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Space systems — Space environment — Simulation guidelines for radiation exposure of non-metallic materials

Systèmes spatiaux — Environnement spatial — Lignes directrices de simulation pour l'exposition aux radiations des matériaux non métalliques

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 15856 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

The purpose of this International Standard is to establish guidelines for designing space systems that are highly reliable and will have long mission life spans. It is impossible to reproduce the space environment for ground testing of space system elements because of the variety and complexity of the environments and the effects on materials. The reliability of the test results depends on simulating the critical effects of the space environments for a particular mission. The main objectives of the simulation are to get test results that are satisfactory for the material behaviour in a space environment and to use existing radiation sources and methods available in the test laboratory.

Non-metallic materials used in space systems are affected by electrons and protons in a broad energy interval, electromagnetic solar radiation (both the near and the far ultraviolet radiation) and X-ray radiation. The response of non-metallic materials to radiation depends on the type of radiation and energy that defines the ionization losses density, and the radiation response of materials depends on these losses. The radiation spectrum and chemical composition of materials define the absorbed dose distribution, especially in the near-the-surface layers.

During the design of the space system, it is necessary to simulate long mission time in reasonable ground time. For this reason, it is necessary to perform accelerated radiation tests requiring the use of dose rates that may be of an order of magnitude greater than in the natural space environment. These high dose rates can influence the effects on the properties of materials. Therefore, the main requirement for the correct simulation in radiation tests involves simulating the correct effects of materials in space by considering the type, spectrum (energy), and absorbed dose rate of the radiation. Simulation is complex because the various properties of materials may respond differently to the approximations of the natural space environment used for testing. In addition, various materials may respond differently to the same simulated space radiation environment. This is valid for different classes of materials such as polymeric and semiconductor materials.

The space engineering materials in space environment are exposed not only to charged particles and electromagnetic solar radiation but also to a number of other environmental factors, e.g. atomic oxygen, deep vacuum, thermocycling, etc. Synergistic interactions can significantly increase the material degradation, i.e. decrease the time of operation, but in certain cases (like solar absorptance variation under UV and protons) synergistic interaction can decrease the degradation. These effects are not well understood and have to be simulated as far as possible. Space environment simulation at the combined exposure is a much more complicated procedure than the simulation of each factor separately. Development of corresponding standards, both for different factors and different classes of materials, will be provided in the following stages of the standard set preparation for space environment simulation at on-ground tests of materials.

This International Standard contains normative statements, recommended practices and informative parts. The term “shall” indicates a normative statement.