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LM-3A Series Launch Vehicle User's Manual

Issue 2011

- China Great Wall Industry Corporation
- China Academy of Launch Vehicle Technology
- China Satellite Launch and Tracking Control General

LM-3A Series Launch Vehicle User's Manual Issue 2011

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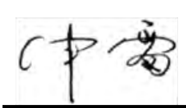

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FOREWORD

This *Long March 3A (LM-3A) Series Launch Vehicle User's Manual* is intended to provide the essential technical and programmatic information on the LM-3A, LM-3B, LM-3B Enhanced (LM-3BE) and LM-3C launch vehicles for the customers' preliminary mission planning and spacecraft design. The Manual also provides information of the launch site facilities, the documentation required, typical launch processing, the mission analysis requirements and details of the additional engineering support available to the customer's mission. This Manual is to be used as the baseline for using the LM-3A Series launch vehicle, and the detailed requirements will be defined in the relevant technical documents of the launch services contract.

This Manual will be updated as necessary. The updated information will be provided to existing customers. The current version and all updates will also be posted to the www.cgwic.com and www.calt.com web site for download as needed.

This Issue will supersede any information given in the previous issues or occasions.

Users of this Manual are encouraged to contact the offices listed below to discuss the LM-3A Series launch vehicle and how the Long March (LM) launch vehicles can meet the user's requirements.

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REVISION HISTORY

Issue	Title	Change Description	Approval
2011	*LM-3A Series Launch Vehicle User's Manual*	Completely revised compared to Issue 1999.	CEN Zheng Director General LM-3A Series
2003	*LM-3A Series Launch Vehicle User's Manual (Chinese Version)*	Three manuals in Issue 1999 were integrated into one manual in Issue 2003. (Only Chinese version was published for Issue 2003.)	LONG Lehao Director General LM-3A Series
1999	*LM-3A User's Manual* *LM-3B User's Manual* *LM-3C User's Manual*	There were three independent manuals in Issue 1999, for LM-3A, LM-3B and LM-3C respectively.	LONG Lehao Director General LM-3A Series

PREFACE

China Aerospace Science and Technology Corporation (CASC) evolved from China Aerospace Corporation, which was created from the Fifth Academy of the Ministry of National Defense established on October 8, 1956. The Fifth Academy was expanded into the Seventh Ministry of Machinery Industry and underwent further changes through the Ministry of Space Industry, the Ministry of Aerospace Industry and China Aerospace Industry Corporation, from which CASC was formally founded on July 1, 1999 with the approval of the State Council of the People's Republic of China. CASC is a large state-owned enterprise group with its own internationally recognized brands such as Long March and Shenzhou. CASC has developed its own intellectual properties in the space industry, and it has an outstanding record for its core business and is highly competitive in the international market. As an institutional investor authorized by the State Council, CASC has eight large R&D and production entities in addition to China Great Wall Industry Corporation, plus many other institutions and companies directly subordinated to it. CASC's primary business includes research, design, manufacture and launch of space systems and products, such as launch vehicles, satellites and manned spaceships.

China Great Wall Industry Corporation (CGWIC) is a launch services provider offering low risk and reliable solutions to deliver the customers' satellites into a wide range of orbits. The launch services are provided directly through CGWIC, which is the exclusive commercial organization authorized by the Chinese Government to offer Long March launch services to the international market. As the prime contractor for launch services, CGWIC is responsible for marketing launch services, negotiation and implementation of the launch services contract. CGWIC provides the customer with a single point of contact for all communications related to launch services contract.

China Academy of Launch Vehicle Technology (CALT) is the designer and manufacturer of LM-3A Series launch vehicles and is a subcontractor for launch services. CALT is responsible for the launch vehicle design, development, manufacture, testing, mission analyses, launch vehicle technical interface coordination and flight safety engineering.

CGWIC and CALT are both wholly – owned subsidiaries of CASC.

China Satellite Launch and Tracking Control General (CLTC) is in charge of China's TT&C network and launch sites, including XSLC, JSLC and TSLC. As the subcontractor of Long

March launch services, CLTC is responsible for the TT&C and launch site technical and interface coordination, launch site operations, launch control and launch site safety.

In cooperation with CALT and CLTC, CGWIC has established an outstanding launch record that clearly demonstrates the high reliability of Long March launch vehicles and their ability to deliver the customers' satellite into designed orbit in an accurate and reliable manner.

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ABBREVIATIONS AND ACRONYMS

Acronym	Meaning
Ω	Right Ascension of Ascending Node
ω	Argument of perigee
A	
A	Ampere(s)
a	Semi-major Axis
A/D	Analog to Digital
ADS	Autonomous Destruction System
AIT	Assembly, Integration and Test
B	
BACC	Beijing Aerospace Control Center
BL	Launch Vehicle Processing Building
BM	Solid Propellant Motor Testing and Processing Building
BMX	X-ray Building
BS	SC Test and Fueling Building
BS2	SC Non-Hazardous Operation Building
BS3	SC Hazardous Operation Building
C	
°C	Degree(s) Celsius
CALT	China Academy of Launch Vehicle Technology
CASC	China Aerospace Science and Technology Corporation
CAST	China Academy of Space Technology
CDR	Critical Design Review
CDS	Command Destruction System
CGWIC	China Great Wall Industry Corporation
CLA	Coupled Loads Analysis
CLTC	China Satellite Launch and Tracking Control General
CoG	Center of Gravity
COTE	Check-Out Test Equipment
CS	Command Shutdown
CTS	LM-2C Top Stage
D	
D/A	Digital to Analog
dB	Decibel(s)
dBm	Decibel(s) Relative to 1 Miliwatt
dBW	Decibel(s) Relative to 1 Watt
dBpT	Decibel(s) Relative to 1 Picotesla
dBμV	Decibel(s) Relative to 1 Microvolt
Deg, °	Degree(s)
Dia	Diameter
E	
e	Eccentricity

Acronym	Meaning
EDC	Effective Date of the Contract
EGSE	Electrical Ground Support Equipment
EIRP	Equivalent Isotropic Radiated Power
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EPKM	LM-2E Perigee Kick Motor
F	
f	Frequency
FER	Fore-positioned Equipment Rooms
FM	Frequency Modulation
FMAR	Final Mission Analysis Review
FMH	Free Molecular Heating
G	
g	Acceleration of Gravity
GEO	Geostationary Earth Orbit
GNSS	Global Navigation Satellite System
GTO	Geostationary Transfer Orbit
H	
Ha	Height of Apogee
Hp	Height of Perigee
Hr	Hour(s)
Hz	Hertz
I	
i	Inclination
ICD	Interface Control Document
IFD	In-Flight Disconnector
IMU	Inertial Measurement Unit
IRD	Interface Requirement Document
J	
JSLC	Jiuquan Satellite Launch Center
K	
kg	Kilogram(s)
km	Kilometer(s)
kN	Kilo-Newton(s)
kPa	Kilo-Pascal(s)
kW	Kilo-Watt(s)
L	
LC	Launch Complex
LCC	Launch Control Center
LEO	Low Earth Orbit
LEOP	Launch and Early Orbit Phase
LH_2	Liquid Hydrogen
LM	Long March
LM-3BE	LM-3B Enhanced
LOX	Liquid Oxygen
LRR	Launch Readiness Review
LSC	Launch Services Contract
LV	Launch Vehicle
M	
m	Meter(s)
mA	Mili-Ampere(s)

Acronym	Meaning
ms	Mili-second(s)
Max	Maximum
MCCC	Mission Command and Control Center
MDP	Maximum Dynamic Pressure
MEO	Medium Earth Orbit
min	Minute(s)
MM, mm	Millimeter(s)
MMH	Monomethyl Hydrazine
MRS	Minimum Residual Shutdown
m/s	Meter(s) per second
N	
N	Newton(s)
N_2	Nitrogen
N_2O_4	Nitrogen Tetroxide
N/A	Not Applicable
O	
Oct.	Octave
P	
Pa	Pascal(s)
PCM	Pulse Code Modulation
PFD	Power Flux Density
PLA	Payload Adapter
PLF	Payload Fairing
PMAR	Preliminary Mission Analysis Review
PPB	Payload Preparation Building
PSR	Pre-Shipment Review
PUS	Propellant Utilization System
Q	
Q	Quality Factor
R	
RAAN	Right Ascension of the Ascending Node
rad	Radian(s)
Rx	Receive
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
rpm	Round(s) per minute
S	
s, sec	Second(s)
SAST	Shanghai Academy of Spaceflight Technology
SC, S/C	Spacecraft / Satellite
SGTO	Super Geostationary Transfer Orbit
SOW	Statement of Work
SPM	Solid Propellant Motor
sq	Square
SSO	Sun Synchronous Orbit
STE	Satellite Test Equipment
T	
t	Ton(s)
TAS	Thales Alenia Space
TIM	Technical Interchange Meeting
Tx	Transmit

Acronym	Meaning
TSLC	Taiyuan Satellite Launch Center
TT&C	Telemetry, Tracking and Control
U	
UDMH	Unsymmetrical Dimethyl Hydrazine
UPS	Uninterrupted Power Supply
V	
V	Volt, Velocity
VEB	Vehicle Equipment Bay
vs	Versus
W	
W	Watt(s)
W/m^2	Watt(s) Per Square Meter
WSLC	Wenchang Spacecraft Launch Center
X	
XSCC	Xi'an Satellite Control Center
XSLC	Xichang Satellite Launch Center

CHAPTER 1 INTRODUCTION

The development of Long March (LM) launch vehicle family can be traced back to the 1960s. Up to now, the Long March family of launch vehicles has included the LM-2C Series, the LM-2D, the LM-4 Series, the LM-3A Series and the LM-2F launch vehicles for LEO, SSO and GTO missions. With the further expanded launch capability developed over the last few years, the Long March launch vehicle family has successfully launched a series of manned spacecraft.

The LM launch vehicle family is shown in Figure 1-1.

Figure 1-1 Long March Family of Launch Vehicles

The LM-1, LM-2, LM-2E, LM-2E/EPKM and LM-3 are no longer in service. Currently, the LM-3A Series launch vehicles, including LM-3A, LM-3B, LM-3BE and LM-3C, are the workhorse launch vehicles for China's GTO launch missions.

The main characteristics of Long March launch vehicle family in service are shown in Table 1-1.

Table 1-1 The Main Characteristics of Long March Family

Items	LM-2C	LM-2C/ CTS1	LM-2C/ CTS2	LM-2D	LM-4B/ LM-4C	LM-2F	LM-3A	LM-3B	LM-3BE	LM-3C
Height (m)	43.0	43.0	43.0	41.0	48.0	58.3/ 52.0	52.5	54.8	56.3	54.8
Lift-off Mass (t)	245	245	245	250	250	497.9	241	425.8	456	345
Lift-off Thrust (kN)	2,962	2,962	2,962	2,962	2,962	5,923	2,962	5,923	5,923	4,443
Fairing Diameter (m)	3.35	3.35	3.35	3.35/3.80	2.90/3.35/ 3.80	3.80/ 4.20	3.35	4.00	4.00/4.20	4.00
Stage-1 Propellant	N_2O_4 / UDMH									
Stage-2 Propellant	N_2O_4 / UDMH									
Stage-3 Propellant	N/A	Solid propellant	Solid propellant	N/A	N_2O_4 / UDMH	N/A	LOX / LH_2			
Main Mission	LEO/SSO	SSO	GTO	LEO/ SSO	SSO	LEO	GTO			
Launch Capability (kg)	3,850/ 900	2,100	1,250	4,000/ 1,150	2,230/ 2,950	8,080/ 8,600	2,600	5,100	5,500	3,800
Launch Site	JSLC/ TSLC/ XSLC	JSLC/ TSLC/ XSLC	JSLC/ TSLC/ XSLC	JSLC/ TSLC	JSLC/ TSLC	JSLC	XSLC			

1.1 Long March Family of Launch Vehicles - Development History

The development of the Long March (LM) launch vehicles began in the mid-1960s and has resulted in the establishment of a family of launch vehicles suitable for a full range of missions and payloads. The LM launch vehicles have a long list of successful launches and this record is attributed to the fact that the launch vehicle development has been based on mature and proven technologies, which includes using the same product at subsystem level, wherever possible among the members of the LM family. This has resulted in an improved reliability and a high launch success rate as demonstrated by the whole LM launch vehicle family. The members of LM family that have been used for international commercial launch services include LM-2C and its enhanced version LM-2C/CTS1, the LM-2E, the LM-2E/EPKM, the LM-3, the LM-3B and the LM-3BE.

Figure 1-2 Long March Flights

The LM-1 performed its first flight successfully in April 1970, sending the first Chinese satellite into a low earth orbit. After the second flight in 1971, the LM-1 was phased out.

The LM-2 is a two-stage launch vehicle developed based on LM-1. Its upgraded version, the LM-2C successfully made its first flight in November 1975. The enhanced versions of the LM-2C are designated as the LM-2C/CTS1 and LM-2C/CTS2, which are three-stage launch vehicles capable of delivering heavier payloads into the orbits that require greater launch capability. The LM-2C, LM-2C/CTS1 and LM-2C/CTS2 have a record of 32 consecutive successful flights from the maiden flight in 1975 as of the end of 2010.

The LM-2E and LM-2E/EPKM use the LM-2C as their core stage, around which there are four strap-on boosters. The LM-2E and LM-2E/EPKM has been phased out since the end of 1995.

The LM-3 is a three-stage launch vehicle, of which the first and second stages were derived from the LM-2C. The third stage has a cryogenic engine, using LOX and LH_2 as the propellants, which gives the third stage engine a re-start capability, thus providing greater flexibility in the mission. The first flight of the LM-3 was in January 1984, and in the middle of 2000 after 13 flights, the LM-3 launch vehicle has been phased out.

The LM-3A launch vehicle is also a three-stage launch vehicle based on the mature technologies of the LM-3. A newly designed third stage, which also uses LOX and LH_2 as propellants, was used by the LM-3A. The LM-3A third stage can also perform attitude adjustment maneuvers to orient the payloads and to provide adjustable spin-up operations. The first LM-3A launch took place in February 1994 and as of the end of 2010 had flown 19 times, all of which were successful.

The LM-3B employs the LM-3A vehicle configuration as the core stage plus four strap-on boosters on the first stage. The first LM-3B launch was conducted in February 1996, and it has been launched 10 times as of the end of 2010. Besides the failure of the maiden flight and the anomaly that occurred in the Palapa-D mission in 2009, all other LM-3B flights were successful. (In Palapa-D mission, the satellite was sent into a GTO with an apogee altitude lower than specified due to an anomaly on the third stage engine and as a result the expected satellite in orbit life was reduced from 15 years to approximately 11 years).

The LM-3BE was developed based on LM-3B with a lengthened first core stage and strap-on boosters. The launch capability was improved for LM-3BE and the first flight took place in May 2007. As of the end of 2010, the LM-3BE had made three successful fights.

The LM-3C is a simplified version of LM-3B with only two strap-on boosters on the first stage. The first LM-3C launch was conducted in April 2008 and there have been six LM-3C launches as of the end of 2010, all successful.

The LM-2D and LM-4 Series launch vehicles are both developed and manufactured by Shanghai Academy of Spaceflight Technology (SAST). As of the end of 2010, all the 14 LM-2D flights and 22 LM-4 Series flights are successful.

Please refer to summary Table 1-3 on page 1-10.

1.2 Long March Launch Services

1.2.1 Overview

CGWIC, a wholly-owned subsidiary of CASC, was established in 1980. CGWIC is the sole commercial organization authorized by the Chinese government to provide commercial launch services to international customers. Over the past decades, CGWIC has provided the international launch services with support from CALT and CLTC. The relationship among these organizations is illustrated in Figure 1-3. To implement the launch services for the customer, CGWIC organizes and coordinates the joint team comprising CALT and CLTC for the execution of the launch service contract. Table 1-2 summarizes the main responsibilities of these organizations.

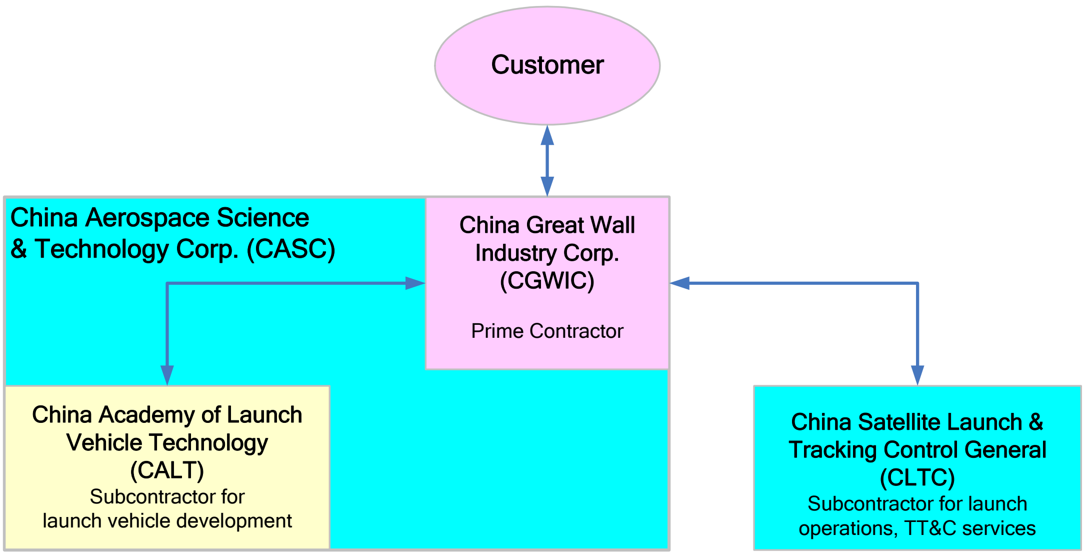


Figure 1-3 The Organization of Long March Launch Services

Table 1-2 Responsibilities of the Launch Services Related Organizations

Subcontractor	Prime Contractor	Subcontractor
CLTC	**CGWIC**	**CALT**
◆ Launch Site Technical Interface Coordination ◆ Launch Campaign Planning & Organization ◆ Launch Site Operations ◆ TT&C ◆ Launch Site & Launch Safety ◆ Flight Safety Engineering	◆ Marketing and Sales of Long March launch services ◆ Program management ◆ Interaction with customers ◆ Insurance and financing services on case by case basis	◆ Launch vehicle - Design, - Development, - Manufacture, and - Testing ◆ Mission Analyses ◆ LV Technical Interface Coordination ◆ LV Quality Control

CALT is one of the main subsidiaries of CASC, and is the leading company engaged in the development and production of launch vehicles. CALT is located in Beijing and has a total staff of 25,000, which includes 8,000 engineers and 1,800 senior engineers and scientists. The LM-1, LM-2, LM-2C Series, LM-3A Series and LM-2F are all designed and manufactured by CALT.

Figure 1-4 Long March LV Assembly and Test Workshop

CLTC is the organization that performs the launch operations and provides the launch facilities including the telemetry and tracking ground station network for the launch. CLTC manages three independent satellite launch centers, a global TT&C network that includes tracking ships, and two research institutes. CLTC has a team of 5,000 technical staff to support the launch and tracking operations.

1.2.2 Customer Interfaces

CGWIC is the single point of contact with the customer. When a launch services contract is signed, CGWIC nominates a Program Manager who is responsible for implementing the launch services contract.

1.3 Overview of the Launch Centers

There are three launch centers in China, i.e. Xichang Satellite Launch Center (XSLC), Jiuquan Satellite Launch Center (JSLC) and Taiyuan Satellite Launch Center (TSLC). Figure 1-5 shows their locations. Wenchang Spacecraft Launch Center (WSLC) in Hainan Province is under construction.

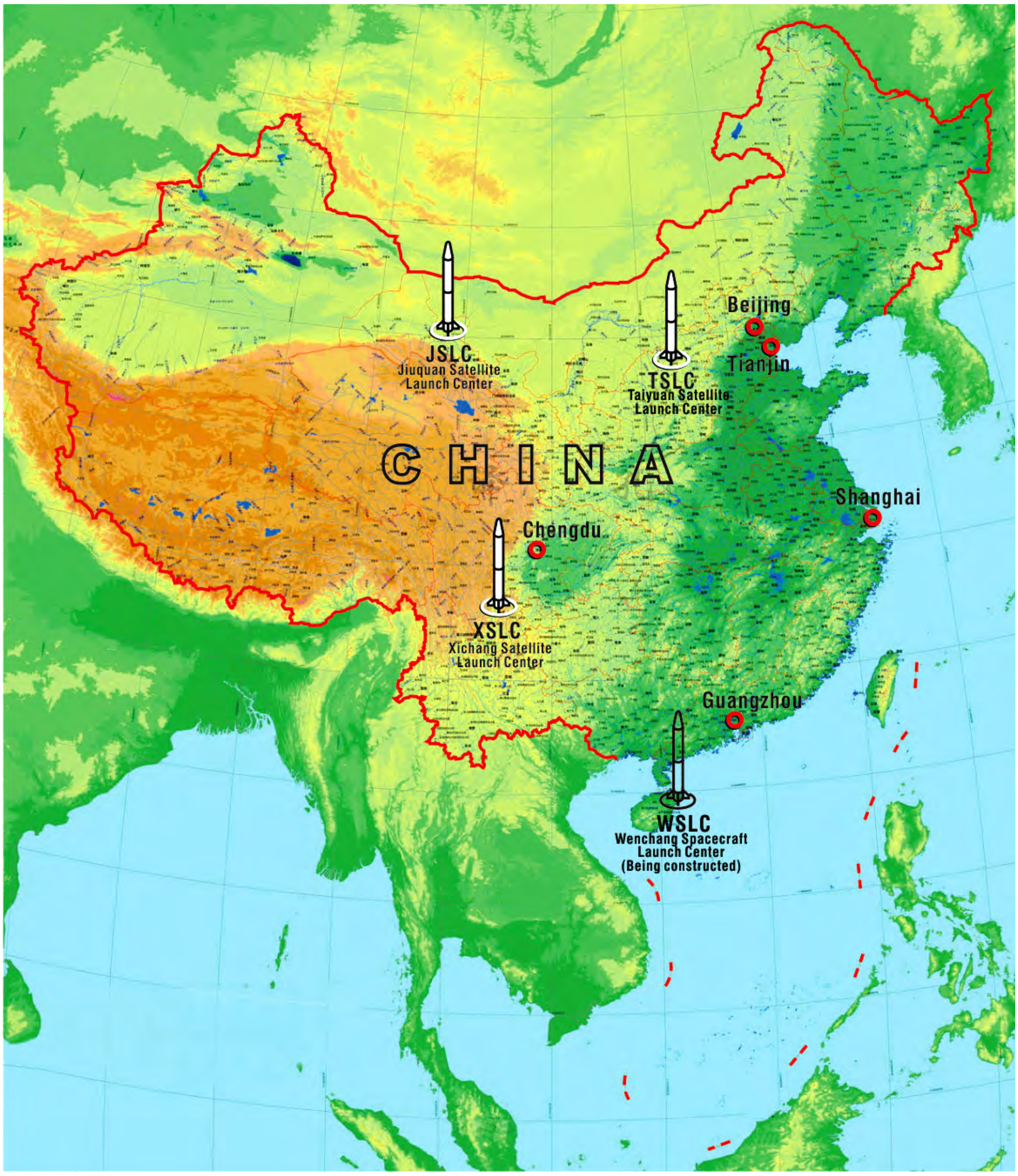


Figure 1-5 Satellite Launch Centers

1.3.1 Xichang Satellite Launch Center (XSLC)

XSLC is located in Sichuan Province, southwestern China, and is primarily used for GTO missions. The launch center comprises processing buildings for the pre-launch preparation of the launch vehicles, satellites and solid motors as well as the ground support equipment. XSLC has two launch complexes (LC), one of which (LC-3) is primarily used for LM-3A launch operations and the other one (LC-2) is for LM-3B, LM-3BE and LM-3C launch operations.

Figure 1-6 Xichang Satellite Launch Center

1.3.2 Taiyuan Satellite Launch Center (TSLC)

TSLC is located in Shanxi Province, northern China, and is primarily used for LEO missions utilizing the LM-2C Series and SSO missions utilizing the LM-4 Series.

Figure 1-7 Taiyuan Satellite Launch Center

1.3.3 Jiuquan Satellite Launch Center (JSLC)

JSLC is located in Gansu Province, northwestern China. It is the first launch site in China. It is mainly used for LEO launch missions and MEO launch missions using the LM-2C Series, LM-2D and LM-4 Series launch vehicles. It is also used for China's manned space missions with the LM-2F launch vehicles.

Figure 1-8 Jiuquan Satellite Launch Center

1.4 Launch Record of Long March

The Long March series of launch vehicles has been undergoing continuous development in China since the mid-1960s. Different launch vehicles with various capabilities have been developed, which has enabled China's launch business to enter into both domestic and international markets and to accomplish different LEO, GTO and SSO satellite launch missions.

The Long March launch vehicle spectrum and their track record are summarized in Table 1-3 below:

Table 1-3 Flight Record of Long March (As of January 1, 2011)

	Launch Vehicle	Success/ Flight	Total Success/ Total Flight	Status
LEO & SSO Missions	LM-1	02/02	07/10	Out of Service
	LM-2	00/01		
	LM-2E	03/05		
	LM-4A	02/02		
	LM-2C & LM-2C/CTS	32/32	73/73	In Service
	LM-2D	14/14		
	LM-4B & LM-4C	20/20		
	LM-2F	07/07		
GTO Missions	LM-2E/EPKM	02/02	12/15	Out of Service
	LM-3	10/13		
	LM-3A	19/19	36/38	In Service
	LM-3B	11/13		
	LM-3C	06/06		
Total			128/136	

1.5 Long March Launch Services Advantages

The selection of the Long March launch services provides the customer with some key advantages:

a) Long March launch vehicles are flight proven, highly reliable and compatible with all major satellite platforms.

b) The system, sub-systems and major equipment production of the Long March family is wholly controlled within CASC group, which facilitates the launch vehicle hardware and software development process.

c) The Long March launch is conducted on a dedicated basis with no risk of launch delay by co-passengers and scheduling flexibility can be arranged to the customer's benefit.

d) As it is a dedicated launch, any residual margin in the launch capability can be used to optimize the injection parameters in order to extend the satellite's in-orbit life. This is without any additional cost to the customer. If the additional margin in launch vehicle capability is identified early in the launch services program, it could provide the customer with greater flexibility in the satellite design.

e) The state-of-the-art ground support facilities are purpose built, and the satellite processing facility at the launch site is handed over to the customer for the duration of the launch campaign.

f) The security of the customer's satellite technology is regarded as paramount and all necessary security measures are implemented and reviewed with the customer. The security measures include an exemption for the customer's satellite from the Chinese customs inspection and the full control of access to the satellite processing facility by the customer throughout the launch campaign.

g) CGWIC procures the launch vehicles in bulk which allows the lead time to meet the customers launch schedule requirements. The launch vehicle is subject to comprehensive tests and checkouts at the launch vehicle manufacturing facility before shipment to the launch site, which allows the launch vehicle processing at the launch site to be streamlined for completion in approximately 24 days. This provides additional schedule flexibility for the launch vehicle up to combined operations. In addition, the use of two launch complexes and two satellite processing facilities makes it possible for two launch campaigns to be conducted in parallel, which further increases the schedule flexibility of Long March launch services.

h) CGWIC has full support from the Chinese government for the provision of launch services to international customers, and there are no obstacles for CGWIC in obtaining the Chinese government's approval to perform the launch services for an international customer.

i) A fully equipped modern hotel is located at the launch site providing comfortable living conditions and easy access to the processing facilities.

j) CGWIC demonstrated its abilities and proved its competence in over 20 years of space-related activities and has a dynamic and experienced engineering and management team.

CHAPTER 2 GENERAL DESCRIPTION

2.1 Summary

The China Academy of Launch Vehicle Technology (CALT) started to develop the LM-3A Series launch vehicles in 1986, and they are three-stage liquid propellant launch vehicles used mainly for Geostationary Transfer Orbit (GTO) missions. LM-3A Series launch vehicles include the LM-3A, LM-3B, LM-3B Enhanced (LM-3BE) and LM-3C. The configuration of LM-3A Series launch vehicles is shown in Figure 2-1. The GTO capability of LM-3A is 2,600 kg.

The LM-3B is a three-stage launch vehicle, which utilizes the proven LM-3A as its core stage and has been upgraded by the addition of four liquid strap-on boosters to the first stage. The second stage tanks were also increased in volume, which increased the GTO capability up to 5,100 kg for the LM-3B version.

The LM-3BE is based on the LM-3B but has a lengthened first stage and boosters, which increases the GTO launch capability up to 5,500 kg.

The LM-3C is a three-stage launch vehicle but with two liquid strap-on boosters. The LM-3C variant is capable of delivering a satellite with the mass of 3,800 kg into GTO. The LM-3C and LM-3B variants were developed in parallel using the same modular design as the LM-3A. The LM-3C uses the same SC/LV interface and payload fairing as is used by the LM-3B.

All the LM-3A Series launch vehicles are flight proven.

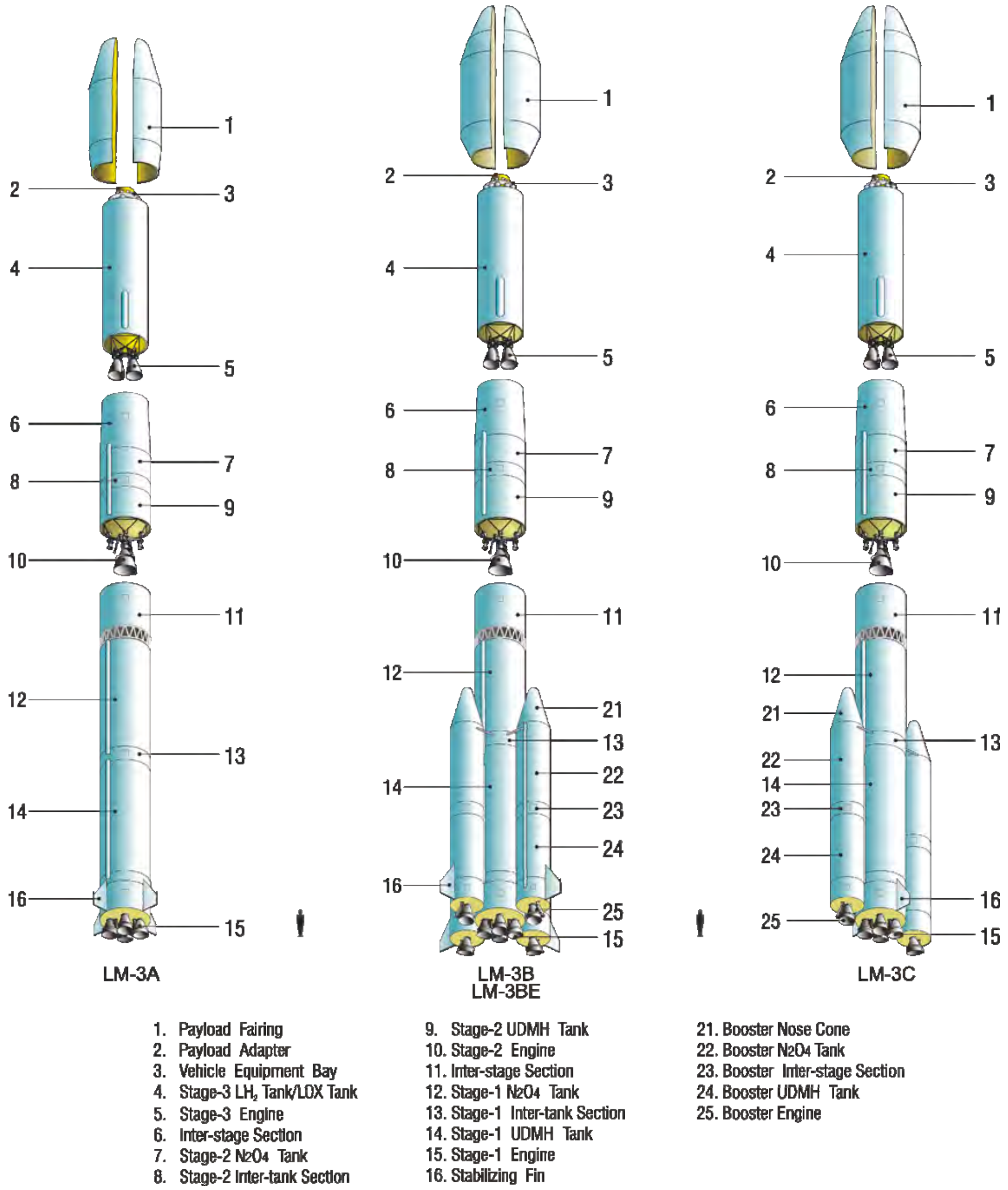


Figure 2-1 LM-3A/3B/3BE/3C Configuration

2.2 LM-3A Launch Vehicle

2.2.1 Technical Parameters

LM-3A is 52.52 m long with lift-off mass of 242 tons and uses a fairing that is 8.887 m long with diameter of 3.35 m.

Figure 2-2   LM-3A Launch Vehicle

Technical Parameters of the First Stage:

Length	23.272 m
Diameter	3.35 m
Propellant	N_2O_4 / UDMH
Mass of Propellant	171,800 kg
Engine	YF-21C
Ground Thrust	2,961.6 kN
Ground Specific Impulse	2,556.5 N·s/kg

Technical Parameters of the Second Stage:

Length	11.276 m
Diameter	3.35 m
Propellant	N_2O_4 / UDMH
Mass of Propellant	32,600 kg
Engine	YF-24E
Thrust (in vacuum)	Main Engine: 742 kN Vernier Engine: 47.1 kN
Specific Impulse (in vacuum)	Main Engine: 2,922.57 N·s/kg Vernier Engine: 2,910.5 N·s/kg

Technical Parameters of the Third Stage:

Length	12.375 m
Diameter	3.0 m
Propellant	LOX / LH_2
Mass of Propellant	18,200 kg
Engine	YF-75
Thrust (at vacuum)	167.17 kN
Specific Impulse (in vacuum)	4,295 N·s/kg

2.2.2 LM-3A Description

The LM-3A launch vehicle consists of the following major subsystems: vehicle structure, propulsion system, control system, measurement system (telemetry system and tracking & range safety system), propellant management system & reaction control system, propellant utilization system, separation system and auxiliary system.

Vehicle Structure

The function of the vehicle structure is to withstand the internal and external loads on the launch vehicle during ground transportation, hoisting and flight, in addition to housing all the sub-systems. The vehicle structure comprises the first stage, second stage, third stage and payload fairing.

Figure 2-3 CALT Assembly Area

The first stage includes inter-stage section, oxidizer tank, inter-tank section, fuel tank, rear transit section, tail section, engine, valves and pipes.

The second stage is comprised of oxidizer tank, inter-tank section, fuel tank, and engine.

The third stage includes the Payload Adapter (PLA), vehicle equipment bay (VEB), cryogenic propellant tanks and engine. The PLA mates the satellite with the LM-3A and transfers the loads between them. The PLA can be one of the international standard interfaces designated as 937B, 1194 or 1194A. The VEB is a circular structure made of metal honeycomb and trusses (see Figure 2-4), which is mounted on top of the propellant tanks. The propellant tank of third stage is thermally insulated with a common bulkhead, convex upward in the middle. The common bulkhead is thermally insulated with dual-layer honeycomb vacuum thermal insulation. The tanks are arranged with the liquid hydrogen (LH_2) in the upper tank and liquid oxygen (LOX) in the lower tank.

The payload fairing consists of the dome, forward cone section, cylindrical section, reverse cone section, and fairing separation mechanisms (see Chapter 4 for details).

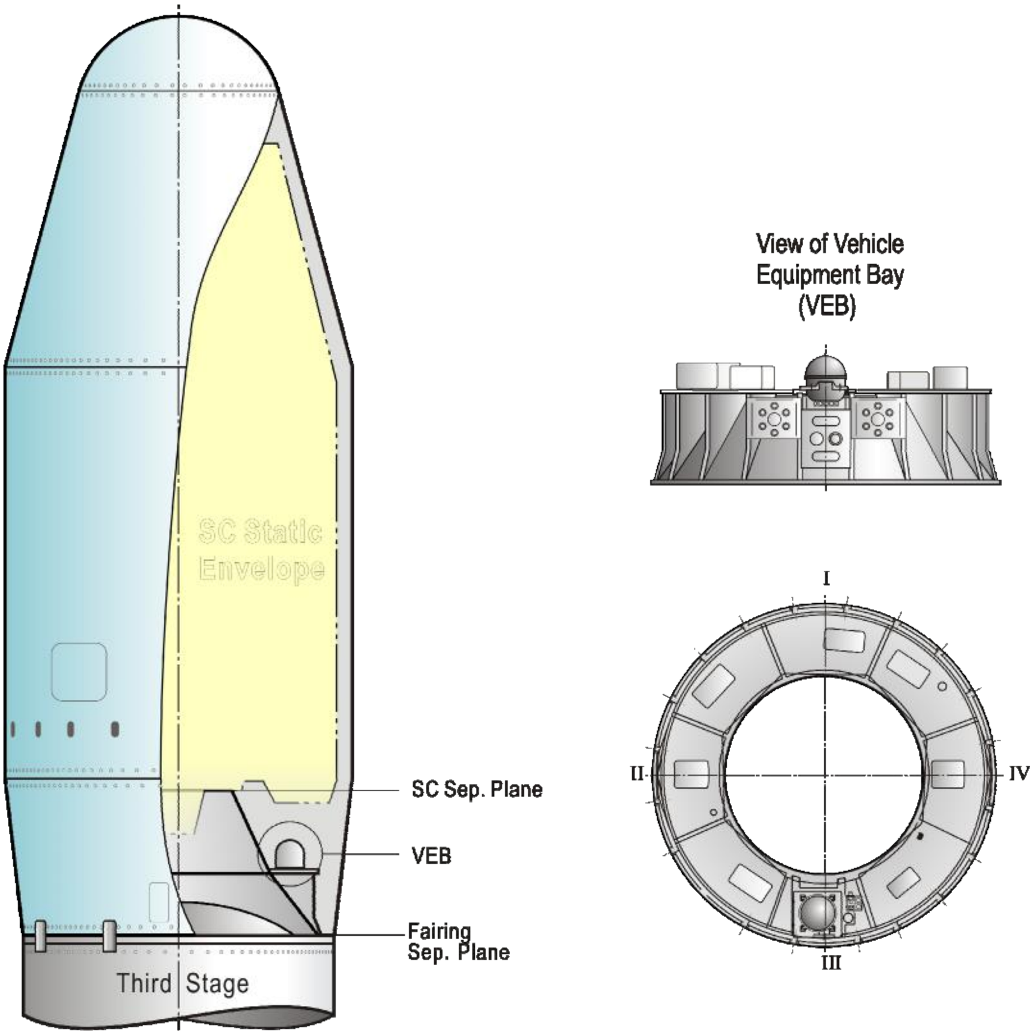


Figure 2-4 LM-3A VEB Configuration

Propulsion System

The propulsion system, which consists of the engines and pressurization system, generates the flight thrust and vehicle control forces.

There are four engines symmetrically installed in the first stage, each of which can swing in tangentially to the thrust vector. The propellant tanks are pressurized by the autogenous pressurization systems.

There are one main engine and four vernier engines on the second stage, and as with the first stage the propellant tanks are pressurized by the autogenous pressurization systems.

The first stage and second stage employ storable propellants, nitrogen tetroxide (N_2O_4) and unsymmetrical dimethyl hydrazine (UDMH).

The third stage is equipped with two universal gimbaled cryogenic engines with restart capability. The propellants are liquid hydrogen (LH_2) and liquid oxygen (LOX). The LH_2 tank is pressurized with helium by the autogenous pressurization system, and the LOX tank is pressurized with heated helium by the autogenous pressurization system.

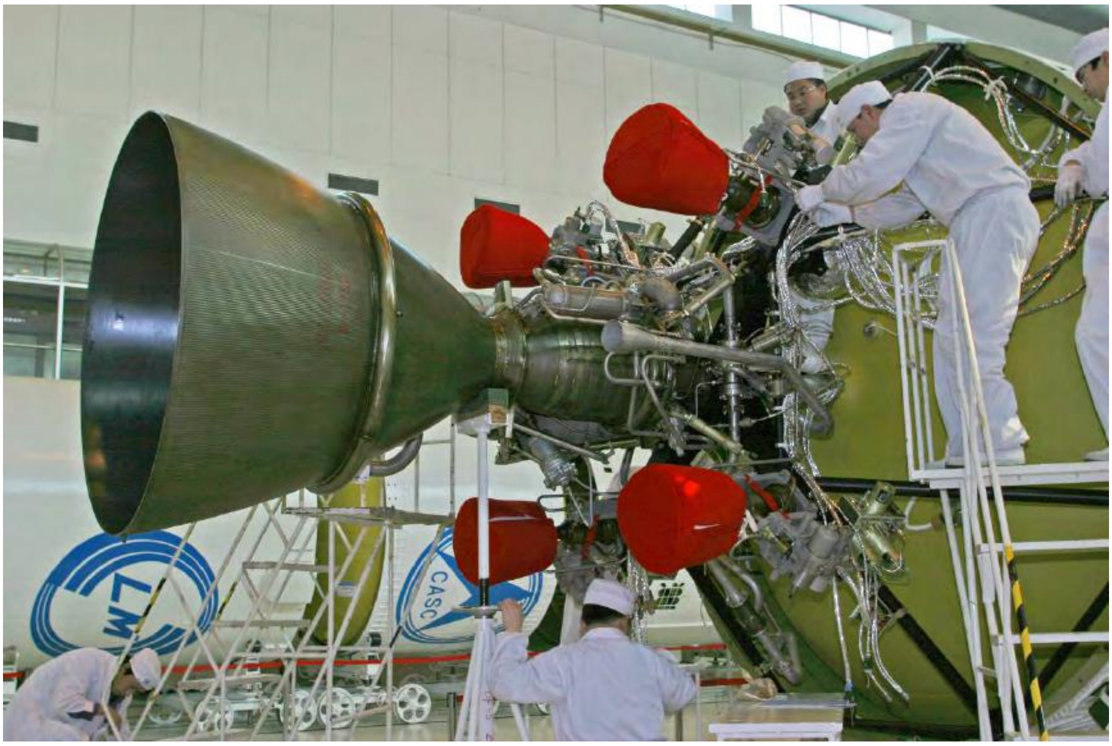


Figure 2-5 Second Stage Engines

See Figure 2-6a, Figure 2-6b and Figure 2-6c for propulsion systems of the first, second and third stages.

