INTERNATIONAL STANDARD

ISO 19923

First edition
2017-06

Space environment (natural and artificial) — Plasma environments for generation of worst case electrical potential differences for spacecraft

Environnement spatial (naturel et artificiel) — Environnements plasmatiques pour la génération de différences de potentiel électrique les plus défavorables pour les véhicules spatiaux

Reference number
ISO 19923:2017(E)

© ISO 2017



COPYRIGHT PROTECTED DOCUMENT

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword ... **iv**
1 Scope ... **1**
2 Normative references ... **1**
3 Terms and definitions ... **1**
4 Symbols and abbreviated terms ... **2**
5 Criteria for worst-case environment ... **2**
6 Procedures for application to spacecraft design ... **2**
7 Space environments for worst-case simulations ... **3**
7.1 GEO worst-case environment ... 3
7.2 PEO and MEO worst-case environments ... 3
Annex A (informative) **Spacecraft charging analysis tools** ... **4**
Annex B (informative) **Round-robin simulation**[7] ... **5**
Annex C (normative) **Material properties** ... **10**
Annex D (informative) **Tailoring guideline for this document** ... **13**
Bibliography ... **14**

© ISO 2017 – All rights reserved

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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

© ISO 2017 – All rights reserved

Space environment (natural and artificial) — Plasma environments for generation of worst case electrical potential differences for spacecraft

1 Scope

This document specifies space plasma environments that lead to the generation of the worst-case surface potential differences for spacecraft. It also specifies how to estimate worst-case potential differences by using the simulation codes provided.

This document includes plasma energy and density in GEO, PEO, and MEO. This document does not include descriptions of plasma energy and density in LEO because large surface charging in LEO is likely to be due to high-voltage power generation by instrumentation of the spacecraft.

This document deals with external surface charging of spacecraft only.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
double Maxwellian distribution
electron and proton distribution functions in GEO fitted with two temperatures

Note 1 to entry: Maxwellian distribution is as follows[12]:

$$f(v)=\left(\frac{m}{2\pi}\right)^{3/2}\left[\frac{n_1}{(kT_1)^{3/2}}\exp\left(-\frac{mv^2}{2kT_1}\right)+\frac{n_2}{(kT_2)^{3/2}}\exp\left(-\frac{mv^2}{2kT_2}\right)\right]$$

where

m is the mass of particle;

k is the Boltzmann constant 1,380 648 52 × 10^{-23} J/K;

n_1, n_2 are the number density of particle;

T_1, T_2 are the temperature of particle.

3.2
differential voltage
differential potential
potential difference between any two points in spacecraft, especially the insulator surface and the spacecraft body, during differential charging

© ISO 2017 – All rights reserved

3.3
inverted potential gradient
result of differential charging where the insulating surface or dielectric reaches a positive potential with respect to the neighbouring conducting surface or metal: PDNM (positive dielectric negative metal)

3.4
normal potential gradient
result of differential charging where the insulating surface or dielectric reaches a negative potential with respect to the neighbouring conducting surface or metal: NDPM (negative dielectric positive metal)

3.5
surface charging
deposition onto or the removal of electrical charges from external surfaces of the spacecraft

4 Symbols and abbreviated terms

eV	electron volt, where 1 eV = 1,602 × 10^{-19} J
GEO	geosynchronous orbit
LEO	low Earth orbit
MEO	medium Earth orbit
PEO	polar Earth orbit
Ne	electron density
Ni	ion density
Te	electron temperature
Ti	ion temperature

5 Criteria for worst-case environment

The worst-case environment shall be defined as the space environment measured in space that causes the maximum potential difference between the spacecraft electrical grounding body and external non-conductive surfaces or isolated conductive surfaces. Worst-case conditions shall be realistic.

Combinations of densities and temperatures for a valid worst-case condition shall be subject to all of the following:

— reported in the literature or published databases;

— checked to make sure they are based on valid measurements;

— physically realistic (i.e. do not violate energy density or other physical requirements); and

— verified using good spacecraft charging codes (i.e. COULOMB-2, MUSCAT, SPIS, NASCAP-2k).

This document is a part of spacecraft charging design.

6 Procedures for application to spacecraft design

Spacecraft charging simulation should be carried out at an early stage of spacecraft design. Ideally, this should be before selecting the materials for those spacecraft surfaces that will be exposed to the space environment.

© ISO 2017 – All rights reserved