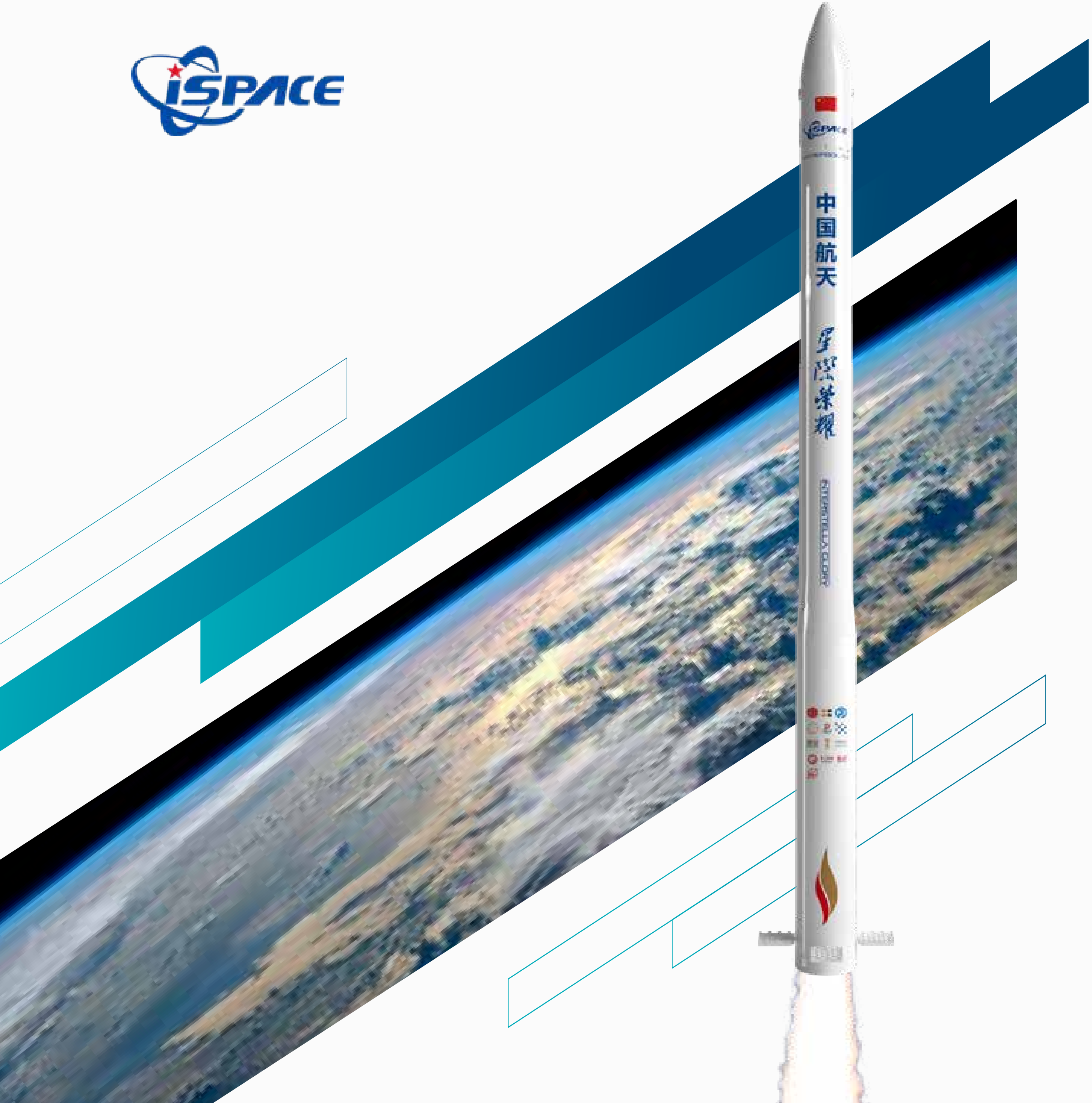

Hyperbola-1 User Manual

The Hyperbola-1 launch vehicle is the first orbital launch vehicle independently designed by Beijing Interstellar Glory Space Technology Co. We have full independent intellectual property rights of rocket-borne computers, three-stage solid rocket engines and four-stage liquid attitude and orbit control engines.

