47th SYMPOSIUM ON SAFETY, QUALITY AND KNOWLEDGE MANAGEMENT IN SPACE ACTIVITIES (D5)
Prediction and measurement of space weather conditions and impacts on space missions (3)

Author: Dr. Jean-Charles Matéo-Vélez
ONERA, France, mateo@onera.fr

Mrs Angélica Sicard-Piet
Office National d'Etudes et de Recherches Aérospatiales (ONERA), France, angelica.sicard@onecert.fr
Mr. Payan Denis
Centre National d'Etudes Spatiales (CNES), France, denis.payan@cnes.fr
Mr. D. Lazaro
Office National d'Etudes et de Recherches Aérospatiales (ONERA), France, sebastien.bourdarie@onecert.fr
Dr. Pierre Sarrailh
ONERA, France, Pierre.Sarrailh@onera.fr
Dr. Thierry Paulmier
France, thierry.paulmier@onera.fr
Dr. Sébastien Bourdarie
ONERA, France, sebastien.bourdarie@onera.fr
Dr. Balcon Nicolas
Centre National d'Etudes Spatiales (CNES), France, nicolas.balcon@cnes.fr
Dr. Inguimbert Virginie
ONERA, France, virginie.inguimbert@onera.fr
Mr. Jean-Francois Roussel
Office National d'Etudes et de Recherches Aérospatiales (ONERA), France, jean-francois.roussel@onera.fr

DETERMINATION OF WORST-CASE ENVIRONMENTS FOR GEOSTATIONARY SPACECRAFT SURFACE CHARGING

Abstract

Spacecraft electrostatic charging is a concern for primes and space agencies. The complex interaction with the ambient plasma leads to both absolute and differential surface charging, the latter being responsible for electrostatic discharges. In the past severe events led to power loss and sometimes to mission loss. Estimating charging levels at the very beginning of satellite design is a key aspect that needs a clear methodology.

This paper presents a comprehensive study combining flight measurements, lessons learnt from ground tests, estimation of worst-cases situations and analysis by numerical simulations. The first point concerns the processing of environment energy spectrum as measured by LANL spacecraft over a period of 15 years in GEO. This processing requires a careful treatment of spacecraft voltage effects on raw data. The second point concerns the main information extracted from years of material testing in laboratory. The material properties at play are secondary electron emissions under electron, photon and proton impact; conductivity, including radiation induced conductivity; and material structural assemblies (such as cover glasses glued on solar cells). Hazardous configurations leading to electrostatic discharges are also analyzed. This analysis led us to propose a set of criteria for the definition of worst-case environments for GEO spacecrafts, based on both absolute potentials measured in-flight and differential charging measured on ground testing (which is usually not measured in-flight, although this is the main source of risk). Finally,

this set of environments is used as input for numerical simulations using SPIS, the Spacecraft Plasma Interaction Software. The charging levels obtained on several spacecraft configuration are analyzed. It provides a basis for defining a consistent methodology to estimate worst-case spacecraft charging in GEO.