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Evaluation for flight results of geosynchronous communications satellite

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FOREWORD

The standard is translated from the Chinese version of Standard on GB/T 29080-2012 released by Standardization Administration of China (SAC) under the management of State General Administration of Quality Supervision and Inspection and Quarantine. TC 425 is responsible for the translation. In case of any doubt about the contents of English version, the Chinese original shall be considered authoritative.

This standard is drafted in accordance with rules given in GB/T 1.1-2009.

This standard is proposed by China Aerospace Science and Technology Corporation.

This standard is under the jurisdiction of National Technical Committee on Space Technology and Operation of Standardization Administration of China (SAC/TC 425).

INTRODUCTION

This standard belongs to the National Standard System of China Space. The National Standard System of China Space is applicable to the formulation, revision, and management of national standards in the field of space, covering three sectors of space management, space technology, and space application and services and serving as the basis for guiding spacecraft and launch vehicle project management, engineering, space launch services, and in-orbit satellite applications.

A phase of in-orbit test will be finished to examine functions and performance of satellite platform and payloads, and to evaluate the in-orbit flight state of satellite by related test data after orbit injection of geosynchronous communications satellite. Communications satellite cannot be delivered to customers until the requirements specified in contract are confirmed by customers and contractors. The definition and standardization of related evaluation basis, principles, items and methods are necessary to ensure the objectivity and fairness, and are agreed by the customers and contractors, which are critical to the development and delivery of geosynchronous communications satellite.

Evaluation for flight results of geosynchronous communications satellite

1 Scope

This standard specifies the evaluation principles, bases, grade definitions, items, methods, grade determinations for the evaluation of flight results of geosynchronous communications satellite.

This standard is applicable to the evaluation of flight results given by satellite contractor based on the in-orbit test data which tested after the separation of satellite and launch vehicle and prior to the delivery of geosynchronous communications satellite to the customers.

2 Terms and definitions

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

2.1

communications satellite

artificial Earth satellite used for the radio signal relay of communication information.

2.2

geosynchronous orbit

earth satellite prograde orbit which orbital period is equal to rotation period of the Earth.

2.3

geosynchronous communications satellite

communications satellite which operates in geosynchronous orbit.

2.4

geostationary communications satellite

a kind of geosynchronous communications satellites which orbit inclination and orbit eccentricity are zero. This kind of satellite is stationery relative to the ground.

2.5

equivalent isotropic radiated power (EIRP**)**

product of radio frequency input power to the antenna and absolute gain of antenna along the given direction.

2.6

G/T ratio

ratio of antenna gain to the system noise temperature.

2.7

saturation flux density (SFD)

input flux density required for saturating the output power of a transponder channel on the satellite.

2.8

out-band suppression

suppression degree of out-band radio frequency signals by the communication system.

2.9

station accuracy

the accuracy of keeping station after satellite is captured into orbit location.

2.10

PVT (Pressure-Volume-Temperature) method

a kind of method used to calculate the residual propellant inside the tank according to the compressed gas mass conservation and based on gas equation with the compress factor.

3 Evaluation principles

3.1 Grade of evaluation shall be classified according to the degree of mission completion by geosynchronous communications satellite (hereinafter referred to as the satellite).

3.2 When satellite components with redundancy failed and did not affect the mission of satellite, the grades of evaluation shall not be influenced.

3.3 Non-direct malfunctions shall be evaluated additionally, which mainly include:

a) Satellite failure or service life shortened caused by launch vehicle faults;
b) Intersatellite signal interference which exceeds the international rated value and lowers the communication quality;
c) The satellite transponder failure caused by the communications uplink signal;
d) Satellite faults caused by the improper operation of ground TT&C (Tracking, Telemetry and Telecommand) stations;
e) Other faults or cases which satellite products are not concerned, lead to mission object can’t be realized.

3.4 Flight results shall be evaluated after the completion of in-orbit test and prior to delivery to the customers for use. If it is necessary, the times of evaluation shall be added.

4 Foundation of evaluation

4.1 Documents

Documents shall include:

a) Application requirements, performance specifications, contract requirements and relevant requirements stated in the contract annex;
b) Mission plan;
c) Satellite in-orbit test plan.

4.2 In-orbit test results

In-orbit test results shall include:

a) Evaluation of operating state and performance of satellite platform according to telemetry data;

b) Evaluation of satellite communication function and performance according to the in-orbit test results;

c) Evaluation of TT&C implementation on the satellite based on the measurement and control effects from the ground measurement and control center.

5 Grade classification

Based on the operating conditions of satellite, grade of evaluation shall be classified as follows:

a) Success;

b) Basic success;

c) Partial success;

d) Fail.

6 Evaluation items

6.1 Payloads

Main evaluation details of payloads shall be listed as follows:

a) Equivalent isotropic radiated power (EIRP);

b) G/T ratio;

c) Saturation flux density;

d) Amplitude-frequency characteristic;

e) Frequency accuracy and stability;

f) Operating frequency and bandwidth;

g) Coverage area;

h) Polarization isolation;

i) Channel number of transponders in normal operation;

j) Other customer requirements.

