TECHNICAL SPECIFICATION

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Space systems — Space environment (natural and artificial) — Observed proton fluences over long duration at GEO and guideline for selection of confidence level in statistical model of solar proton fluences

Systèmes spatiaux — Environnement spatial (naturel et artificiel) — Fluences de protons observées sur une longue durée au GEO et ligne directrice pour la sélection du niveau de confiance dans le modèle statistique des fluences de protons solaires

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Foreword

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ISO/TS 12208 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

This Technical Specification is intended for use in the engineering community.

It is well known that solar energetic protons (SEPs) damage spacecraft systems, i.e. electronics and solar cells, through ionization and/or atomic displacement processes. This results in single-event upsets and latch-ups in electronics, and output degradation of solar cells.

Solar cells of spacecraft are obviously one of the key components of spacecraft systems. Degradation of solar cells by energetic protons is unavoidable and causes power loss in spacecraft systems. Estimation of cell degradation is crucial to the spacecraft's long mission life in geosynchronous earth orbit (GEO). Therefore, an estimation of SEP fluences in GEO is needed when designing solar cell panels.

Solar cell engineers use a statistical model, the jet propulsion laboratory (JPL) fluence model for example, for estimating solar cell degradation. However, with regard to solar cell degradation, a statistical model predicts higher SEP fluences than the values actually experienced by spacecraft in GEO, especially seven years after the launch. Nowadays, spacecraft manufacturers are very conscious of minimum cost design of spacecraft because the lifetime of spacecraft is becoming longer (15-18 years) and the cost of manufacturing spacecraft is increasing. Therefore, the aerospace industry requires a more accurate SEP fluence model for a more realistic design of solar cells.

Space systems — Space environment (natural and artificial) — Observed proton fluences over long duration at GEO and guideline for selection of confidence level in statistical model of solar proton fluences

1 Scope

This Technical Specification describes a method to estimate energetic proton fluences in geosynchronous earth orbit (GEO) over a long duration (beyond the 11-year solar cycle), and presents guidelines for the selection of a confidence level in a model of solar proton fluences to estimate solar cell degradation.

Many of the proton data observed in GEO are archived, for example GMS (Japan), METEOSAT (ESA) and GOES (USA). This method is a direct integration of these fluence data (or the observed data over 11 years is used periodically).

As a result, the confidence level can be selected from a model of solar proton fluences.

This Technical Specification is an engineering-oriented method used for specific purposes such as estimating solar panel degradation.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
confidence level
level used to indicate the reliability of a cumulative fluence estimation

2.2
extremely rare event
a solar energetic proton (SEP) event that occurs about once in a solar cycle and whose fluence dominates that for the entire cycle

NOTE Examples are those which took place in August 1972, October 1989 and July 2000.

2.3
flux
number of particles passing through a specific zone per unit time

2.4
fluence
time-integrated flux

2.5
***n*-year fluence**
a given fluence during a mission of a selected duration, n years

3 Symbols and abbreviated terms

EOL end of life

ESA European Space Agency

JPL jet propulsion laboratory