Hyperbola-1 User Manual

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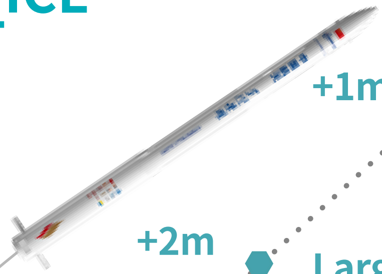
ABOUT US

Beijing Interstellar Glory Space Technology Co. was founded in October 2016. At present, the company has more than 100 R&D personnel, which are the top aerospace R&D designer team and first-class model R&D management team in China. The core members have experienced the whole process of domestic launch vehicle development. Team members are all graduated from famous universities at home and abroad. The proportion of graduates from 985 and 211 universities is over 95%, the proportion of graduates with master’ s degree or above is over 90%, and the proportion of those with senior titles such as researcher and senior engineer is over 80%. In total, we have won dozens of national and ministerial awards, hundreds of awards for achievements in the aerospace industry, hundreds of academic monographs and papers, and hundreds of authorized patents. The backbone of the R&D team is senior aerospace engineers and technicians, many of whom have served as carrier rockets, missile weapons and space vehicles. We have a professional team, process, knowledge, design, and provide professional services. At the same time, we have the comprehensive capabilities of inheritance and subversive innovation and development, complex system integration design and product overall performance optimization.

The Hyperbola-1 launch vehicle is the first orbital launch vehicle independently designed by Beijing Interstellar Glory Space Technology Co. We have full independent intellectual property rights of rocket-borne computers, three-stage solid rocket engines and four-stage liquid attitude and orbit control engines.

Hyperbola-1 launch vehicle does not depend on launch site, its production cycle is less than 6 months, and its technical preparation cycle is less than 5 days, which is suitable for high density, high frequency and fast response launch mission.

TASK LOAD SERVICE PROCESS CHART



+1m

Products and services

Design, production, test (satellite and rocketmatching and electromagnetic compatibility), test (satellite mechanical environment test, satellite and rocketunlocking and separation test), launch service

+1m

Formal Business Negotiations

Define the subject matter of the contract and other clauses

+2m

Large-scale system coordination

Launch Site launch cite area, overflight area, Landing Area, TT&C) Insurance, Launch License (Rocket/Satellite)

+1m

Preliminary Business Negotiations

Preliminary Consultation on Technical and Commercial Terms

+1m

Technology coordination

Mechanical, electrical interfaces, environmental conditions, timing, orbit and attitude accuracy, measurement and control, etc.

+3d

Demand docking

Type of service (main load/carrier), track, weight, geometric envelope, launch time, etc.

T0

Contact us

Tel: 010-87169903

Website: www.i-space.com.cn

LAUNCH PLAN

1. Rocket Overview

Hyperbola-1 is a four-stage small solid launch vehicle, the first three sub-stages are solid engines, and the fourth sub-stage is liquid attitude and orbit control engine. It is mainly used for launching missions of low earth orbit satellites.

The Hyperbola-1 carrier rocket provides a satellite fairing with adjustable length according to user’ s needs and a variety of interfaces, which is convenient for users to choose and use.

2. Technical parameters

The Hyperbola-1 launch vehicle has a length of about 21 meters, a total mass of about 31 tons and a takeoff thrust of 555 KN. The main overall parameters are shown.

Table 1 Main Rocket General Parameters

Parameter	one sublevel	Two sublevel	Three sublevel	Four sublevel
Propellant	Butyl hydroxyl tetrad	Butyl hydroxyl tetrad	Butyl hydroxyl tetrad	MON-3/MMH
Loading capacity (kg)	14356	8776	2618	750
Working hours (room temperature)	≮60	≮60	≮60	≮600
Specific impulse (room temperature)	245	280(High altitude)	283(High altitude)	290(High altitude)
Thrust (KN)	≮555	≮390	≮120	≮3
Diameter (mm)	1400	1200	1200	1200
Level length (mm)	7415	6871	2793	3771

3. Rocket System Composition

Hyperbola-1 launch vehicle is composed of rocket body structure, power system, control system, electrical system and remote external security system. The Hyperbola-1 launch vehicle consists of a fairing, a four-stage liquid attitude and orbit control stage, a three-stage front segment, a three-stage solid engine, a three-stage rear segment, a two-stage front segment, a two-stage solid engine, a two-stage rear segment, a first-stage front segment, a first-stage solid engine, a first-stage rear segment and a grid rudder. As shown in Figure 1.

