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

This British Standard is the UK implementation of ISO 12208:2015. It supersedes DD ISO/TS 12208:2011 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ACE/68, Space systems and operations.

A list of organizations represented on this committee can be obtained on request to its secretary.

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ISBN 978 0 580 89355 1

ICS 49.140

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 December 2015.

Amendments/issued since publication

Date Text affected
Space systems — Space environment (natural and artificial) — Observed proton fluences over long duration at GEO and guidelines 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 lignes directrices pour la sélection du niveau de confiance dans le modèle statistique des fluences de protons solaires
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>iv</td>
</tr>
<tr>
<td>Introduction</td>
<td>v</td>
</tr>
<tr>
<td>1 Scope</td>
<td>1</td>
</tr>
<tr>
<td>2 Terms and definitions</td>
<td>1</td>
</tr>
<tr>
<td>3 Symbols and abbreviated terms</td>
<td>2</td>
</tr>
<tr>
<td>4 Principles of the method (see Reference [3])</td>
<td>2</td>
</tr>
<tr>
<td>4.1 Cumulative fluence</td>
<td>2</td>
</tr>
<tr>
<td>4.2 Confidence level</td>
<td>3</td>
</tr>
<tr>
<td>4.3 Archives of observed energetic protons in GEO</td>
<td>3</td>
</tr>
<tr>
<td>4.4 Remarks</td>
<td>3</td>
</tr>
<tr>
<td>5 Guidelines for selection of a confidence level in a statistical model of solar proton fluences</td>
<td>4</td>
</tr>
<tr>
<td>Annex A (informative) Example of estimation and selection</td>
<td>5</td>
</tr>
<tr>
<td>Bibliography</td>
<td>9</td>
</tr>
</tbody>
</table>
Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The committee responsible for this document is ISO/TC 20, Aircraft and space vehicles, Subcommittee SC 14, Space systems and operations.

Introduction

This International Standard 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 years to 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 guidelines for selection of confidence level in statistical model of solar proton fluences

1 Scope

This International Standard 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 from 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 International Standard 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
solar energetic proton (SEP) event that occurs about once in a solar cycle and whose fluence dominates that for the entire cycle

Note 1 to entry: Examples are those which took place in August 1972, October 1989 and July 2000.

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

2.4 fluence
time-integrated flux

2.5 n-year fluence
fluence during a mission of n years duration