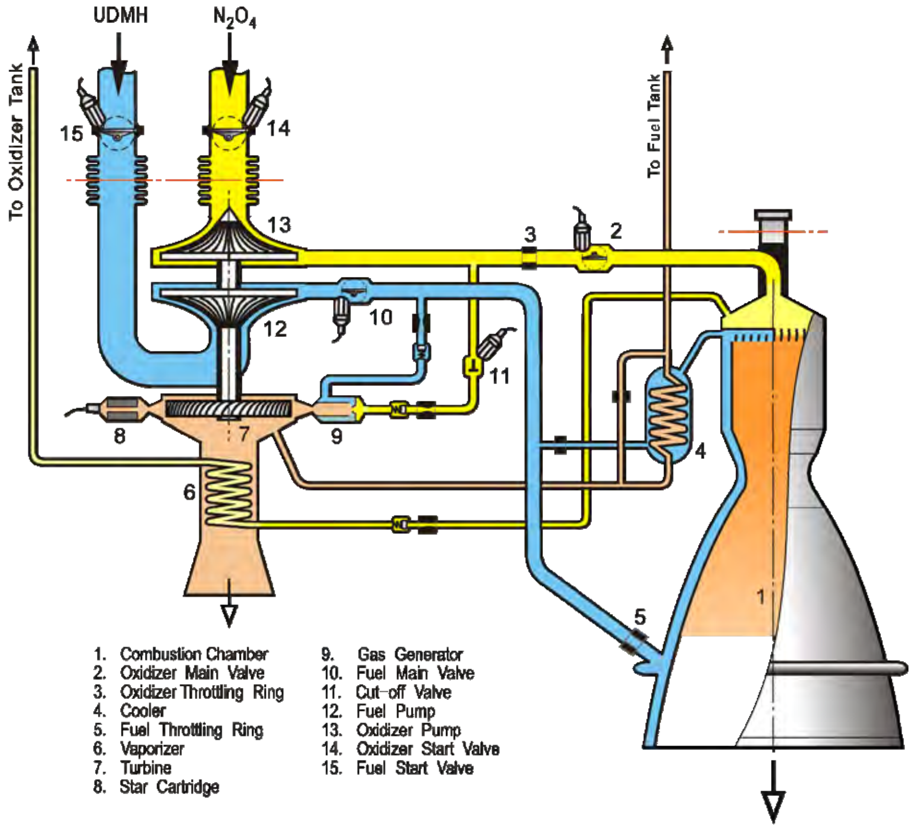


Figure 2-6a Schematic Diagram of Stage-1 Propulsion System

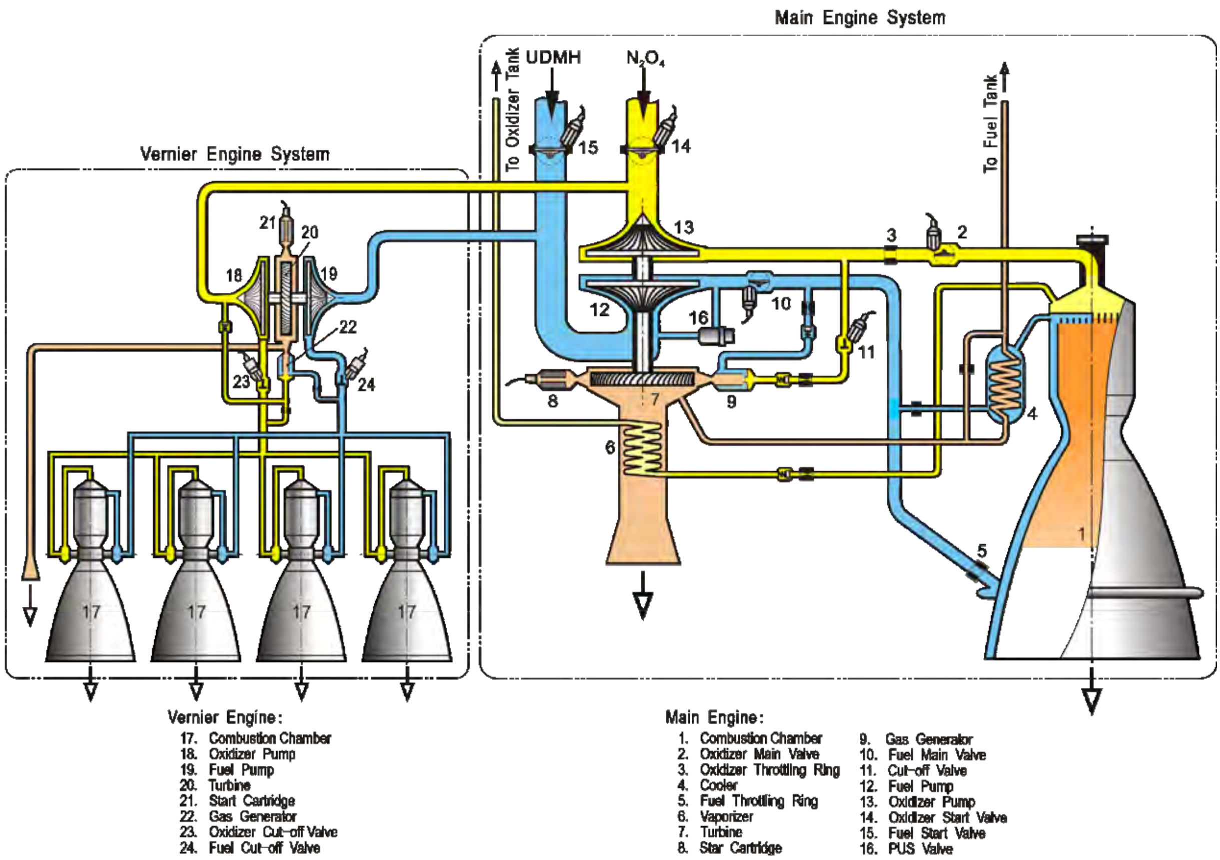


Figure 2-6b Schematic Diagram of Stage-2 Propulsion System

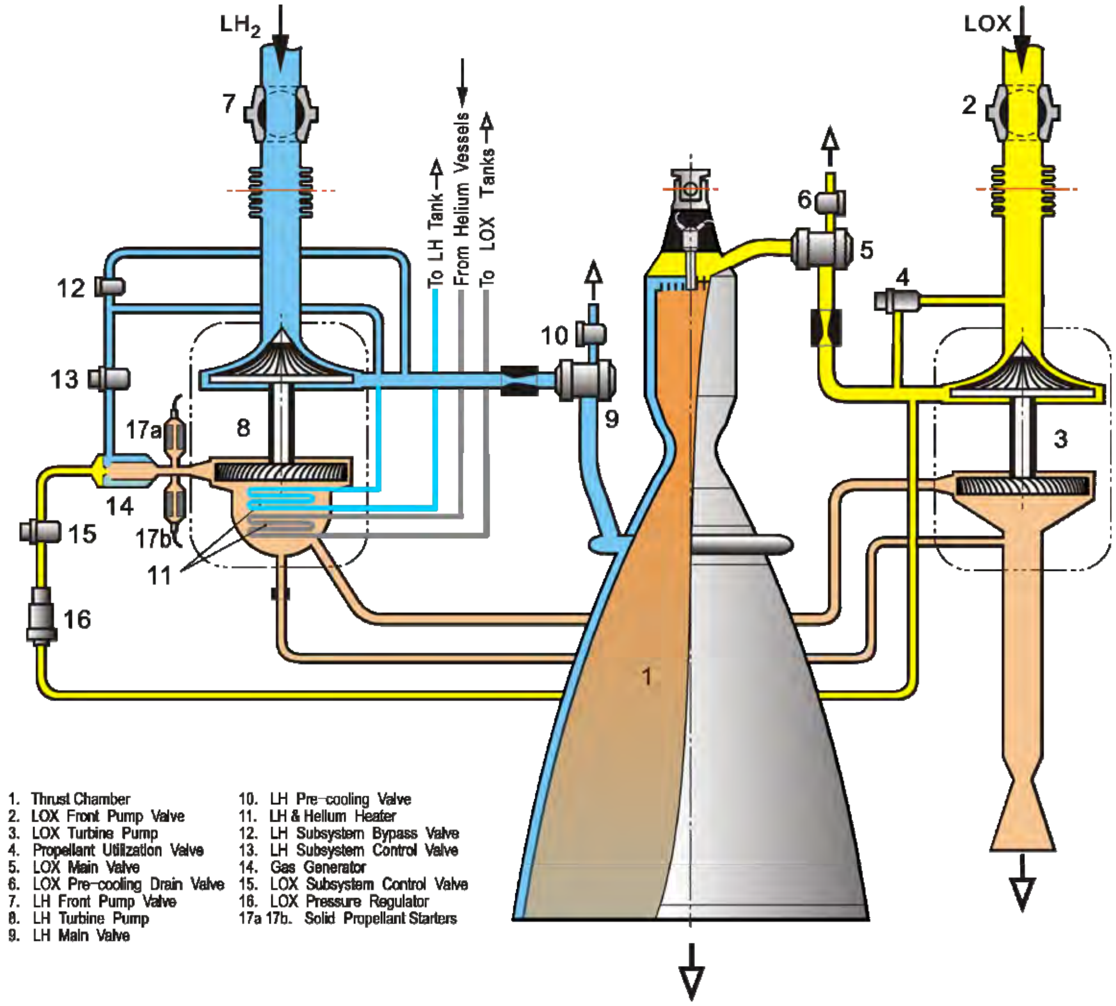


Figure 2-6c Schematic Diagram of Stage-3 Propulsion System

Control System

The function of control system is to maintain the flight stability, perform the navigation and guidance functions to deliver the satellite into the predetermined orbit. The control system uses a four-axis inertial platform and laser IMU, combined with computer-controlled guidance and digital attitude control. The control system uses advanced digital technologies and redundancy design to provide enhanced reliability and flexibility for a wide range of missions for the LM-3A. Figure 2-7a, Figure 2-7b and Figure 2-7c illustrate the schematic diagrams of the LM-3A Series launch vehicles control system.

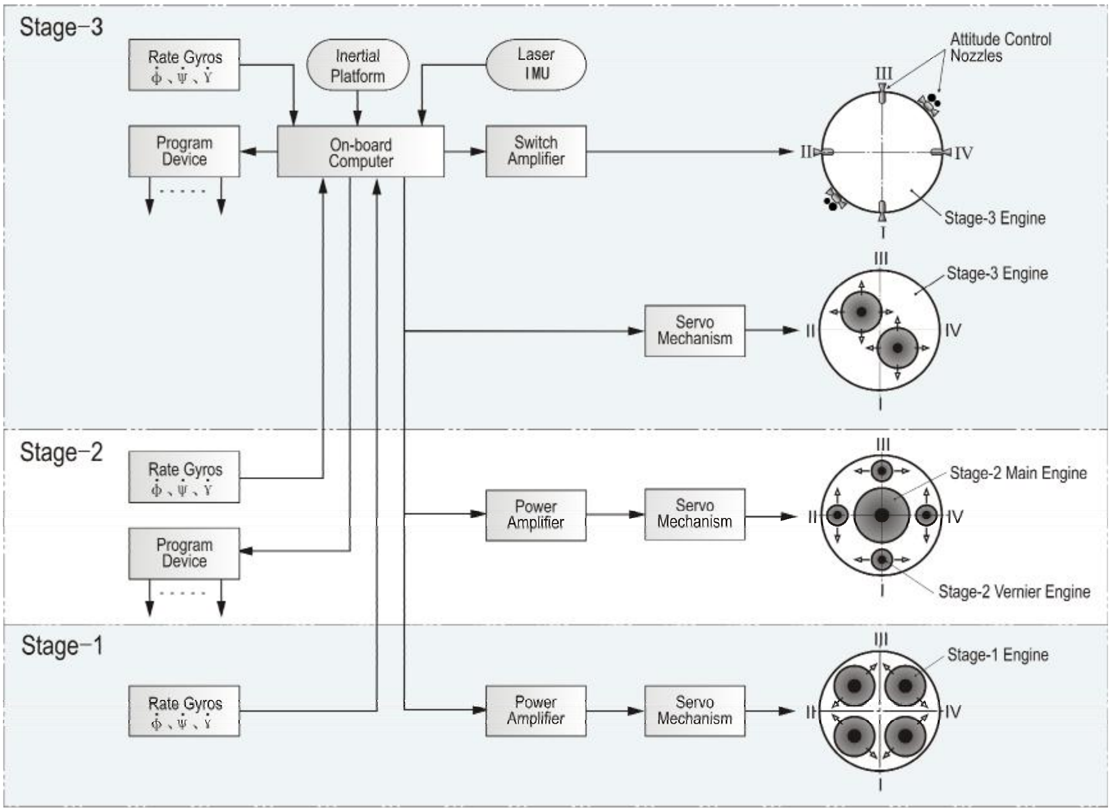


Figure 2-7a Schematic Diagram of LM-3A Guidance & Control System

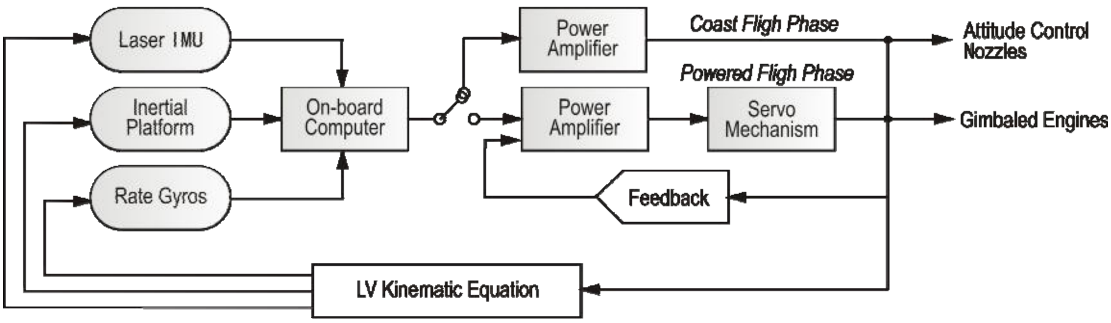


Figure 2-7b Schematic Diagram of LM-3A Attitude Control System

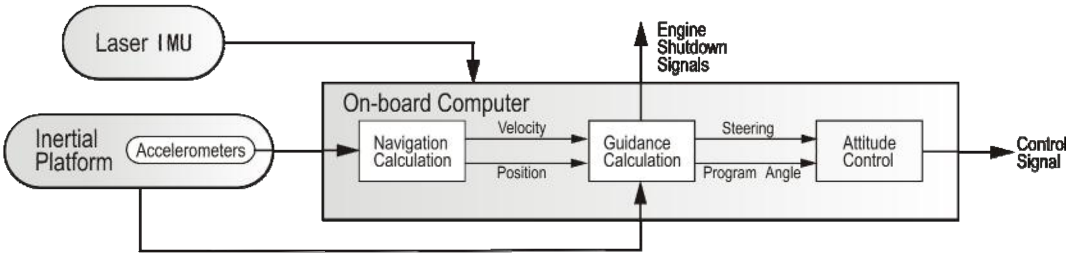


Figure 2-7c Schematic Diagram of LM-3A Guidance System

Measurement System

The measurement system includes the telemetry system and the tracking and range safety system.

(a) Telemetry System

The functions of telemetry system are to measure and transmit parameters of the launch vehicle in flight. Some measured data can be processed in real time. The data acquisition and encoding units in the telemetry system are powered in group based on sensors' location. The measurements of the command signals are digitized. The powering and check-up are performed automatically. The on-board digital converters are intelligent. Totally about 560 parameters are measured in flight. Refer to Figure 2-8 for the diagram of LM-3A Telemetry System.

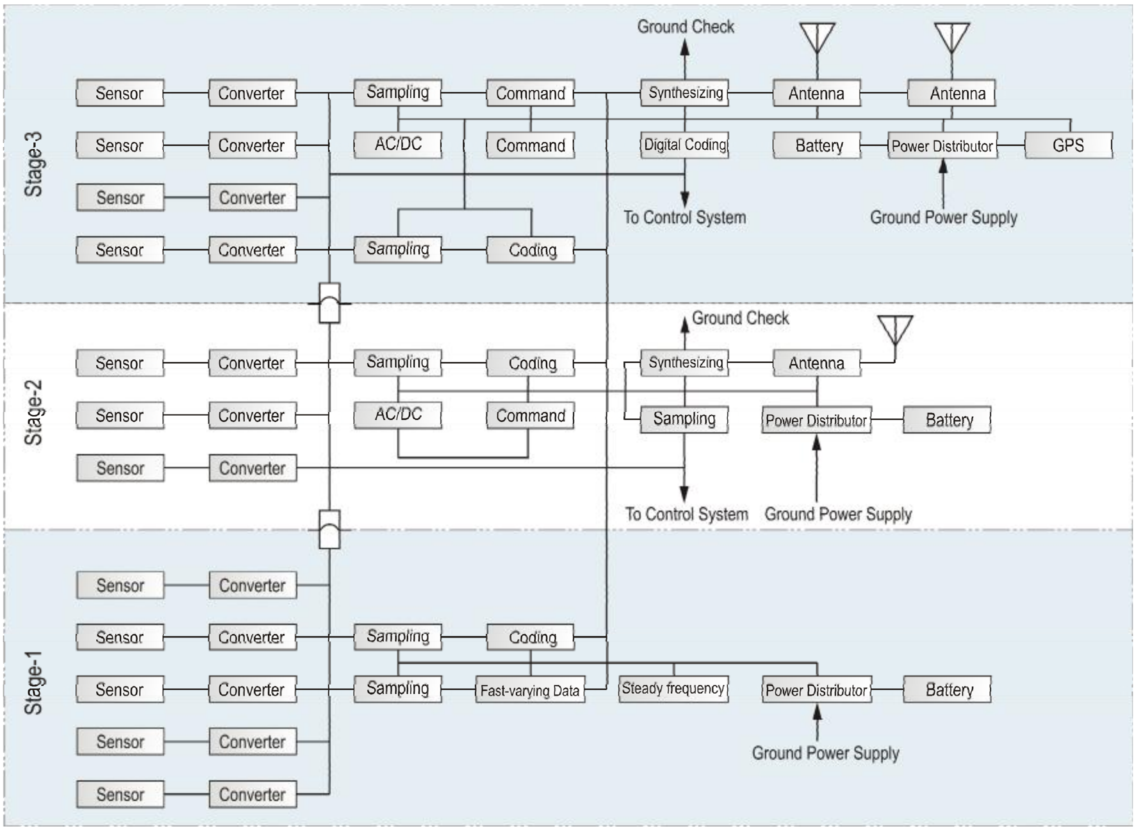


Figure 2-8 Schematic Diagram of LM-3A Telemetry System

(b) Tracking and Range Safety System

The tracking and range safety system is used to measure the trajectory data and final injection parameters, and provide safety assessment information. Self-destruction or destruction by remote control will be conducted if flight anomaly occurs. See Figure 2-9.

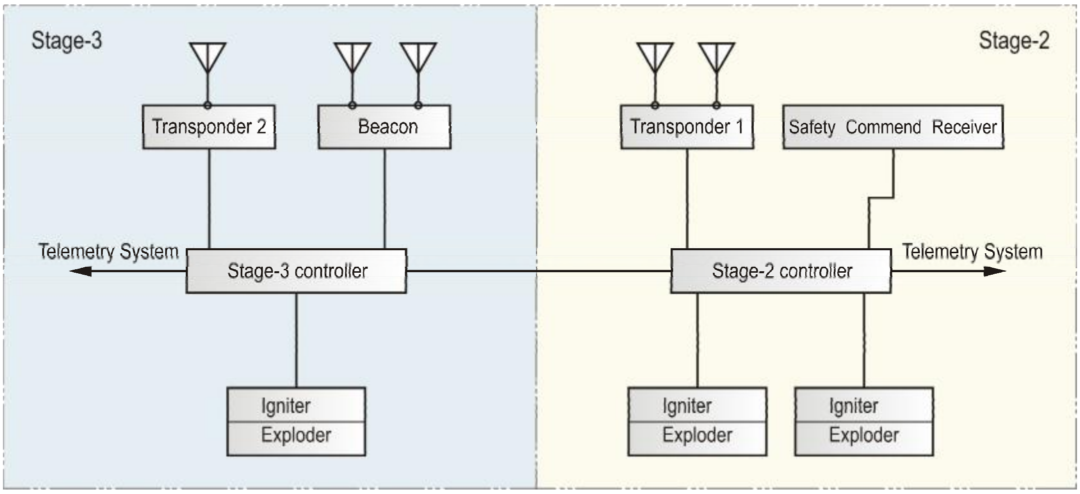


Figure 2-9 Schematic Diagram of LM-3A Tracking & Range Safety System

Propellant Management and Attitude Control System

This system is used for the attitude control and propellant management during the coast phase of the third stage, final velocity adjustment after engines shutdown and attitude reorientation prior to satellite separation. It adopts a set of reaction control thrusters fueled by pressure-fed hydrazine, which can be started for multiple times according to the command. See Figure 2-10 for the system diagram.

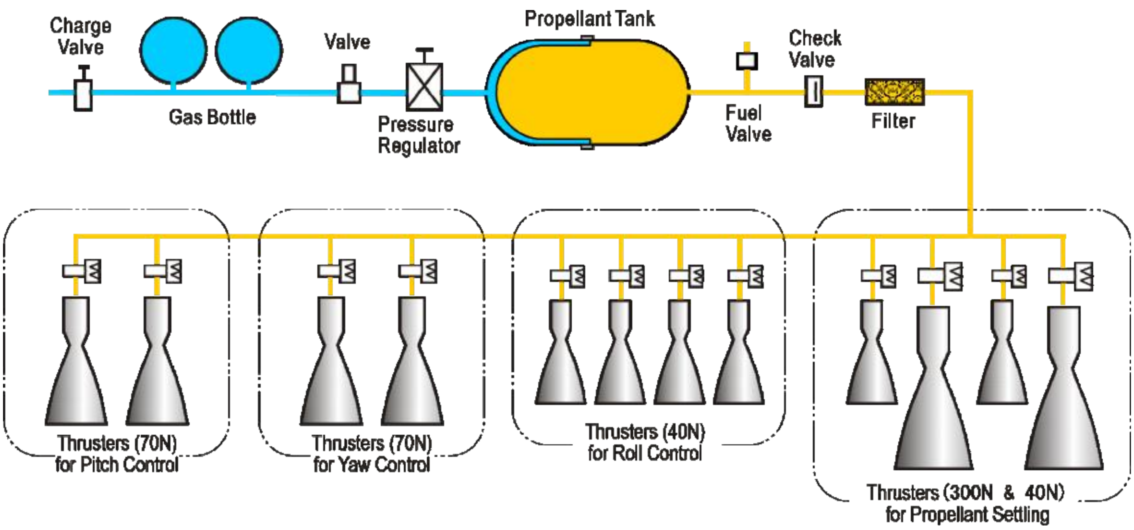


Figure 2-10 LM-3A Propellant Management & Attitude Control System

Propellant Utilization System

The propellant utilization system on third stage is to measure in real time the level of propellants inside the third stage tanks and to adjust the consuming rate of liquid oxygen (LOX) to achieve the residual propellants in an optimum proportion. The adjustment of propellant mixture ratio is used to compensate the deviation due to engine performance and propellant loading to enhance the launch capability. The system contains a processor, propellant level sensors and adjusting valves. Refer to Figure 2-11 for the system configuration.

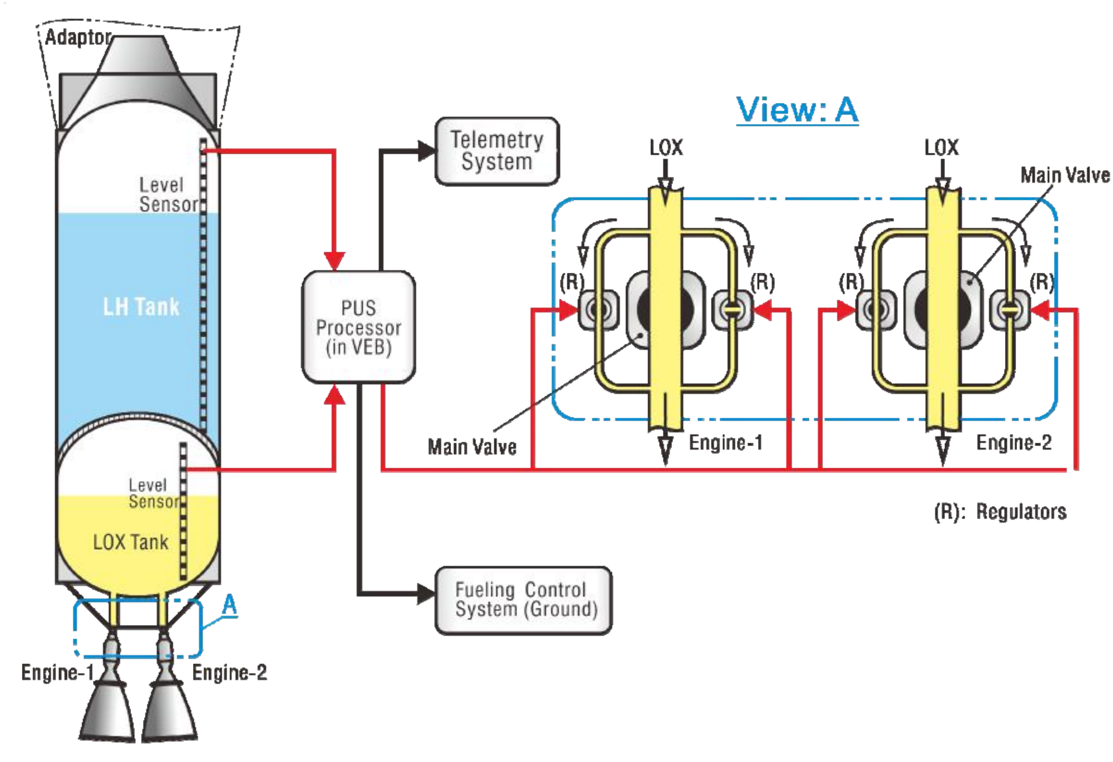


Figure 2-11 LM-3A Series Launch Vehicles Propellant Utilization System

Separation System

Separation system is to unlock the connecting mechanism and separate the connected sections. For LM-3A, four separations take place in sequence during the flight phase, i.e. first/second stage separation, fairing jettisoning, second/third stage separation and SC/LV separation as illustrated in Figure 2-12.

(a) First/Second Stage Separation

First/second stage separation employs "hot separation", which means the first stage is pushed away by the jet of the second stage engine after explosive bolts connecting the first stage and the second stage are unlocked.

(b) Fairing Jettisoning

During payload fairing separation, lateral explosive bolts are unlocked first and then followed by longitudinal explosive bolts, and finally the fairing turns outward around the hinges under the force of separation springs.

(c) Second/Third Stage Separation

The second/third stage separation is a "cold separation". The explosive bolts are unlocked first and then the retro-rockets on the second stage generate separation force and push the second stage away.

(d) SC/LV Separation

The SC is bound together with the LV through a clampband tightened by two explosive bolts. The clampband is released immediately after either one or both of the two explosive cutters are ignited. Then the separation springs provide separation force, pushing satellite and the third stage away from each other.

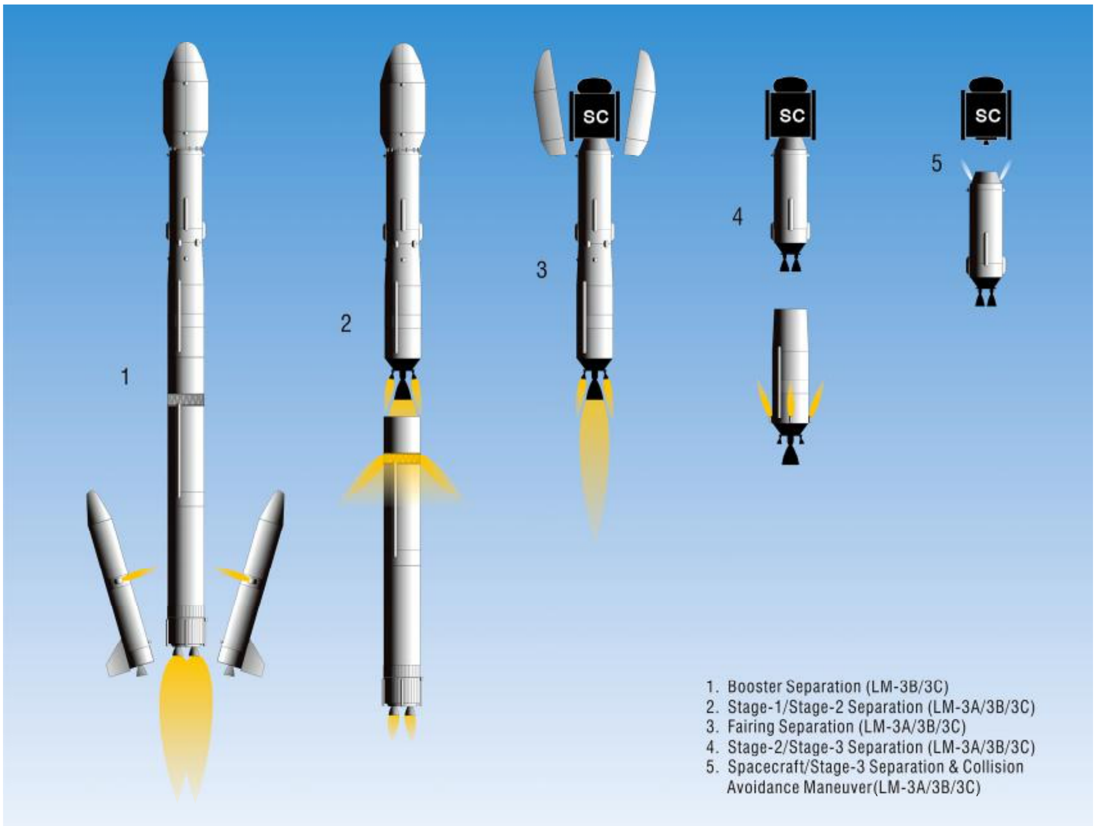


Figure 2-12 LM-3A/3B/3C Separation Events

Auxiliary System

In addition to the main subsystems as mentioned above, there are auxiliary systems to perform necessary functions before the launch vehicle lift-off, which includes measuring the propellant level and temperature, air-conditioning, water-proofing and dehumidifying for payload fairing.

2.3 LM-3B and LM-3BE Launch Vehicles

2.3.1 Technical Parameters

The total lift-off mass for the LM-3B and LM-3BE is 426 tons and 456 tons respectively. The total length is 54.838 m ~ 57.056 m depending on the type of payload fairing to be used and fairing encapsulation method selected.

Figure 2-13 LM-3B Launch Vehicle

There are four types of payload fairing available for launch services with the nominal diameter of 3.7 m (for dual launch), 4.0 m and 4.2 m respectively. The option selected is dependent on whether the fairing is encapsulated on the pad or in BS3 (SC Hazardous Operation Building). The two encapsulation ways are as follows:

Encapsulation-on-Pad

When the satellite is encapsulated on the pad, the satellite and fairing are transported to launch pad separately; then the fairing is encapsulated following the mate of satellite to the launch vehicle.

Encapsulation-in-BS3

When the satellite is encapsulated in BS3, the satellite is mated to the Payload Adapter (PLA) and encapsulated in the fairing in BS3. The encapsulated satellite is shipped to the launch pad in the fairing and the complete assembly is mated to the launch vehicle on the launch pad.

Technical Parameters of Booster:

	LM-3B	**LM-3BE**
Length	15.326 m	16.094 m
Diameter	2.25 m	2.25 m
Propellant	N_2O_4 / UDMH	N_2O_4 / UDMH
Mass of Propellant	37,700 kg	41,100 kg
Engine Designation	YF-25	YF-25
Ground Thrust	740.4 kN	740.4 kN
Ground Specific Impulse	2,556.2 N·s/kg	2,556.2 N·s/kg

Technical Parameter of First Stage:

	LM-3B	**LM-3BE**
Length	23.272 m	24.76 m
Diameter	3.35 m	3.35 m
Propellant	N_2O_4 / UDMH	N_2O_4 / UDMH
Mass of Propellant	171,800 kg	186,200 kg
Engine	YF-21C	YF-21C
Ground Thrust	2,961.6 kN	2,961.6 kN
Ground Specific Impulse	2,556.5 N·s/kg	2,556.5 N·s/kg

Technical Parameter of Second Stage:

Length	12.92 m
Diameter	3.35 m
Propellant	N_2O_4 / UDMH
Mass of Propellant	49,400 kg
Engine	YF-24E
Thrust (in vacuum)	Main Engine: 742 kN Vernier Engine: 47.1 kN
Specific Impulse (in vacuum)	Main Engine: 2,922.57 N·s/kg Vernier Engine: 2,910.5 N·s/kg

Technical Parameter of Third Stage

Length	12.375 m
Diameter	3.0 m
Propellant	LH_2 / LOX
Mass of Propellant	18,200 kg
Engine	YF-75
Thrust (in vacuum)	167.17 kN
Specific Impulse (in vacuum)	4,295 N·s/kg

2.3.2 LM-3B and LM-3BE Description

The LM-3B and LM-3BE launch vehicles are comprised of the vehicle structure, propulsion system, control system, measurement system (telemetry system and tracking & range safety system), propellant management and reaction control system, propellant utilization system, separation system and auxiliary system, etc.

Vehicle Structure

The vehicle structure consists of the core stage and boosters, with the core stage being similar to that of LM-3A but with an enhanced tank structure to meet the flight load requirements of LM-3B. The tanks of the second stage have been extended by a total of 1.65 m to allow more propellants to be loaded (See Figure 2-1).

The booster consists of nose, oxidizer tank, inter-tank section, fuel tank, rear transit section, tail section, fins, engine, valves and pipes, etc.

The third stage includes the Payload Adapter (PLA), vehicle equipment bay (VEB), cryogenic propellant tanks and engines. The PLA mates the satellite to LM-3B and bears the mechanical loads. The PLA can be one of the international standard interfaces designated as 937B, 1194 or 1194A. The satellite can be encapsulated on the pad or in BS3 (See Figure 2-14 and Figure 2-15).

The payload fairings consist of the dome, bi-conic section, cylindrical section, and reverse cone section and separation mechanisms. See Chapter 4 for details.

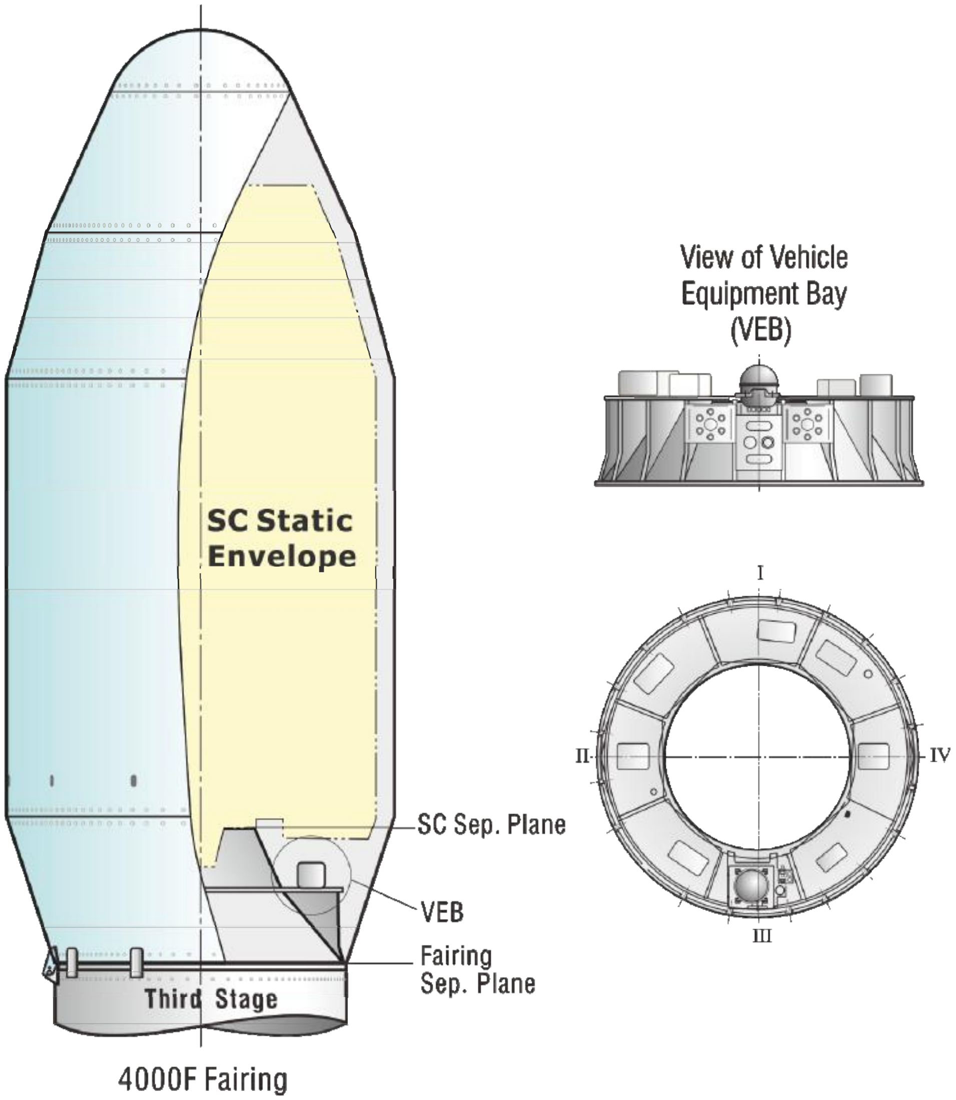


Figure 2-14 LM-3B & LM-3C Fairing for Encapsulation-on-Pad

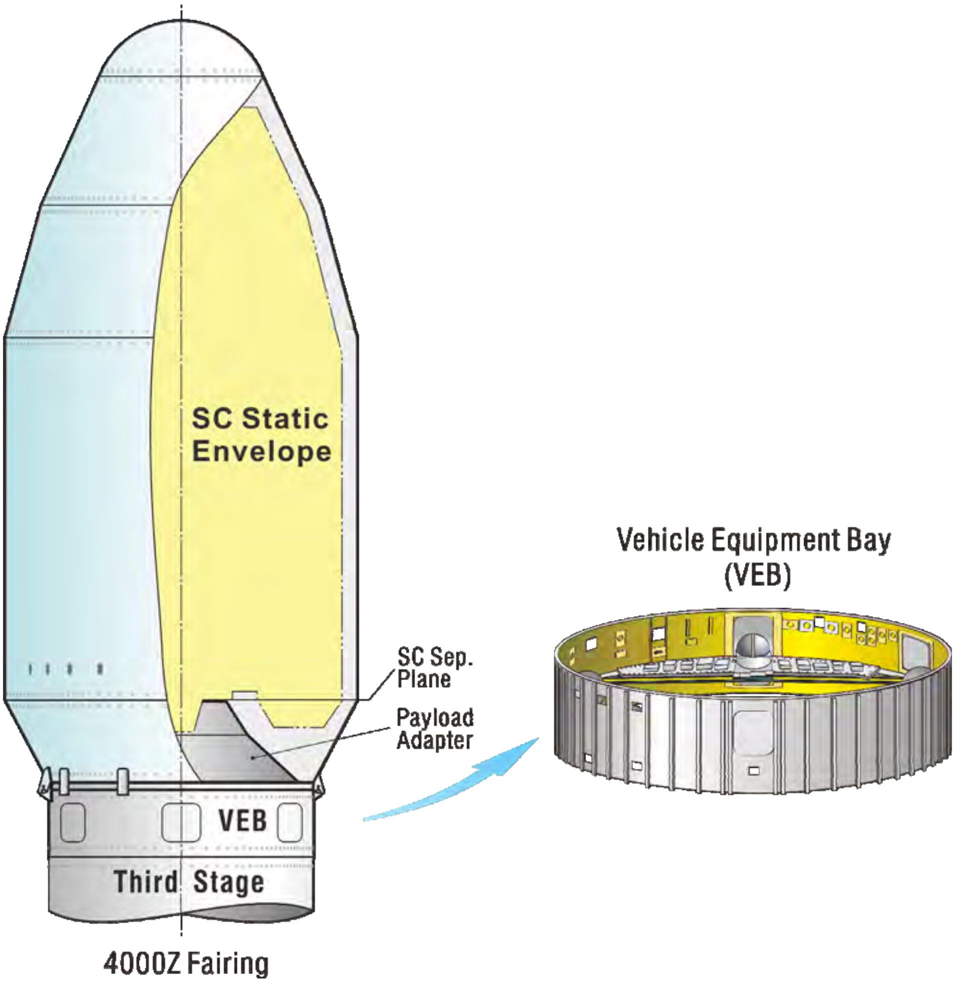


Figure 2-15 LM-3B & LM-3C Fairing for Encapsulation-in-BS3

Propulsion System

The propulsion system consists of the engines and pressurization system, and generates the flight thrust, which includes the dynamic control system and is identical to that of the LM-3A.

There are four strap-on boosters attached to the first stage, each equipped with a single engine that is identical to that of the core stage and each booster has an autogenous pressurization system.