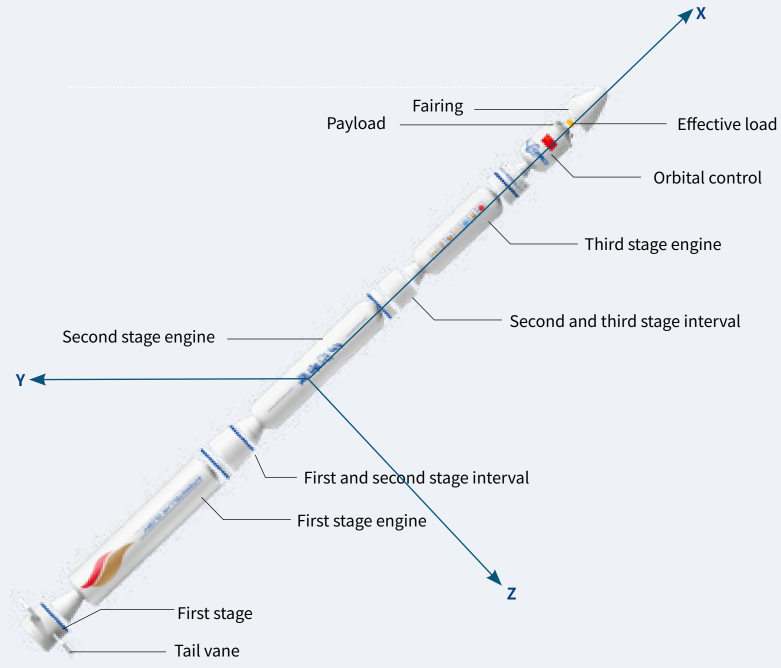


Figure 1 Composition diagram of Hyperbola-1 launch vehicle

4. Carrier Capacity and Orbital Accuracy

The carrying capacity of the Hyperbola-1 launch vehicle is based on the following five premises:

(1) Considering the safety requirements of airspace and the requirements of ground TT&C station.

(2) The satellite support belongs to the rocket structure, and its mass has been considered by the rocket side. The carrying capacity refers only to the mass of the satellite.

(3) The average radius of the earth's equator is 6378.14 km.

(4)Jiuquan Satellite Launch Center is located in Gansu Province, China. Its geographical coordinates are as follows:

Latitude: 40.96 degrees N

Longitude: 100.29 degrees E

Height: 1072 M

(5)The typical mission of Hyperbola-1 launch vehicle is 280kg (LEO, 300km). The carrying capacity of different LEOs and SSOs is shown in Figure 2, the accuracy of orbit entry is shown in Table 2 and Table 3, and the separation accuracy is shown in Table

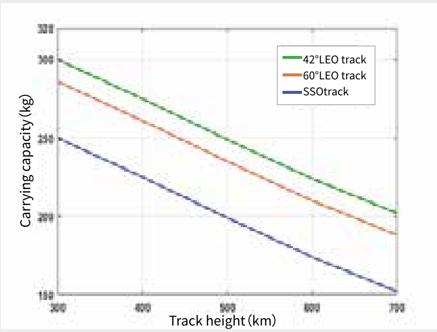


Figure 2 The launch capability of Hyperbola-1 launch vehicle (Jiuquan Satellite Launch Center)

Table 2 Accuracy of elliptical orbit entry

Parameter	Symbol	Orbit accuracy
Semi long axis	Δa	5km
Eccentricity	Δe	0.002
Orbit inclination angle	Δi	0.10deg
Longitude of ascending intersection	ΔΩ	0.12deg
Perigee angle	Δω	1.8deg

Note: The above table shows the precision of the elliptical orbit with the perigee height of 200 km and the apogee height of 400 km.

