.2.2, using a single Maxwellian representation of the environment) and in tables B-1 and B-2 (Section B.2.1). Appendix B.2.1 suggests a third approach: start with the average of the appropriate parameter and then increase it by one or more standard deviations, depending on the analyst's opinions.

Table I-1. Worst-Case Geosynchronous Environments

Parameter	Deutsch [1] ATS-6	Mullen [2] SCATHA	Mullen [3] SCATHA
Electrons			
Number density (ND) (cm^{-3})	1.22	0.9	3
Current density (J) (nA cm^{-2})	0.41	0.187	0.501
Energy density (ED) (eV cm^{-3})	2.93E+04	9.60E+03	2.40E+04
Energy flux (EF) (eV cm^{-2} s^{-1} sr^{-1})	2.64E+13	6.68E+12	1.51E+13
Number density for population 1 (N1, cm^{-3})	0	--	--
Parallel	--	0.2	1.0
Perpendicular	--	0.2	0.8
Temperature for population 1 (T1, keV)	0	--	--
Parallel	--	0.4	0.6
Perpendicular	--	0.4	0.6
Number density for population 2 (N2, cm^{-3})	1.22	--	--
Parallel	--	0.6	1.4
Perpendicular	--	2.3	1.9
Temperature for population 2 (T2, keV)	16.0	--	--
Parallel	--	24.0	25.1
Perpendicular	--	24.8	26.1
Electron average temp (Tav) (keV)	16	7.7	5.33
Electron root-mean-square temp (Trms) (keV)	16.1	9	7.33
Ions (Protons)			
Number density (ND) (cm^{-3})	0.245	2.3	3
Current density (J) (nA cm^{-2})	0.00252	0.00795	0.0159
Energy density (ED) (eV cm^{-3})	1.04E+04	1.90E+04	3.70E+04
Energy flux (EF) (eV cm^{-2} s^{-1} sr^{-1})	2.98E+11	3.42E+11	7.48E+11
Number density for population 1, N1, cm^{-3}	0.00882	--	--
Parallel	--	1.6	1.1
Perpendicular	--	1.1	0.9
Temperature for population 1 (T1, keV)	0.111	--	--
Parallel	--	0.3	0.4
Perpendicular	--	0.3	0.3
Number density for population 2 (N2, cm^{-3})	0.236	--	--
Parallel	--	0.6	1.7
Perpendicular	--	1.3	1.6
Temperature for population 2 (T2, keV)	29.5	--	--
Parallel	--	26	24.7
Perpendicular	--	28.2	25.6
Ion average temperature (Tav) (keV)	28.4	5.5	8.22
Ion root-mean-square temperature (Trms) (keV)	29.5	12	11.8

References

[1] M.-J. Deutsch, "Worst Case Earth Charging Environment," *Journal of Spacecraft and Rockets,* vol. 19, no. 5, pp. 473–477, 1982.

[2] E. G. Mullen, D. A. Hardy, H. B. Garrett, and E. C. Whipple, "P78-2 SCATHA Environmental Data Atlas," *Spacecraft Charging Technology 1980*, NASA CP 2182/AFGL-TR-81-0270, National Aeronautics and Space Administration, pp. 802–813, 1981.

[3] E. G. Mullen, M. S. Gussenhoven, and H. B. Garrett, *A 'Worst Case' Spacecraft Environment as Observed by SCATHA on 24 April 1979* AFGL-TR-81-0231, AFGL, Hanscom Air Force Base, Massachusetts, 1981.