Engine systems for the first stage, second stage and third stage are identical to those of LM-3A, with one main engine and four vernier engines on the second stage and two universal gimbaled cryogenic engines on the third stage. The schematic diagrams of the propulsion system are shown in Figure 2-6a, Figure 2-6b and Figure 2-6c.

Control System

The function and composition of the Control System is basically similar to that of the LM-3A, except that an additional control circuit has been added to control the engine ignition, shutdown and separation of the strap-on boosters. See Figure 2-7a, Figure 2-7b and Figure 2-7c.

Measurement System

(a) Telemetry System

The telemetry system is basically similar to that of LM-3A with telemetry circuit added to measure parameters of the boosters. There are altogether about 800 parameters measured in flight. See Figure 2-8.

(b) Tracking and Range Safety System

The Tracking and Range Safety System has the similar function and composition to that of LM-3A. See Figure 2-9.

Propellant Management and Attitude Control System during Coast Flight

There is a Propellant Management and Attitude Control System on the third stage. The system has the same function and composition with those of LM-3A. To meet the requirements of attitude control of LM-3B, two small reaction nozzles each with thrust of 40N are added for pitch and yaw. The thrust of propellant settling nozzle is increased from 40N in LM-3A to 45N in LM-3B /3C due to the mass increase during the coast flight phase of LM-3B/3C. See Figure 2-16.

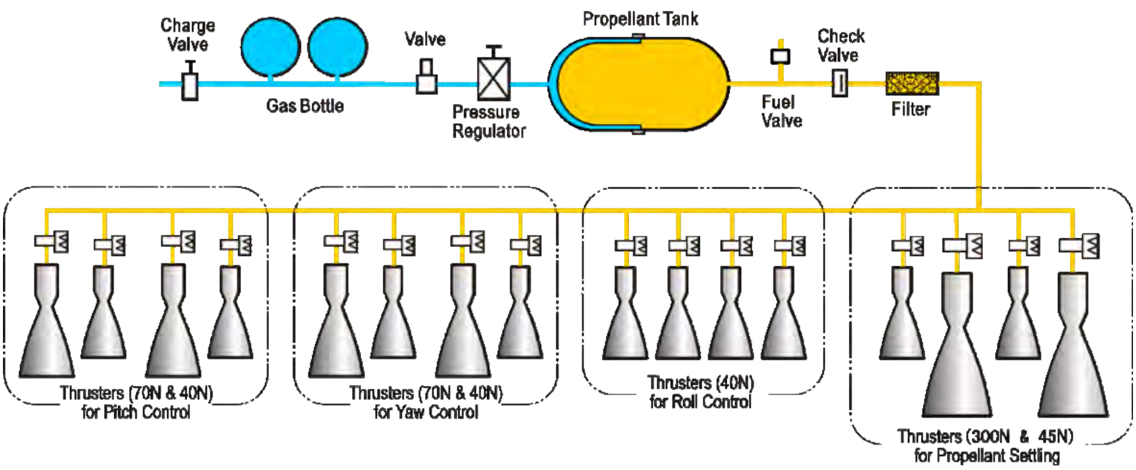


Figure 2-16　LM-3B/3BE/3C Propellant Management & Attitude Control System

Separation Systems

There are five separation actions during the flight of LM-3B: booster separation, first/second stage separation, fairing jettisoning, second/third stage separation and SC/LV separation as illustrated in Figure 2-12.

(a) Booster Separation.

The boosters are "thrown-away" upon separation. Before separation, boosters are mounted to the core stage through three pairs of explosive bolts at the front section and a separation nut at the rear section. Four small separation nozzles generate outward separation force to push the boosters away from the first stage following the simultaneous unlocking of the explosive bolts and the separation nut.

(b) First/Second Stage Separation

The same as that of LM-3A.

(c) Fairing Jettisoning

During the payload fairing separation, the lateral explosive bolts unlock first and then the longitudinal detonation cord and explosive bolts unlock. The fairing turns outward around the hinges under the force of separation springs.

(d) Second/Third Stage Separation

The same as that of LM-3A.

(e) Satellite Separation System

The same as that of LM-3A.

Propellant Utilization System and Auxiliary System

The propellant utilization system is identical to that of LM-3A. See Figure 2-11. The auxiliary system is same as that of LM-3A.

2.4 LM-3C Launch Vehicle

Total lift-off mass of the LM-3C (Figure 2-17) is approximately 345 tons and its overall length is 54.838 m with a fairing of 4 m in diameter (Encapsulation-on-Pad). The fairings available and their encapsulation methods are the same as that of LM-3B. See Section 2.3 covering the LM-3B for details.

The function and composition of the LM-3C launch vehicle is the same as the LM-3B with the exception that only two boosters are attached on the first stage.

Figure 2-17 LM-3C Launch Vehicle

2.5 Launch Vehicle Coordinate System

The origin (O) of coordinate (OXYZ) of the Launch Vehicle is located at the instantaneous mass center, i.e. the integrated mass center of SC/LV combination including the Payload Adapter (PLA), propellants and Payload Fairing (PLF), etc. The OX axis coincides with the longitudinal axis of the launch vehicle. The OY axis is perpendicular to the OX axis and falls in the plane of the launching direction. The OX, OY and OZ axes form a right-handed orthogonal system. The flight attitude of the launch vehicle axis is defined as shown in Figure 2-18. The satellite manufacturer will define the spacecraft coordinate system, and the relationship or clocking orientation between the launch vehicle and spacecraft coordinate systems will be determined through technical coordination meetings for the specific project.

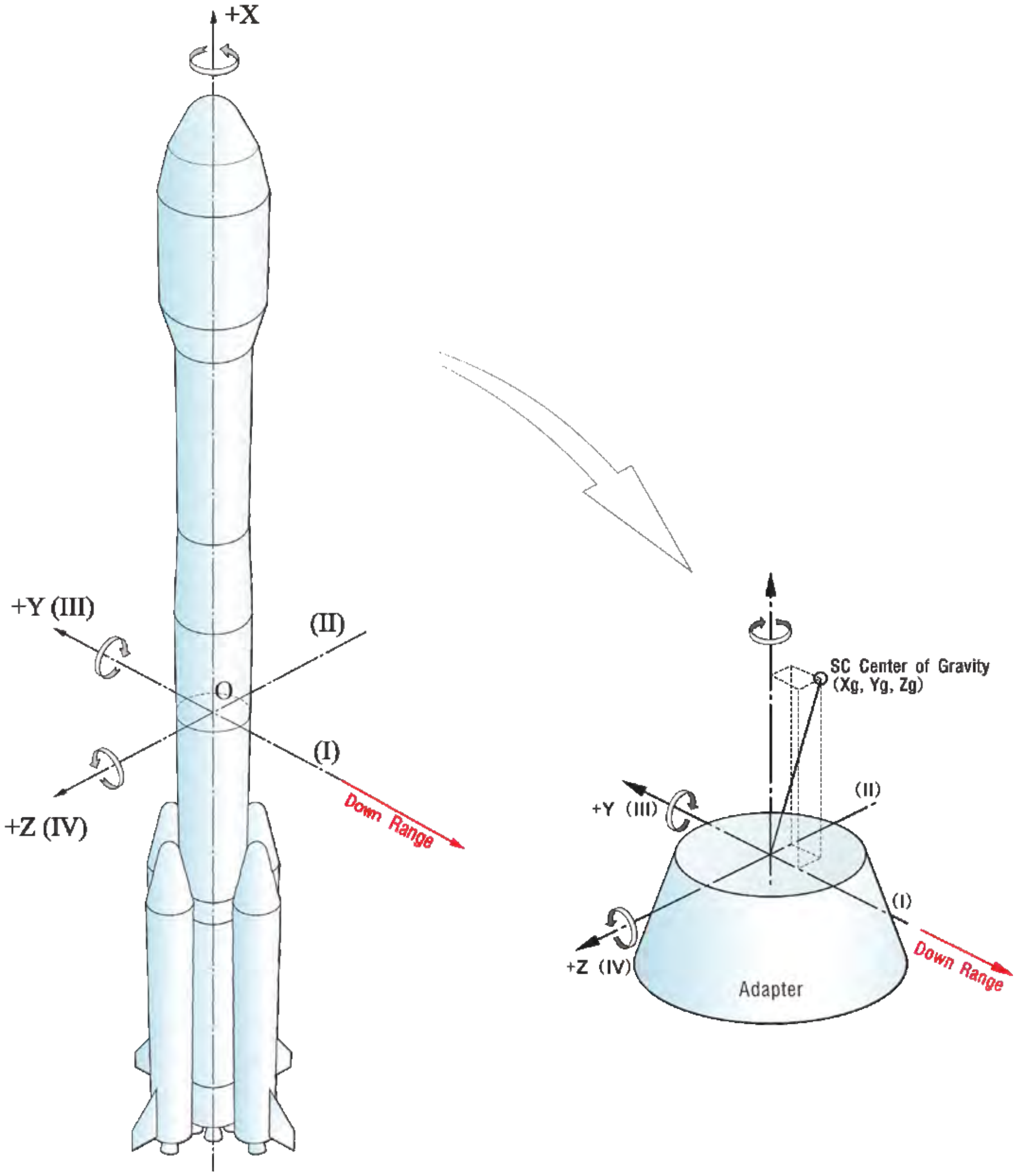


Figure 2-18 Coordinate System of LM-3A/3B/3BE/3C

2.6 Launch Missions of LM-3A Series Launch Vehicles

LM-3A Series launch vehicles are primarily used for GTO missions, although LEO and SSO missions can also be conducted if required by customers.

GTO Missions

The main mission for the LM-3A Series launch vehicles is to deliver the satellite into Geostationary Transfer orbit (GTO). The transfer of the satellite from GTO to the Geostationary Earth Orbit (GEO) will be conducted by the engine carried on the satellite. GTO refers to an elliptical orbit with an apogee altitude equal or even higher than the altitude of GEO. GEO is the satellite working orbit, on which the SC has the same orbital period as the rotation period of the Earth, with orbit plane coinciding with the equatorial plane of the Earth. Typical GTO mission profiles for the LM-3B/3BE and LM-3C launch vehicles are shown in Figure 2-19.

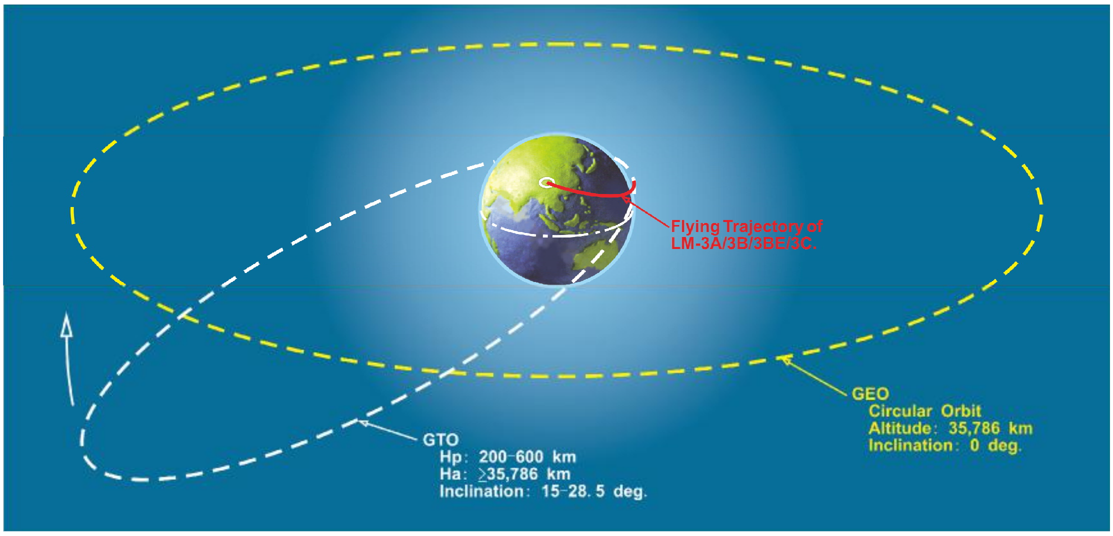


Figure 2-19 Schematic Drawing of GTO and GEO

LEO Missions

The LM-3A Series launch vehicles can also be used to inject satellite into low earth orbit (LEO), which refers to orbits with average altitude lower than 2,000km.

The LM-3A Series launch vehicles can also be used to inject satellite into sun synchronous orbit (SSO). SSO refers to an orbit that maintains a fixed angle with respect to the earth – sun direction. That is, the orbital plane has a fixed orientation with respect to the earth – sun direction and the angle between the orbital plane and the earth – sun direction is constant.

Deep Space Missions

The LM-3A Series launch vehicles can also be used to launch space probes into escape orbit beyond the earth gravitational field, for example for mission to the Moon and Mars.

2.7 Satellites Launched

LM-3A Series launch vehicles have conducted a total of 38 launches as of January 1, 2011. See Table 2-1 for details.

Table 2-1 SC launched by LM-3A Series LV (As of January 1, 2011)

LV		SC Manufacture	SC Name	Launch Date	Designed Orbit			SC Mass (Kg)
					i (deg)	Hp (km)	Ha (km)	
LM-3A	F01	CAST/CALT	SJ-4/KF-1	1994.02.08	28.5	200	36,311	396/1,342
	F02	CAST	ChinaSat-5	1994.11.30	28.5	200	36,185	2,232
	F03	CAST	ChinaSat-6	1997.05.12	28.5	200	36,065	2,267
	F04	CAST	ChinaSat-22	2000.01.26	25.0	200	41,991	2,320
	F05	CAST	BD-1A	2000.10.31	25.0	200	41,991	2,315
	F06	CAST	BD-1B	2000.12.21	25.0	200	41,991	2,311
	F07	CAST	BD-1C	2003.05.25	25.0	200	41,991	2,325
	F08	CAST	ChinaSat-20	2003.11.15	25.0	200	41,991	2,307
	F09	SAST	FY-2C	2004.10.19	27.1	280	36,056	1,400
	F10	CAST	ChinaSat-22A	2006.09.13	25.0	200	41,991	2,330
	F11	SAST	FY-2D	2006.12.08	24.9	200	36,407	1,390
	F12	CAST	BD-1D	2007.02.03	25.0	200	41,991	2,299
	F13	CAST	Compass-01	2007.04.14	55.0	200	21,650	2,320
	F14	CAST	SinoSat-3	2007.06.01	25.0	200	41,991	2,320
	F15	CAST	CE-1	2007.10.24	31.0	200	51,000	2,352
	F16	SAST	FY-2E	2008.12.23	24.1	200	35,700	1,390
	F17	CAST	Compass-05	2010.08.01	55.0	200	35,991	2,300
	F18	CAST	ChinaSat-20A	2010.11.25	25.0	200	41,991	2,325
	F19	CAST	Compass-07	2010.12.18	55.0	200	35,991	2,300
LM-3B / LM-3BE (marked with *)	F01	SS/Loral	Intelsat-708	1996.02.15	24.5	200	35,786	4,594
	F02	SS/Loral	MABUHAY	1997.08.20	24.5	200	47,924	3,775
	F03	SS/Loral	APSTAR-2R	1997.10.17	24.5	200	47,924	3,746
	F04	Lockheed Martin	ChinaStar-1	1998.05.30	24.5	200	85,000	2,917
	F05	Aerospatial	SinoSat-1	1998.07.18	19.0	600	35,786	2,832
	F06	Alcatel Space	APSTAR-VI	2005.04.12	26.0	200	50,000	4,576
	F07	CAST	SinoSat-2	2006.10.29	28.5	200	35,786	5,107
	F08*	CAST	NigComSat-1	2007.05.14	25.2	200	41,991	5,086
	F09	TAS	ChinaSat-6B	2007.07.05	24.3	200	50,289	4,516
	F10	TAS	ChinaSat-9	2008.06.09	24.2	200	50,289	4,466
	F11*	CAST	VeneSat-1	2008.10.30	24.8	200	41,991	5,050
	F12	TAS	Palapa-D	2009.08.31	21.2	200	50,291	4,100
	F13*	CAST	SinoSat-6	2010.09.06	25.2	200	41,991	5,100
LM-3C	F01	CAST	TL-1	2008.04.25	18.0	200	41,991	2,475
	F02	CAST	Compass-02	2009.04.15	20.5	200	35,974	3,060
	F03	CAST	Compass-03	2010.01.17	20.5	200	35,974	3,060
	F04	CAST	Compass-04	2010.06.02	20.5	200	35,974	3,060
	F05	CAST	CE-2	2010.10.01	28.5	200	364,160	2,480
	F06	CAST	Compass-06	2010.11.01	20.5	200	35,974	3,060

2.8 Future Enhancements for LM-3A Series Launch Vehicles

The following enhancements are being planned for the LM-3A Series launch vehicles:

a) To further improve the reliability and robustness of LM-3A Series launch vehicles.

b) To study the feasibility to improve the launch capability of LM-3B to 6 tons for the standard GTO mission.

c) To introduce a newly developed upper stage, so that payloads can be launched into 10,000~20,000 km circular orbit or directly injected into GEO. The new upper stage has the capability to readjust attitude and reorient so that multiple satellites can be launched with one launch vehicle. Launch vehicles for deep space exploration will be developed on the basis of LM-3A Series launch vehicles, which are the basic carriers for space exploration flight in China to send the payloads into transfer orbit to the Moon or Mars.

d) Please refer to our web site for announcements and updates.

CHAPTER 3

LAUNCH PERFORMANCE AND INJECTION ACCURACY

3.1 Summary

The LM-3A Series launch vehicles' performance data given in this Chapter are based on the following conditions:

a) The launch is from XSLC, with initial launch azimuth 97.5 deg for the LM-3B, LM-3BE and LM-3C, 104 deg for the LM-3A.

b) In the process of launch orbit design the following requirements have been taken into consideration: limitations of the impact area, range safety and flight tracking.

c) The mass of the Payload Adapter (PLA) is included in the third stage. So the launch capability refers to the mass above the SC/LV interface.

d) The third stage of LM-3A Series launch vehicles is loaded with sufficient propellant to reach the predetermined orbit with a probability of no less than 99.73%.

e) At fairing jettisoning, the aerodynamic flux by free molecular is no greater than 1,135 W/m^2.

f) Radius of the earth equator is 6,378.14 km.

3.2 Standard Mission Profile

3.2.1 Coordinates of Launch Pads

The LM-3A Series launch vehicles are launched from Launch Complex No.2 (LC-2) (for LM-3B, LM-3BE and LM-3C) and Launch Complex No.3 (LC-3) (for LM-3A) of Xichang Satellite Launch Center (XSLC), the geographic coordinates of LC-2 are as follows:

Latitude	28.25 deg N
Longitude	102.025 deg E
Elevation	1,825 m

The geographic coordinates of the LC-3 are as follows:

Latitude	28.25 deg N
Longitude	102.029 deg E
Elevation	1,825 m

The launch coordinate system for LM-3A, LM-3B, LM-3BE and LM-3C is illustrated in Figure 3-1, Figure 3-2 and Figure 3-3.

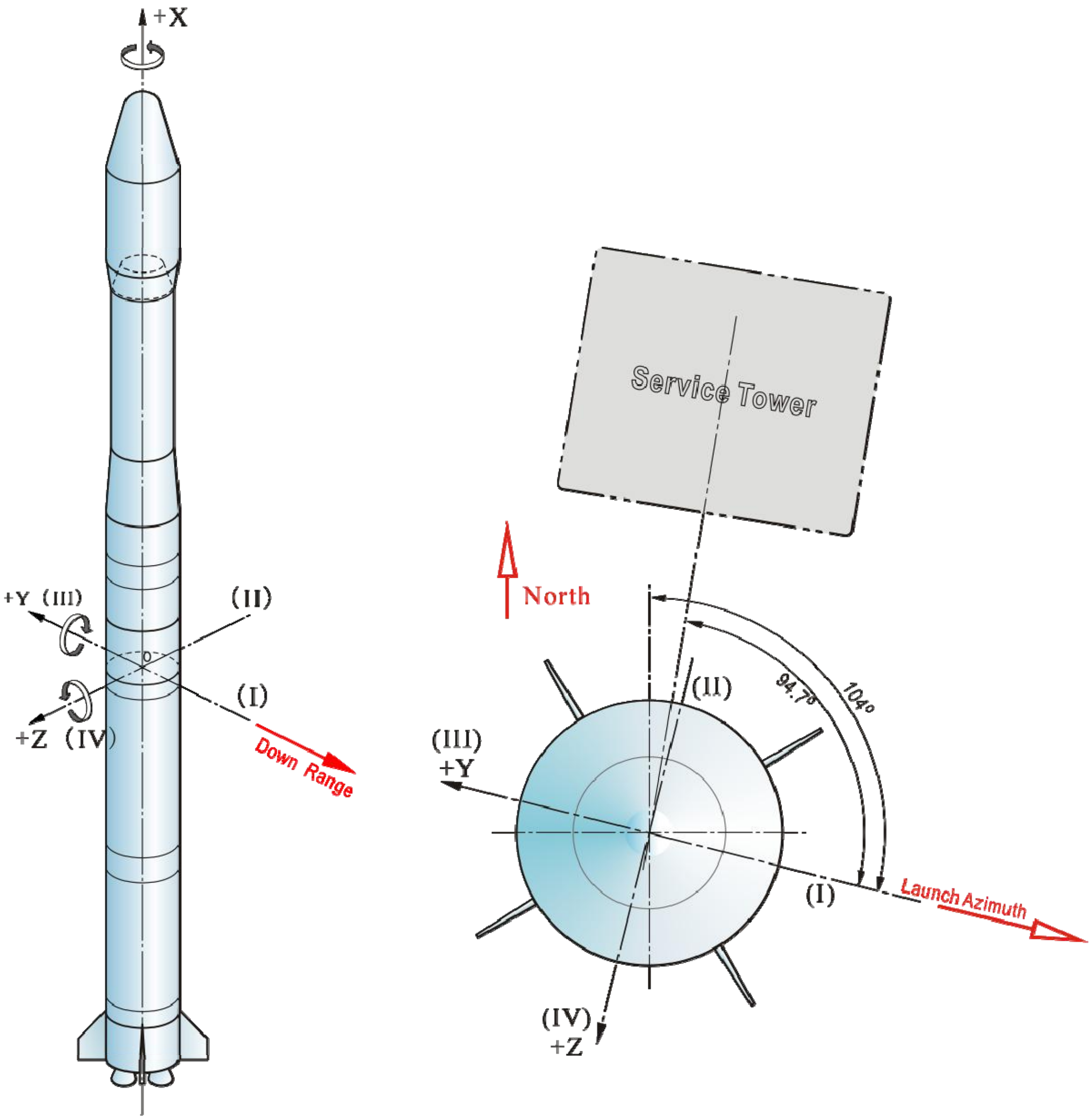


Figure 3-1 Launch Azimuth of LM-3A

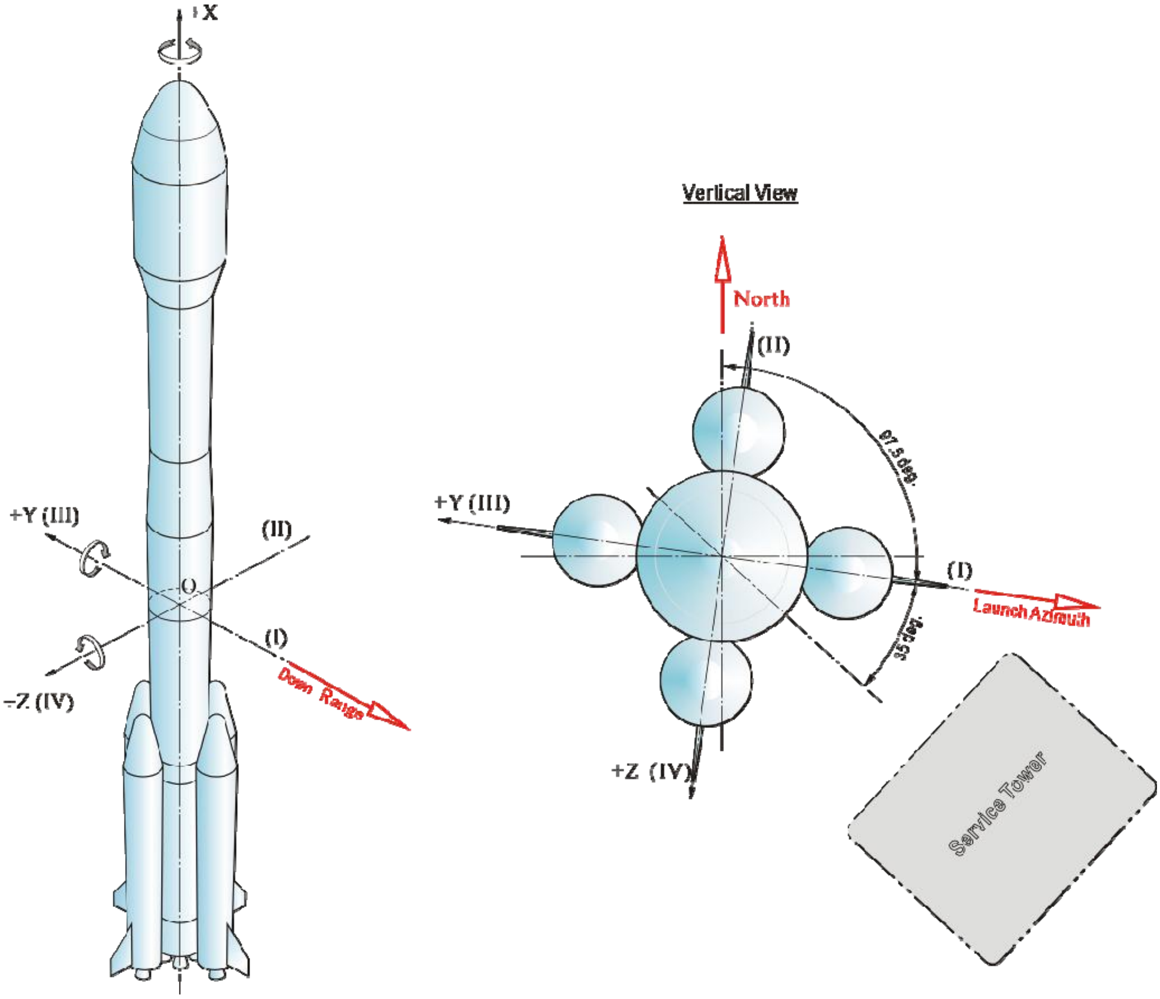


Figure 3-2　Launch Azimuth of LM-3B and LM-3BE

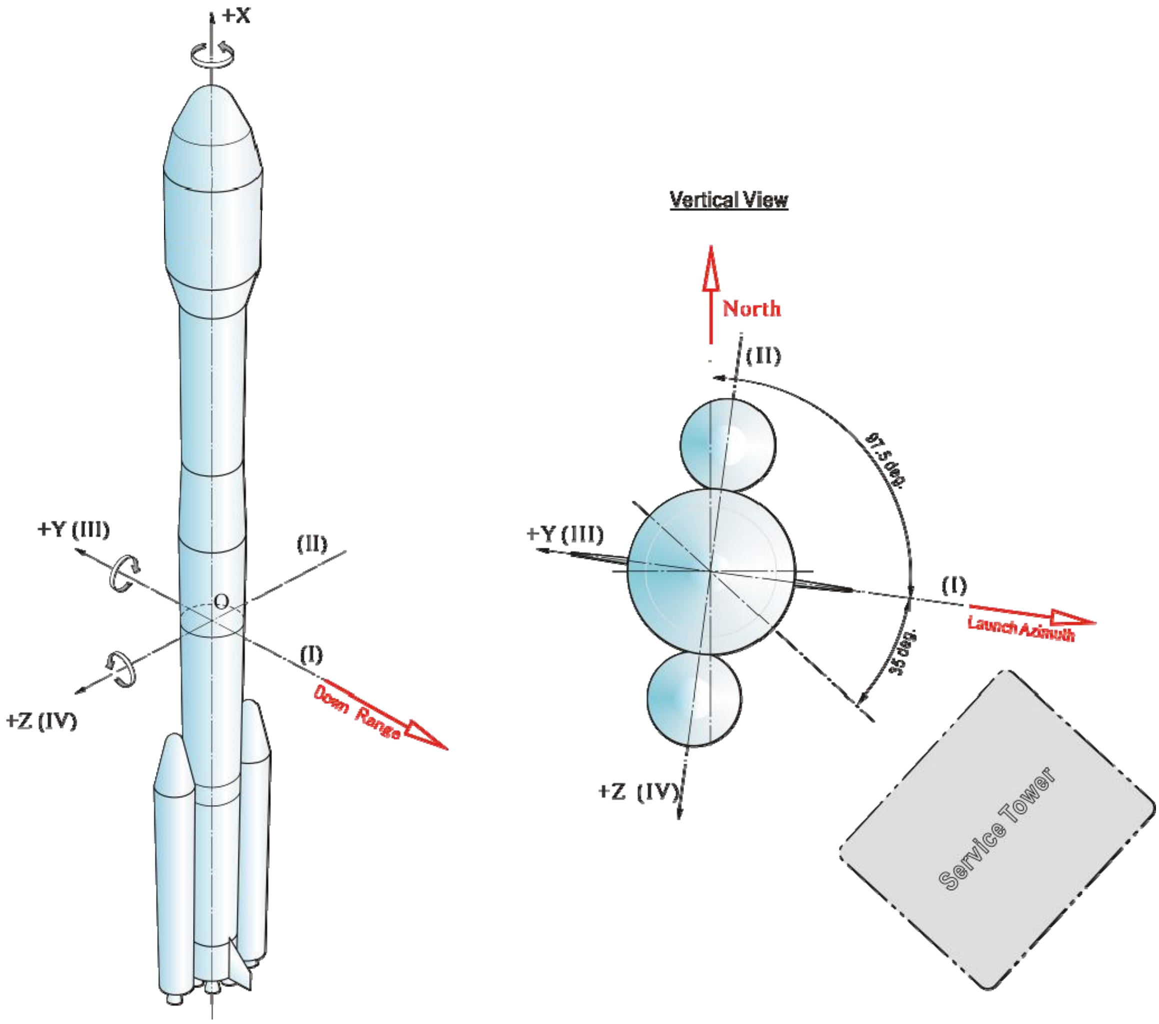


Figure 3-3 Launch Azimuth of LM-3C

3.2.2 Geostationary Transfer Orbit Missions and Other Orbit Missions

The delivery of a satellite to GTO is the prime mission for LM-3A Series launch vehicles. The mission can be an injection to a standard GTO or a GTO tailored to the customer requirements. The standard GTO is the baseline mission with following injection parameters from XSLC.

Perigee Altitude	Hp	200 km
Apogee Altitude	Ha	35,958* km
Inclination	i	28.5 Deg
Perigee Argument	ω	179.6 Deg

Note: * The parameters in the table represent the SC's immediate orbit upon separation, where Ha corresponds to the altitude of 35,786km when the SC arrives at its first apogee after a period of unpowered flight, taking into account the perturbation caused by the earth's oblateness.

LM-3A Series launch vehicles can inject the satellite into a Super Geostationary Transfer Orbit (SGTO). It results in a smaller delta velocity required for satellite to reach the final orbit location consuming less propellant, which will increase the satellite in-orbit life.

The LM-3A Series launch vehicles can be also used for special missions tailored to the customers' specific requirements, which include SSO missions, LEO missions, MEO missions and deep space exploration missions. In addition, dual-launch and multiple-launch missions can also be performed with the LM-3A Series launch vehicles.

3.2.3 GTO Mission Injection Optimization

The third stage of LM-3A Series launch vehicle operates in either of the following two shutdown modes, Command Shutdown (CS) and Minimum Residual Shutdown (MRS).

The Command Shutdown (CS) means that the third stage of LM-3A Series launch vehicle carries sufficient propellant allowing the satellite to enter the predetermined orbit with probability no less than 99.73%, which is the standard mission profile for the LM-3A Series launch vehicles.

The Minimum Residual Shutdown (MRS) means that the propellants in the third stage are burned to minimum acceptable residual level, which allows a significant increase in the nominal performance with a decrease in injection accuracy. The third stage of LM-3A Series launch vehicle has a Propellant Utilization System (PUS), which can adjust the mixture ratio to optimize the consumption of propellant and assure the reliability under Minimum Residual Shutdown (MRS).

The launch capability defined in this User's Manual are based on the Command Shutdown (CS) mechanism unless stated otherwise.

3.2.4 Minimum Residual Shutdown (MRS) Missions

The MRS mission will provide a higher apogee for the satellite transfer orbit upon separation from launch vehicle, resulting in a reduction of the propellant used during the Launch and Early Orbit Phase (LEOP), which increases the satellite operational life. The MRS mission allows heavier payloads to be launched and the mission is therefore optimized to maximize the satellite life, but with a relative reduction in injection accuracy.

Customers can opt for a trade-off between satellite mass, injection altitude and injection accuracy with the MRS offering the biggest lift-off mass. The relationship between CS probability up to MRS and the corresponding gains of launch capability are shown in Table

3-1.

Table 3-1 Launch Capability vs. Command Shutdown Probability

Command Shutdown Probability	Gains of Launch Capability (kg)
99.7%	0
95.5%	33
68.3%	67
50.0%	78

3.2.5 Orbit Injection Accuracy

The orbit injection accuracy and covariance matrix for standard GTO mission is shown in Table 3-2a and Table 3-2b.

Table 3-2a Injection Accuracy for Standard GTO Mission (1σ)

Symbol	Parameters	Deviation
a	Semi-major Axis	40 km
i	Inclination	0.07°
ω	Perigee Argument	0.20°
Ω	Right Ascension of Ascending Node	-0.20° *
Hp	Perigee Altitude	10 km

Note: * the error of launch time is not considered in determining $\Delta\Omega$

Table 3-2b Covariance Matrix of Injection for Standard GTO Mission

	a Semi-major axis	e Eccentricity	i Inclination	ω Argument of perigee	Ω Right Ascension of Ascending node
a	1524	0.02492	0.5266	3.2344	-0.09688
e		0.52706E-6	0.8615E-5	0.6146E-4	0.5314E-8
i			0.4752E-2	0.1237E-3	-0.4212E-2
ω				0.03897	-0.01780
Ω					0.03927

3.2.6 Pointing Accuracy

The attitude control system on the third stage initiates a reorientation maneuver for the SC/LV combination to the required orientation from 20 seconds after the final third stage shutdown to separation. It takes 80 seconds to complete the reorientation maneuver. The attitude accuracy following the maneuver up to separation of the satellite is less than 2 deg.

The pointing requirements are defined by the customer with reference to the perigee coordinates system (OUVW).

The perigee coordinate system (OUVW) is defined as follows:

OU is a radial vector with the origin at the earth center, pointing to the intended perigee.

OV is perpendicular to OU in the intended orbit plane and points to the intended direction of the perigee velocity.

OW is perpendicular to OV and OU, and OUVW forms a right-handed orthogonal coordinate system.

The coordinate system is shown in Figure 3-4.

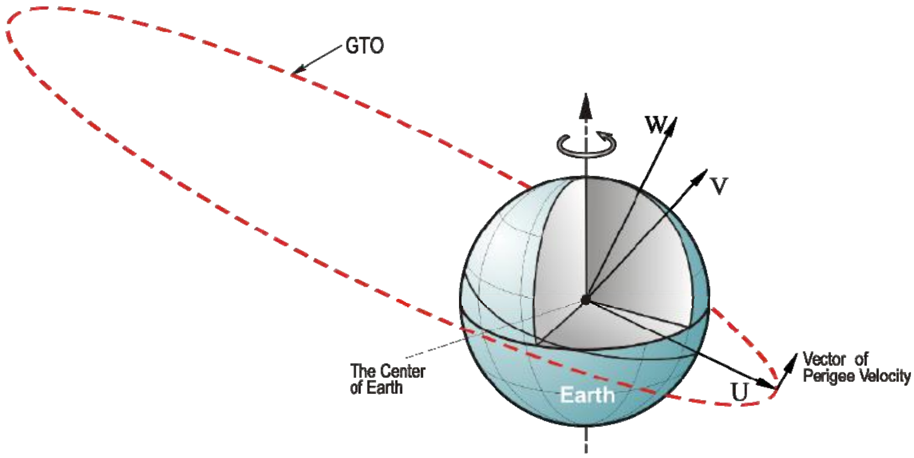


Figure 3-4 Perigee Coordinate Systems

3.2.7 Separation and Spin-up Accuracy

For missions where the satellite does not require spin-up before separation, the post-separation pointing parameters are as follows: if the lateral angular rate ω <1 deg/s the instant deviation of geometry axis is δX<3 deg.

For missions where the satellite requires a spin rate between 5 rpm to 10 rpm along the launch vehicle X axis after separation, the post-separation pointing parameters are as follows: the deviation of longitudinal angular rate is ±0.6 rpm, and if the lateral angular rate ω<2.5 deg/s, the deviation of angular momentum pointing direction is δH<8 deg.

For missions where the satellite needs a spin rate below 3 deg/s around the satellite lateral axes after separation, the post-separation pointing parameters are as follows: if the lateral angular rate ω<0.7 deg/s, the deviation of angular momentum pointing direction δH<15 deg.

The parameters for separation are shown in Figure 3-5.

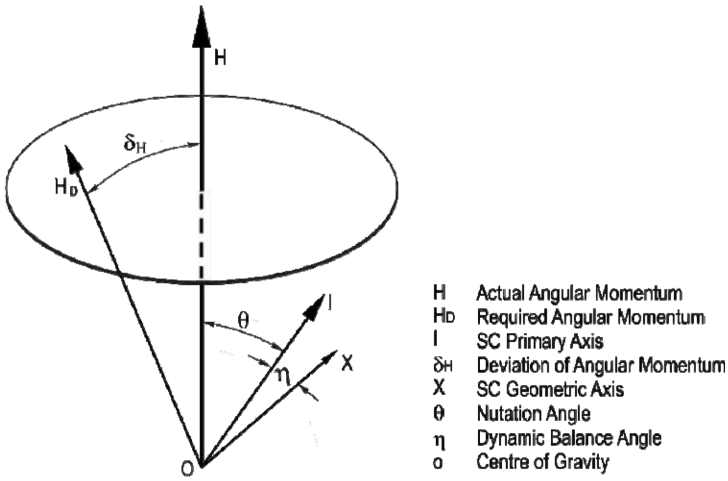


Figure 3-5 Definition of Separation Accuracy

3.2.8 Launch Windows

3.2.8.1 Definitions

The following definitions apply to the launch windows for each of the LM-3A Series launch vehicles.

Launch Period

The Launch Period is a period of three consecutive calendar months during which the customer wants to launch their satellite and there is a launch opportunity on each day of the period.

Launch Slot

The Launch Slot has a duration of one calendar month that falls within the Launch Period.

Launch Day

The Launch Day is the calendar day within the Launch Slot on which the launch is scheduled to take place.

Launch Window

The launch window is the period during which the launch can take place and is based on the injection parameters. A launch window of at least 45 minutes duration is required on every calendar day of the launch period.

3.2.8.2 GTO Launch Window Requirements

The launch window is required to be a minimum of 45 minutes on each calendar day of the launch period. If a 45 minutes launch window is not available during a period, the customer will be required to review the potential options with CALT.

3.2.9 Separation Attitude

The attitude at separation should be stipulated in the Interface Control Document.

3.2.10 Separation Velocity

The separation system is designed to provide a relative separation velocity between the spacecraft and launch vehicle upon separation. Typically, the minimum relative separation velocity provided is 0.5 m/s.

3.2.11 Collision Avoidance Maneuver

The mission analysis will verify that the relative separation velocity is sufficient to prevent re-contact between the third stage and the spacecraft. In addition, the third stage will activate a collision avoidance maneuver to ensure that no re-contact can occur. Two seconds after separation, the third stage helium thrusters will automatically initiate a reverse thrust maneuver to slow down the launch vehicle and ensure an adequate separation distance to the spacecraft.

3.3 LM-3A Launch Vehicle

3.3.1 Typical Orbit Parameters

3.3.1.1 Flight Sequence and Events

The typical flight sequence for the LM-3A launch vehicle in a standard GTO mission is shown in Table 3-3 and Figure 3-6. The characteristic parameters of the typical trajectory are shown in Table 3-4.