Table 3 Accuracy of orbital entry of circular track

Parameter	Symbol	Orbit accuracy
Orbital altitude	ΔH	5km
Orbit inclination angle	Δi	0.10deg
Longitude of ascending intersection	ΔΩ	0.12deg

Note: The above table shows the accuracy of circular orbit H = 500km as an example

Table 4 Separation Accuracy

Parameter	One sublevel
Roll angular velocity	<0.5°/s
Yaw angular velocity	<1.1°/s
Pitch angular velocity	<1.1°/s
Pitching Angle	<3.2°
Yaw Angle	<3.2°
Roll Angle	<1.5°

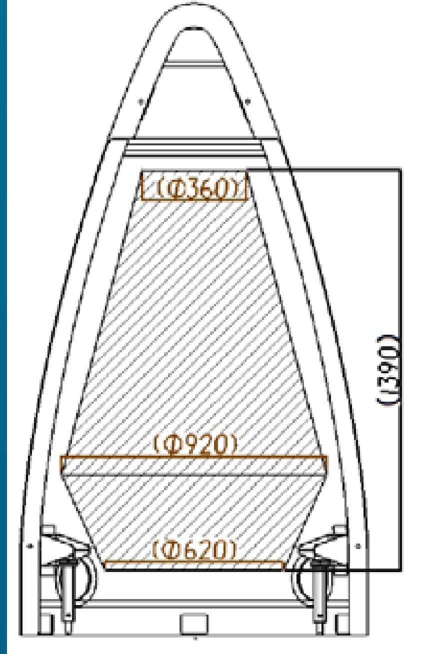


Figure 3. Configuration and envelope of fairing for Hyperbola-1 launch vehicle

5. Fairing

The function of the satellite fairing is mainly to provide a good environment for the satellite when the rocket flies in the atmosphere and to bear all kinds of influencing factors generated by the atmosphere, including aerodynamic force, aerodynamic heat, noise and so on. The heat generated by high-speed airflow is absorbed or isolated by the satellite fairing, so that the ambient temperature in the fairing is controlled within a certain range. Noise generated by airflow and rocket engine operation can be reduced to the allowable range of satellite through satellite fairing.

After the rocket flies out of the atmosphere, the satellite fairing can be thrown away. The shape and envelope of the fairing of the Hyperbola-1 launch vehicle satellite are shown in Fig. 3 below.

6. Satellite-Rocket Interfac

6.1 Mechanical Interface

The standard GJB4228-2001 "Dimension Spectrum of Satellite-Launch Vehicle Docking" is used to provide users with a general interface for large satellites, as shown in Figure 4.

When using the launch plan, the small satellite installation board is arranged in the circumference of the main satellite, as shown in Fig. 5.

Several main satellite can be installed in a drawer type with layers, as shown in Fig. 6.

Medium-sized satellites are installed at the well beam above the equipment cabin in the way shown in Figure 7.

When launching several small satellites, the central load-bearing cylinder is used to install the guide rail, as shown in Figure 8.

The microsatellite distributor adopts a multi-layer and circular layout. Each layer of the distributor is equipped with eight satellite interface devices. Five layers can install 40 microsatellites, as shown in Figure 9.

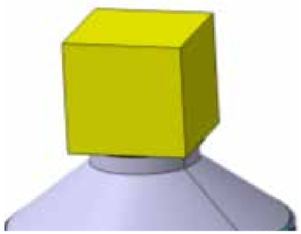


Figure 4
Large Satellite Installation

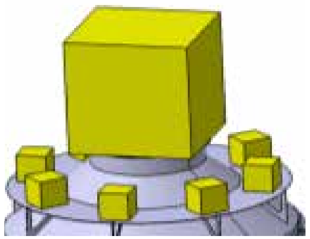


Fig. 5
Installation of small satellites around the main satellite

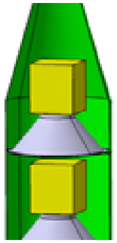


Fig. 6
Cage-drawer Satellite Installation

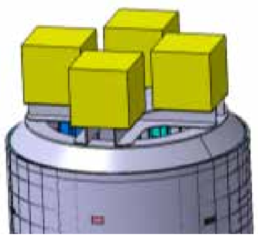


Figure 7
Installation of Medium-sized Satellite

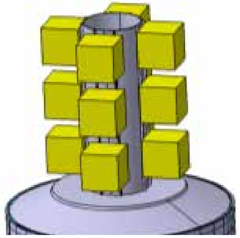


Figure 8
Small Satellite Installation

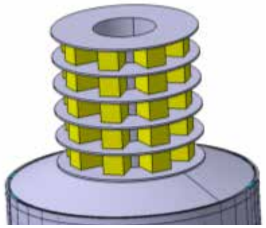


Figure 9
Installation of microsatellites

6.2 Electrical Interface

After the launch center satellite is hoisted and docked with the rocket mechanically and electrically, the satellite is usually connected with the rocket through the satellite-rocket separation connector. The type of satellite-rocket separation connector is usually determined by the satellite side. The satellite side provides the rocket side with half of the disconnection connector (referring to the plug/seat connected with the satellite in the rocket cable network). At the same time, the satellite side provides the necessary operation tools such as processing, installation, test and inspection instructions. Specific installation location and core definitions are negotiated by both parties and specified in the interface control document.

