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NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

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Replacing GB/T 34515-2017

Thermal balance test method for spacecraft

航天器热平衡试验方法

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Foreword

This document complies with the provisions of GB/T 1.1-2020 "Standardization Work Guidelines Part

1.Structure and Drafting Rules of Standardization Documents". Drafting. This document replaces GB/T 34515-2017 "Test Methods for Thermal Balance of Spacecraft". Compared with GB/T 34515-2017, except for structural adjustment... Aside from integration and editorial changes, the main technical changes are as follows:

---Added a criterion for steady-state conditions to the temperature stability criterion in thermal equilibrium tests [see 7.3.2c). Please note that some content in this document may involve patents. The issuing organization of this document assumes no responsibility for identifying patents. This document was proposed and is under the jurisdiction of the National Technical Committee on Standardization of Aerospace Technology and Its Applications (SAC/TC425). This document was drafted by: Beijing Satellite Environmental Engineering Institute, Beijing Spacecraft Overall Design Department, and Shanghai Satellite Engineering Institute. Shanghai Satellite Equipment Research Institute, Aerospace Dongfanghong Satellite Co., Ltd., and China Aerospace Standardization Institute. The main drafters of this document are. Sun Yuwei, Wang Jing, Zhao Qiwei, Liu Xiaoning, Zhao Xiaoxiang, Tao Dongxing, Chen Li, Zhang Dong, Pei Yifei, and Gao Qinghua. Feng Yao, Qin Jiayong, Liu Bo, Ren Xiaoyu, Jin Yu, Fang Hongjun. This document was first published in.2017, and this is its first revision. Spacecraft thermal balance test methods

1.Scope This document specifies the purpose, requirements, thermal simulation methods, operating conditions, data measurement, equipment, and procedures for spacecraft thermal balance testing. Procedures, test interruptions and handling, test evaluation and data utilization. This document applies to thermal balance tests at the spacecraft system level, subsystem level, and module level.

4.Experimental Objective The objectives of the spacecraft thermal balance test are as follows:

a) Verify the correctness of the spacecraft's thermal design;

b) Verify the correctness of the spacecraft thermal analysis model and provide data for revising the thermal analysis model.

5 Test Requirements

5.1 Test Model Requirements The experimental model should meet the following requirements.

a) The external structure, materials, layout of instruments and equipment, cable network, various thermal control measures, and products meet the requirements of the research and development status;

b) The external dimensions, surface condition, installation and connection method, internal heat generation, and heat capacity of the instruments and equipment meet the requirements of the research and development status;

c) Considering the capabilities, safety, and special requirements of the testing equipment and instruments, individual instruments are permitted to use thermal performance parameters that meet the requirements. The requested substitute is a process part, a certification part, or a simulation part;

d) The thermal properties of the outer surface coating are the same as those in the manufacturing process;

e) External components such as large antennas and solar panels may be excluded from the test, but their impact on the test must be assessed, and hot-edge testing may be conducted as needed. Appropriate measures should be taken in boundary simulation;

f) For test models with sealed compartments, appropriate measures should be taken during the test to suppress the influence of natural gas convection within the sealed compartment;

g) For parts that exchange heat with the experimental model but do not participate in the experiment, alternative structures are used to participate in the experiment and simulate the thermal boundary;

h) Add protective gas to the propellant tank.

5.2 Volume requirements for space environment simulation chamber The volume of the space environment simulation chamber should meet the following requirements.

a) When using the incident heat flow method, the ratio of the characteristic dimensions (such as length, diameter, etc.) of the space environment simulation chamber to the test model shall not be less than 3;

b) When using the heat absorption method, the ratio of the characteristic dimensions (such as length, diameter, etc.) of the space environment simulation chamber to the test model shall not be less than 2.

5.3 Requirements for Installing the Test Model When installing the test model in a space environment simulation chamber, the following factors should be comprehensively analyzed.

a) Installation method and orientation;

6.1 Simulation of External Heat Flow

6.1.1 External Heat Flow Simulation Method The following are generally available methods for simulating external heat flow.

a) Incident heat flow method;

b) Absorption heat flow method;

c) A combination of the two methods above.

6.1.2 Types and Control Methods of External Heat Flow Simulation Devices The types and control methods of external heat flow simulation devices are as follows:

a) Solar simulator. Control the direction of incident heat flow as required;

b) Infrared radiation heater. Controlled based on the measurement of radiant heat flux using a radiation heat flux meter;

c) Contact electric heater. The heating circuit current is controlled according to the required power.

6.1.3 Selection Principles for External Heat Flow Simulation Devices Depending on the characteristics of the test model (such as size, shape, heat dissipation surface location, heat dissipation surface coating type, etc.), one or more external heat flow simulation methods can be selected. The combination of devices enables the simulation of external heat flow. The main principles for selecting an external heat flow simulation device are as follows:

a) Appropriate to the capabilities of the testing equipment;

b) Possesses the required accuracy for simulating external heat flow to meet experimental

requirements;

c) It can adapt to the shape of the test model and the type of surface coating;

d) Easy to implement.

6.2 Internal Heat Source Simulation The simulation of internal heat sources should meet the following requirements.

7 Test Conditions

7.1 Types of Test Conditions Based on the internal heat source heating mode, simulated external heat flow, and other thermal boundary conditions, the following four test conditions can generally be combined.

a) Steady-state condition. The internal heat source, simulated external heat flow, and other thermal boundary conditions are all constant values. Both high-temperature and low-temperature conditions fall under this steady-state condition. Operating conditions.

b) Quasi-steady-state condition. The internal heat source operates according to a set periodic variation pattern, and the simulated external heat flow and other thermal boundary conditions are constant. A constant value.

c) Periodic transient condition. The internal heat source operates according to a set periodic variation pattern, simulating external heat flow and other thermal boundary conditions according to the orbit. It operates according to the cyclical change pattern.

d) Transient operating condition. Within a specified time, the internal heat source, simulated external heat flow, or other thermal boundary conditions operate in a non-periodic change mode. For periodic transient or quasi-steady-state operating conditions, tests are generally conducted according to the orbital period of the spacecraft. This can be based on one orbital cycle. The heat source working mode and simulated external heat flow were repeatedly tested for several cycles until the temperature of the test model reached a stable period. Alternatively, a number of orbital periods can be used as a test cycle, and this cyclical test can be repeated continuously for several test cycles until the test model is fully operational. The temperature reaches a stable period.

7.2 Principles for Determining Test Conditions The principles for determining test conditions are as follows:

a) The test conditions can obtain sufficient key parameters to support the validation of the thermal analysis model and the prediction of flight missions;

b) For tests that directly verify the thermal control design, at least high-temperature and low-temperature conditions must be included;

c) Tests that only verify the thermal analysis model generally include transient conditions;