Table 3-3 LM-3A Typical Flight Sequence

Events	Time (s)
Liftoff	0.0
Pitch Over	12.0
Stage-1 Shutdown	146.4
Stage-1/Stage-2 Separation	147.9
Fairing Jettisoning	236.9
Stage-2 Main Engine Shutdown	258.3
Stage-2 Vernier Engine Shutdown	263.3
Stage-2/Stage-3 Separation/Stage-3 First Start	264.3
Stage-3 First Shutdown	617.3
Coast Flight Phase Beginning	620.8
Coast Phase Ending/Stage-3 Second Start	1252.5
Stage-3 Second Shutdown/Velocity Adjustment Beginning	1374.4
Velocity Adjustment Ending	1394.4
SC/LV Separation	1474.4

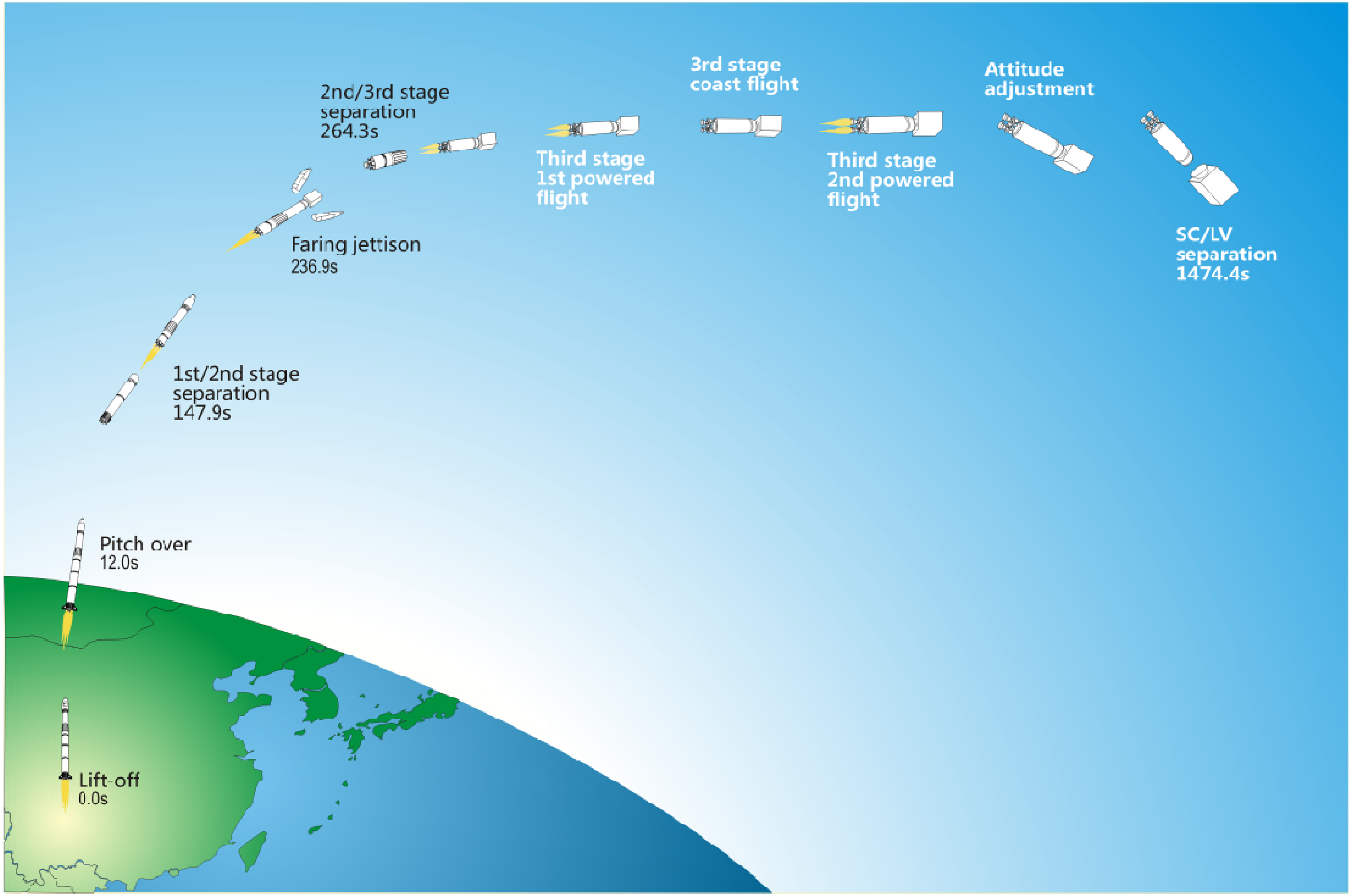


Figure 3-6 LM-3A Flight Profile

Table 3-4 Characteristic Parameters of Typical Trajectory

Events	Flight Altitude (km)	Ground Range (km)	Projection Latitude (deg)	Projection Longitude (deg)
Liftoff	1.8	0.0	28.2	102.0
Stage-1 Shutdown	55.6	79.1	27.9	102.8
S-1/S-2 Separation	56.8	82.3	27.9	102.8
Fairing Jettisoning	119.0	324.9	27.3	105.2
S-2 Main Engine Shutdown	134.1	403.3	27.1	106.0
S-2 Vernier Engine Shutdown	137.8	423.0	27.1	106.2
S-2/S-3 Separation	138.6	427.0	27.1	106.2
Stage-3 First Shutdown	195.3	2291.5	21.4	123.5
Coast Phase Beginning	195.2	2316.6	21.3	123.8
Stage-3 Second Start	194.9	6853.7	2.1	160.8
Stage-3 Second Shutdown	212.9	7855.1	-2.4	168.5
Velocity Adjust. Ending	222.7	8044.3	-3.3	170.0
SC/LV Separation	288.0	8793.0	-6.6	175.9

3.3.1.2 Main Parameters Curves of Typical Orbit

The flight acceleration, velocity, Mach numbers and altitude vs. time are shown in Figure 3-7a and Figure 3-7b.

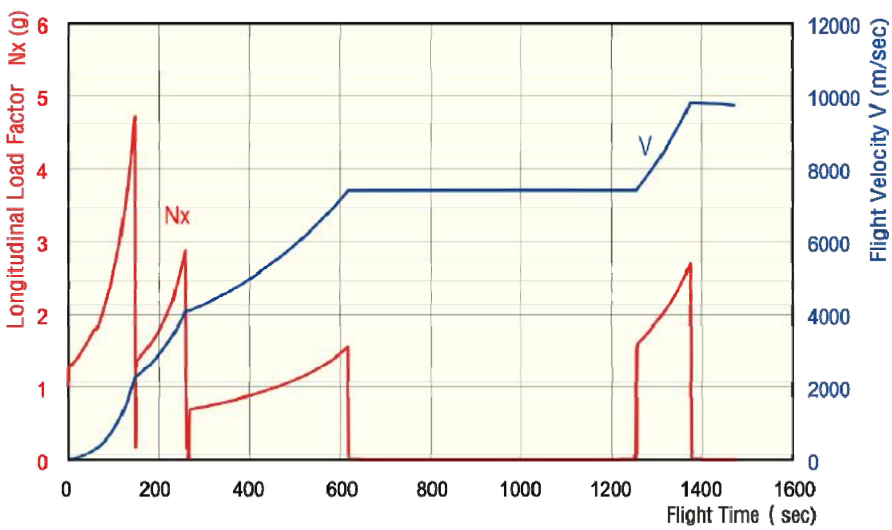


Figure 3-7a LM-3A Load Factor & Velocity vs. Flight Time

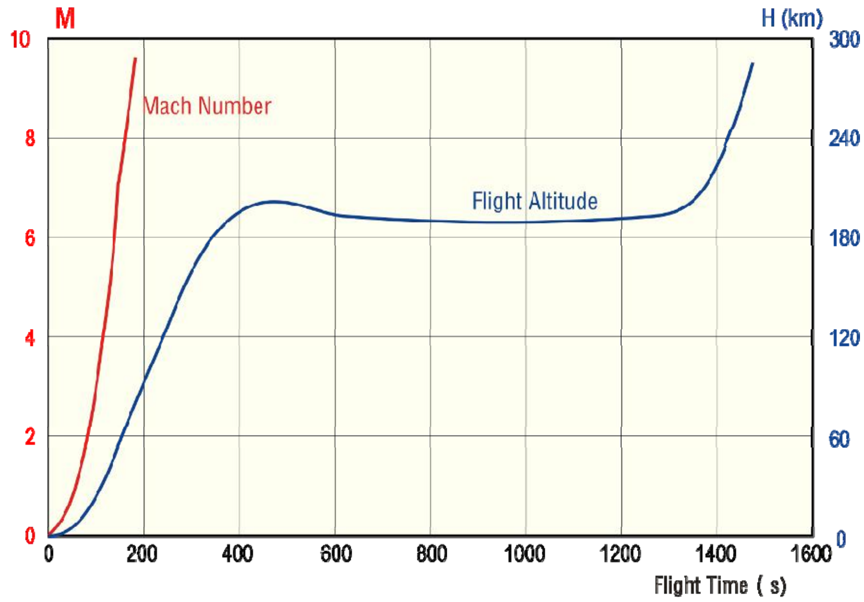


Figure 3-7b   LM-3A Altitude & Mach vs. Flight Time

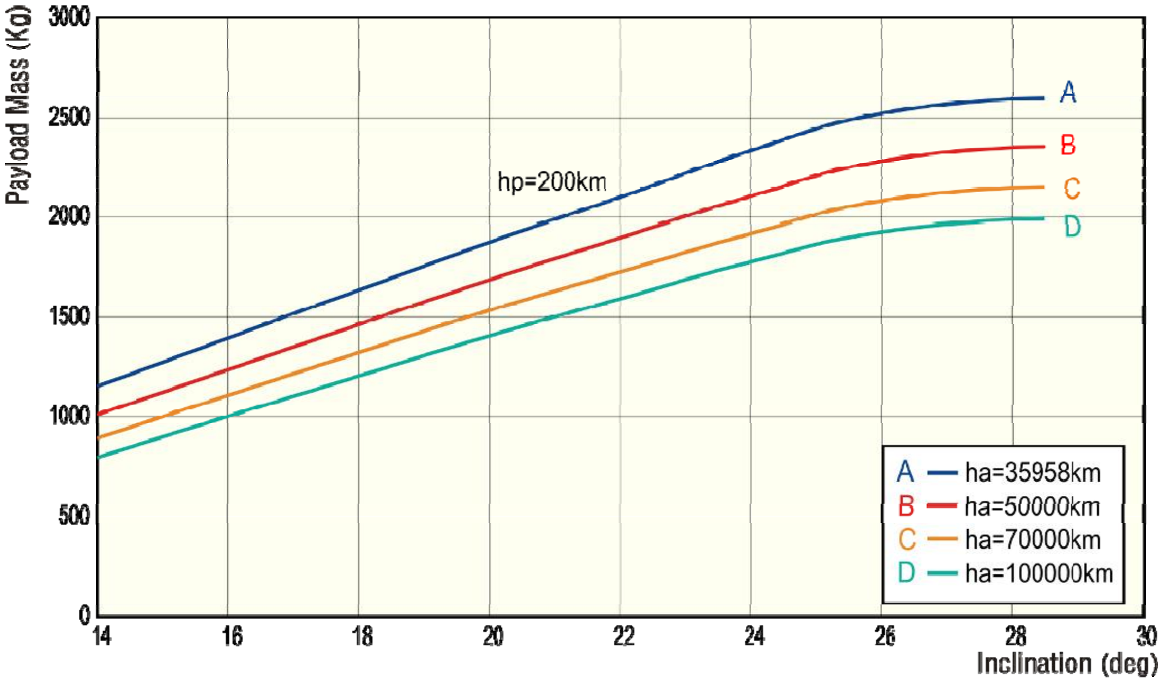
3.3.2 Launch Capability for LM-3A Launch Vehicle

3.3.2.1 Standard GTO Mission

LM-3A launch capability is 2,600 kg for standard GTO mission.

3.3.2.2 Non-Standard GTO

The LM-3A GTO launch capability varies with apogee altitudes for a range of inclinations, as shown in Figure 3-8.



Inclination (deg)	Apogee Altitude (km)			
	35,958	50,000	70,000	100,000
14	1,154	1,011	892	795
16	1,395	1,238	1,110	1,003
18	1,637	1,463	1,323	1,206
20	1,877	1,689	1,534	1,407
22	2,101	1,899	1,729	1,593
24	2,334	2,106	1,920	1,780
26	2,523	2,282	2,083	1,928
28.5	2,600	2,354	2,153	1,993

Figure 3-8 LM-3A GTO Capability

3.3.2.3 Low-Earth Orbit (LEO) Mission

The launch capability of the LM-3A for standard LEO mission into a 200 km circular orbit at 28.5 deg. inclination is 6,000 kg.

3.3.2.4 Sun-Synchronous Orbit (SSO) Mission

The LM-3A has the capability to inject a satellite directly into a Sun-Synchronous Orbit (SSO). The launch performance of LM-3A for a Sun Synchronous Orbit mission is shown in Figure 3-9.

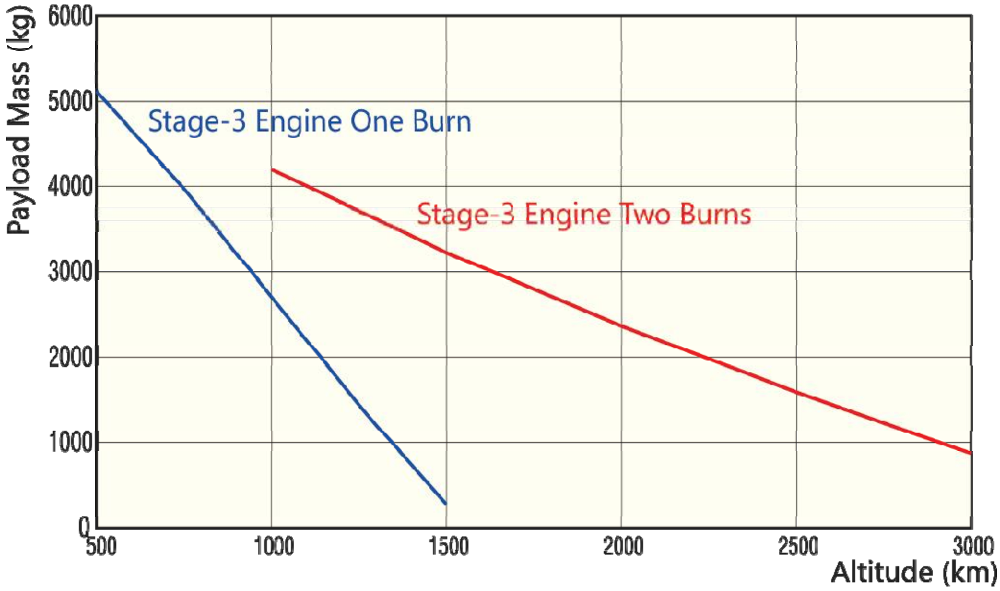


Figure 3-9 LM-3A SSO Capability

3.3.2.5 Deep Space Exploration Mission

The LM-3A has the capability to inject a satellite into an Earth-Escape orbit for deep space exploration and interplanetary missions. The launch capability of LM-3A for Earth-Escape mission is shown in Figure 3-10, where C3 is the square of the velocity at infinity in km^2/s^2.

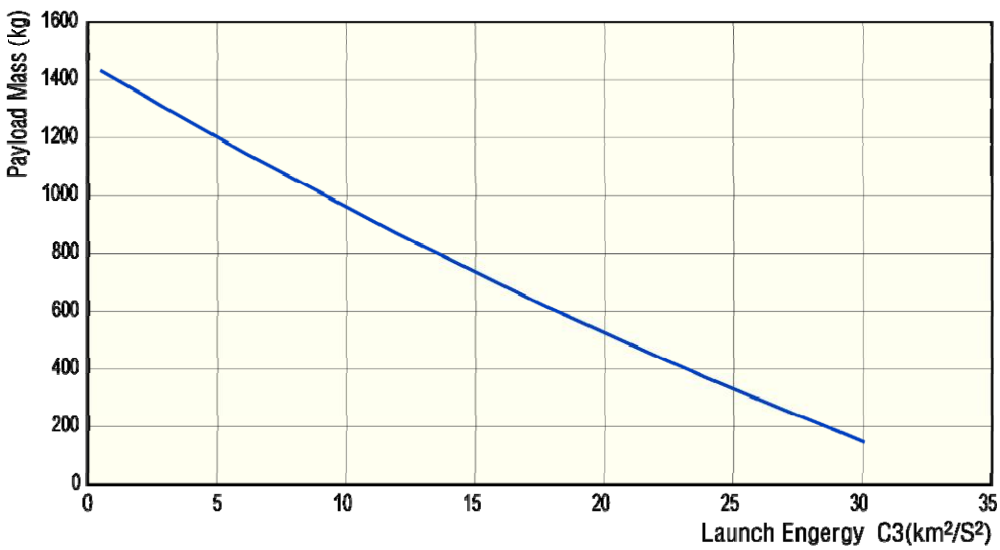


Figure 3-10 LM-3A Earth-Escape Mission Capability

3.4 LM-3B Launch Vehicle

3.4.1 Typical Orbit Parameters

3.4.1.1 Flight Sequence and Events

The typical flight sequence for the LM-3B launch vehicle in a standard GTO mission is shown in Table 3-5 and Figure 3-11. The characteristic parameters of typical trajectory are shown in Table 3-6.

Table 3-5 LM-3B Typical Flight Sequence

Events	Time (s)
Liftoff	0.0
Pitch Over	10.0
Boosters Shutdown	127.2
Boosters Separation	128.7
Stage-1 Shutdown	144.7
Stage-1/Stage-2 Separation	146.2
Fairing Jettisoning	215.2
Stage-2 Main Engine Shutdown	325.5
Stage-2 Vernier Engine Shutdown	330.5
Stage-2/Stage-3 Separation, and Stage-3 First Start	331.5
Stage-3 First Shutdown	615.7
Coast Phase Beginning	619.2
Coast Phase Ending, and Stage-3 Second Start	1258.4
Stage-3 Second Shutdown, Velocity Adjustment Beginning	1437.7
Velocity Adjustment Ending	1457.7
SC/LV Separation	1537.7

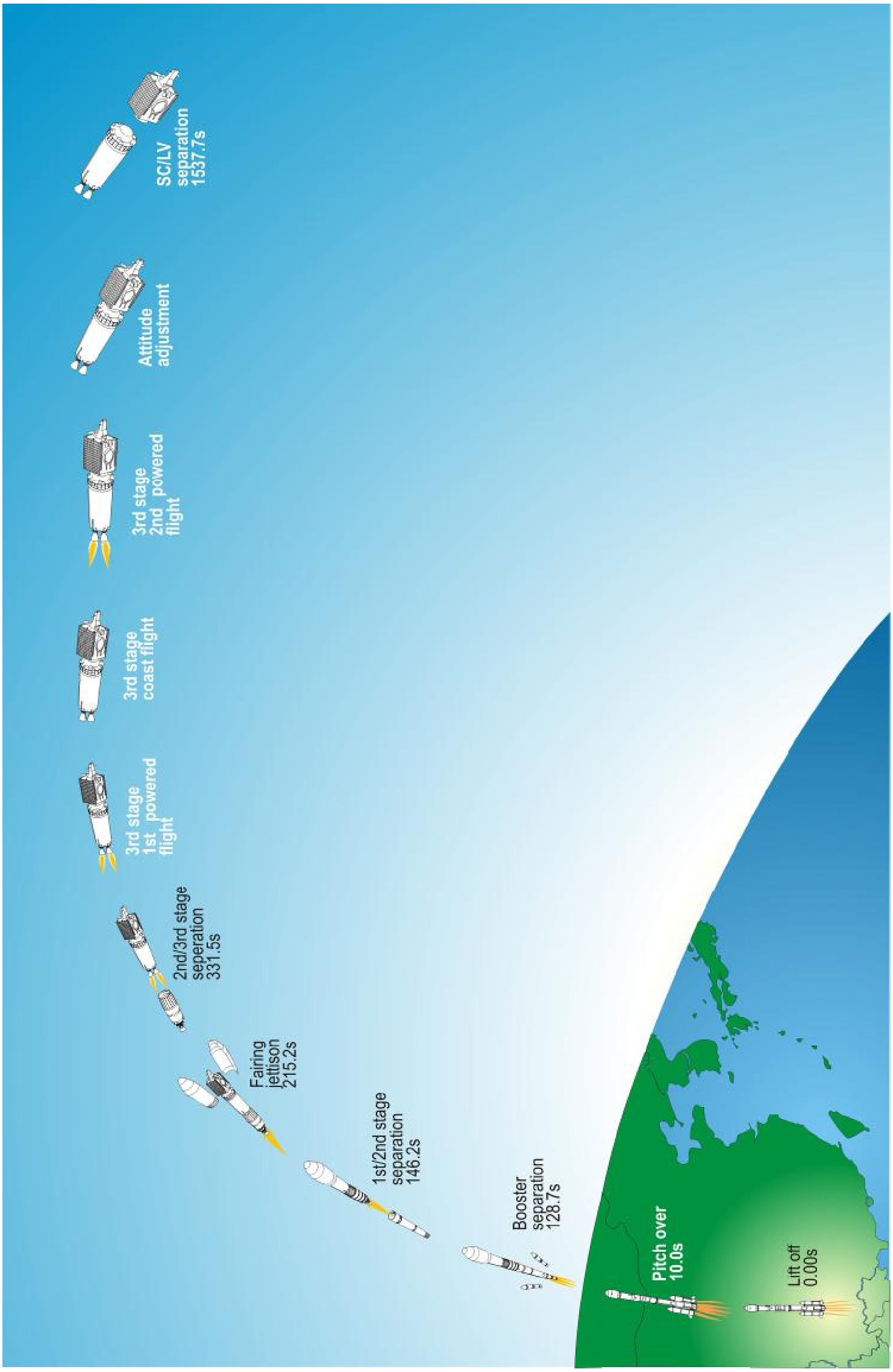


Figure 3-11 LM-3B GTO Flight Profile

Table 3-6 Characteristic Parameters of Typical Trajectory

Event	Flight Altitude (km)	Ground Range (km)	Projection Latitude (deg)	Projection Longitude (deg)
Liftoff	1.8	0.0	28.2	102.0
Booster Shutdown	53.9	68.7	28.2	102.7
Boosters Separation	55.4	71.8	28.2	102.8
Stage-1 Shutdown	71.0	108.2	28.1	103.1
S-1/S-2 Separation	72.5	112.0	28.1	103.2
Fairing Jettisoning	131.5	307.2	17.8	105.1
S-2 Main Engine Shutdown	190.3	744.8	27.1	109.5
S-2 Vernier Engine Shutdown	192.1	769.8	27.0	109.7
S-2/S-3 Separation	192.5	774.8	27.0	109.8
Stage-3 First Shutdown	204.3	2466.2	22.8	125.9
Coast Phase Beginning	204.3	2491.2	22.7	126.1
Stage-3 Second Start	200.1	7061.3	4.4	164.1
S-3 Second Shutdown	219.9	8531.1	-2.3	175.5
Velocity Adjust. Ending	231.6	8720.0	-3.2	177.0
SC/LV Separation	304.6	9466.1	-6.5	182.8

3.4.1.2 LM-3B Main Parameters Curves of Typical Orbit

The flight acceleration, velocity, Mach numbers and altitude vs. time are shown in Figure 3-12a and Figure 3-12b.

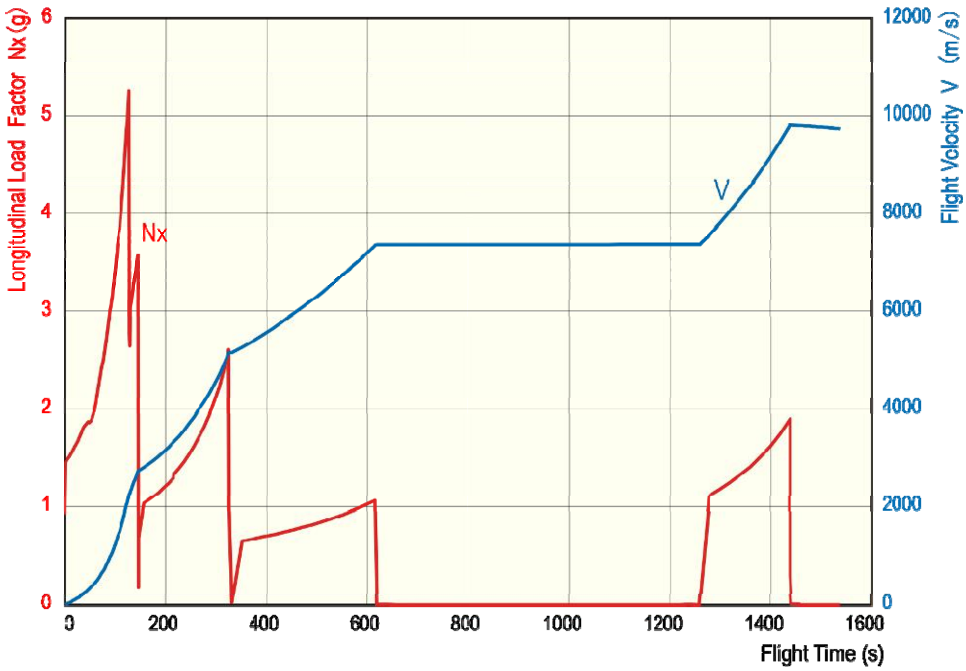


Figure 3-12a LM-3B Load Factor & Velocity vs. Flight Time

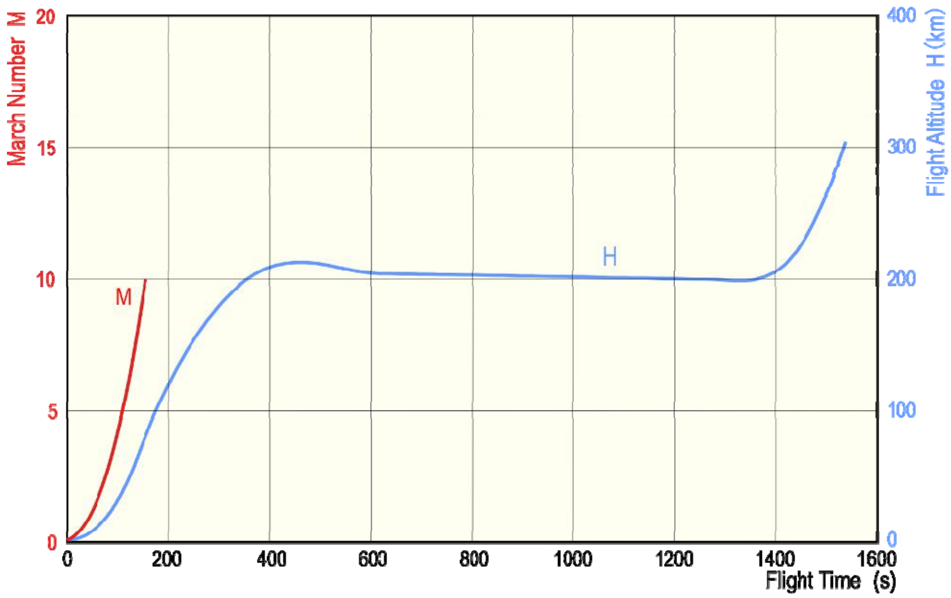


Figure 3-12b LM-3B Flight Mach & Altitude vs. Flight Time

3.4.2 Launch Capability for LM-3B Launch Vehicle

3.4.2.1 Standard GTO Mission

The GTO launch capability, which varies with the fairing encapsulation mode, is as follows:

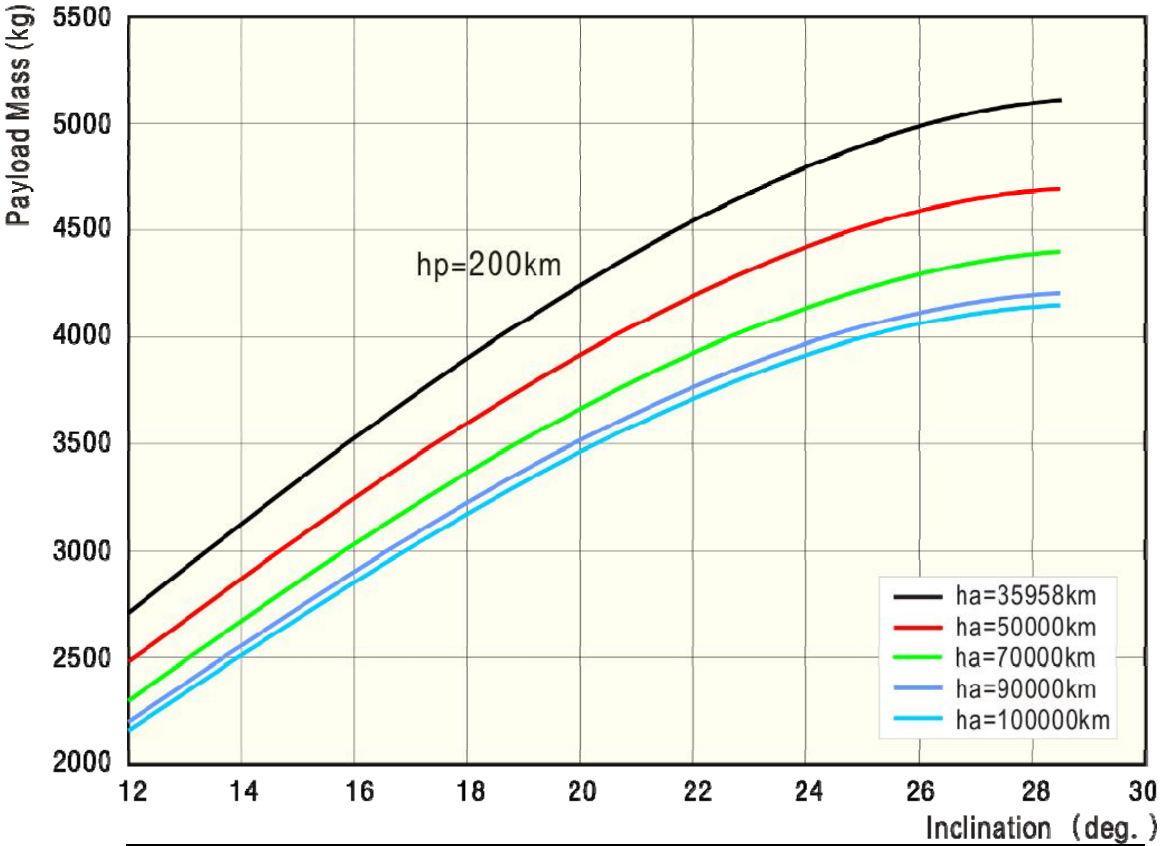
Encapsulation-on-Pad: 5,100 kg (With 4000F fairing)

Encapsulation-in-BS3: 4,000 kg (For dual launch with 3700Z fairing only)

The launch capability of LM-3B for the standard and recommended GTO mission as the baseline in this manual is 5,100 kg.

3.4.2.2 Non-standard GTO Missions

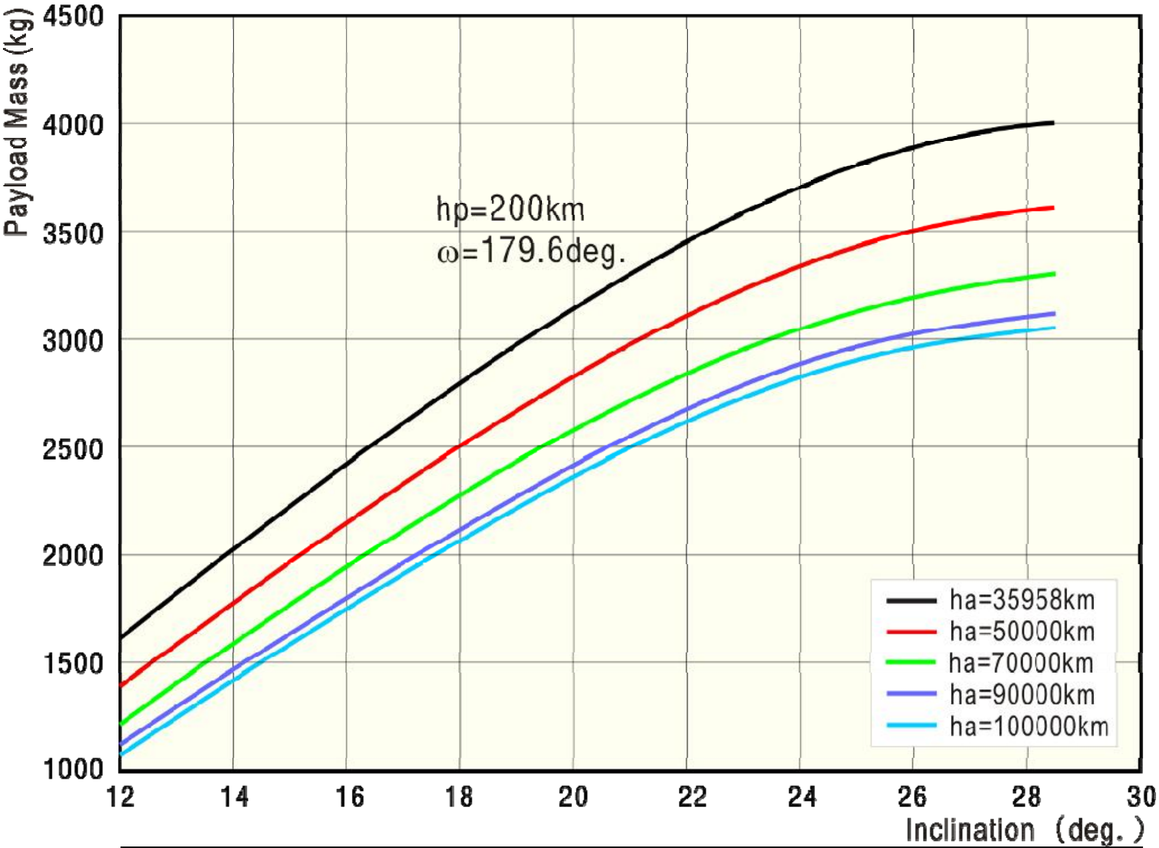
The LM-3B GTO launch capability with the third stage operating command shutdown and satellite encapsulation at the pad varies with apogee altitudes in a range of inclinations, as shown in Figure 3-13.



Inclination (deg)	Apogee Altitude (km)			
	35,958	50,000	70,000	100,000
14	3,110	2,880	2,680	2,570
16	3,520	3,250	3,030	2,900
18	3,890	3,590	3,370	3,230
20	4,240	3,920	3,670	3,520
22	4,560	4,210	3,940	3,780
24	4,805	4,440	4,150	3,980
26	4,990	4,600	4,300	4,130
28.5	5,100	4,700	4,400	4,210

Figure 3-13 LM-3B GTO Performance (Encapsulation-on-Pad)

The LM-3B GTO launch capability with the third stage operating command shut-down and satellite Encapsulation-in-BS3 varies with apogee altitudes for a range of inclinations, as shown in Figure 3-14.



Inclination (deg)	Apogee Altitude (km)			
	35,958	50,000	70,000	100,000
14	2,010	1,780	1,580	1,470
16	2,420	2,150	1,930	1,800
18	2,790	2,490	2,270	2,130
20	3,140	2,820	2,570	2,420
22	3,460	3,110	2,840	2,680
24	3,705	3,340	3,050	2,880
26	3,890	3,500	3,200	3,030
28.5	4,000	3,600	3,300	3,110

Figure 3-14 LM-3B GTO Performance (Encapsulation-in-BS3)

3.4.2.3 Low-Earth Orbit (LEO) Mission

The launch capability of the LM-3B for LEO mission into a 200 km circular orbit with an inclination of 28.5 deg is 11,200 kg.

3.4.2.4 Sun-Synchronous Orbit (SSO) Mission

The LM-3B launch vehicle has the capability of injecting a satellite directly into a Sun-Synchronous Orbit. The launch performance of LM-3B for a sun synchronous mission is shown in Figure 3-15.

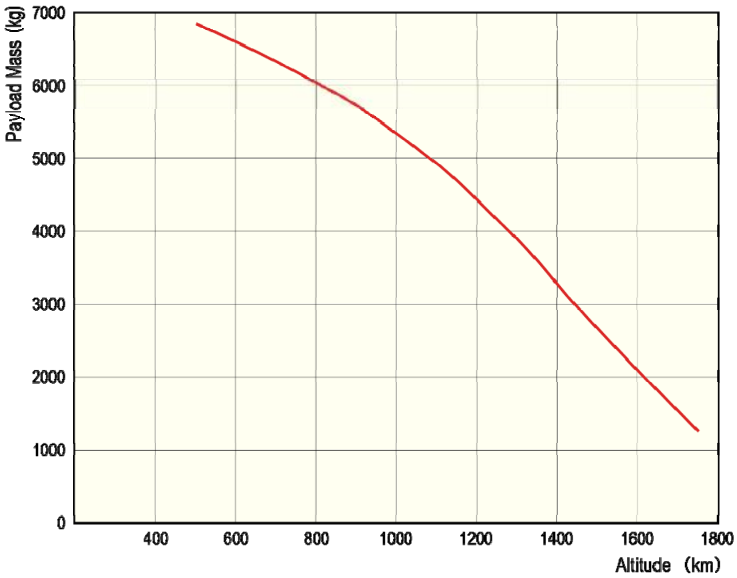


Figure 3-15 LM-3B Sun synchronous Capability

3.4.2.5 Deep Space Exploration Mission

The LM-3B has the capability of injecting a satellite into an Earth Escape orbit for deep space exploration and interplanetary missions. The launch capability of LM-3B for Earth-Escape mission is shown in Figure 3-16, where C3 is the square of the velocity at infinite in km^2/s^2.

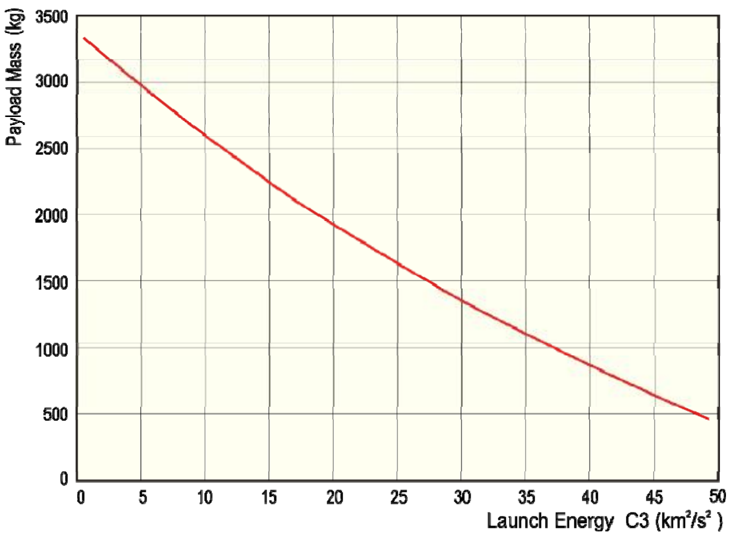


Figure 3-16 LM-3B Earth Escape Mission Capability

3.5 LM-3BE Launch Vehicle

3.5.1 Typical Orbit Parameters

3.5.1.1 Flight Sequence and Characteristic Parameters

The typical flight sequence of the LM-3BE launch vehicle for a standard GTO mission is shown in Table 3-7 and Figure 3-17. The characteristic parameters of typical trajectory are shown in Table 3-8.

Table 3-7 LM-3BE Typical Flight Sequence

Events	Time (s)
Liftoff	0.0
Pitch Over	11.0
Boosters Shutdown	140.1
Boosters Separation	141.6
S-1 Shutdown	157.5
S-1/S-2 Separation	159.0
Fairing Jettisoning	235.2
S-2 Main Engine Shutdown	339.4
S-2 Vernier Engine Shutdown	344.4
S-2/S-3 Separation/S-3 First Start	345.4
S-3 First Shutdown	628.6
Coast Phase Beginning	632.1
Coast Phase Ending/S-3 Second Start	1276.1
S-3 Second Shutdown/Velocity Adjustment Beginning	1470.5
Velocity Adjustment Ending	1490.5
SC/LV Separation	1570.5

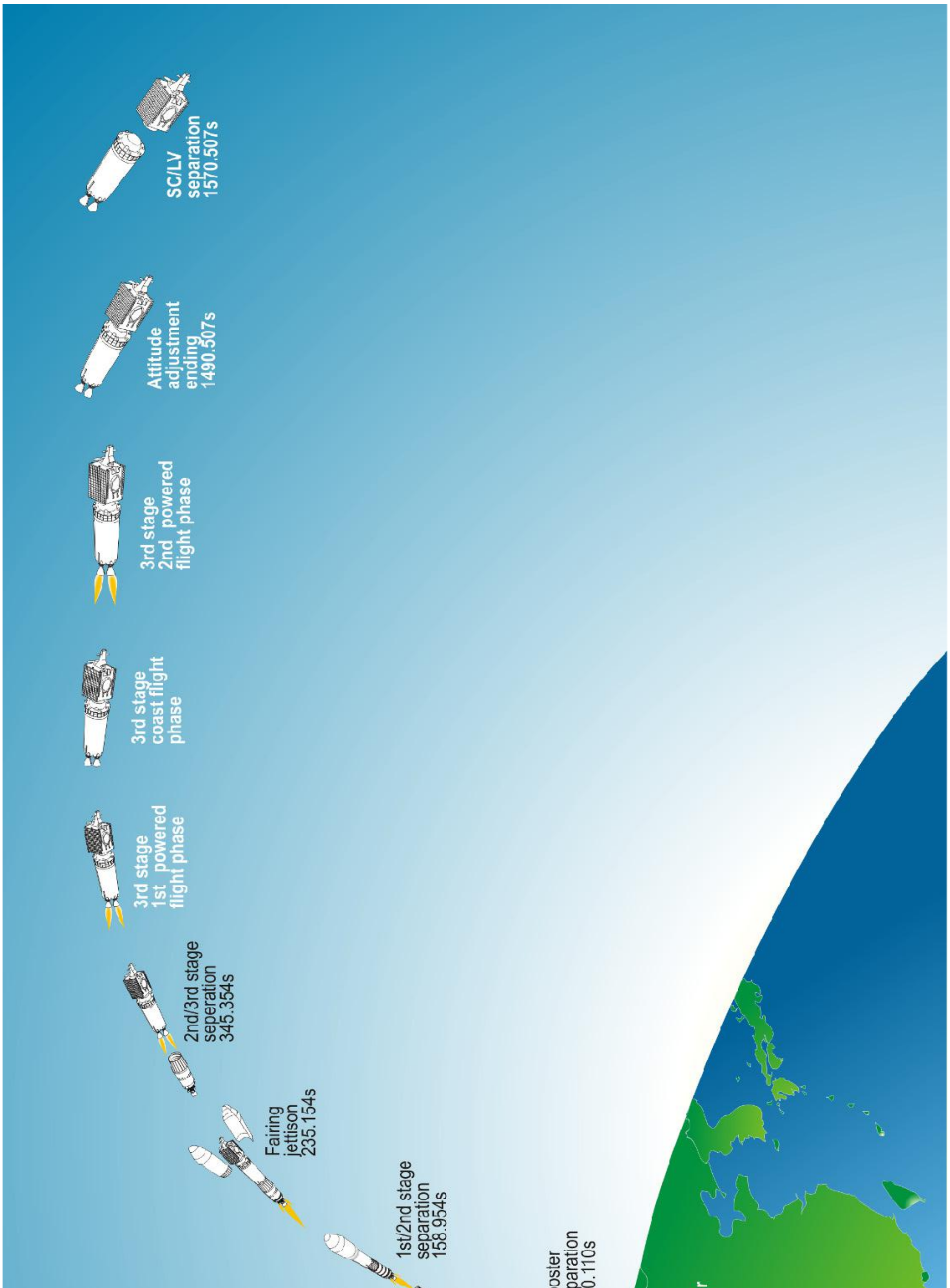


Figure 3-17 LM-3BE Flight Profile

Table 3-8 LM-3BE Characteristic Parameters of Typical Trajectory

Events	Flight Altitude (km)	Ground Range (km)	Projection Latitude (deg)	Projection Longitude (deg)
Liftoff	1.8	0.0	28.2	102.0
Booster Shutdown	55.7	79.2	28.0	102.8
Boosters Separation	57.0	82.5	28.0	102.9
Stage-1 Shutdown	70.7	121.2	28.0	103.2
S-1/S-2 Separation	72.0	125.3	28.0	103.3
Fairing Jettisoning	125.2	356.9	27.6	105.6
S-2 Main Engine Shutdown	167.5	794.8	26.8	110.0
S-2 Vernier Engine Shutdown	169.2	820.7	26.8	110.2
Stage-2/Stage-3 Separation	169.5	825.9	26.8	110.3
Stage-3 First Shutdown	178.8	2552.6	22.4	126.7
Coast Phase Beginning	178.7	2578.0	22.3	126.9
Stage-3 Second Start	181.6	7248.1	3.4	165.6
Stage-3 Second Shutdown	231.4	8852.2	-3.4	178.3
Velocity Adjustment Ending	246.0	9041.3	-4.2	179.9
SC/LV Separation	331.2	9786.8	-7.1	-174.1

3.5.1.2 LM-3BE Main Parameters Curves of Typical Orbit

The flight acceleration, velocity, Mach numbers and altitude vs. time are shown in Figure 3-18a and Figure 3-18b.

