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Space systems — Development technology of a thermal vacuum chamber

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Foreword

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Introduction

Since the first artificial satellite was launched into space successfully in 1957, space activities have been developed over the decades. The large amount of experience collected during that period demonstrates that a significant number of failures or defects appearing during spacecraft in-orbit operation were induced by space environment factors. These factors include space vacuum, cold black background, solar radiation, and also albedo and eigenradiation of the Earth. Therefore, thermal balance tests and thermal vacuum tests for spacecraft are performed in a simulated environment generated by ground simulation facilities in order to evaluate spacecraft performance, to verify thermal analysis models, and to discover early failures and defects in the spacecraft design and manufacturing process.

Countries engaged in spacecraft development have established several thermal test facilities, known as thermal vacuum chambers. They also have standardized requirements for thermal vacuum tests and thermal balance tests. These efforts greatly improved spacecraft reliability and played an important role in space activities.

A thermal vacuum chamber is designed to simulate vacuum, cold black and heat flux environment that a spacecraft experiences during its mission in space. It is composed of vacuum vessel, shroud, nitrogen system, vacuum system, heat flux simulation system, specimen support mechanism, measurement and control system, etc. Based on the state-of-the-art simulation technology, the relevant test standards and experiences accumulated from facilities development, this document provides development technology of a thermal vacuum chamber.

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TECHNICAL REPORT **ISO/TR 6832:2023**

Space systems — Development technology of a thermal vacuum chamber

1 Scope

This document describes the technology for simulating space environments such as vacuum, cold black, and heat flux, as well as the compositions and functions of a thermal vacuum chamber (TVC). This kind of facility defined in this document is suitable for thermal vacuum tests (TVT) and thermal balance tests (TBT) on spacecraft-system level as well as on large-spacecraft-component level.

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 terminology databases for use in standardization at the following addresses:

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

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

3.1
thermal vacuum chamber
TVC
space environment simulator
facility to simulate the space vacuum, cold black, and heat flux environment on the ground

Note 1 to entry: It is used for *thermal vacuum tests (TVT)* (3.4) and *thermal balance tests (TBT)* (3.5) of spacecraft.

3.2
shroud
subsystem of a *thermal vacuum chamber (TVC)* (3.1) to simulate the *cold black environment* (3.3) in space

Note 1 to entry: It is cooled by liquid nitrogen or gaseous nitrogen to simulate the cold black environment in space. It is also called heat sink.

3.3
cold black environment
space environment without considering the solar and Earth radiation and the Earth's atmospheric albedo

Note 1 to entry: The radiated energy from spacecraft under cold black environment will be completely absorbed.

3.4
thermal vacuum test
TVT
test which is conducted to demonstrate the capability of the test item and to operate according to requirements in vacuum at predefined temperature conditions

Note 1 to entry: A spacecraft is validated by a *thermal balance test (TBT)* (3.5) and a thermal vacuum test (TVT) in a similar environment provided by a *thermal vacuum chamber (TVC)* (3.1) prior to launch.

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