7. Satellite Environmental Conditions and Tests

The conditions at the interface between satellite and rocket are given in this section. If there is no special description, the axis is the vehicle's axis, and the transverse direction is perpendicular to the axis.

7.1 Mechanical Environment Conditions

7.1.1 Overload

The maximum axial flight overload of SQX-1 is 7.8g.

7.1.2 Sinusoidal Vibration

The low frequency (zero peak) vibration environment of the satellite-rocket interface is as follows:

7.1.3 random vibration

The high-frequency random vibration environment at the interface of satellite-rocket is as follows:

7.1.4 noise

Noise environment inside the fairing is mainly caused by engine jet noise and aerodynamic noise. The order of magnitude is as follows:

7.1.5 impact

The rocket-induced impact is mainly caused by the unlocking of the fairing separation initiating explosive device (excluding the impact caused by the satellite separation mechanism). The magnitude of the impact is as follows:

7.1.6 Ground Use Conditions

In the course of ground operation with rocket, the maximum axial overload and the maximum lateral overload at the satellite-rocket interface are (+1g) and (+2g).

Table 5 Low Frequency Vibration Conditions of Satellite-Arrow Interface

Position	Frequency range (Hz)	Magnitude of vibration
satellite and rocket interface	5~10	2.0mm
	10~100	0.8g

Table 6 high frequency vibration conditions of satellite and rocket interface

Position	Frequency range (Hz)	Power spectral density (g2/Hz)	Root mean square acceleration (g)
Rocket interface	20~150	3dB/oct	6.94
	20~150	0.04	
	20~150	-6dB/oct	

Table 7 noise conditions in fairing

Octave center frequency (Hz)	Sound pressure level (dB)
31.5	109
63	121
125	124
250	130
500	135
1000	136
2000	131
4000	122
8000	118
Total sound pressure level	140

Table 8 Shock Conditions at Star-Arrow Interfaces

Position	Frequency range (Hz)	Shock Response Spectrum (g)
Rocket interface	100~1000	9dB/oct
	1000~8000	3000

7.2 Satellite Load Design Conditions

7.2.1 Fundamental Frequency Requirements

The first-order natural frequency of the whole satellite is not less than 20Hz under the fixed support condition.

7.2.2 Static Conditions

The static conditions of the satellite active phase consider the following three flight overload conditions as operating loads:

Table 9 Static Conditions

	Axial overload (g)	Lateral overload (g)
Transonic speed	2.3	1.5
Maximum Overdrive	7.8	0.5
Shutdown condition	±1	0.5
Ground operation	±1	2

Note:

· The satellite design load is equal to the use load multiplied by the safety factor, which is not less than 1.25.

· The transverse load represents any direction perpendicular to the longitudinal direction in which it acts.

· Transverse and longitudinal loads coexist.

· Axial overload is positive for compression and negative for tension.

· For special loads, the effects of small or zero overloads need to be considered.

7.3 Load Appraisal and Acceptance Test

The deviation of mechanical environment test is carried out in accordance with GJB1027A “Test Requirements for Vehicles, Upper Stages and Spacecraft”.

7.3.1 Static Test

Satellites should be tested or analyzed in accordance with the static design conditions in 1.2.2 to ensure that the structure has sufficient strength and that no strength damage affecting rocket flight occurs during the active flight.

7.3.2 Sinusoidal Vibration Test

The low frequency sinusoidal vibration test conditions of the satellite are as follows:

7.3.3 Impact test

The magnitude of test conditions is 4.1.5. Three appraisal tests and one acceptance test were done.

7.3.4 Random Vibration Test

The high frequency random vibration test conditions of the satellite are as follows:

7.3.5 Noise Test

The acceptance level noise test condition is 4.1.4, and the acceptance level test condition is increased by 4 dB on the basis of the acceptance level test condition. Acceptance level noise test time is 1 minute, identification level noise test time is 2 minutes.