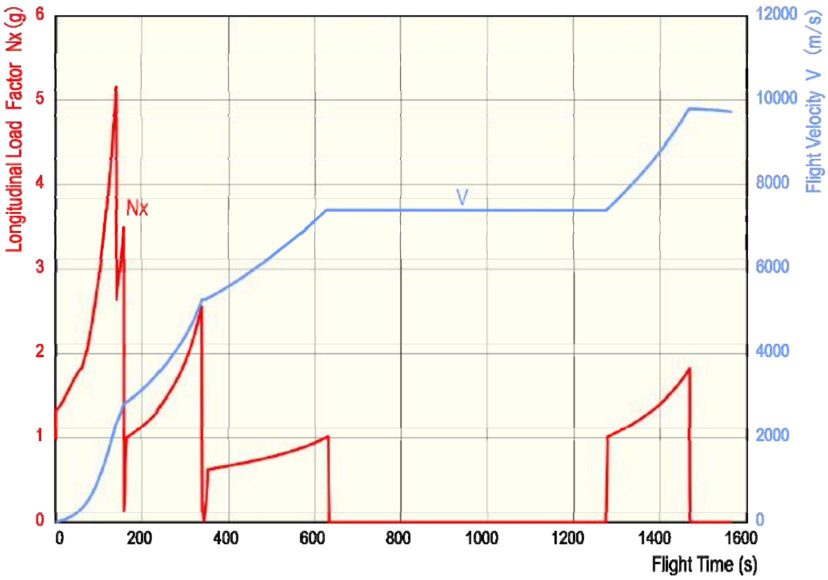


Figure 3-18a LM-3BE Load Factor & Velocity vs. Flight Time

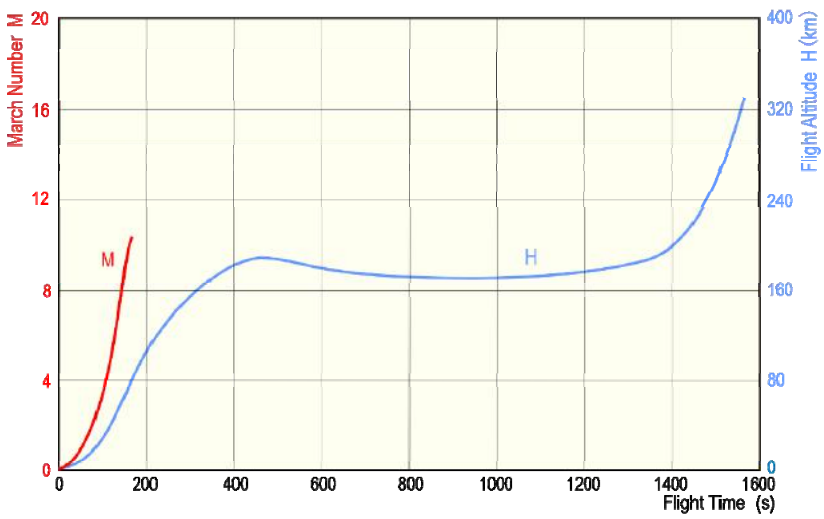


Figure 3-18b LM-3BE Altitude & Mach vs. Flight Time

3.5.2 Launch Capability for GTO Missions

3.5.2.1 Standard GTO

The GTO launch capability of LM-3BE, which varies with fairing encapsulation mode, is as follows:

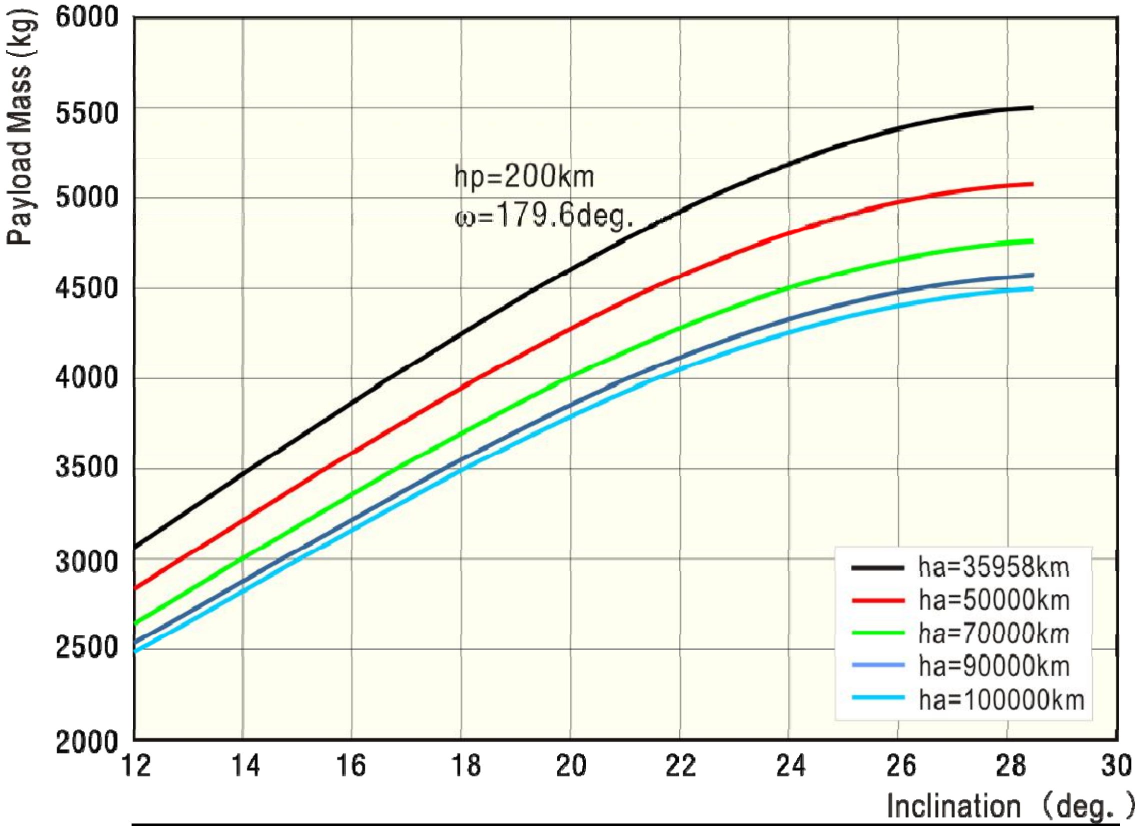
Encapsulation-on-Pad: 5,500 kg (Encapsulation-on Pad with 4000F fairing)

Encapsulation-in-BS3: 5,300 kg (Encapsulation-in-BS3 with 4200Z fairing)

The LM-3BE launch capability for the standard and recommended GTO mission as the baseline in this manual is 5,500 kg.

3.5.2.2 Non-standard GTO Missions

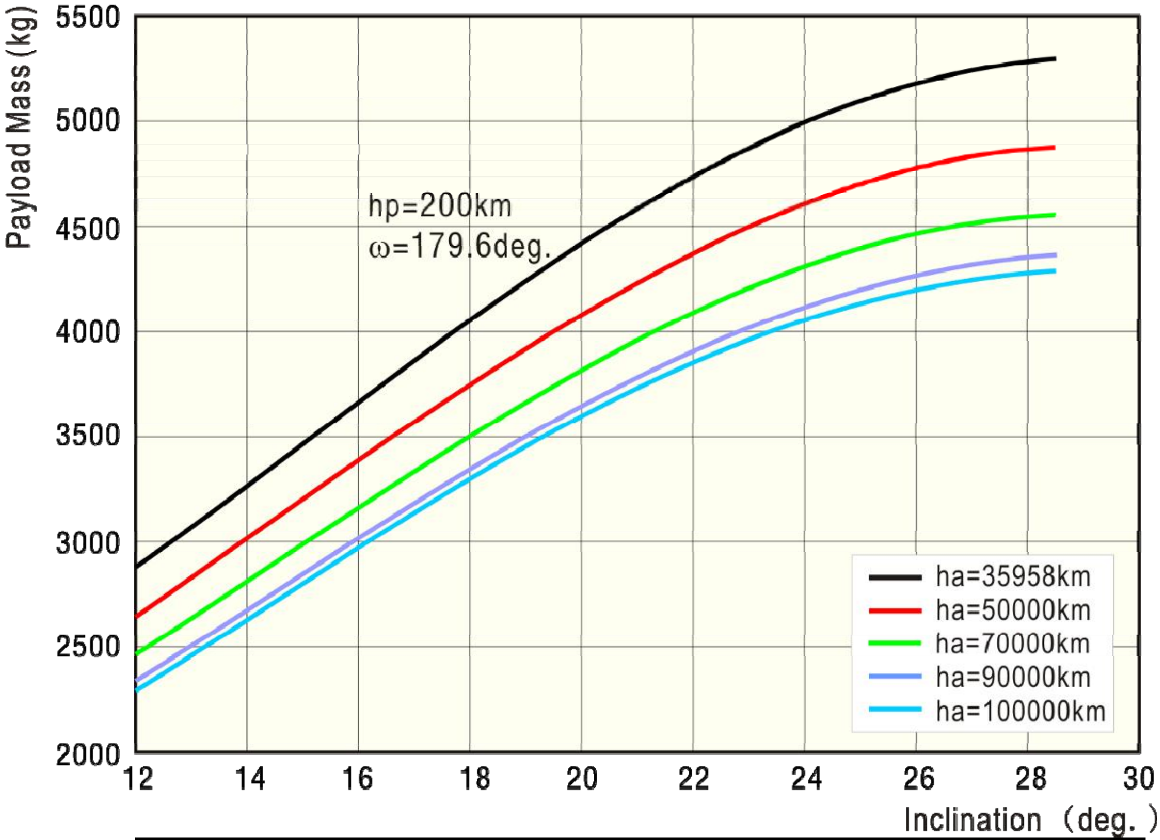
The LM-3BE GTO launch capability with third stage operating command shut-down and satellite encapsulation on the pad varies with apogee altitudes for a range of inclinations, as shown in Figure 3-19.



Inclination (deg)	Apogee Altitude (km)				
	35,958	**50,000**	**70,000**	**90,000**	**100,000**
14	3,470	3,220	3,010	2,880	2,840
16	3,870	3,590	3,360	3,220	3,180
18	4,260	3,950	3,700	3,550	3,500
20	4,620	4,280	4,020	3,850	3,800
22	4,940	4,580	4,290	4,110	4,060
24	5,200	4,820	4,510	4,330	4,270
26	5,390	4,990	4,670	4,480	4,420
28.5	5,500	5,080	4,760	4,560	4,500

Figure 3-19 LM-3BE GTO Performance (Encapsulation-on-Pad)

The LM-3BE GTO launch capability with third stage operating command shut-down and satellite encapsulation in BS3 varies with apogee altitudes for a range of inclinations, as shown in Figure 3-20.



Inclination (deg)	Apogee Altitude (km)				
	35,958	**50,000**	**70,000**	**90,000**	**100,000**
14	3,270	3,020	2,810	2,680	2,640
16	3,670	3,390	3,160	3,020	2,980
18	4,060	3,750	3,500	3,350	3,300
20	4,420	4,080	3,820	3,650	3,600
22	4,740	4,380	4,090	3,910	3,860
24	5,000	4,620	4,310	4,130	4,070
26	5,190	4,790	4,470	4,280	4,220
28.5	5,300	4,880	4,560	4,360	4,300

Figure 3-20 LM-3BE GTO Performance (Encapsulation-in-BS3)

3.5.2.3 Low-Earth Orbit (LEO) Mission

The launch capability of LM-3BE for LEO mission into a 200 km circular orbit with an inclination of 28.5 deg is 11,500 kg.

3.5.2.4 Sun-Synchronous Orbit (SSO) Mission

The LM-3BE launch vehicle has the capability of injecting a satellite directly into Sun-Synchronous Orbit. The launch performance of LM-3BE for sun synchronous missions is shown in Figure 3-21.

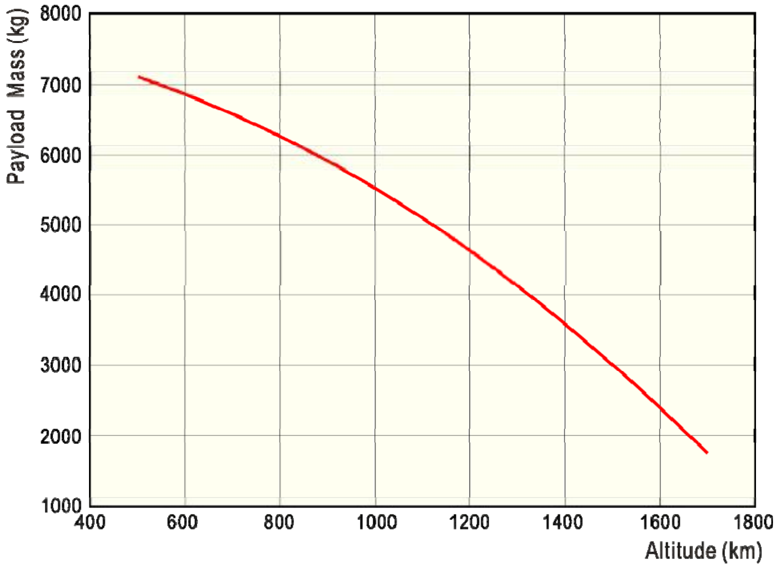


Figure 3-21　LM-3B Enhanced SSO Capability

3.5.2.5 Deep Space Exploration Mission

The LM-3BE launch vehicle has the capability of injecting a satellite into Earth Escape orbit for deep space exploration and interplanetary missions. The launch capability of LM-3BE launch vehicle for Earth-Escape mission is shown in Figure 3-22, where C3 is the square of the velocity at infinite in km^2/s^2.

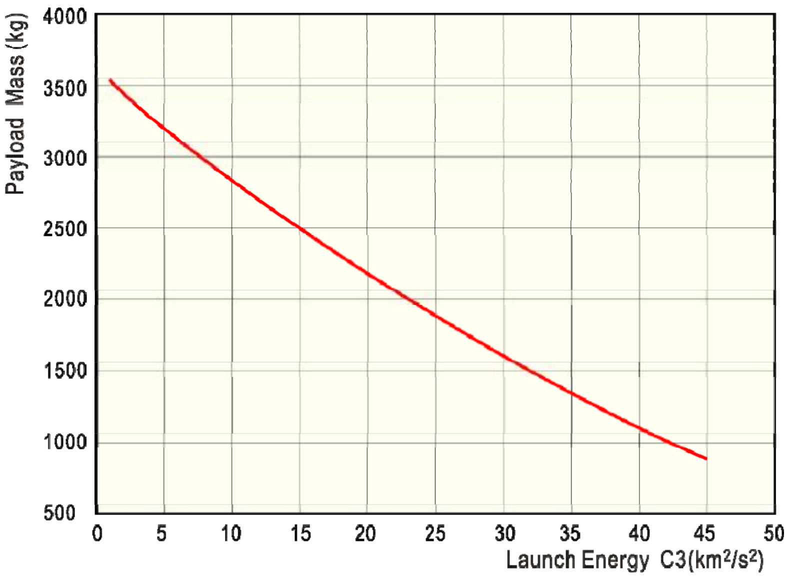


Figure 3-22　LM-3BE Earth Escape Mission Capability

3.6 LM-3C Launch Vehicle

3.6.1 Typical Orbit Parameters

3.6.1.1 Flight Sequence and Characteristic Parameters

The typical flight sequence of LM-3C for standard GTO mission is shown in Table 3-9 and Figure 3-23. The characteristic parameters of typical trajectory are shown in Table 3-10.

Table 3-9 LM-3C Typical Flight Sequence

Events	Time (s)
Liftoff	0.0
Pitch Over	10.0
Boosters Shutdown	127.5
Boosters Separation	129.0
S-1 Shutdown	145.2
S-1/S-2 Separation	146.7
Fairing Jettisoning	258.7
S-2 Main Engine Shutdown	328.0
S-2 Vernier Engine Shutdown	333.0
S-2/S-3 Separation/S-3 First Start	334.0
S-3 First Shutdown	650.6
Coast Phase Beginning	654.1
Coast Phase Ending/S-3 Second Start	1323.2
S-3 Second Shutdown/Velocity Adjustment Beginning	1474.9
Velocity Adjustment Ending	1494.9
SC/LV Separation	1574.9

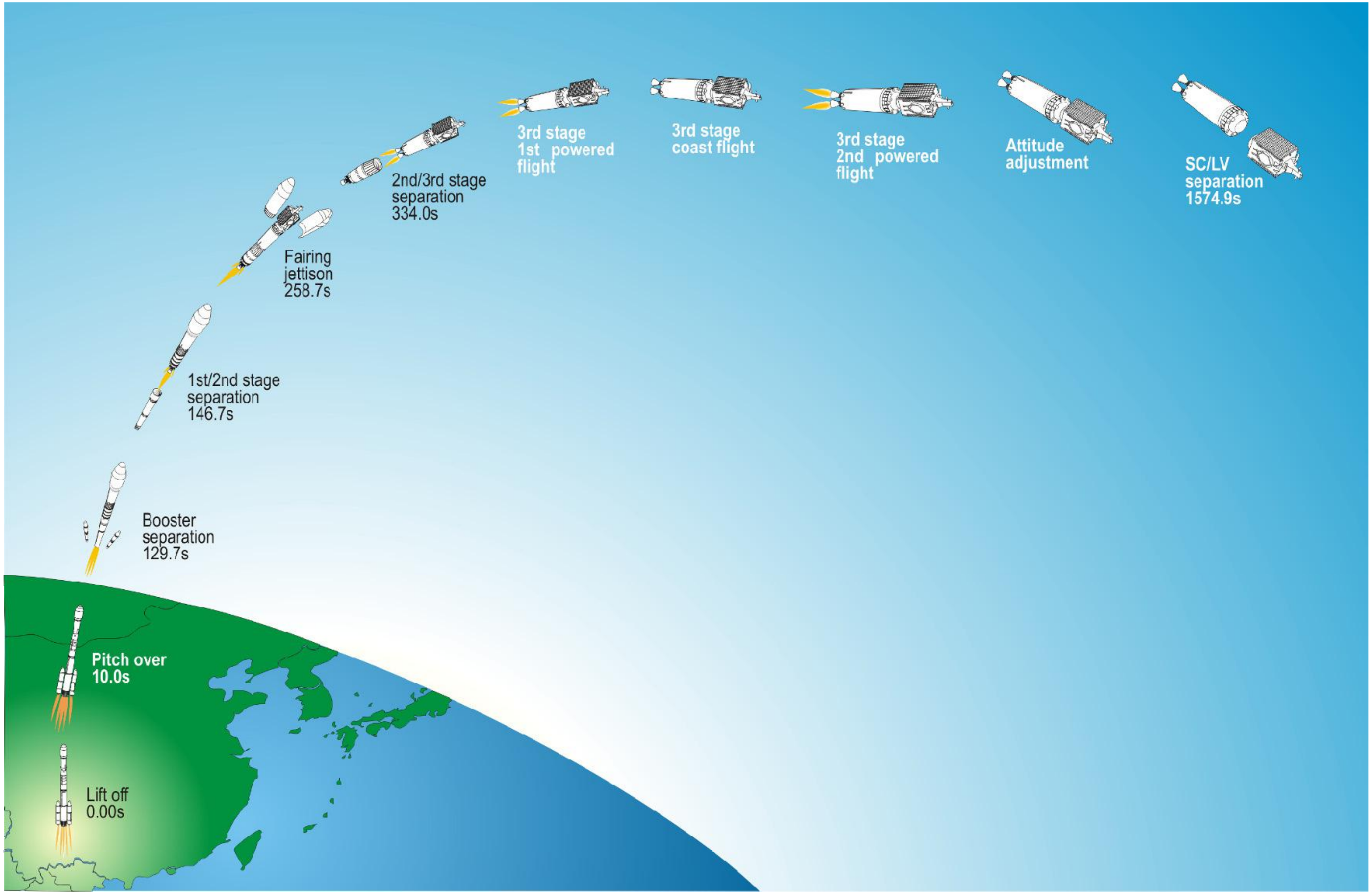


Figure 3-23 LM-3C Flight Profile

Table 3-10 LM-3C Characteristic Parameters of Typical Trajectory

Events	Flight Altitude (km)	Ground Range (km)	Projection Latitude (deg)	Projection Longitude (deg)
Liftoff	1.8	0.0	28.2	102.0
Booster Shutdown	48.7	50.6	28.2	102.5
Boosters Separation	50.0	52.9	28.2	102.6
Stage-1 Shutdown	64.7	82.0	28.1	102.9
S-1/S-2 Separation	66.1	85.1	28.1	102.9
Fairing Jettisoning	147.5	374.7	27.7	105.8
S-2 Main Engine Shutdown	181.9	640.6	27.3	108.4
S-2 Vernier Engine Shutdown	184.3	663.4	27.2	108.7
Stage-2/Stage-3 Separation	184.8	667.9	27.2	108.7
Stage-3 First Shutdown	208.7	2465.0	22.8	125.8
Coast Phase Beginning	208.6	2490.0	22.7	126.1
Stage-3 Second Start	194.8	7295.2	3.2	165.9
Stage-3 Second Shutdown	215.8	8541.6	-2.5	175.6
Velocity Adjustment Ending	226.4	8730.8	-3.3	177.0
SC/LV Separation	295.1	9478.8	-6.6	182.9

3.6.1.2 LM-3C Main Parameters Curves of Typical Orbit

The flight acceleration, velocity, Mach numbers and altitude vs. time are shown in Figure 3-24a and 3-24b.

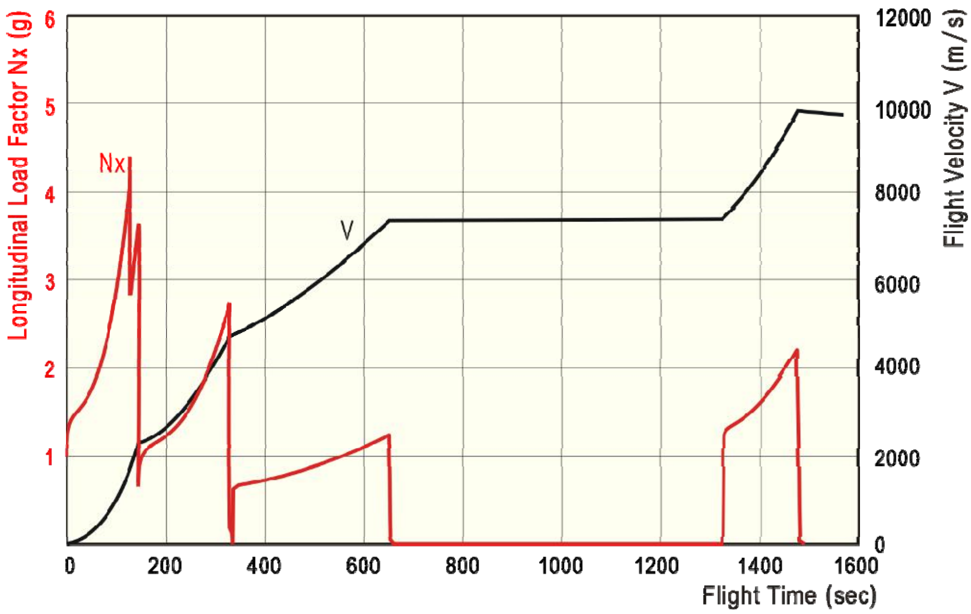


Figure 3-24a LM-3C Load Factor & Velocity vs. Flight Time

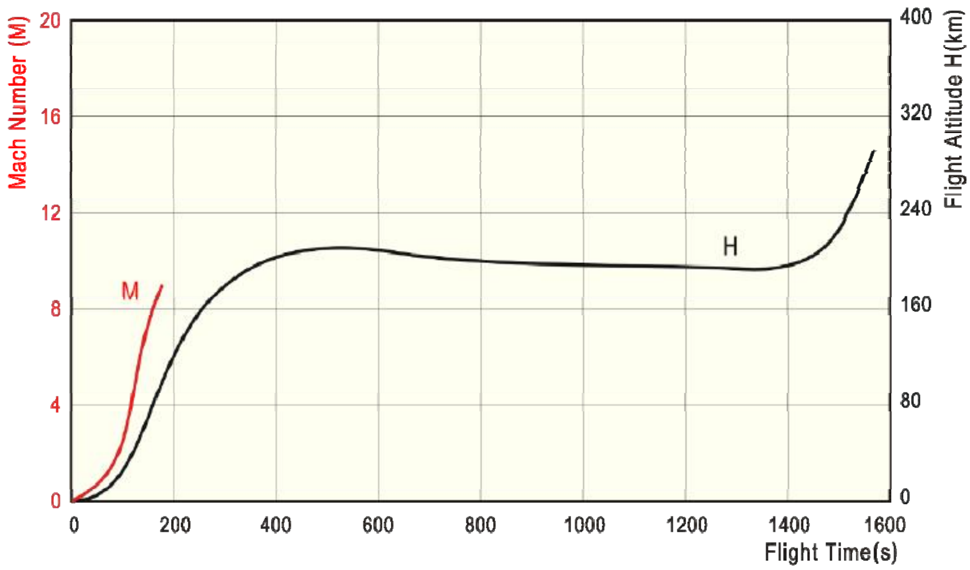


Figure 3-24b LM-3C Altitude & Mach vs. Flight Time

3.6.2 Launch Capability for GTO Missions

3.6.2.1 Standard GTO

The LM-3C launch capability for GTO, which varies with the fairing encapsulation mode, is as follows:

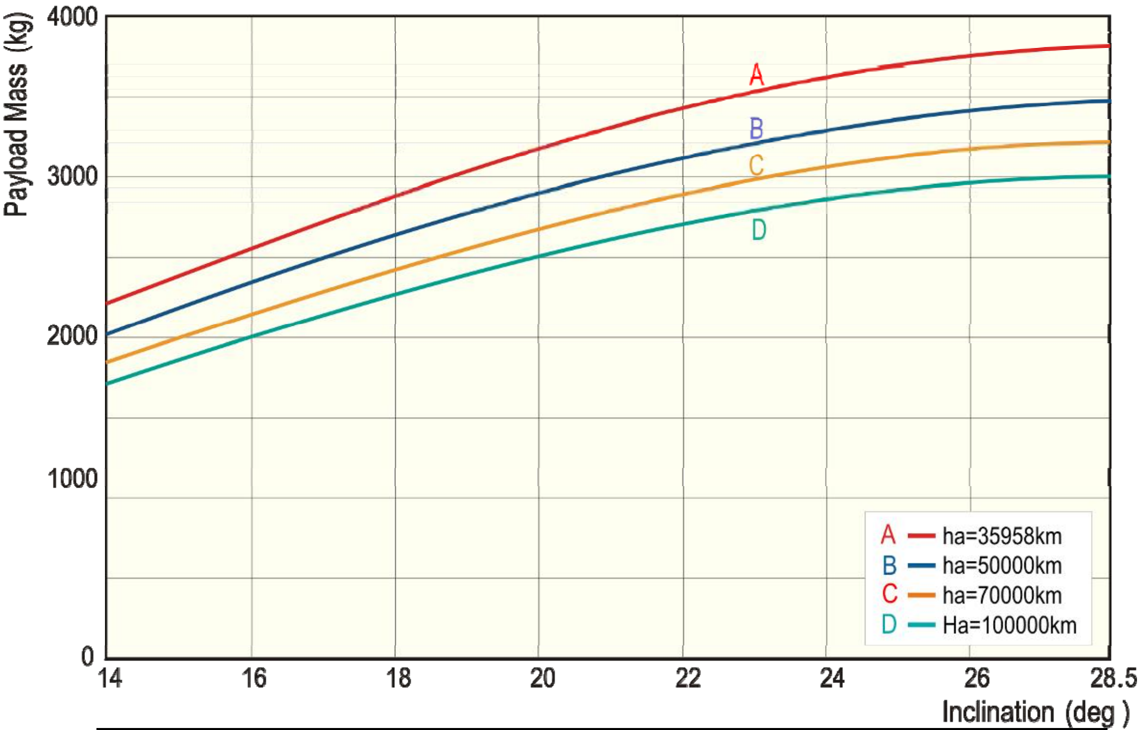
Encapsulation-on-Pad: 3,800 kg (With 4000F fairing)

Encapsulation-in-BS3: 3,600 kg (Single launch with 3700Z fairing)

The LM-3C launch capability for the standard and recommended GTO mission as the baseline in this manual is 3,800 kg.

3.6.2.2 Non-standard GTO Missions

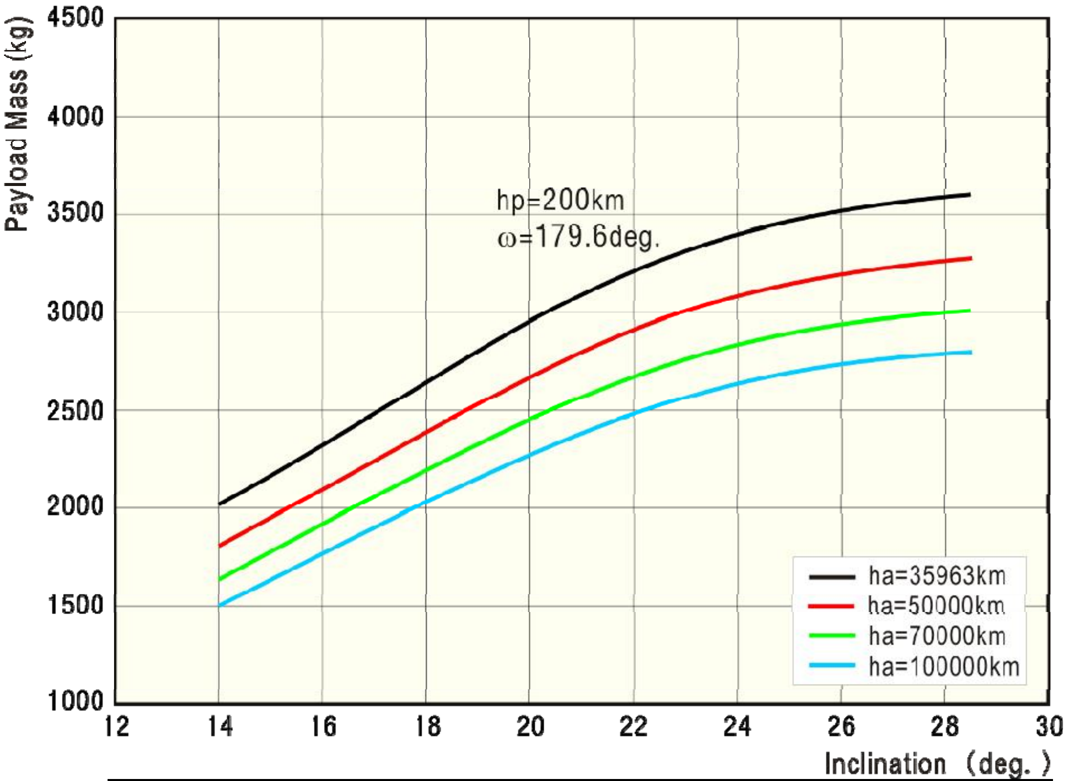
The LM-3C launch capability for GTO mission with the third stage operating command shut-down and the satellite encapsulation on the pad varies with apogee altitudes for a range of inclinations, as shown in Figure 3-25.



Inclination (deg)	Apogee Altitude (km)			
	35,958	**50,000**	**70,000**	**100,000**
14	2,215	2,004	1,835	1,702
16	2,532	2,304	2,121	1,971
18	2,834	2,585	2,385	2,228
20	3,150	2,876	2,658	2,480
22	3,420	3,120	2,882	2,697
24	3,600	3,287	3,039	2,845
26	3,721	3,402	3,141	2,944
28.5	3,800	3,471	3,210	3,001

Figure 3-25 LM-3C GTO Performance (Encapsulation-on-Pad)

The LM-3C launch capability for GTO mission with the third stage operating command shut-down and the satellite encapsulation in BS3 varies with apogee altitudes for a range of inclinations, as shown in Figure 3-26.



Inclination (deg)	Apogee Altitude (km)			
	35,958	**50,000**	**70,000**	**100,000**
14	2,015	1,804	1,635	1,502
16	2,332	2,104	1,921	1,771
18	2,634	2,385	2,185	2,028
20	2,950	2,676	2,458	2,280
22	3,220	2,920	2,682	2,497
24	3,400	3,087	2,839	2,645
26	3,521	3,202	2,941	2,744
28.5	3,600	3,271	3,010	2,801

Figure 3-26 LM-3C GTO Performance (Encapsulation-in-BS3)

3.6.2.3 Low-Earth Orbit (LEO) Mission

The launch capability of the LM-3C for LEO mission into a 200 km circular orbit with an inclination of 28.5 deg is 9,100 kg.

3.6.2.4 Sun-Synchronous Orbit (SSO) Mission

The LM-3C launch vehicle has the capability of injecting a satellite directly into

Sun-Synchronous Orbit. The launch performance of LM-3C for sun synchronous missions is shown in Figure 3-27.

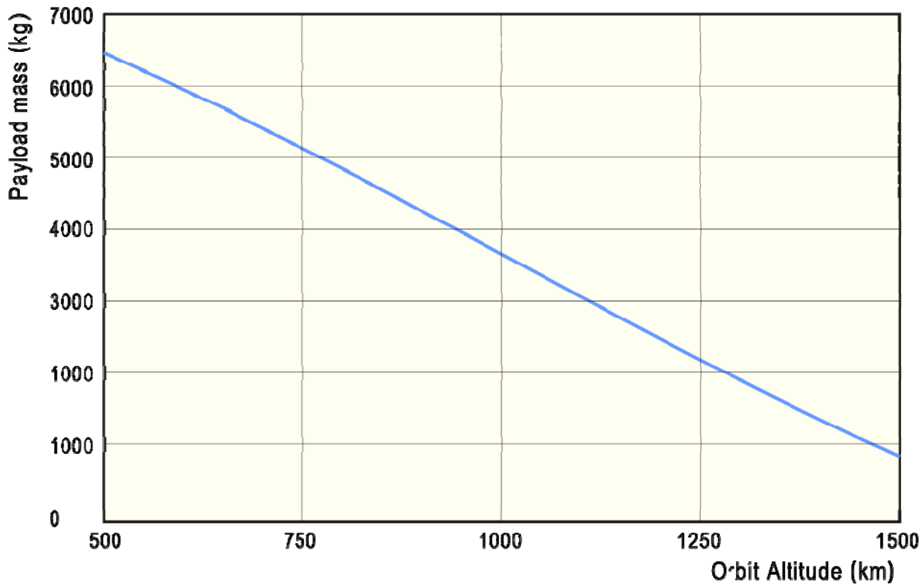


Figure 3-27 LM-3C SSO Capability

3.6.2.5 Deep Space Exploration Mission

The LM-3C launch vehicle has the capability of injecting a payload into Earth Escape orbit for deep space exploration and interplanetary missions. The launch capability of LM-3C for Earth-Escape mission is shown in Figure 3-28, where C3 is the square of the velocity at infinite in km^2/s^2.

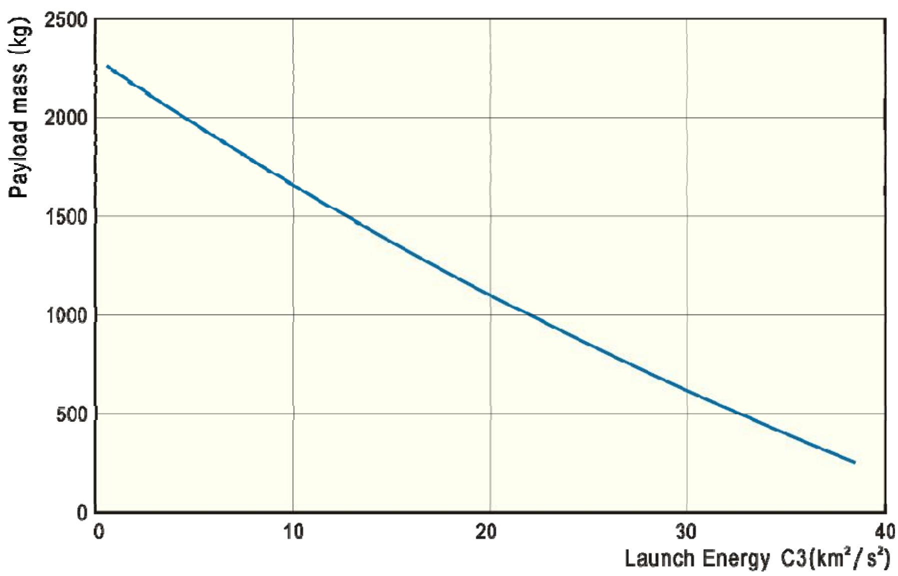


Figure 3-28 LM-3C Earth Escape Mission Capability

CHAPTER 4 PAYLOAD FAIRING

4.1 Introduction

The fairing is designed to limit the aerodynamic thermal load transmitted to the satellite and attenuate the acoustic loads from the main engines during launch.

Figure 4-1 Payload Faring Encapsulation on Launch Pad

The aerodynamic thermal flux upon fairing jettison is not greater than 1,135 W/m^2. This is the standard mission profile and all satellites are required to meet the thermal flux requirements.

There are five fairings available for the LM-3A Series launch vehicles, which are designated as 3350, 3700Z, 4000F, 4200F and 4200Z.

The two encapsulation methods are as follows:

Encapsulation-on-Pad: When the satellite is encapsulated on the pad the satellite and fairing are transported to launch pad separately, then the fairing is encapsulated following the mate of satellite to the launch vehicle.

Encapsulation-in-BS3: When the satellite is encapsulated in BS3 the satellite is mated to the Payload Adapter (PLA) and encapsulated in the fairing in BS3. The encapsulated satellite is shipped to the launch pad in the fairing and the complete assembly is mated to the launch vehicle.

The application of these fairings is shown in Table 4-1 below.

Table 4-1 Fairing Type

Fairing Type	Diameter (mm)	LV Version	Encapsulation
3350	3,350	LM-3A	On Pad only
3700Z	3,700	LM-3B/3C	In BS3 only
4000F	4,000	LM-3B/3BE/3C	On Pad only
4200F	4,200	LM-3BE	On Pad only
4200Z	4,200	LM-3BE	In BS3 only

4.2 3350 Fairing

The 3350 fairing has an external diameter of 3,350 mm, a total height of 8,887 mm. This fairing is only available for the LM-3A launch vehicle and designed to be encapsulated on the pad. The fairing can be used with the 937B, 1194 and 1194A Payload Adapter (PLA) interfaces and its configuration and static envelope are shown in Figure 4-2a and Figure 4-2b.