6.2 Satellite platform

Main evaluation details of satellite platform shall be listed as follows:

a) Keeping station accuracy (only for the geostationary communications satellite);

b) Attitude accuracy;

c) Power and battery state;

d) Residual propellant;

e) Service life of satellite;

f) Telecommand sensitivity;

g) Telecommand function;

h) Equivalent isotropic radiated power (EIRP) of telemetry downlink;

i) Other customer requirements.

7 Evaluation methods

7.1 Payloads

In-orbit test shall be conducted in accordance with relevant provisions to evaluate the payload performance based on the in-orbit test data, mainly including:

a) Evaluate the satellite EIRP according to the in-orbit test data of EIRP corresponding to each power amplifier;

b) Evaluate the satellite G/T ratio according to the in-orbit test data of G/T ratio corresponding to each uplink beam;

c) Evaluate the satellite saturation flux density value according to the in-orbit test data of saturation flux density of each receiver and power amplifier channel;

d) Evaluate the satellite amplitude-frequency characteristics according to the in-orbit test data of amplitude-frequency characteristics of each channel;

e) Evaluate the satellite frequency accuracy and stability according to the in-orbit test data of frequency conversion accuracy and stability of each receiver and frequency converter;

f) Evaluate the satellite operating frequency and bandwidth according to the in-orbit test data of relevant parameters, such as amplitude-frequency characteristics and out-band suppression;

g) Evaluate the satellite coverage area according to the in-orbit test data verified based on the antenna pattern;

h) Evaluate the satellite polarization isolation according to the in-orbit test data of cross polarization isolation of each beam;

i) Evaluate other satellite performance according to the in-orbit test data corresponding to other customer requirements;

j) Determine the channel number of transponders in normal operation according to the evaluation results of all items mentioned above.

7.2 Satellite platform

7.2.1 Evaluate the station accuracy of satellite based on the orbit measurement results, mainly including:

a) Evaluate the East-West station position accuracy of satellite according to the measurement of orbit semi-major axis, eccentricity and mean longitude;

b) Evaluate the South-North station position accuracy of satellite according to the measurement of orbit inclination.

7.2.2 Evaluate the attitude accuracy of satellite according to the analysis results of satellite telemetry data, mainly including:

a) Before the satellite enters its geosynchronous orbit (or orbit station), evaluate the attitude

control accuracy of transfer orbit mode according to the attitude telemetry data in different transfer orbit phases;

b) After the satellite enters its geosynchronous orbit (or orbit station), evaluate the synchronous orbit attitude control accuracy according to the attitude telemetry data received during the synchronous orbit operation.

7.2.3 Evaluate the power and battery state on the basis of analysis results of satellite telemetry parameters, mainly including:

a) Evaluate the output power of satellite solar arrays according to the current output telemetry data of solar array and the current telemetry data corresponding to power consumption of each equipment;

b) Evaluate the battery charging and discharging functions, depth of discharge according to the telemetry data of battery voltage, charging current or discharging current and so on.

7.2.4 After the satellite enters its geosynchronous orbit (or orbit station), apply relevant methods (such as PVT method) to evaluate the residual propellant of satellite according to the telemetry data of propulsion subsystem.

7.2.5 Estimate the service life of satellite according to the power and residual propellant.

7.2.6 Evaluate the performance of satellite TT&C according to the results of satellite TT&C operation, mainly including:

a) After the satellite enters into its geosynchronous orbit (or orbit station), evaluate the telecommand sensitivity according to the minimum uplink power of ground TT&C station, which ensure that the telecommand can be translated and executed correctly by the satellite subsystem;

b) Evaluate the command functions of satellite according to the telecommand received, distributed and executed results in flight;

c) After the satellite enters into its geosynchronous orbit (or orbit station), evaluate the telemetry EIRP according to the telemetry reception in certain downlink gain.

7.2.7 Satellite platform evaluation of other items can be achieved from the satellite telemetry data and relevant results.

8 Grade judging

8.1 Success

It shall be deemed as success if the following requirements are fully satisfied:

a) Performance of payload evaluation items specified in 6.1 is satisfied with its requirement;

b) Performance of satellite platform evaluation items specified in 6.2 is satisfied with its requirement;

c) The satellite platform is in normal operation state or satisfied the contract requirements even

though there are some emergency treatments once occurred.

8.2 Basic success

When only one of the following conditions occurs while the remaining performance meets the requirements for being ‘success’, it shall be deemed as basic success:

a) Time for satellite staying in orbit (position) can maintain 75% of service life;

b) Coverage area is not less than 90% of its requirement;

c) Communication capacity is not less than 75% of its requirement.

8.3 Partial success

When judging result does not satisfy the requirement for being ‘basic success’ while the following requirements are fully satisfied, it shall be deemed as partial success:

a) The duration of orbit position keeping capacity is more than 50% service life after satellite enters into geosynchronous orbit;

b) Satellite platform can keep the satellite in minimum operation;

c) Coverage area is no less than 50% of its requirement;

d) Communication capacity is no less than 50% of its requirement.

8.4 Fail

When judging result is not satisfied the requirement for being ‘partial success’, it shall be deemed as fail.