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Space systems — Safety and compatibility of materials — Method to determine the flammability thresholds of materials

Systèmes spatiaux — Sécurité et compatibilité des matériaux — Méthode de détermination des seuils d'inflammabilité des matériaux

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Foreword

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ISO/TS 16697 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

Spacecraft fire safety emphasizes fire prevention, which is achieved primarily through the use of fire-resistant materials. Materials selection for spacecraft is based on conventional flammability acceptance tests, along with prescribed quantity limitations and configuration control for items that do not pass these acceptance tests or are questionable. ISO 14624-1 and ISO 14624-2 are the main methods used to evaluate flammability of polymeric materials intended for use in the habitable environments of spacecraft. These methods are upward flame-propagation tests initiated in static environments and using a well-defined igniter flame at the bottom of the sample.

The pass/fail test logic of ISO 14624-1 and ISO 14624-2 does not allow for a quantitative comparison with reduced-gravity or microgravity test results; therefore use of these methods is limited for in-depth theoretical analyses and realistic estimates of spacecraft fire extinguishment requirements. To better understand the applicability of laboratory test data to actual spacecraft environments, this Technical Specification has been proposed which, as an alternative to qualifying materials as pass/fail, measures the actual upward flammability limit for the material.[1] A working group established by NASA to provide recommendations for exploration spacecraft realized the importance of correlating laboratory data with real-life environments, and recommended the development of a flammability threshold test method[2]. The working group indicated that "the flammability threshold information will allow identification of materials with increased flammability risk from oxygen concentration and total pressure changes, minimize potential impacts, and allow for development of sound requirements for new spacecraft and extravehicular landers and habitats". Furthermore, recent research using this method has shown that conventional normal-gravity materials flammability tests do not correlate with the flammability in ventilated, micro- or reduced-gravity conditions.[3][4] Currently, the materials selection for spacecraft is based on the assumed extension of ground flammability test results to spacecraft environments, an assumption which needs to be validated by further testing. In contrast to pass/fail data, materials flammability threshold data acquired in normal gravity can be compared with data obtained in microgravity or reduced-gravity experiments[5] and, consequently, a more accurate assessment of the margin of safety of the material in the real spacecraft environment can be made. In addition, this Technical Specification gives the option of selecting better or best space system materials, as opposed to what would be considered just "acceptable" from a flammability point of view, and realistic assessment of spacecraft fire extinguishment needs, which could result in significant weight savings. The knowledge afforded by this technique allows extrapolations of flammability behaviour to conditions not specifically tested and this could potentially result in significant cost and time savings.[6] This Technical Specification presents a method for evaluating oxygen-concentration flammability extinguishment limits when a material is exposed to a standard ignition source under total pressure, temperature, convective flow, and gravity-level conditions. However, the method can also be used to determine other flammability extinguishment limits, such as the total pressure[7] or forced convective velocity thresholds, while maintaining other test conditions constant.

The intent of this Technical Specification is to highlight the importance of correlating laboratory test data with real-life space system applications. The method presented is just one of the possibilities believed to lead to a better understanding of the applicability of materials flammability test data. International feedback on improving the proposed method, as well as suggestions for correlating test data with space system applications, are being sought.