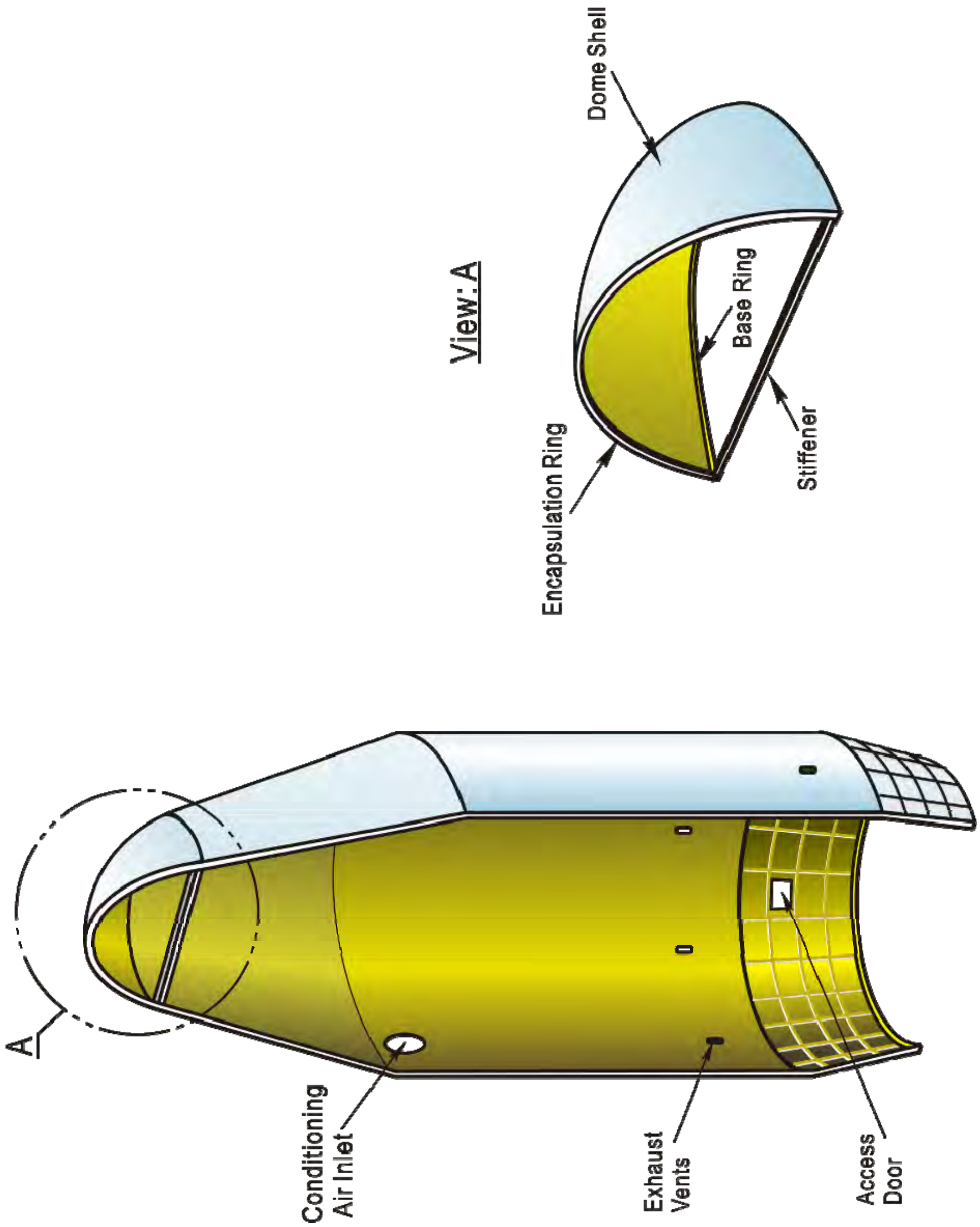


Figure 4-2a LM-3A Fairing

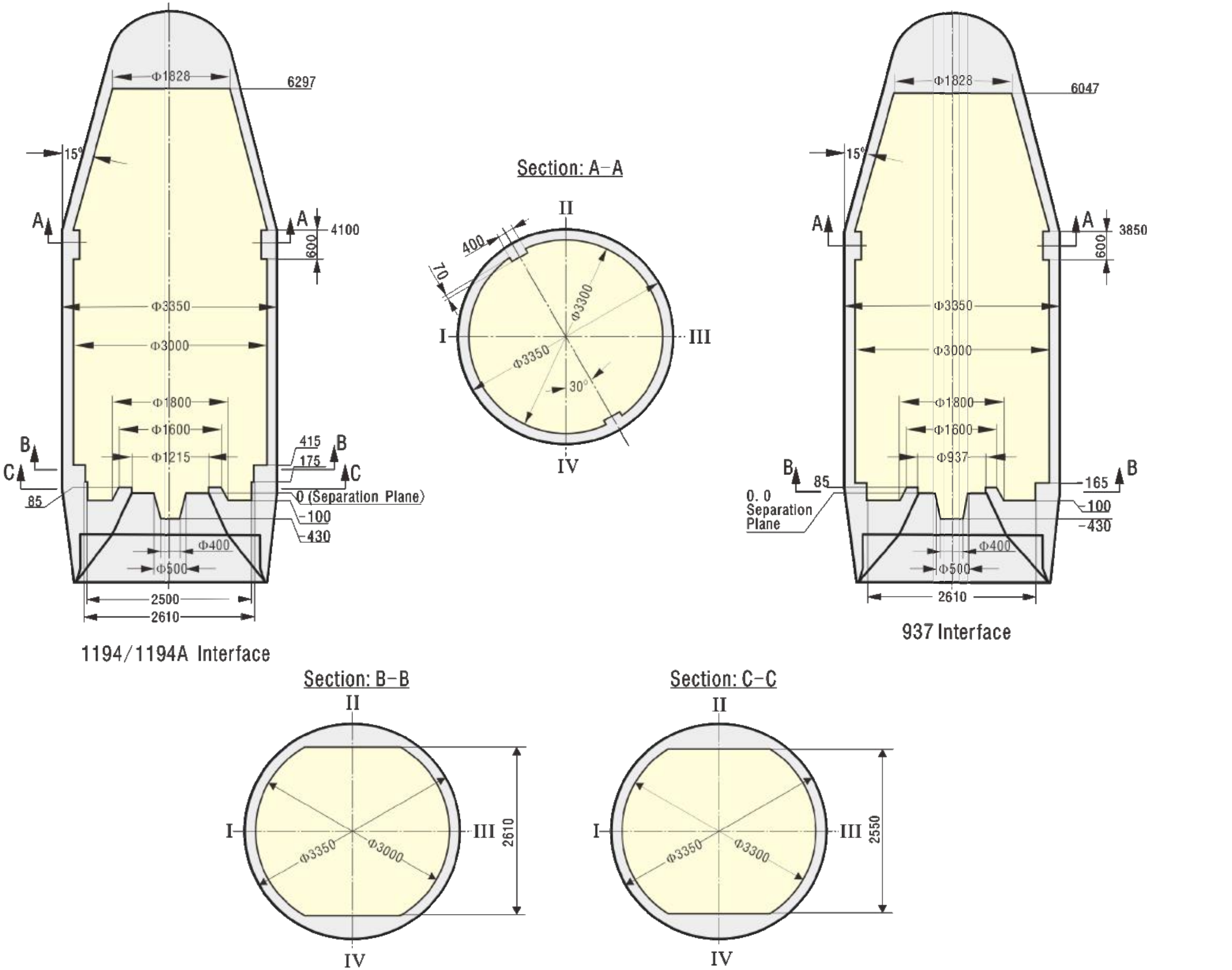


Figure 4-2b 3350 Fairing Static Envelope

Figure 4-3 3350 Fairing Encapsulation-on-Pad

4.3 3700Z Fairing

The 3700Z fairing has an external diameter of 3,700 mm, a total height of 10,796 mm, and is used for dual launch with the LM-3B launch vehicle with satellite encapsulated in the BS3. This fairing can be used with the 1194 and 1194A Payload Adapter (PLA) interfaces. The configuration and static envelope are shown in Figure 4-4a and 4-4b.

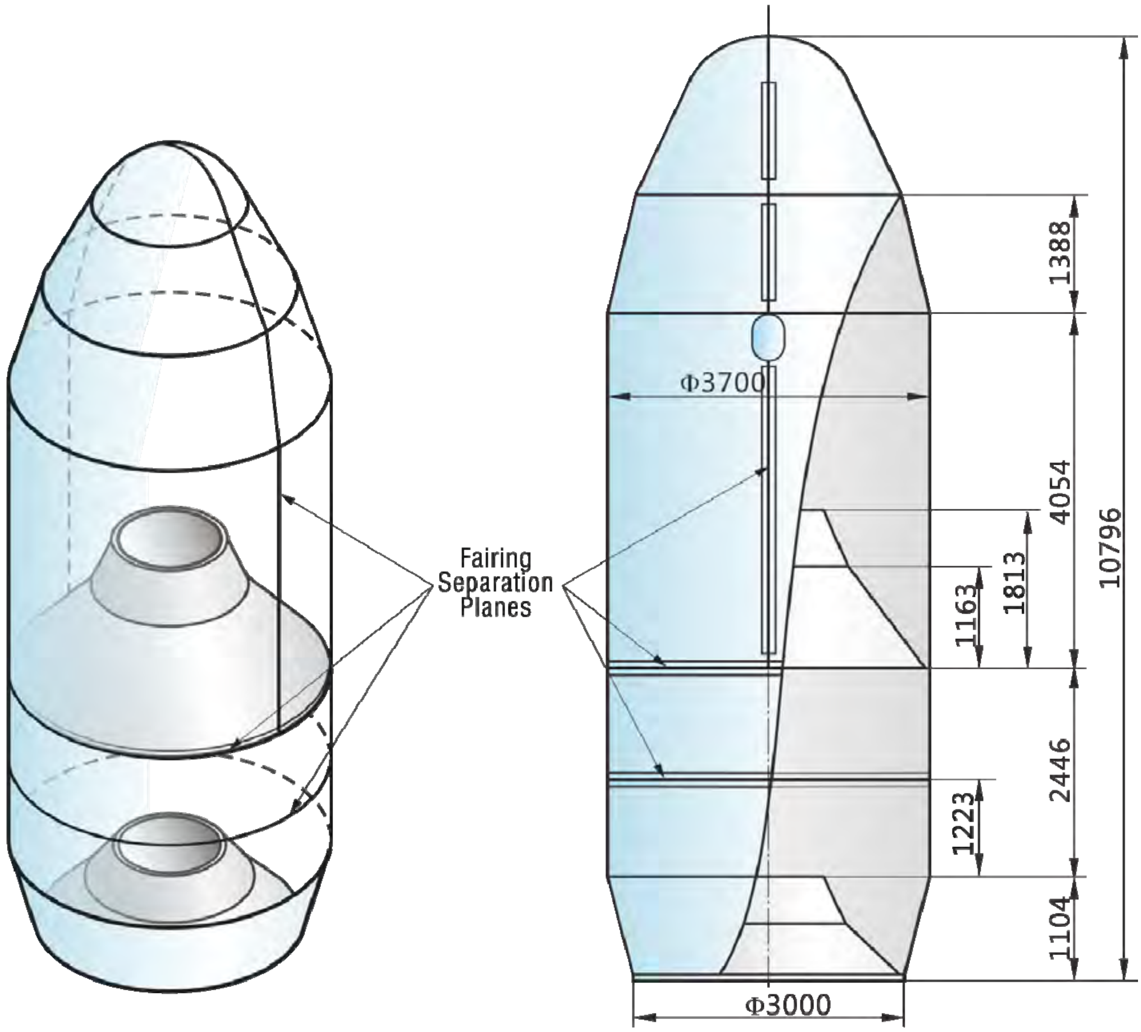


Figure 4-4a 3700Z Fairing

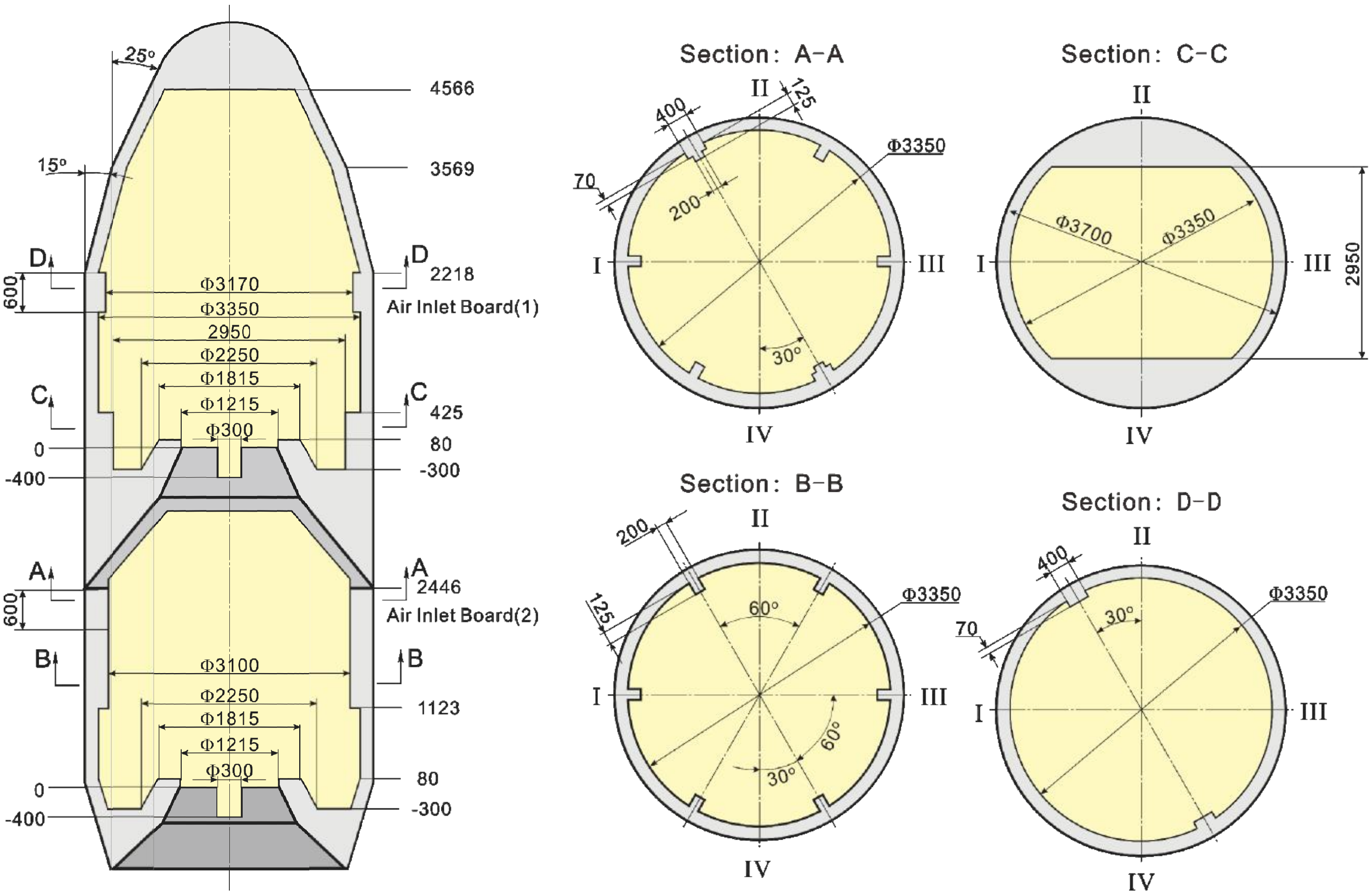


Figure 4-4b 3700Z Fairing Static Envelope

4.4 4000F Fairing

The 4000F fairing has an external diameter of 4,000 mm a total height of 9,561 mm, and is used with the LM-3B and LM-3C launch vehicle for satellite encapsulation on the launch pad. This fairing can be used with the 937B, 1194 and 1194A payload adapters. The configuration and static envelope are shown in Figure 4-5a and Figure 4-5b.

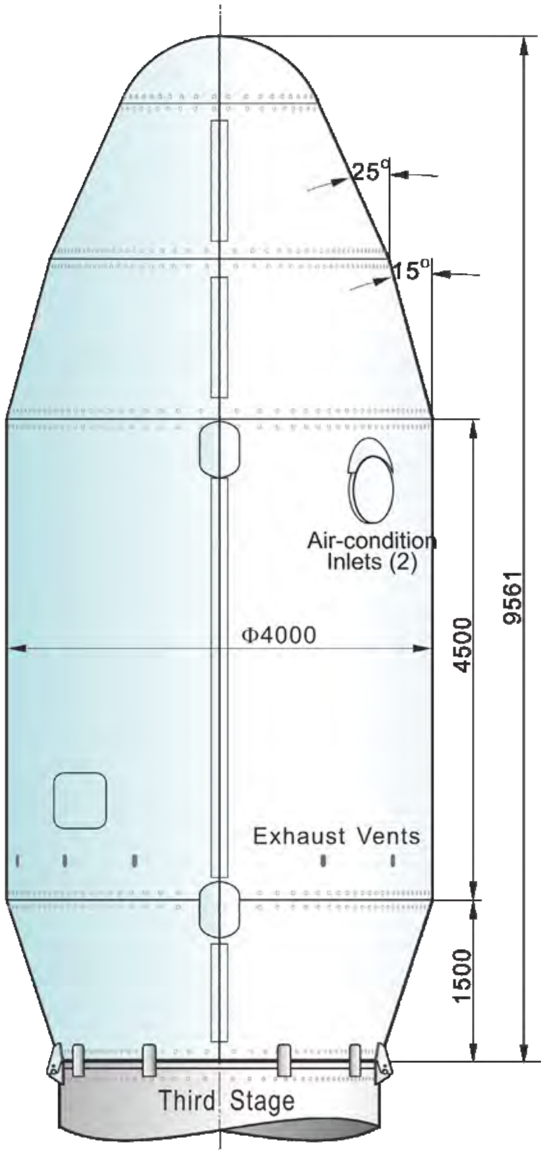


Figure 4-5a 4000F Fairing

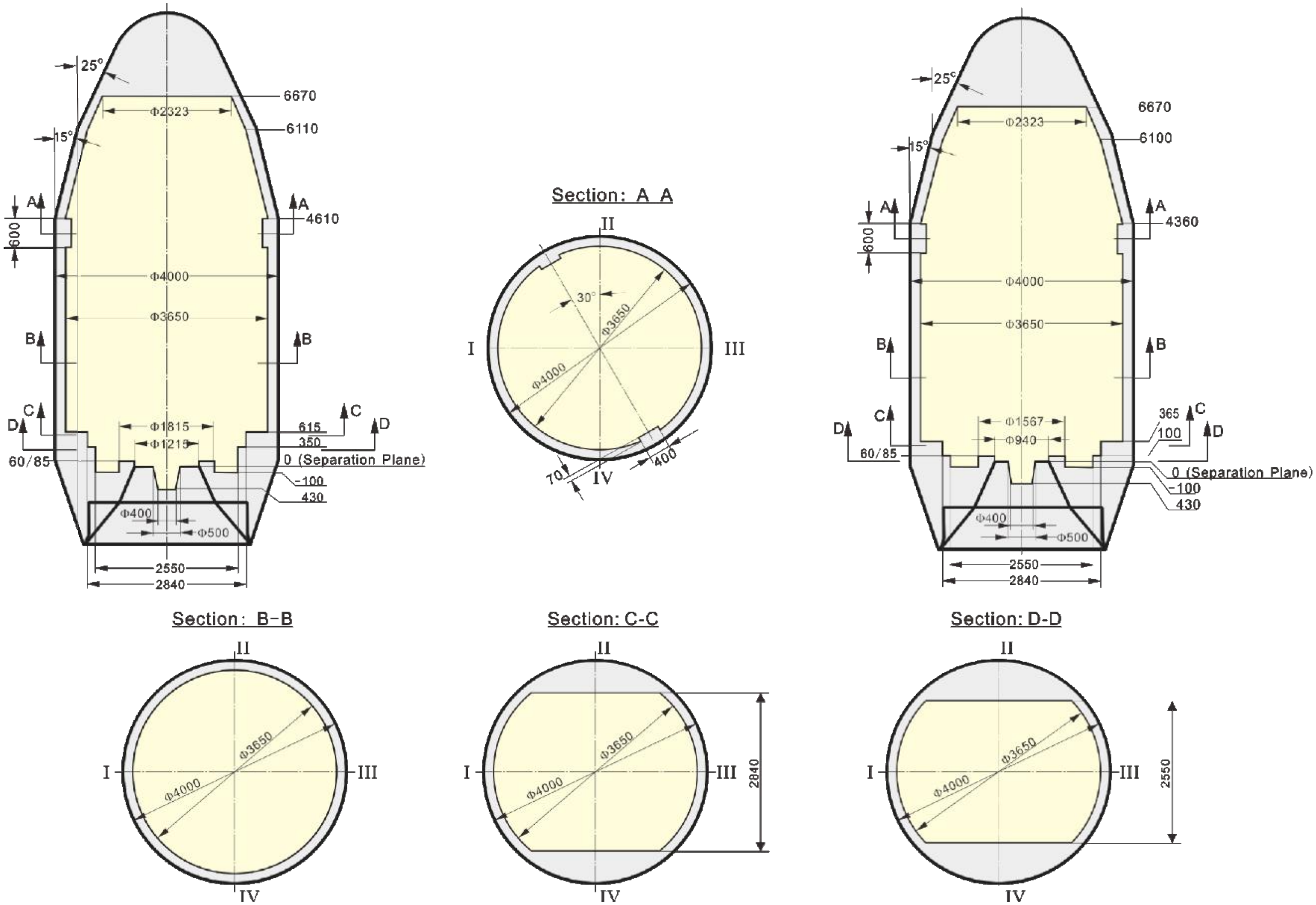


Figure 4-5b 4000F Fairing Static Envelope

Figure 4-6 4000F Faring Encapsulation-on-Pad

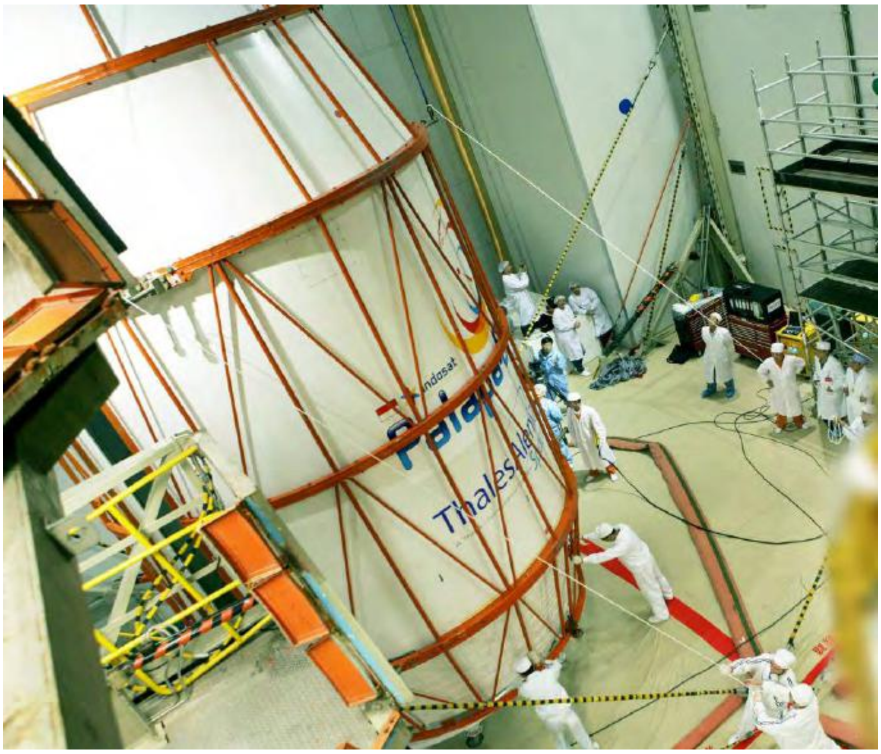


Figure 4-7 4000F Fairing Encapsulation-on-Pad

4.5 4200F Fairing

The 4200F fairing has an external diameter of 4,200 mm, a total height of 9,777 mm, and is used with the LM-3BE launch vehicles for satellite encapsulated on the launch pad. This fairing can be used with the 973B, 1194 and 1194A Payload Adapter (PLA) interfaces. The configuration and static envelope are shown in Figure 4-8a and 4-8b.

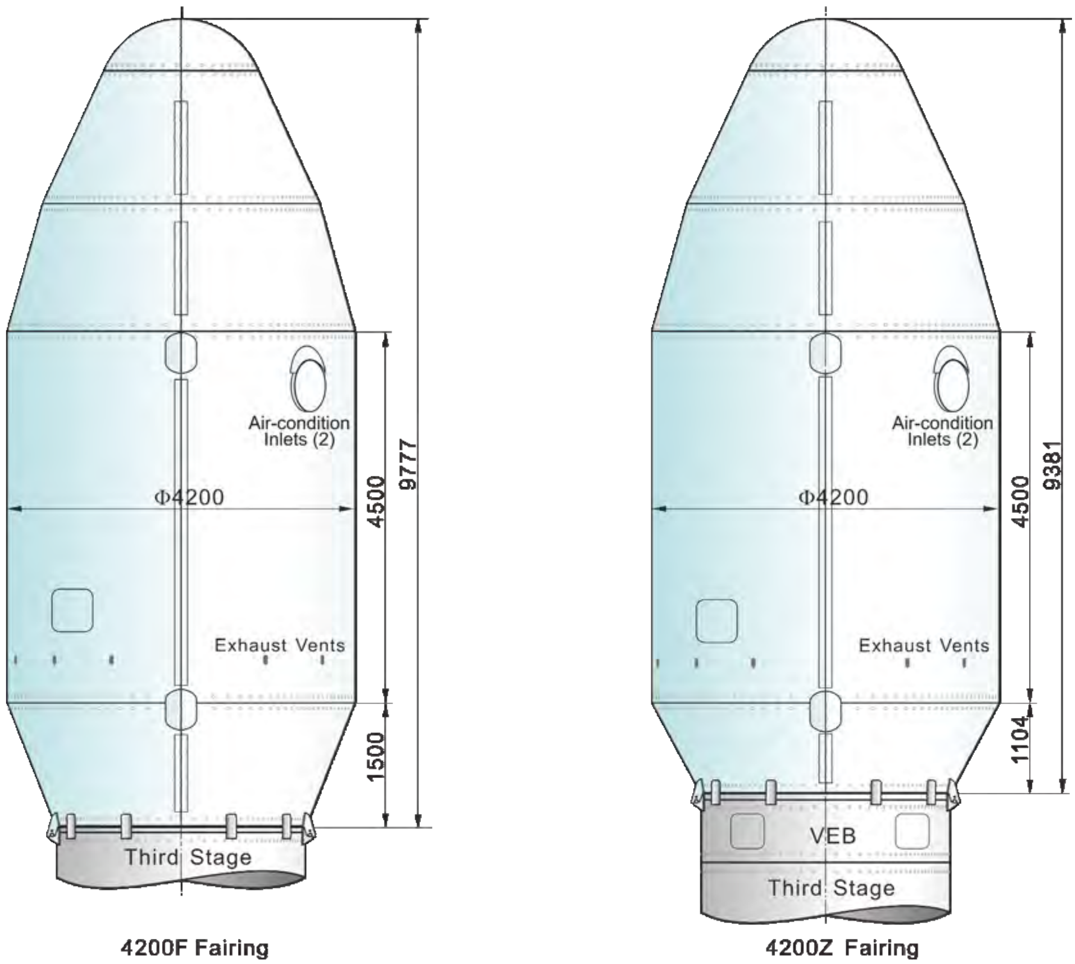


Figure 4-8a 4200F/4200Z Fairing

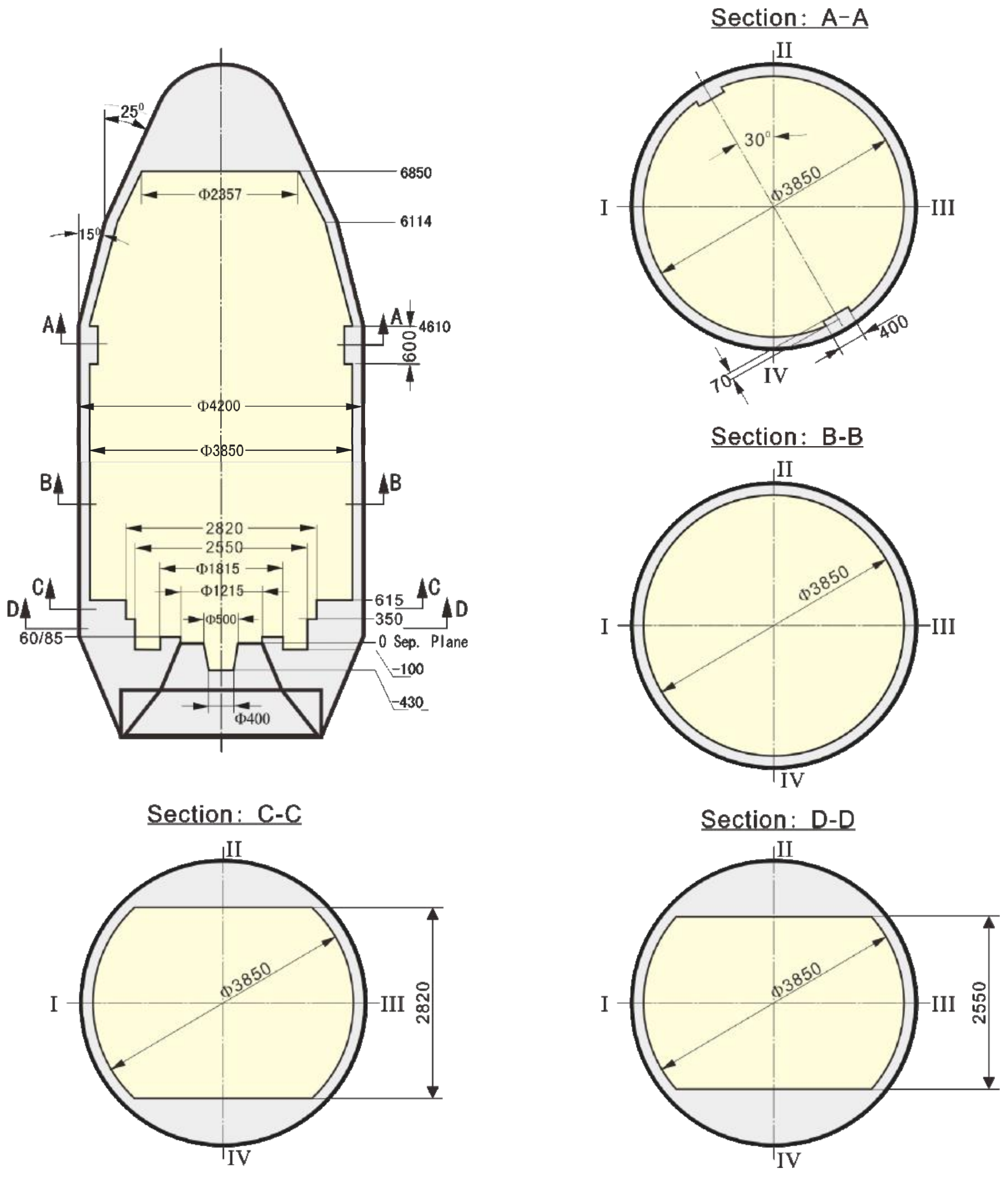


Figure 4-8b 4200F Fairing Static Envelope

4.6 4200Z Fairing

The 4200Z fairing has an external diameter of 4,200 mm, a total height of 9,381 mm, and is used with the LM-3BE launch vehicles for satellite encapsulated in BS3. This fairing can be used with the 973B, 1194 and 1194A Payload Adapter (PLA) interfaces. The configuration and static envelope are shown in Figure 4-8a and Figure 4-8c.

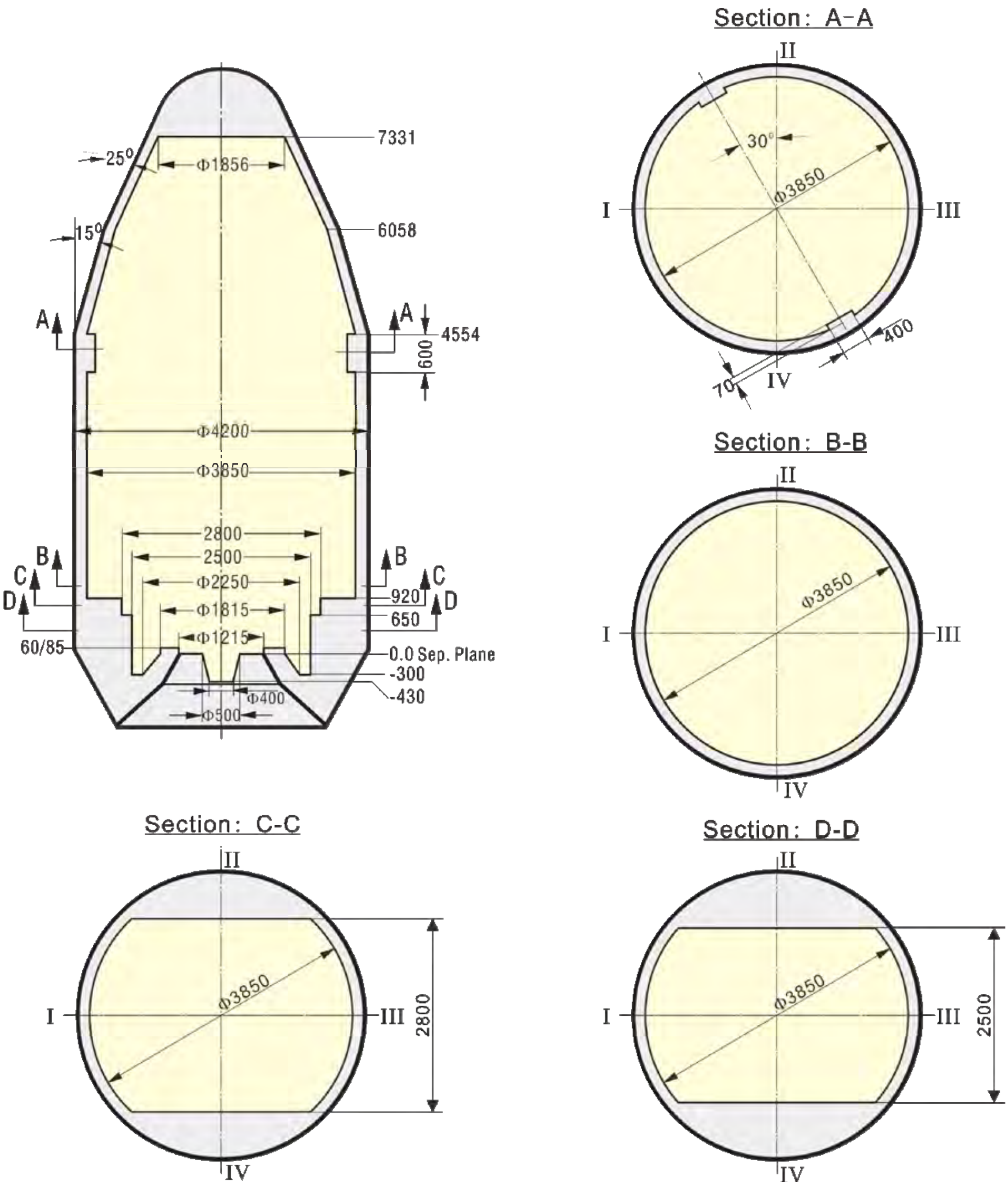


Figure 4-8c 4200Z Fairing Static Envelope

4.7 Static Envelope

The static envelope of the fairing that is usable with the customers' satellite defines the maximum physical dimensions of the satellite to ensure clearance within the fairing. The static envelope varies with the fairing and adapter selected, but within the cylindrical section of the fairing the static envelope for each group of fairings is 3,000 mm diameter for the 3350 fairing, 3,350 mm diameter for the 3700Z fairings, 3,650 mm diameter for the 4000F fairings, and 3,850 mm diameter for the 4200F and 4200Z fairings.

The fairing and adapter static envelopes are shown in Figure 4.2b to Figure 4-8c.

Sections of the satellite appendages that extend into the exclusion zones of the static envelope will require technical coordination with CALT.

4.8 Dynamic Envelope

The dynamic envelope is determined during the mission analysis based on the SC/LV Coupled Loads Analysis (CLA).

4.9 Thermal Protection

The fairings are designed to ensure that the temperature of the inner surface of the fairing structure does not exceed 80°C during the powered flight phase.

4.10 Fairing Separation

The fairing separation system includes a lateral and longitudinal release mechanism with a rotating separation mechanism. The release mechanism for the 3350 fairing uses explosive bolts, and the separation mechanism consists of separation springs with rotating hinges. The release mechanism for the 3700Z, 4000F, 4200F and 4200Z fairing use the notched bolts, explosive cord and explosive bolts, and the separation mechanism consists of separation springs with rotating hinges. See Figure 4-9a and Figure 4-9b.

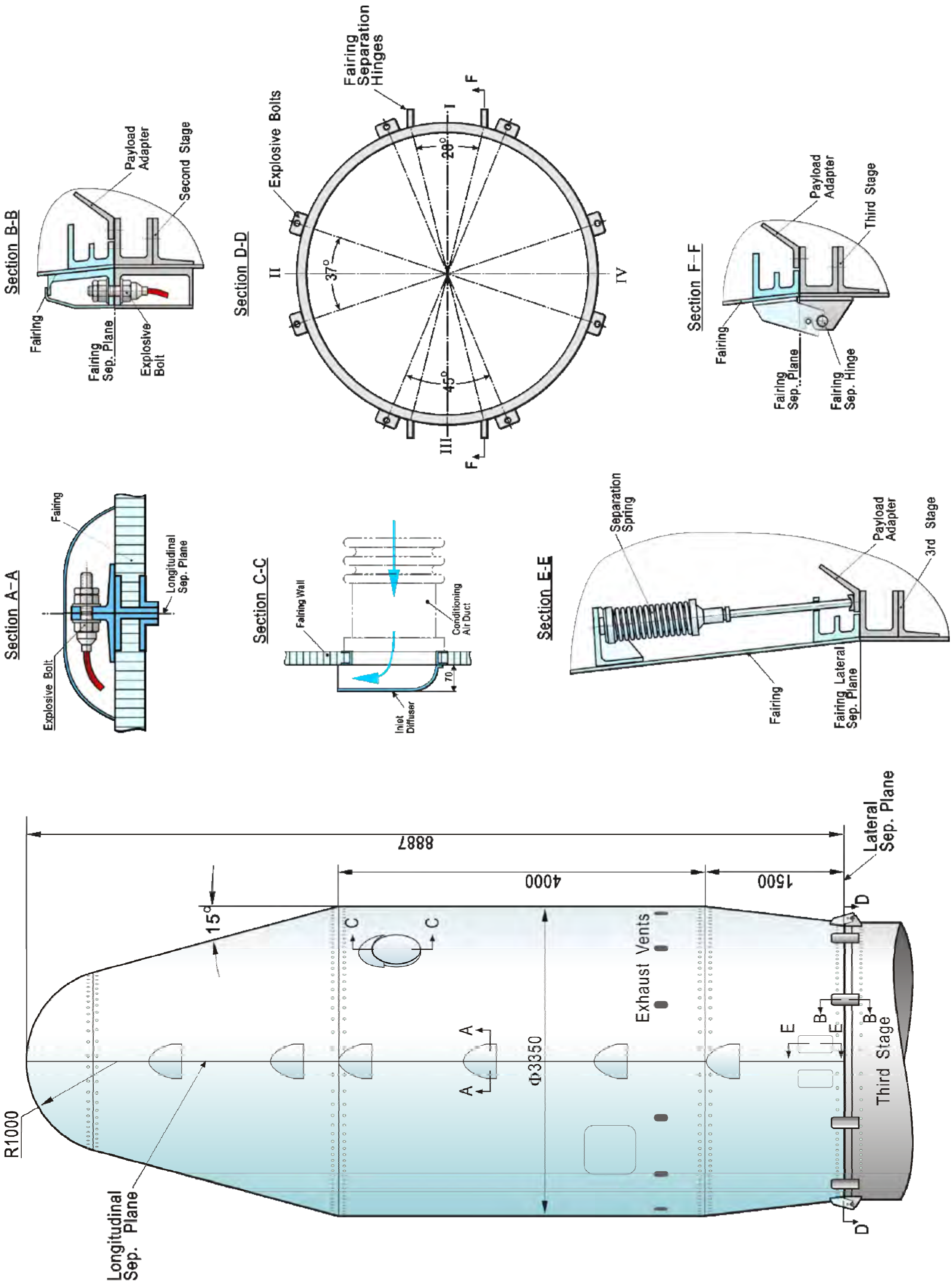


Figure 4-9a Structure & Separation Device of LM-3A Fairing

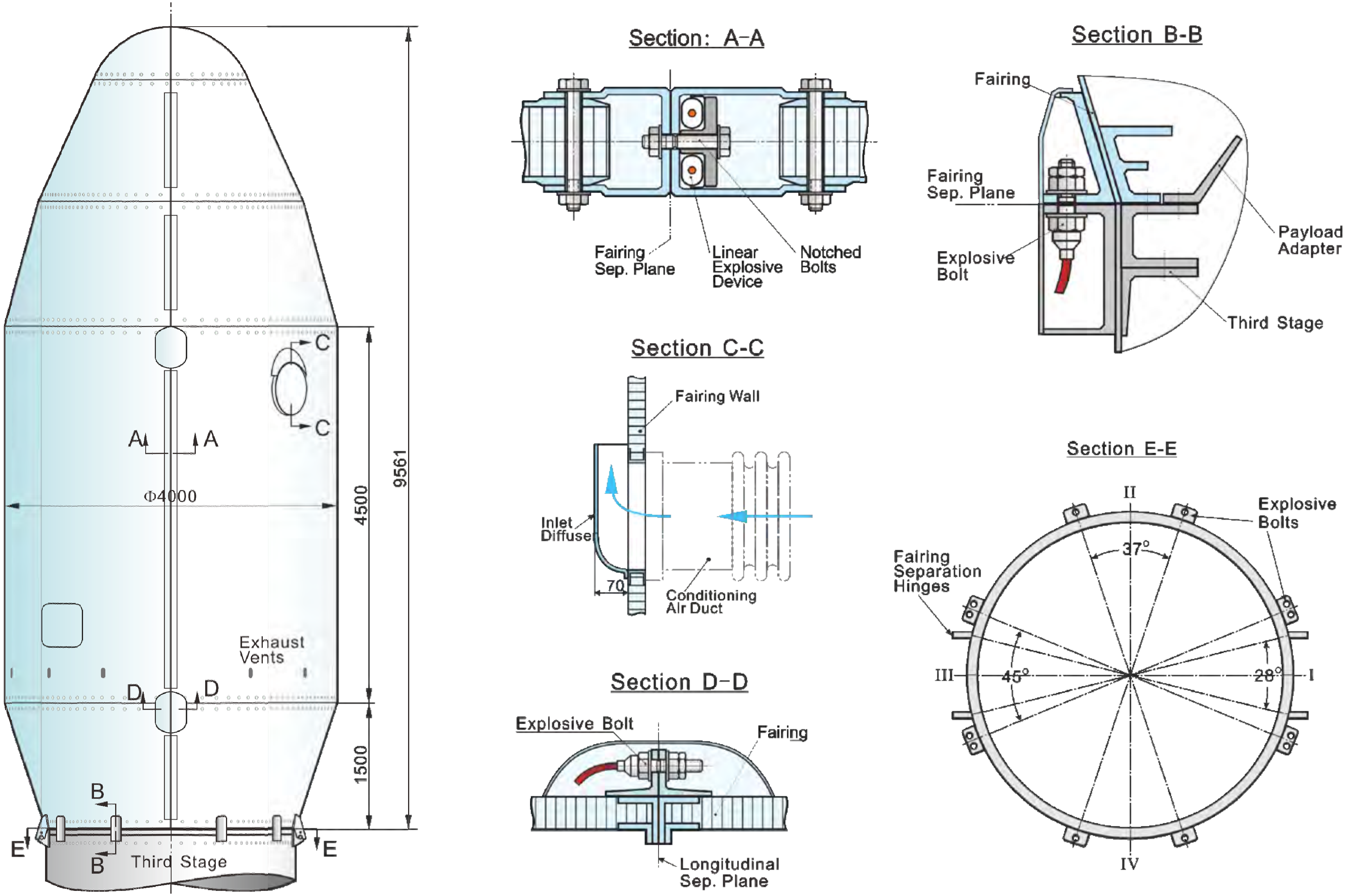


Figure 4-9b Structure & Separation Device of LM-3B/3BE/3C Fairing

4.10.1 Lateral Release Mechanism

For all types of fairing, the base ring of the fairing is connected to the forward skirt of the third stage with explosive bolts. The lateral explosive bolts are simultaneously detonated to release the lateral connection for fairing separation.