If there is no sound-sensitive structure or equipment on the satellite, only random vibration test can be carried out to avoid noise test.

7.4 Natural Environmental Conditions

he annual average relative humidity of Jiuquan Satellite Launch Site ranges from 35% to 55%, and the annual average rainfall is 44 mm.

Table 10 Satellite Low Frequency Vibration Test Conditions

Position	Frequency range (Hz)	Acceptance conditions	Qualification conditions
satellite and rocketinterface	5~10	2.0mm	3.0mm
	10~100	0.8g	1.2g
Scanning rate (oct/min)		4	2

Table 11 Satellite High Frequency Vibration Test Conditions

Position	Frequency range (Hz)	Acceptance level		Appraisal level	
		Test time (min)	Root mean square Acceleration (g)	Power spectral density (g2/Hz)	Root mean square Acceleration (g)
satellite and rocketinterface	20~150	3dB/oct	6.94	3dB/oct	6.94
	150~800	0.04		0.08	
	800~2000	-6dB/oct		-6dB/oct	
Test time (min)		1		2	

Table 12 Temperature of Jiuquan Satellite Launch Center in each month

Month	Maximum temperature (°C)	Minimum temperature (°C)	Average temperature (°C)
1	14.2	-32.4	-11.2
2	17.7	-33.1	-6.2
3	24.1	-21.9	1.9
4	31.6	-13.6	11.1
5	38.1	-5.6	19.1
6	40.9	5.0	24.6
7	42.8	9.7	26.5
8	40.6	7.7	24.6
9	36.4	-4.6	17.6
10	30.1	-14.5	8.3
11	22.1	-27.5	-1.7
12	16.0	-34.0	-9.6

8. Launch site operation

Satellite side of Hyperbola-1 launch vehicle in the launch site mainly includes satellite pre-loading alignment and testing, satellite-rocket docking, fairing closure, assembly transfer and hoisting docking, satellite pre-launch preparation and testing.

8.1 Pre-installation preparation and testing of satellites

The satellite side is responsible for the preparation and testing of the satellite between the satellite preparation and the satellite fuel filling.

8.2 Satellite and rocket docking

The rocket side is responsible for placing the four-stage cabin on the ground bracket, installing the liquid attitude and orbit control vertically, and then installing the four-stage instrument and equipment, and the satellite bracket. The satellite side lifts the satellite onto the four-stage satellite support, and the rocket side is responsible for installing the separation mechanism of the satellite and the mechanical and electrical interface with the satellite. Both sides confirm that.

8.3 Fairing closure

The rocket side is responsible for the closure of the fairing, installing detonation bolts and other separating and unlocking mechanisms of the fairing, forming a combination of four stages and satellites.

8.4 Transportation and hoisting docking of assemblies

The rocket side is responsible for the transfer and lifting of the assembly, and the vertical state of the assembly is turned into a horizontal state, which is connected with the front end of the three sub-stages.

8.5 Pre-launch preparation and testing of satellites

Satellite can be connected to ground test equipment through satellite-rocket electrical interface and rocket umbilical cord cable. Before launching, satellite preparation and test can be carried out. However, the operation of satellite needs to consider the approach ability of rocket and the limitation of radio silence time.

9. Safety Control of overflight area

Hyperbola-1 launch vehicle is equipped with security control system equipment related to autonomous destruction, which can be self-destructed in case of abnormal flight conditions. The safety officer designated by the satellite launching center is responsible for the flight safety of the rocket. The specific responsibilities of the security officer include:

(1) According to the flight safety system design plan of the rocket design unit, the safety control criteria for launch vehicle are formulated jointly with the designer. The safety criteria include the safety boundaries (alarm lines and destruction lines) of flight trajectory permission.

(2) To know the distribution of population and important facilities in the area.

(3) Ensure that the measuring equipment provides flight information required for Ground safety control, so as to effectively show the failure in flight or to make sure that the rocket is flying within a predetermined range.

(4) If the rocket has irreparable faults, it cannot complete the flight mission and may cause harm to the ground. The rocket flight will be terminated according to the requirements of the Guidelines for Safety Control of Launch Vehicles.

For more information on launch services, please feel free to contact us at any time:

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