4.10.2 Longitudinal Release Mechanism

For the 3350 fairing, the longitudinal separation system comprises twelve explosive bolts, which are simultaneously released with the lateral explosive bolts at fairing separation.

For 3700Z, 4000F, 4200F and 4200Z fairings, the longitudinal release mechanism uses notched bolts, explosive cord, expanding hose, and two explosive bolts. All these parts jointly take their actions to perform the release functions.

4.10.3 Fairing Separation Mechanism

The fairing separation mechanism comprises hinges and springs, with each half of the fairing being supported by two hinges. There are six separation springs on each half of the fairing, and after the lateral and longitudinal release mechanisms have been activated, each half of the fairing turns around the hinge under the spring force to accomplish the fairing jettisoning.

4.11 RF Windows and Access Doors

Radio frequency (RF) transparent windows can be incorporated into the fairing biconical section and cylindrical section to allow the satellite command and telemetry signals to be available to the satellite via RF transmission. The RF windows are tailored to the customer's specific requirements as defined in the ICD. The insertion loss and transparency rate for the RF transparent windows are shown in Table 4-2.

Table 4-2 Insertion loss and transparency rate for the RF transparent windows

Frequency (GHz)	0.4	4	8	10	13	15	17
Insertion loss (dB)	0.25	0.47	0.52	1.63	1.4	2.73	4.11
Transparency Rate	0.94	0.89	0.88	0.68	0.72	0.53	0.38

Access doors can be provided in the cylindrical section to permit limited access to the satellite after the fairing encapsulation and these are tailored to the customer's requirements.

The un-shadowed areas in Figure 4-10a, Figure 4-10b and Figure 4-10c are available for RF windows and access doors. The size, location and number of RF window / access door will be fixed at eight months prior to launch (launch - 8 months).

4.12 Customer Logo

The customer can have a specially designed logo painted or sticked to the cylindrical section of the fairing and appropriately positioned. The overall design and location will be determined through the Interface Control Document (ICD) and Mission Reviews. The artwork for the logo is to be supplied by the customer not later than eight months prior to launch (Launch - 8 months).

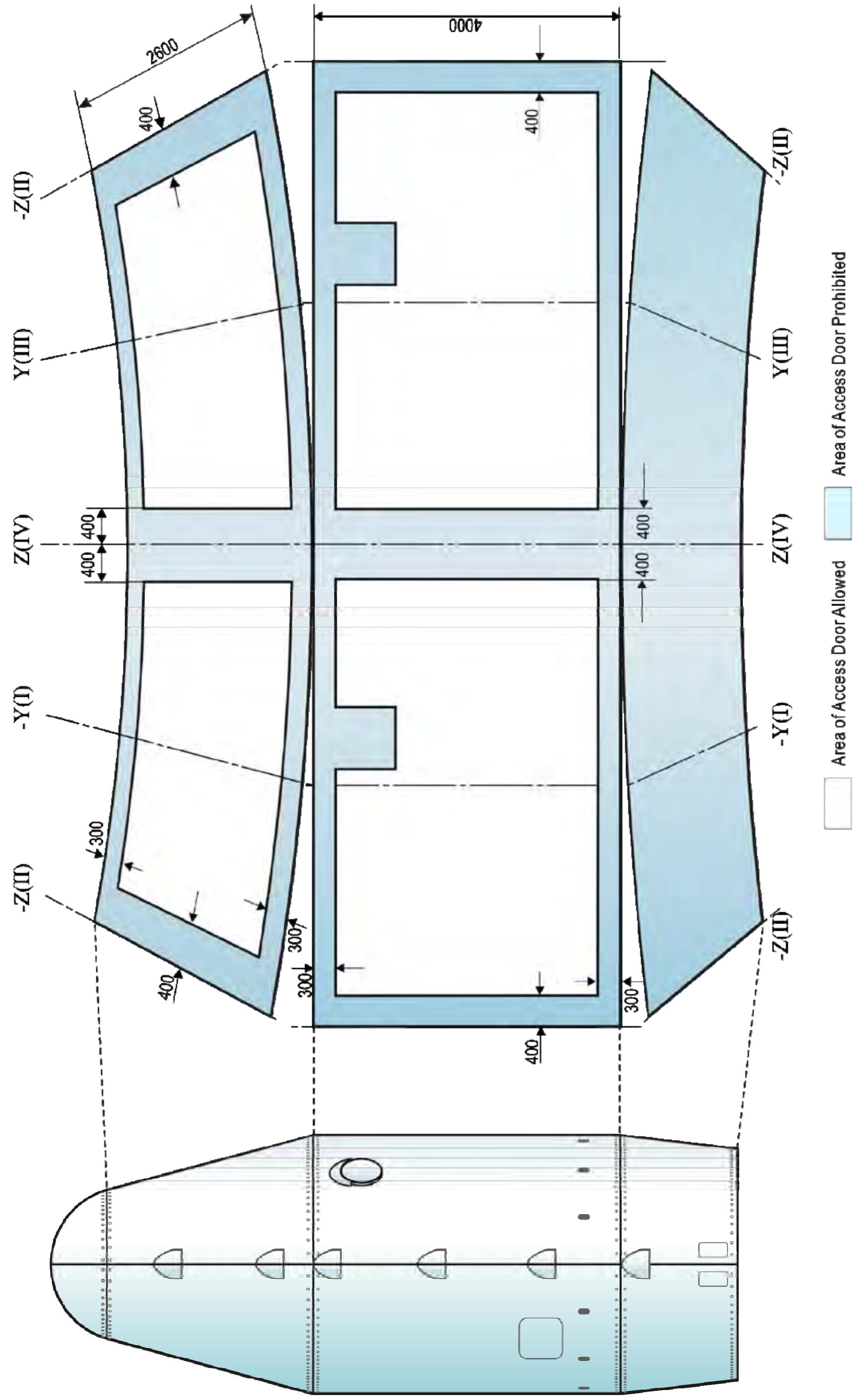


Figure 4-10a Access Door & RF Window Allowable of 3350 Fairing

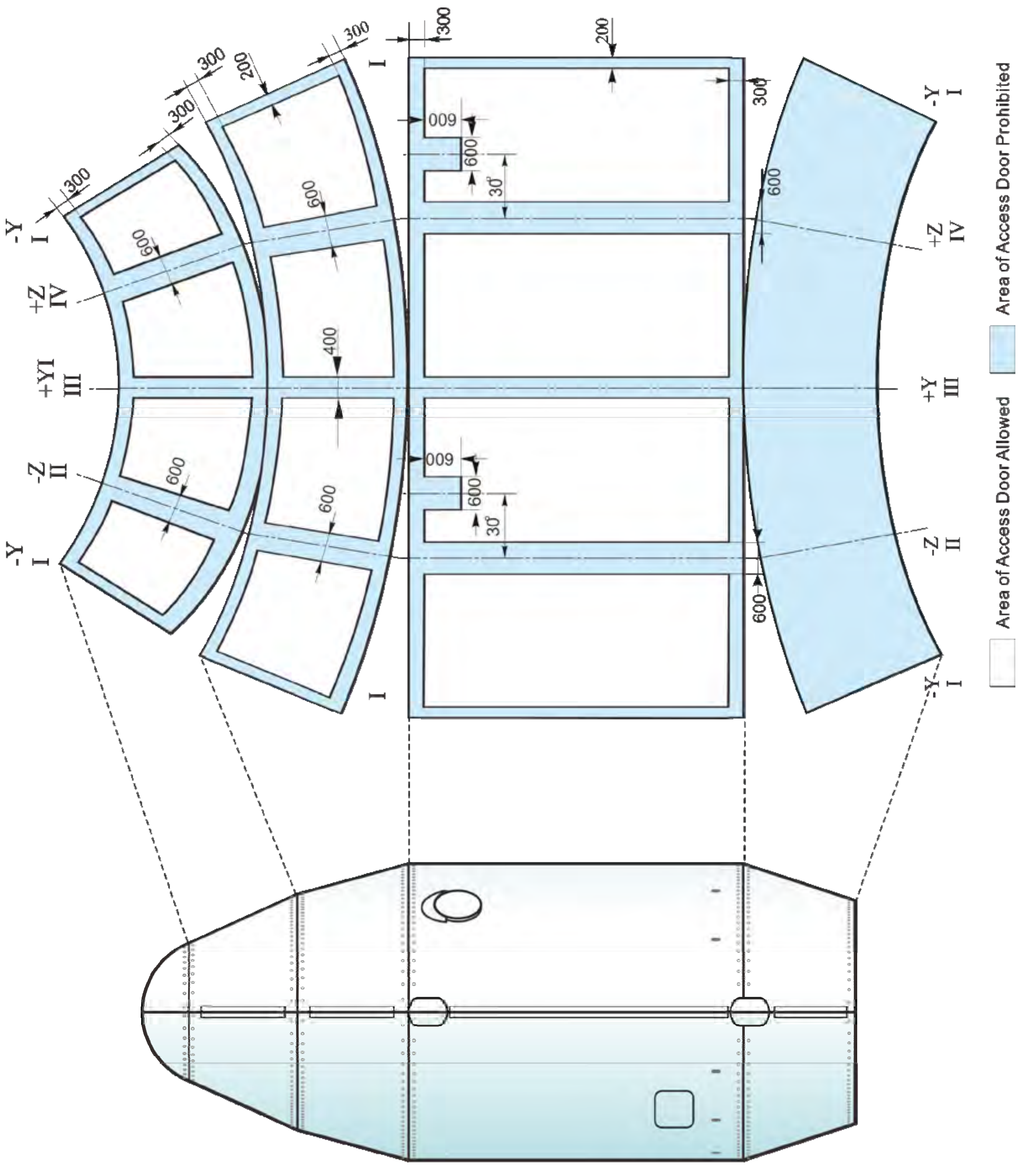


Figure 4-10b　Access Door & RF Window Allowable of 4000F/4200F/4200Z Fairing

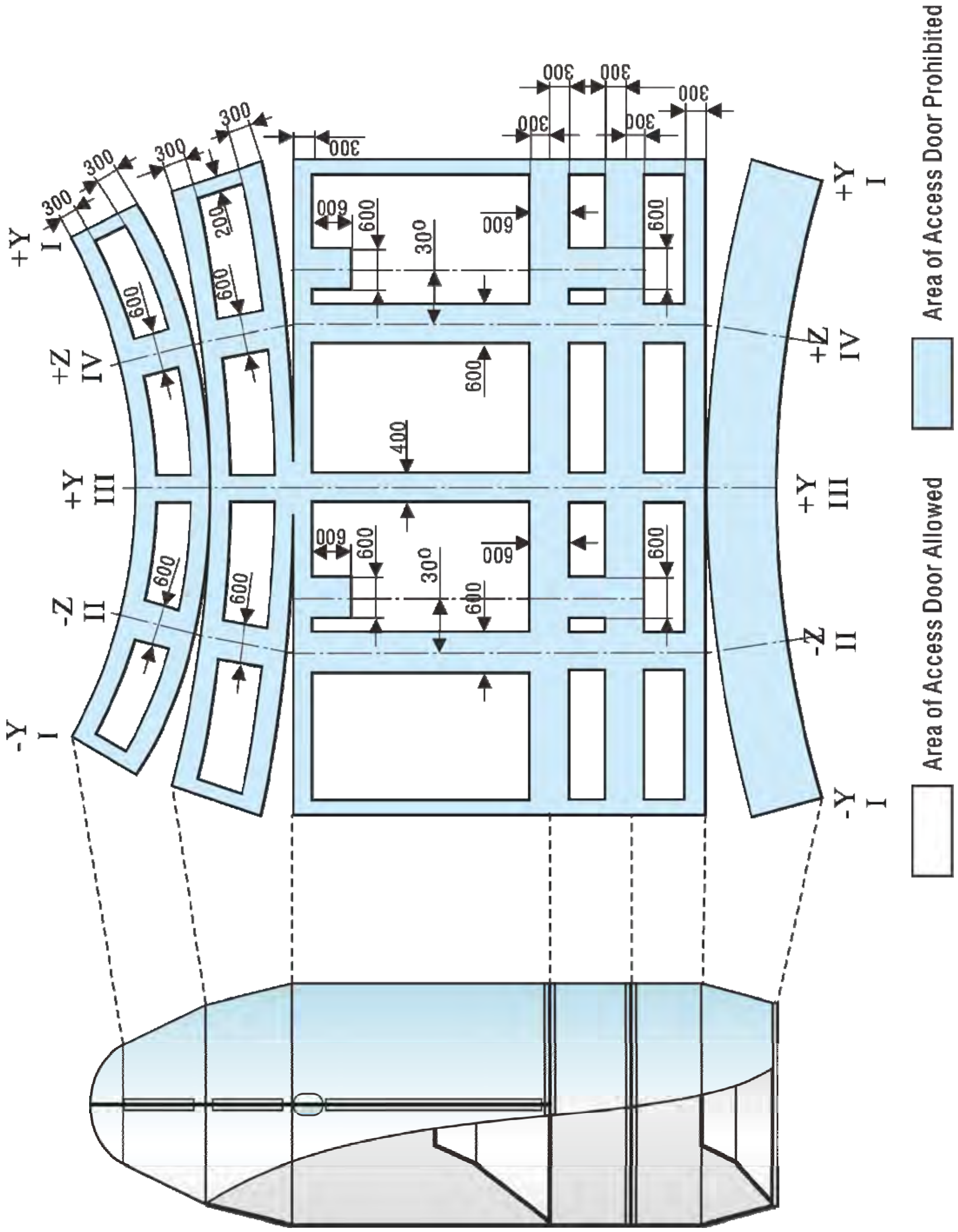


Figure 4-10c Access Door & RF Window Allowable of 3700Z Fairing

CHAPTER 5 MECHANICAL AND ELECTRICAL INTERFACES

5.1 Introduction

This Chapter defines the mechanical and electrical interfaces between the satellite and the LM-3A Series launch vehicles. The mechanical interface is to mate the satellite with the launch vehicle via the Payload Adapter (PLA). The electrical interface electrically connects the satellite with launch vehicle and satellite ground support equipment.

5.2 Satellite Reference Axes

The satellite coordinate system shall be aligned with the coordinate system of the LM-3A Series launch vehicle as shown in Figure 5-1.

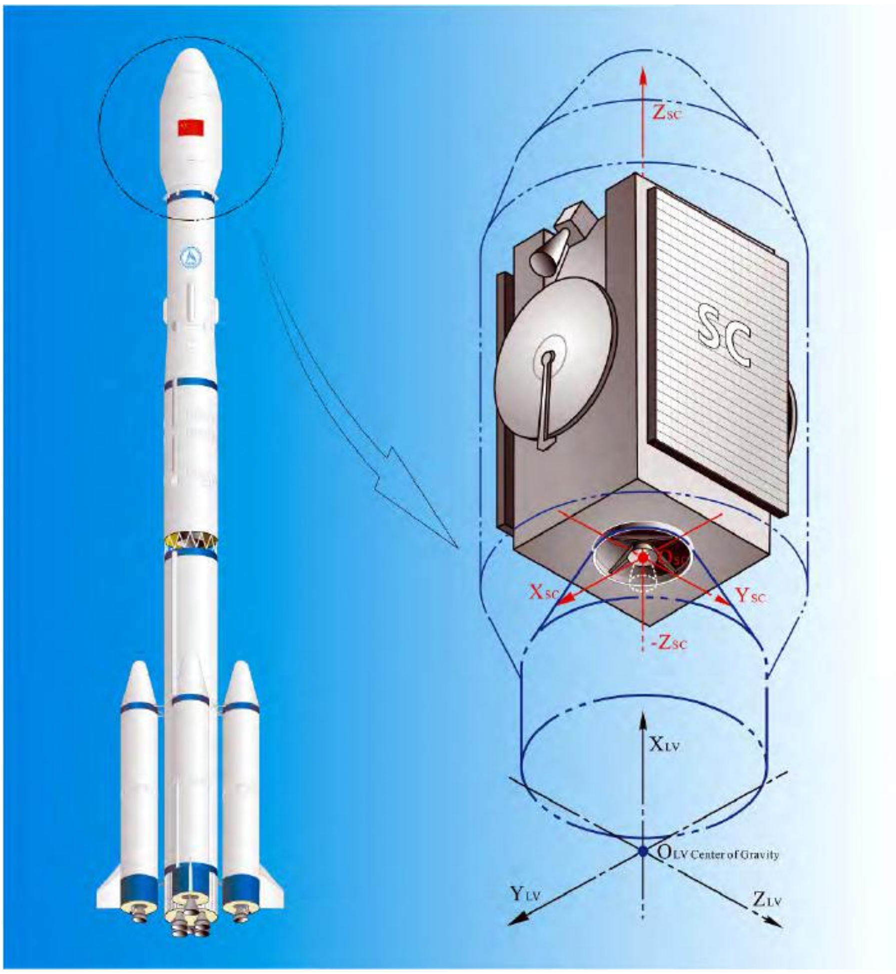


Figure 5-1 LM-3A Series Launch Vehicle Coordinate System

5.3 Mechanical Interface

5.3.1 Introduction

The satellite is mounted on the launch vehicle through the Payload Adapter (PLA) which is mated with the VEB by bolts. The top ring of the PLA is the primary mechanical interface with the satellite, which is attached to the PLA via a clampband. The PLA also includes the separation springs, separation sensors and the umbilical connectors.

5.3.2 Payload Adapter

The LM-3A Series launch vehicle uses the international standard adapter types 937B, 1194 and 1194A to interface with the satellite. These are flight proven adapters and all include the separation system and umbilical brackets. Other interfaces can also be accommodated through technical coordination with CALT.

5.3.2.1 937B Interface (Encapsulation-on-Pad)

The 937B mechanical interface is the upper part of 937B interface adapter, which is a 900 mm high truncated cone. (Refer to Figure 5-2). The top ring, which interfaces with the satellite, is made of high-strength aluminum alloy.

5.3.2.2 1194 Interface (Encapsulation-on-Pad)

The 1194 interface adapter is a 650 mm high truncated cone with top ring diameter of 1,215 mm (Refer to Figure 5-3). The top ring, which interfaces with the satellite, is made of high-strength aluminum alloy.

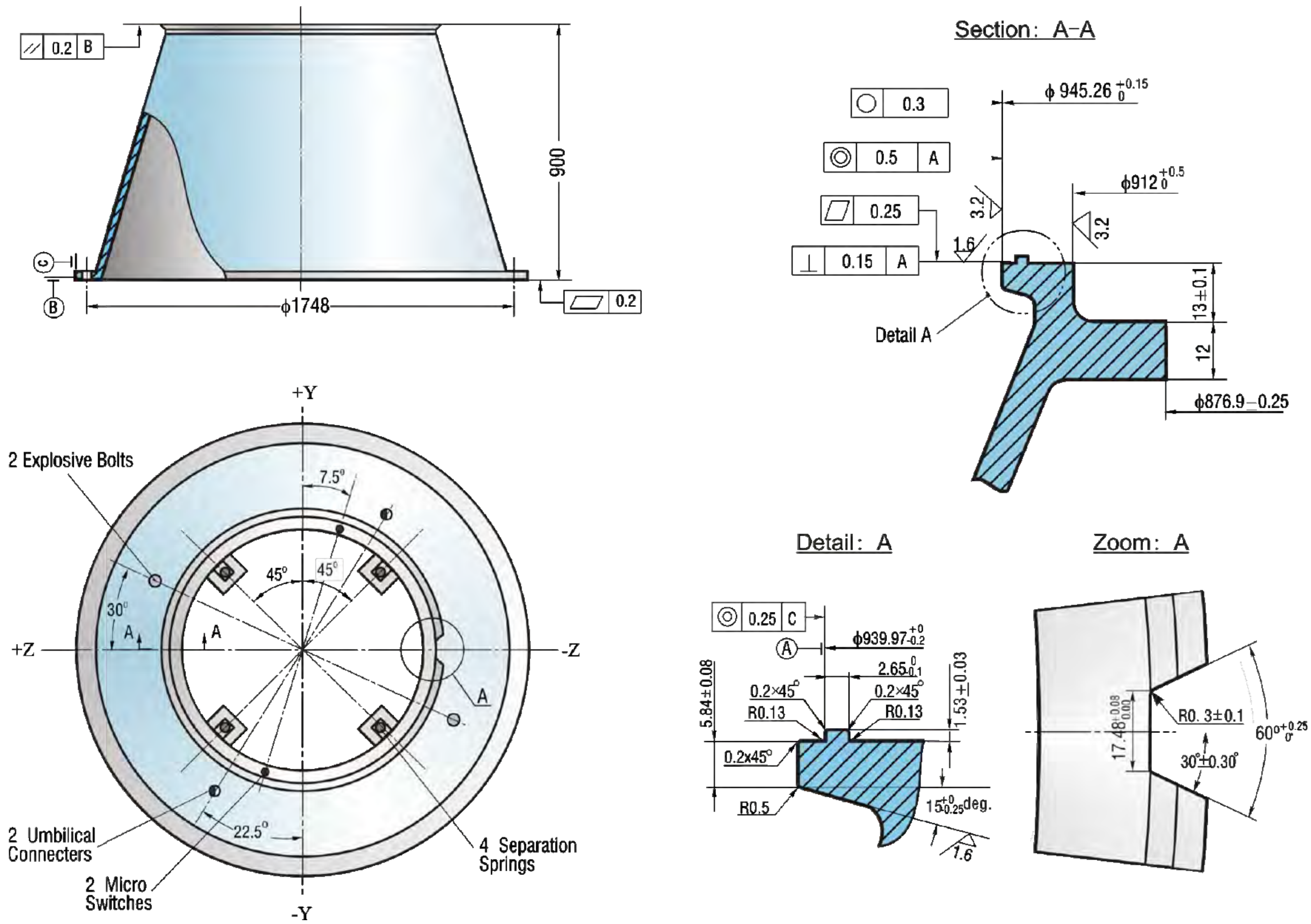


Figure 5-2 937B Interface (Encapsulation-on-Pad)

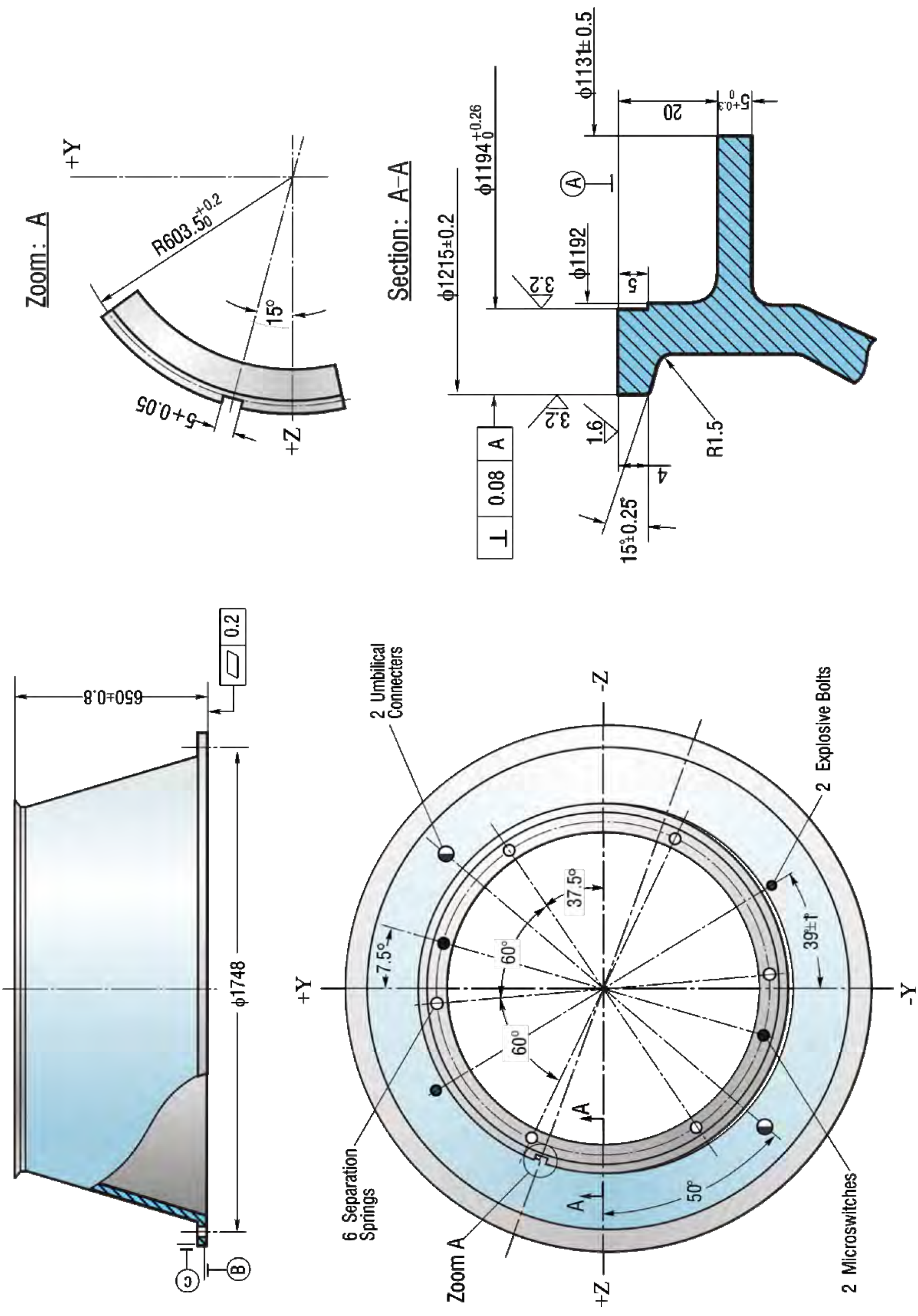


Figure 5-3 1194 Interface (Encapsulation-on-Pad)

5.3.2.3 1194A Interface (Encapsulation-on-Pad)

The 1194A adapter for Encapsulation-on-Pad is a 650 mm high truncated cone (see Figure 5-4 and Figure 5-5).

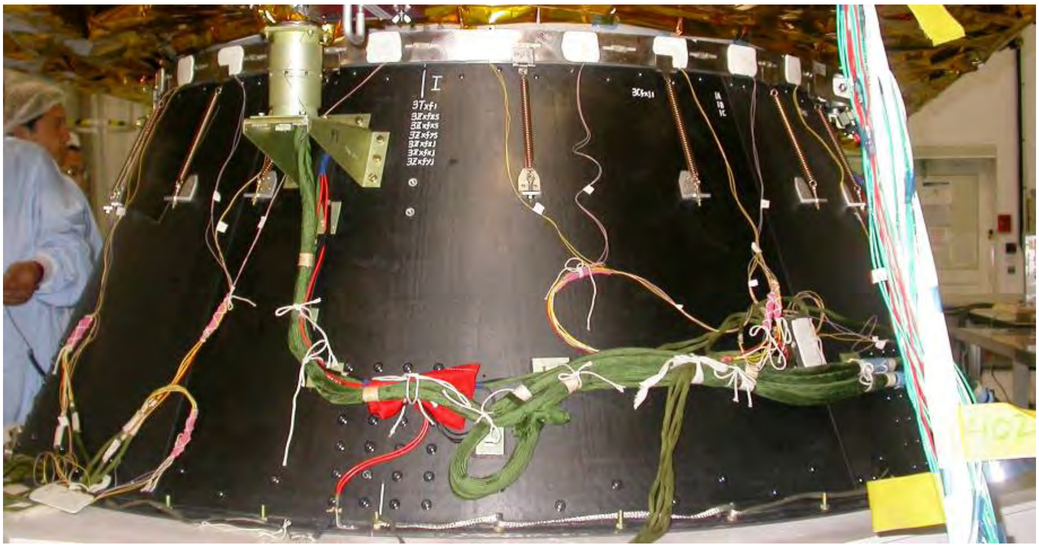


Figure 5-4 Payload Adapter with 1194A Interface

5.3.2.4 1194A interface (Encapsulation-in-BS3)

The 1194A adapter for encapsulation in BS3 is a 450 mm high truncated cone (see Figure 5-6).

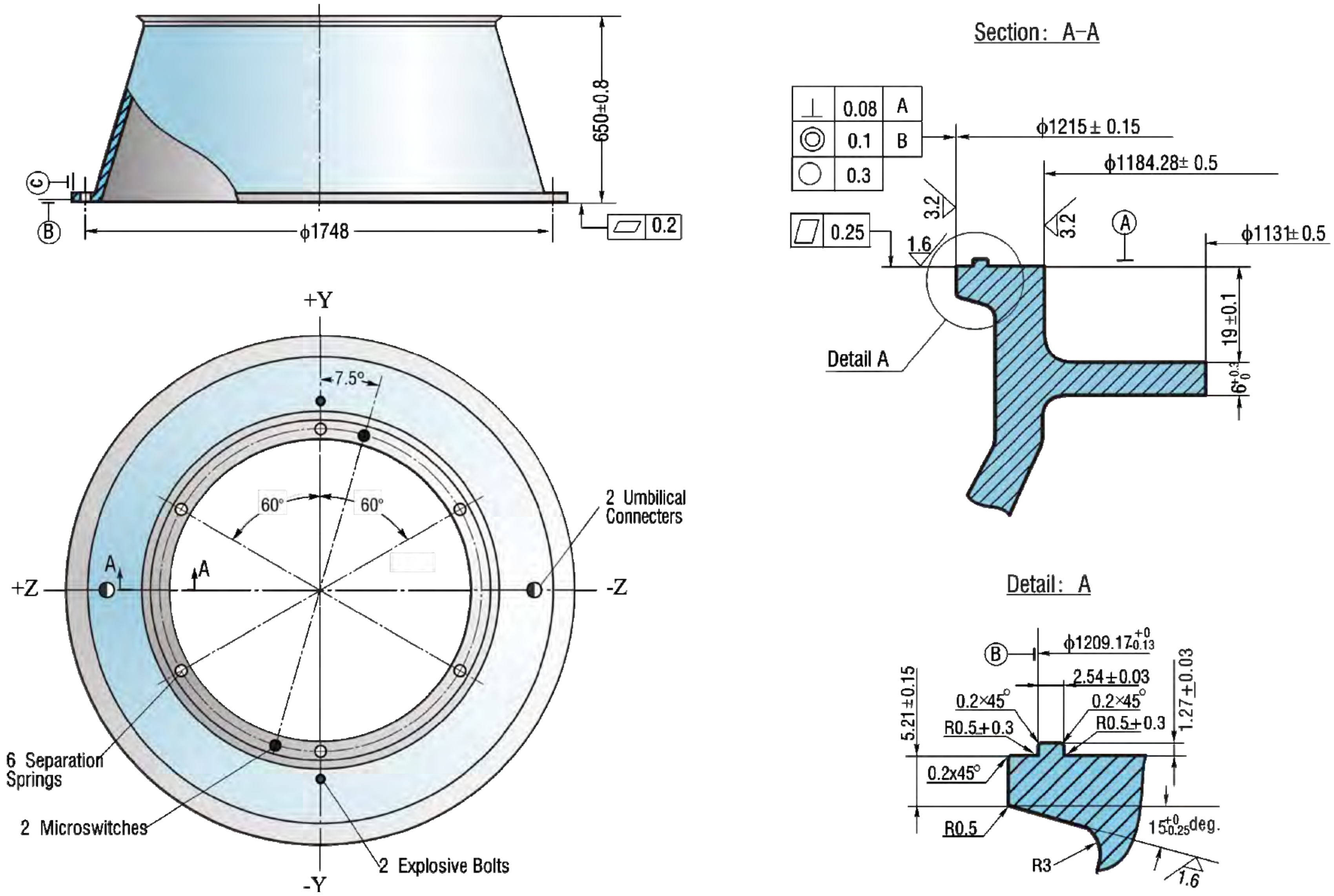


Figure 5-5 1194A Interface (Encapsulation-on-Pad)

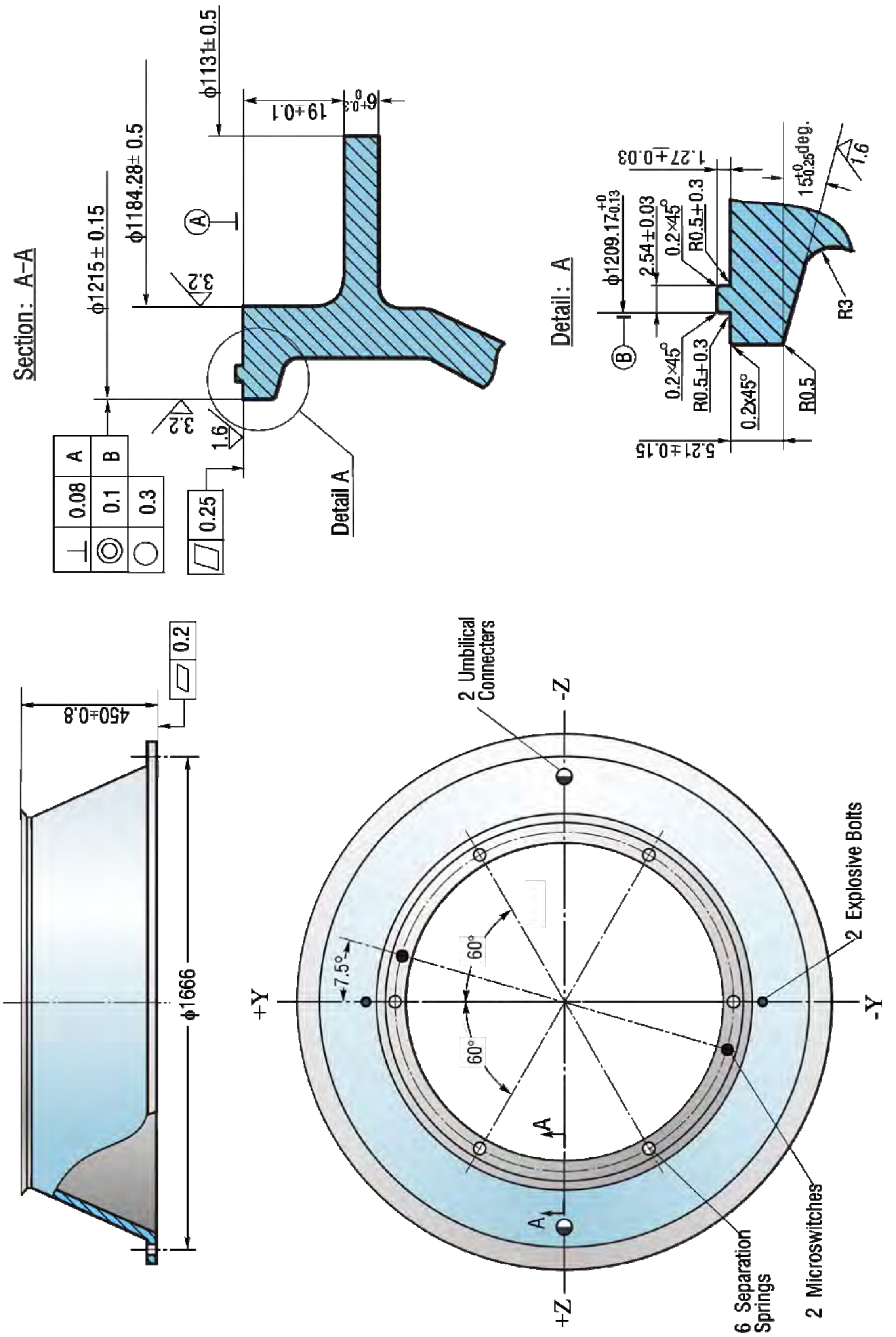


Figure 5-6 1194A Interface (Encapsulation-in-BS3)

5.3.3 Separation System

5.3.3.1 Satellite to Adapter Separation System

The separation system uses a clampband to firmly install the satellite to the Payload Adapter (PLA) and reliably release the satellite from the launch vehicle upon separation. The separation mechanism mounted on the adapter provides the relative separation velocity between the satellite and launch vehicle via separation springs. The separation system is shown in Figure 5-7a, Figure 5-7-b, Figure 5-7c, Figure 5-7d and Figure 5-7e.

5.3.3.2 Separation Mechanism

The separation mechanism consists of a clampband, the non-contamination explosive bolts or cutters, V-shoes, and retention springs.

The clampband consists of two halves made of high-strength steel. There are two models of clampband available, the C100 model which is 100 mm wide and uses two explosive bolts (see Figure5-7a), and C60 model which is 60 mm wide and uses two explosive cutters (see Figures 5-7b and Figure 5-7c).

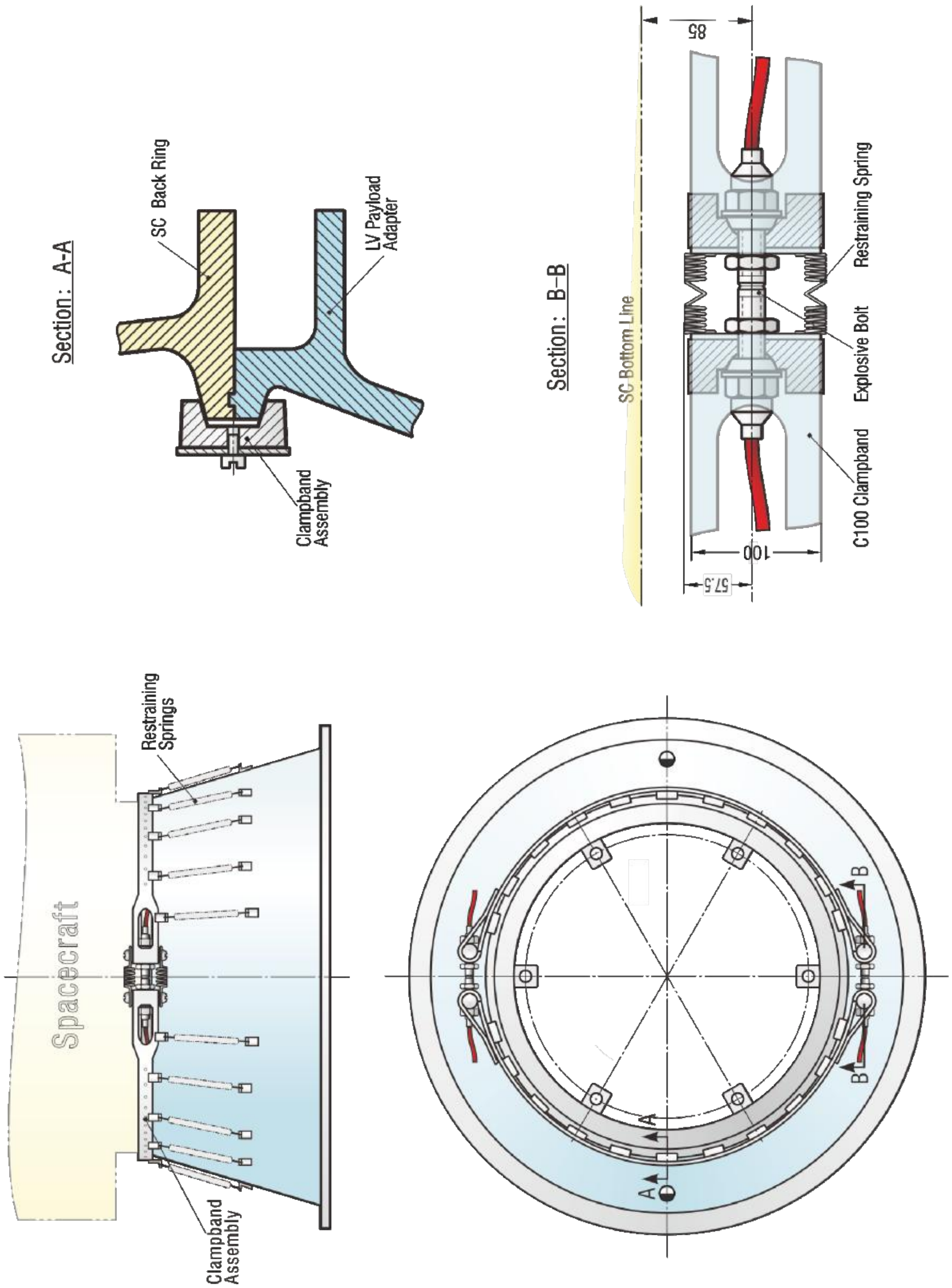


Figure 5-7a C100 Separation Mechanism

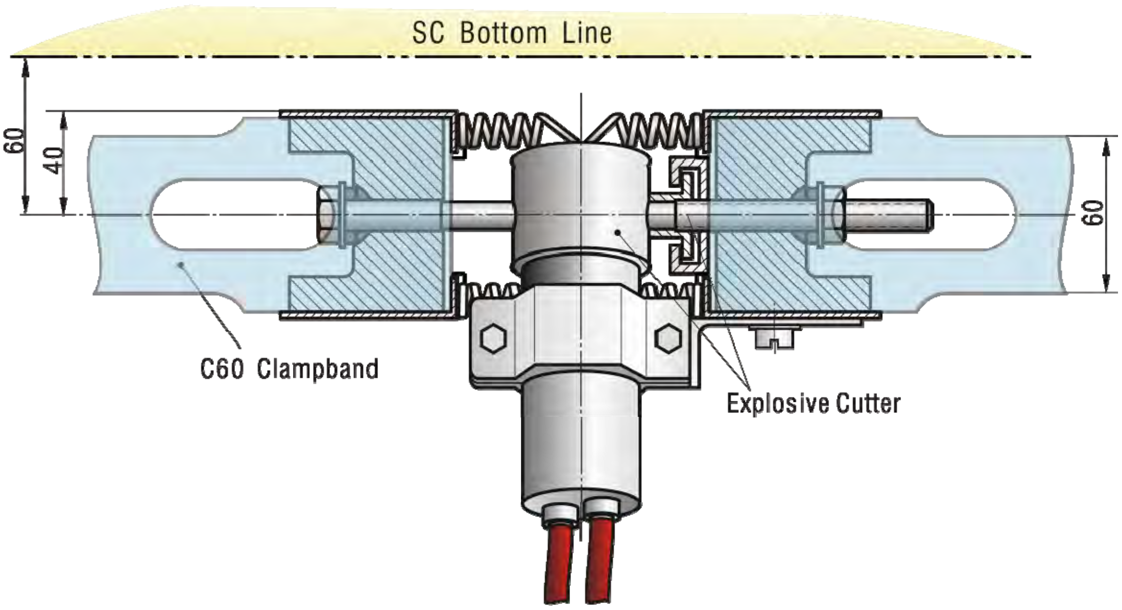


Figure 5-7b C60 Separation Mechanism

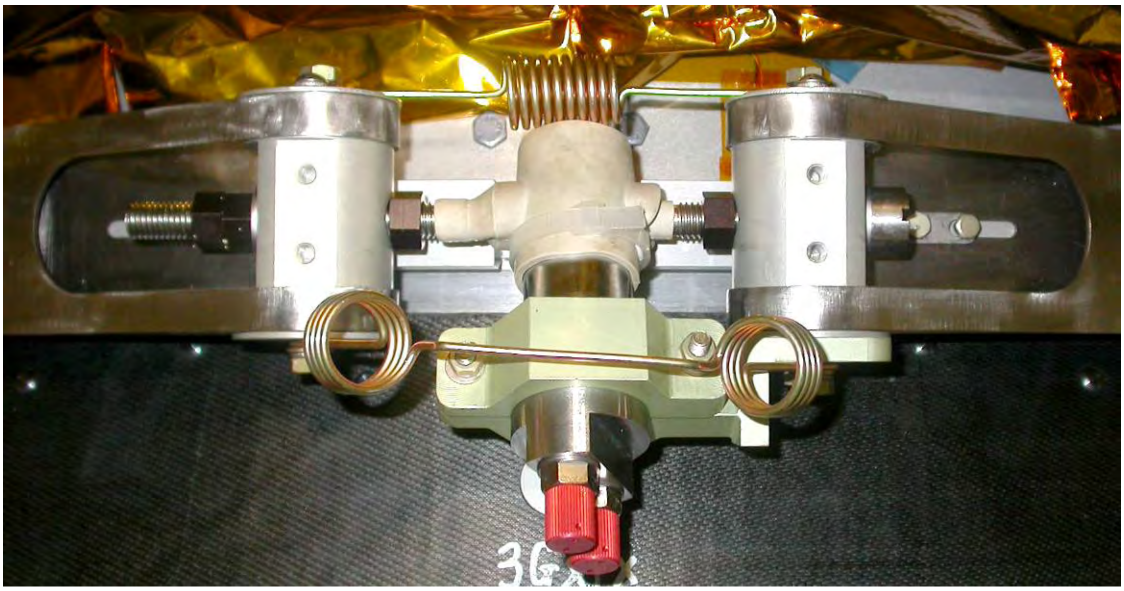


Figure 5-7c C60 Separation Mechanism

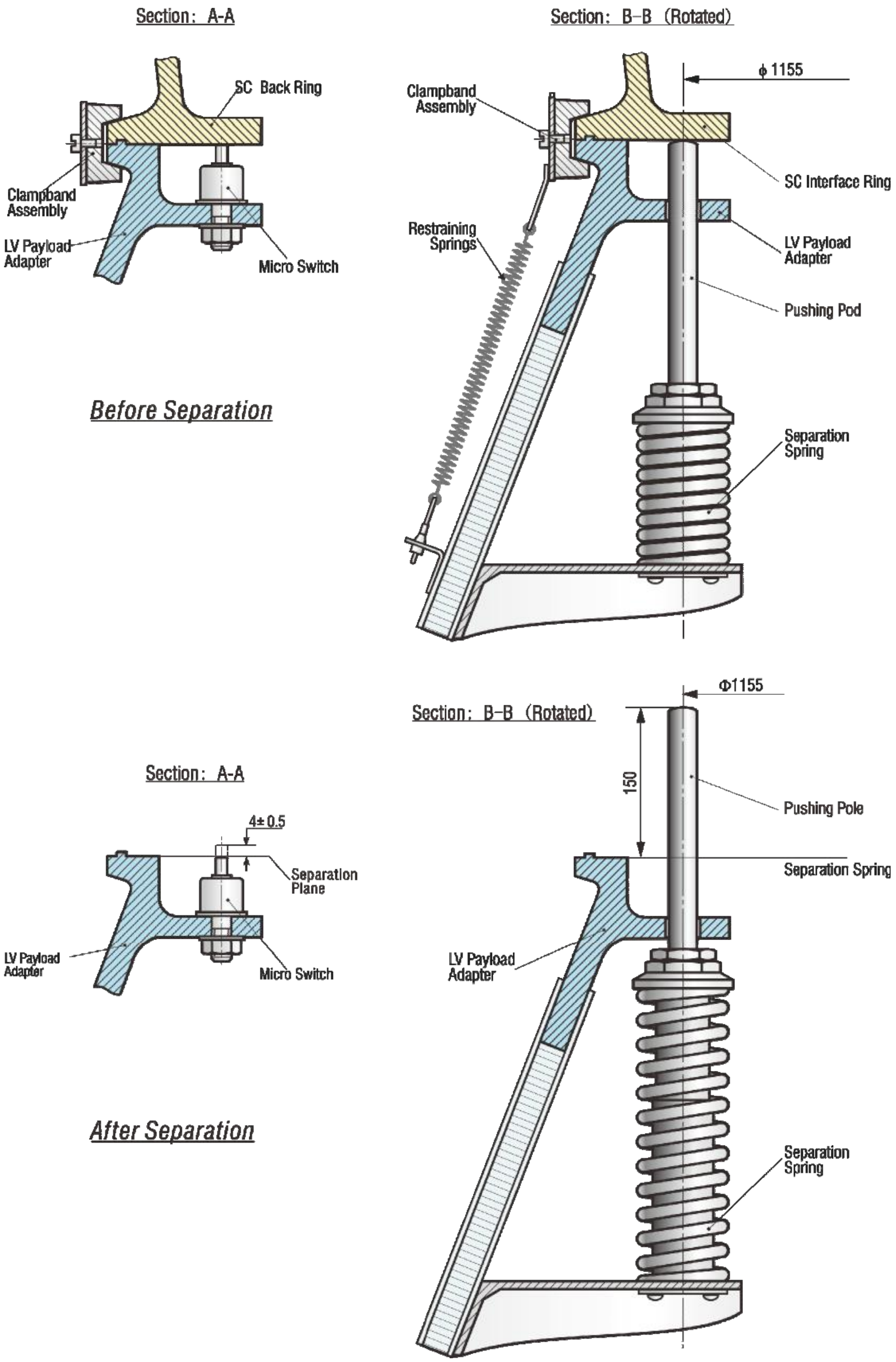


Figure 5-7d SC Separation Springs

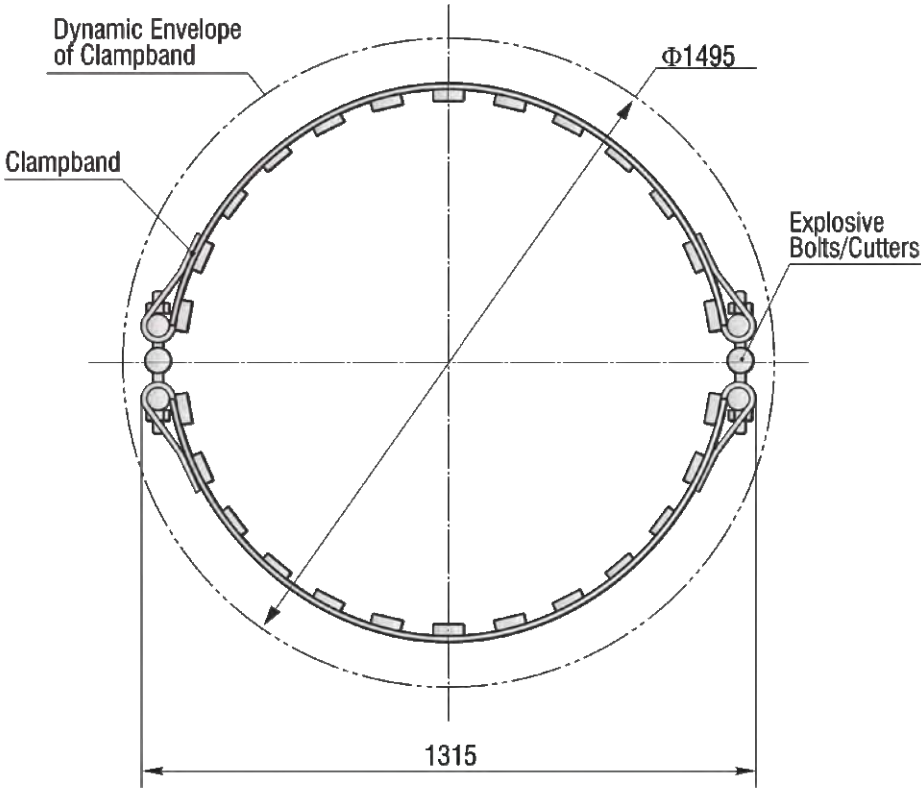


Figure 5-7e 1194/1194A Clampband

The non-contamination explosive bolts and explosive cutters are fully redundant with each bolt or cutter having two igniters. The maximum allowable tension force for cutters is 45 kN, and for the explosive bolt the margin is much greater.

The V-shoes, which are made of high strength aluminum, are used for clamping the interface ring of the satellite to the top ring of the Payload Adapter (PLA).

The lateral-restraining springs are used for restraining the outward movement of the clampband and the longitudinal-restraining springs restrict the movement of the clampband toward the satellite after clampband release. The two halves of the clampband are therefore restrained to the PLA below the separation plane to avoid re-contact.

The separation spring assembly is mounted on the PLA providing a separation velocity of 0.5 m/s or greater, and can also provide a lateral axis spin rate of less than 3.0 deg/s, the spin rate being dependent on the customer's requirement.

5.3.3.3 Installation Requirements

During the installation of the clampband system, 10 strain gauges are installed on each half of the clampband so that the strain and pretension at each measuring point can be monitored in real time. A special purpose tool is used to apply the pretension, which is normally in the range of 24~30 kN. The pretension can, however, be adjusted to meet the specific requirements of the satellite and the results of the coupled load analysis.

For both C100 and C60 clampband, a minimum clearance of ≥ 85 mm for C100 and ≥ 60 mm for C60 is required between the lowest point on the satellite and the separation plane after installation. If that cannot be achieved, there should be a minimum clearance of ≥ 20 mm between the lateral-restraining springs and the lowest point on the satellite.

5.4 Electrical Interfaces

5.4.1 Summary

CLTC and CALT provide the RF link and the umbilical link between the satellite and the satellite Electrical Ground Support Equipment (EGSE) after the satellite is mated with launch vehicle. These links allow the customer to conduct pre-launch testing and monitor the satellite during the launch count down.

The schematic of the umbilical cable and RF links between the satellite and the EGSE is shown in Figure 5-8 and Figure 5-9.

The umbilical cable is designed and manufactured by CALT to meet the requirements of the customer based on their satellite platform. The 350 m cable from FER to the Umbilical Tower, and the hardware labeled EB26/EB36, BOX3 and Power-supply 1&2 are common to all missions. The umbilical cable integral to the launch vehicle plus the ground facility cable from WXTC to ED10, ED12, ED13, ED14, BOX1 and BOX2, will be designed specifically for customer.

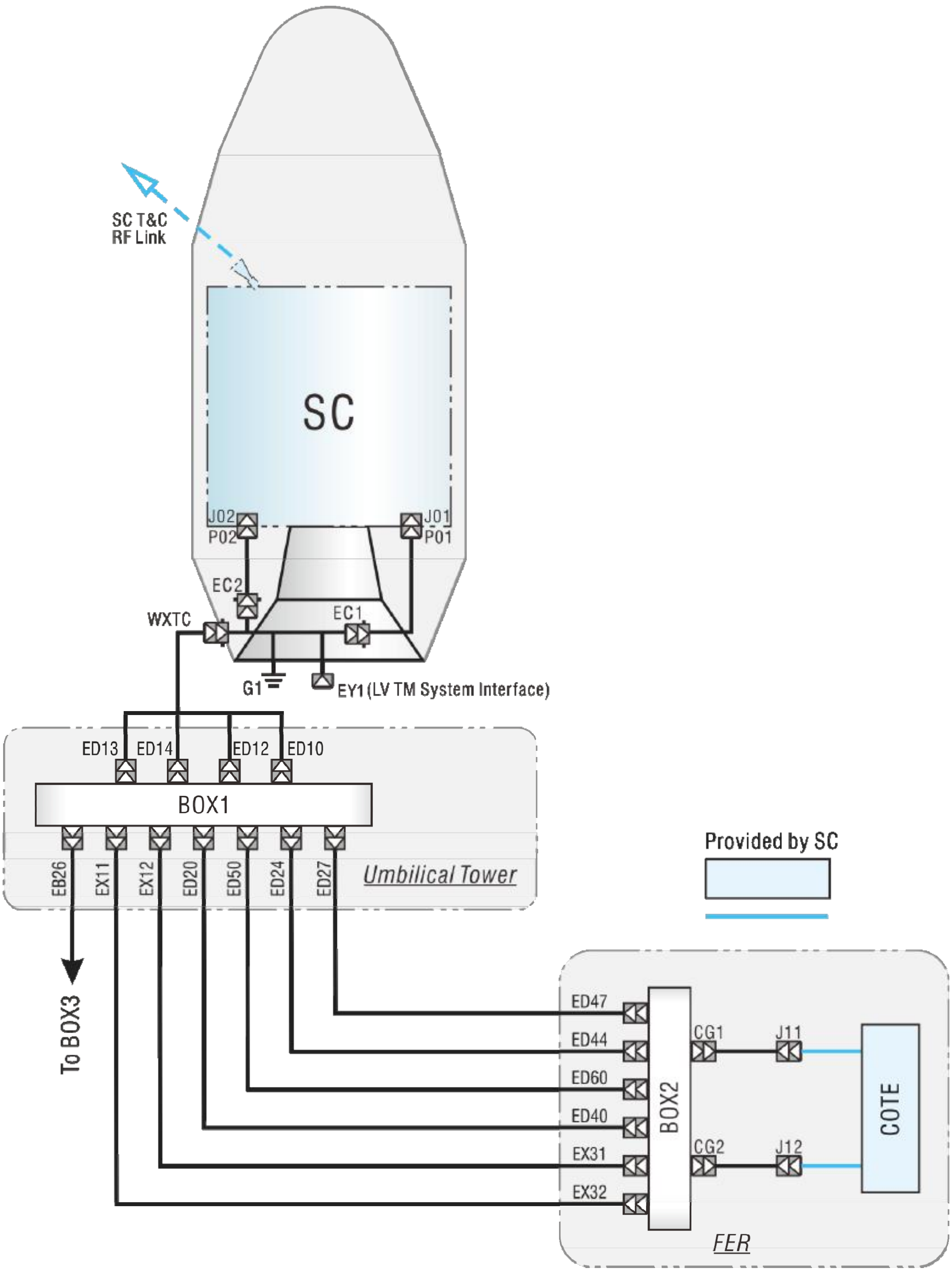


Figure 5-8 SC Umbilical Cable Configuration

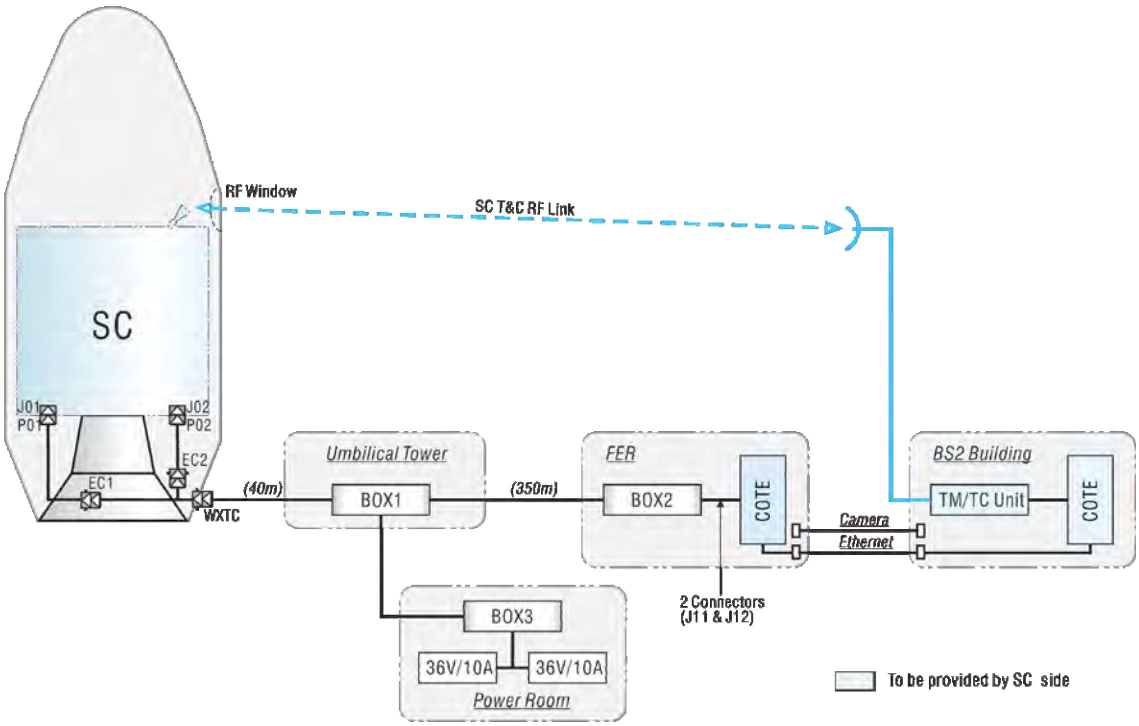


Figure 5-9 SC RF Links & Umbilical Cables

5.4.2 In-Flight-Disconnectors

Two sets of In-Flight-Disconnectors (IFDs) are required and are symmetrically mounted outside the top ring of the Payload Adapter (PLA). The exact location and clocking will be coordinated between customer and CALT and defined in the ICD.

It is normal practice for customer to select the IFDs. In such cases, it is advisable that the customer supply the launch vehicle portion of IFDs including installation tools to CALT. IFDs manufactured by DEUTSCH Engineered Connecting Devices are recommended (see Table 5-1), while the Chinese made YF8-64 are also available if selected.

Table 5-1 IFDs

LV Side		SC Side	
Code	Type	Code	Type
P01	D8179E37-OPN	J01	D8174E37-OSN
P02	D8179E37-OPY	J02	D8174E37-OSY

Notes: The IFDs will be totally disconnected when the two halves have separated from each other by 13.5 mm. The customer can also select other products by Deutsch as required, e.g. the DBAS7061, which is manufactured by cold-press processing.

5.4.3 In-Flight-Disconnectors Characteristics

The customer shall specify all the characteristics of the IFDs, including the pin assignments, usage, maximum voltage, maximum current, one-way maximum resistance, type and pin-assignment of connectors to be mated with the ground equipment, etc. CALT will design the umbilical cable according to the above requirements, which will also be defined in the ICD.

5.4.4 Umbilical Cable Onboard Launch Vehicle

(a) Configuration

The umbilical cables onboard the launch vehicle are cables from the IFDs (P01, P02) to WXTC, which will fly with launch vehicle (See Table 5-2).

Table 5-2 Umbilical Cable

Code	Description
P01, P02	IFD
EC1, EC2	Mechanical technological interfaces between PLA and LV
EY1	Interface between umbilical cable and LV TM system, through which the SC/LV IFD (J01/P01, J02/P02) separation signal is sent to LV TM system
WXTC	Umbilical cable connector (type: JF5-231)
G1	Grounding points to connect the shielding of the wires to the shell of the LV

(b) Separation Signal

The separation signal is generated through break-wires on the IFDs P01 & P02. The satellite will receive the separation signals once the break-wires are disconnected upon separation.

In addition, there are another two break-wires on the IFDs J01 & J02 that will generate the separation signal for the launch vehicle once the break-wires are disconnected upon separation. This separation signal will be sent to the launch vehicle telemetry system through the EY1 interface. The break-wires allow a maximum current of 100 mA and a maximum voltage of 30 V.

Figure 5-10 shows an example the break-wire circuitry.

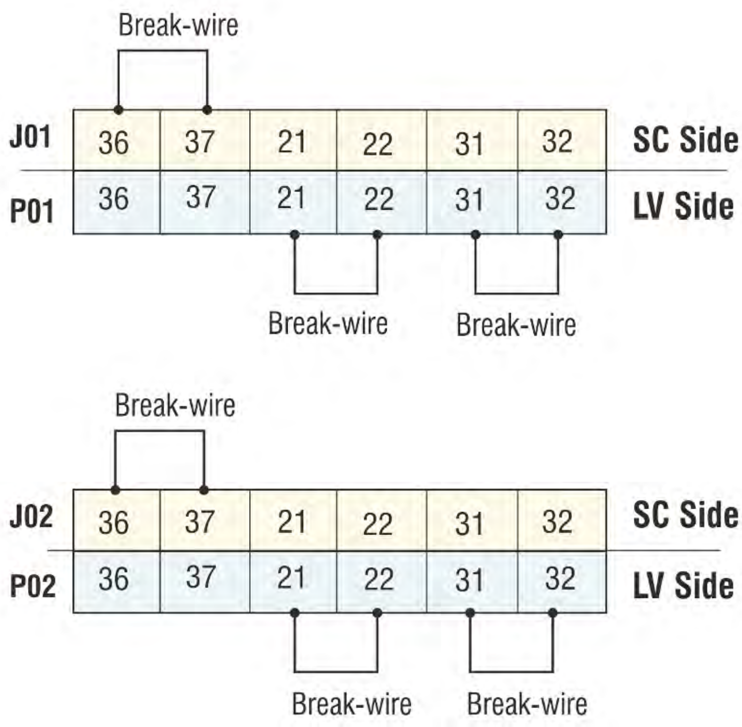


Figure 5-10 An Example of Separation Signals & Break-wires

There are also two micro-switches on the PLA to give the mechanical separation signal, which is also sent to the launch vehicle telemetry system.

5.4.5 Ground Umbilical Cables

(a) Configuration

The ground umbilical cables are cables from the WXTC to COTE in the FER which are shown in Figure 5-9, and the functions are shown in Table 5-3.

Table 5-3 Ground Umbilical Cable Functions

Code	Description
WXTC	WXTC is the umbilical cable connector (LV-Ground) whose female half (socket) is installed at the VEB, while the male half (pin) is attached to the top end of ground cable. The disconnection of WXTC is electrically controlled. (The disconnection is powered by BOX3. In the mean time, forced disconnection is also used as a back-up separation method.) Generally, WXTC disconnects at about 10 minutes prior to launch. If the launch was terminated after the disconnection, WXTC could be reconnected within 30 minutes. The SC should switch over to internal power supply and cut off ground power supply at 5 minutes prior to WXTC disconnection. Therefore, during disconnection only a low current monitoring signal (such as 30 V, ≤100 mA) is permitted to pass through the WXTC.
BOX1	BOX1 is a box adapter for the umbilical cable that is located inside the SC Cable Measurement Room on floor 8.5 of the umbilical tower. (If needed, BOX1 can provide more interfaces for the connection with SC ground equipment.)
BOX2	BOX2 is another box adapter for the umbilical cable that is located inside the SC FER on ground. The SC ground support equipment are also located inside the FER.

(b) Ground Interface

The customer determines the requirement for the ground interface, but normally there are two ground interfaces for the satellite test console (J11 & J12). The detailed requirements for these ground interfaces shall be jointly agreed by customer and CALT (See Table 5-4). CALT typically prepares short interface cables, so the customer is required to provide the mating half of the connectors (J11 & J12) for the cables that interface with the satellite ground equipment.

Table 5-4 Ground Interfaces for Satellite Test

Location	Code	Specification	Quantity
LV side interfaces	J11 J12	To be defined by SC side	2 2

If the customer cannot provide the connectors, there are two options available. CALT can provide the interface cables with each wire labeled with a number in accordance with the pin assignment of the connector for installation into the customer's connectors when available. The second option is for the customer to manufacture this cable and provide it to CALT, in which case CALT will provide the mating set of connectors for BOX2 in Figure 5-8. The length of this cable is approximately 5 m.

5.4.6 Shielding and Grounding

5.4.6.1 Shielding

In order to protect against lightning and stray voltages, the following measures have been implemented:

(a) The ground umbilical cable has two shielding layers. The outer shielding is for protection against lightning and the inner shielding is for EMI protection.

(b) The ground umbilical cables from WXTC to BOX2 have a grounding point every 20 meters for the outer shielding layer to ensure that any charge buildup from a lightning strike or other inductance can be discharged immediately.

(c) After the umbilical connectors are mated, the cable shielding is automatically connected to the launch vehicle shell structure.

(d) The inner shield has a single ground. The inner shields of the umbilical cables onboard launch vehicle are connected to BOX2.

(e) The inner and outer shields are insulated from each other within the cables.

5.4.6.2 Continuity of Satellite Grounding

The satellite shall have a ground reference point close to the separation plane. The resistance between all other metal parts of satellite (shell, structures, etc.) and the reference ground shall be less than 10 mΩ for a current of 10 mA. In order to maintain the continuity of the grounding, the bottom of satellite structure to be mated with the Payload Adapter (PLA) shall not be treated with any protective process that would affect its ability to meet the resistance requirements between the satellite and PLA.

5.5 Satellite Constraints

The satellite shall not transmit any remote signal that could be dangerous or interfere with the launch vehicle flight until the satellite has been completely separated from the launch vehicle. The satellite shall not start its automated post separation program until it receives the separation signal from the launch vehicle.

5.6 RF Links

5.6.1 RF Relay Path

The launch site can provide an RF link between the Satellite Test Equipment (STE) and the SC, whenever the SC is in BS or at the launch pad. The RF link equipment is set up between BS2 and the launch towers. It provides uplink and downlink RF channels that can connect the STE with the SC and transmit the test and control signals when the SC is mated to the launch vehicle at the launch pad. The RF system uses optical fiber to transmit and receive the signals.

5.6.2 Characteristics and Interface of RF Link

(a) Frequency

The optical fiber of the RF system allows the transmission of 350 MHz to 15 GHz signal, while the microwave processing unit allows the transmission of signals in UHF, L, S, C, Ku and X bands.

(b) Signal Level

The signal level interface between RF system and STE is shown in Table 5-5.

Table 5-5 Signal level interface between RF system and STE

Band		SC Antenna		System Terminal	
		EIRP (dBm)	PFD (dBW/m^2)	Input (dBm)	Output (dBm)
S	Uplink	-20 ~ 10	/	/	-50 ~ -80
	Downlink	/	-30 ~ -10	0 ~ 60	/
C	Uplink	-20 ~ 10	/	/	-50 ~ -80
	Downlink	/	-30 ~ -10	0 ~ 60	/
UHF	Uplink	-20 ~ 10	/	/	-50 ~ -80
X	Downlink	/	-30 ~ -10	0 ~ 60	/
L	Downlink	/	-30 ~ -10	0 ~ 60	/
Ku	Uplink	/	-20 ~ 10	/	-50 ~ -80
	Downlink	-30 ~ -10	/	30	/

5.7 Post Encapsulation Interfaces

5.7.1 Payload Usable Volume

The payload usable volume is the area within the fairing that is available to accommodate the satellite when mounted on the Payload Adapter (PLA) of the launch vehicle. This represents the total maximum envelope available for the satellite and includes all manufacturing tolerances, thermal protection, satellite appendages, etc, and also includes the dynamic tolerances based on results of the standard coupled loads analysis.

If the satellite has appendages that protrude to outside the usable envelope, they shall be reviewed during the ICD and Mission Reviews. If the protusions are found after these satellite appendages have been completed, a special review shall be held to resolve the issue.

5.7.2 Satellite Access

The satellite can be accessed while in the fairing via special access doors on the fairing as agreed in the ICD. The satellite can be accessed up until (Launch – 2 hours) after which time the fairing is sealed.

5.8 Interface Verification

5.8.1 Satellite AIT

During the satellite AIT program and prior to final acceptance for delivery to the launch site, a full mechanical and electrical fit check can be performed. This interface verification, or SC/LV fitcheck, is mandatory for all satellite platforms that have not previously been launched with the LM-3A Series launch vehicles.

The primary objective of the test is to verify that the mechanical interface is correct, the electrical interfaces are compatible and all the connectors and arming plugs can be accessed. This fitcheck can then be followed by a SC/LV separation shock test to verify if the satellite could be separated from the Payload Adapter (PLA) properly within the required shock level.

The SC/LV fitcheck and separation shock test is typically performed at the satellite manufacturers' facility using the flight adapter and separation system provided by CALT.

5.8.2 Launch Site Interface Verification

The electrical and RF interfaces between the satellite and each site for satellite processing, including those where the satellite is mated to the launch vehicle, shall be validated prior to the satellite moving to a new facility and after its arrival at a new facility. This verification is to be performed whenever the umbilical connecters are disconnected and reconnected.

5.8.3 Satellite EGSE Interface Verification

There are typically two sets of EGSE. One set is permanently located in BS2 that is used as the primary system for controlling the satellite. The second set moves with the satellite and functions as a remote test interface with the satellite. The interfaces of this EGSE shall be verified prior to its arrival at the launch site and following each move at the launch site.

The interfaces with the launch site facility are defined in Chapter 7.

CHAPTER 6 ENVIRONMENTAL CONDITIONS

6.1 Summary

This Chapter provides the natural environment at Xichang Satellite Launch Center (XSLC), the thermal environment during satellite processing, the thermal and mechanical environment (vibration, shock & noise) experienced during the launch vehicle flight and the electromagnetic environment during ground processing and the flight.

6.2 Environment at XSLC

The environmental data for the XSLC has been monitored over a significant period of time. Table 6-1 and Table 6-2 provide the average monthly temperature and average monthly ground wind speed respectively.

Table 6-1 Average Monthly Temperature in XSLC

Month	Highest (°C)	Lowest (°C)	Average (°C)
January	7.9	4.5	5.9
February	10.4	5.0	8.0
March	14.5	9.7	11.7
April	17.5	13.1	15.0
May	20.2	15.6	17.7
June	21.1	17.7	19.1
July	21.3	19.3	20.0
August	21.3	18.5	19.8
September	19.3	16.2	17.2
October	16.4	13.2	14.1
November	12.3	8.4	10.0
December	8.9	4.6	6.5

Table 6-2 Average Monthly Ground Wind Speed in XSLC

Month	Average Speed (m/s)	Days (>13 m/s)
January	2.2	0.5
February	2.3	1.1
March	2.3	2.5
April	2.0	1.6
May	1.5	0.6
June	1.0	0.4
July	1.1	0.2
August	1.2	0.1
September	0.9	0.2
October	1.1	0.1
November	1.4	0.0
December	1.7	0.2

The relative humidity at launch site:

- Maximum: 90% in rainy season
- Minimum: 42% in dry season

6.3 Satellite Processing Environment

Following arrival at XSLC, the satellite is integrated, tested and fueled in SC Processing Building BS2 and BS3, and then, it is transported to the launch pad for combined operations. The processing environments for the satellite therefore fall into three phases: processing in BS2 and BS3, transportation to launch pad and final preparation on launch tower. The following environment is provided and maintained throughout the whole process:

- Temperature: 15°C ~ 25°C
- Relative humidity: 35% ~ 55%
- Cleanliness: 100,000 class
- Acoustic level: ≤ 90 dB

For the detailed information about satellite processing environment, please refer to the *XSLC User's Manual (Issue 2009*).

6.3.1 Environment in SC Processing Building BS2 and BS3

During the integration and checkout of satellite in BS2 and BS3, the environment inside the building is maintained by air-conditioning system.

6.3.2 Environment during Transportation to Launch Pad

6.3.2.1 For Fairing Encapsulation-on-Pad

The satellite is transferred to the launch pad in an environmentally controlled and sealed container, and the transfer takes approximately 30 minutes. The satellite transfer container is a sealed cylinder with a height of 8,070 mm and diameter of 4,120 mm with its wall made of aluminum sandwich for thermal insulation (See Chapter 8).

Before transportation, the container is pressurized with dry nitrogen, followed by a thermal stabilization period to allow the satellite and container to stay at a steady temperature between 15°C and 25°C. The container is then sealed and moved out of BS3 for transport to the pad.

When the container arrives at the launch pad, it is hoisted to the 8th floor of the Service Tower, where an environmentally controlled clean room has been established. The procedures for this operation are detailed in Chapter 8.

After arrival at the launch pad clean room, the container goes through another stabilization period for the satellite thermal conditions to become adapted to those of the clean room. When the satellite and container have reached a thermally stabilized status, the container is opened and the satellite is moved out to mate to the launch vehicle.

6.3.2.2 For Fairing Encapsulation-in-BS3

The same environment conditions as Paragraph 6.3.2.1 are provided and maintained except that the fairing replaces the SC container.

When the satellite encapsulated with fairing arrives at the launch pad, it is hoisted to the 8th floor of the Service Tower. The fairing is mated to the launch vehicle. The procedures for this operation are detailed in Chapter 8.

6.3.3 Air-conditioning inside Fairing

The fairing air-conditioning system is connected following the mating of the satellite encapsulated in the fairing to the launch vehicle (Encapsulation-in-BS3) or final encapsulation of the satellite at the launch pad (Encapsulation-on-Pad). The air-conditioning system becomes operational immediately following its connection to the fairing and the configuration is shown in Figure 6-1.

The air-conditioning system maintains the environmental conditions within the fairing as shown in Table 6-3.

Table 6-3 Air-conditioning parameters inside Fairing

Temperature	13°C ~ 23°C
Relative Humidity	35% ~ 55%
Cleanliness	100,000 class
Air Speed inside Fairing	≤ 2 m/s
Noise inside Fairing	≤ 90 dB
Air Flow Rate	1500 ~ 3000 m^3/hour (adjustable)

The air-conditioning is shut off 45 minutes before launch and can be re-established within 40 minutes if the launch is aborted. The air-conditioning inlets are shown in Chapter 4.

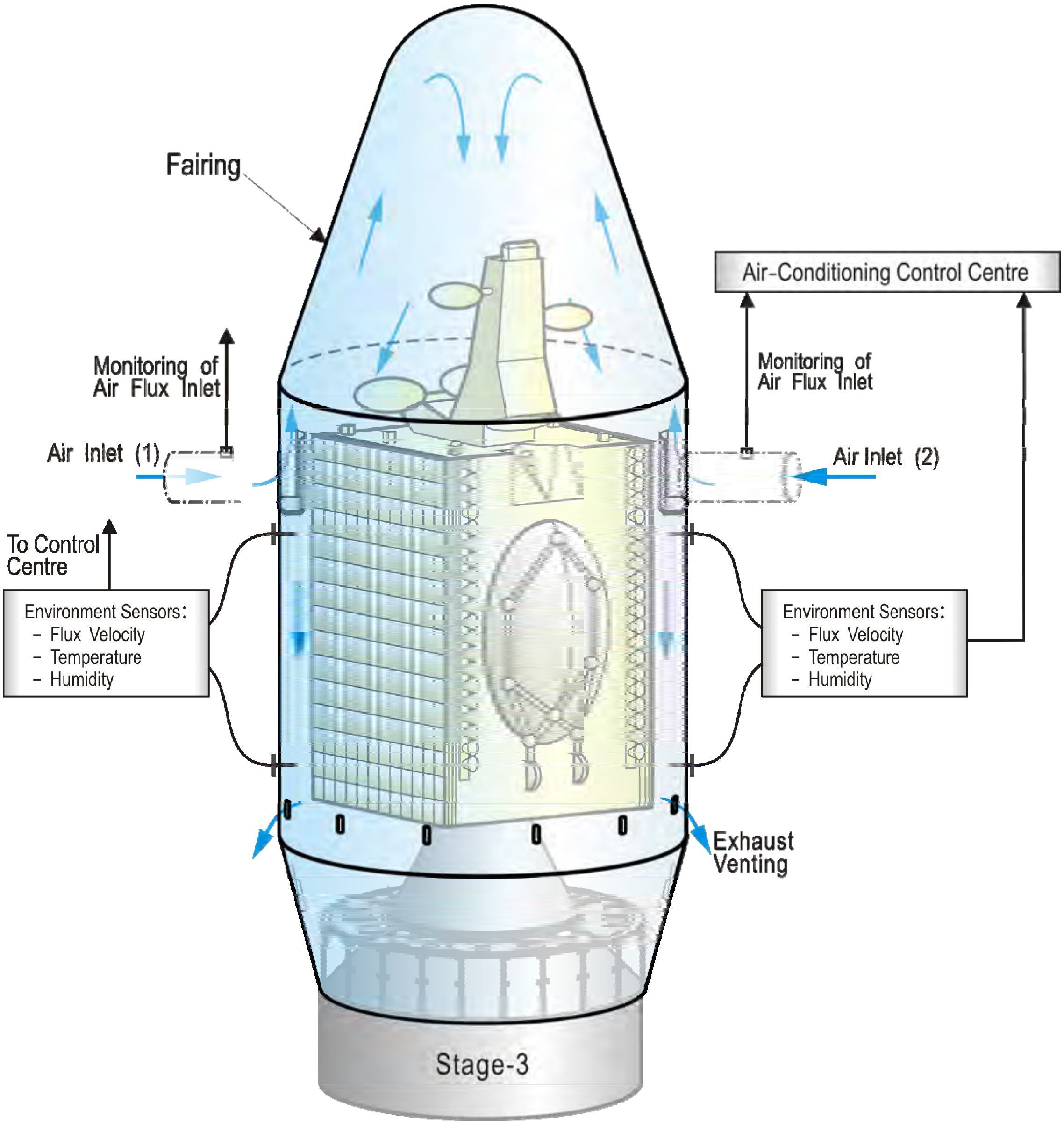


Figure 6-1 Pre-launch Air-condition System of LM-3A Series LVs

6.4 Electromagnetic Environment

The satellite has to withstand the electromagnetic field generated by both the launch site RF facility and launch vehicle RF systems while mounted on the launch vehicle. These transmissions have been minimized to a very low level in the vicinity of the launch complex. This section details the frequencies and levels of the potentially interfering radiation.

6.4.1 Radio Equipment onboard LM-3A Series Launch Vehicles and Ground Test Equipment

Characteristics of on-board radio equipment and ground test equipment are shown in Table 6-4.

Table 6-4 Characteristics of on-board radio equipment and ground test equipment

<table>
<tr><th></th><th>Equipment</th><th>Frequency (MHz)</th><th>Power (W)</th><th>Sensitivity</th><th>Polarization</th><th>Antenna position</th></tr>
<tr><td rowspan="7">LAUNCH VEHICLE</td><td>Telemetry Transmitter 3</td><td>2200~2300</td><td>10</td><td>/</td><td>linear</td><td>VEB</td></tr>
<tr><td>GNSS receiver</td><td>1500~1700</td><td>/</td><td>≤ -130 dBW</td><td>RHCP</td><td>VEB</td></tr>
<tr><td>Telemetry Transmitter 2</td><td>2200~2300</td><td>5</td><td>/</td><td>linear</td><td rowspan="2">Stage-2 Intertank</td></tr>
<tr><td>Responder 1</td><td>Rx 5860~5910
Tx 4210~4250</td><td>2</td><td>≤ -120 dBW</td><td>linear</td></tr>
<tr><td>Responder 2</td><td>Rx and Tx
5580~5620</td><td>300 (peak)
0.8~1.0 μs
800 Hz
<300 mW
(average)</td><td>≤ -90 dBW</td><td>linear</td><td>Stage-3 Rear shell</td></tr>
<tr><td>Beacon</td><td>2730~2770</td><td>2</td><td>/</td><td>linear</td><td>Stage-3 Rear shell</td></tr>
<tr><td>Telemetry command Receiver</td><td>550~750</td><td>/</td><td>≤ -128 dBW</td><td>/</td><td>Stage-2 Intertank</td></tr>
<tr><td rowspan="3">GROUND</td><td>Tester for Responder 1</td><td>5870~5910</td><td>0.5</td><td>/</td><td>/</td><td rowspan="3">Tracking & safety system ground test room at launch pad</td></tr>
<tr><td>Tester for Responder 2</td><td>5570~5620</td><td>100 W
(peak)</td><td>/</td><td>/</td></tr>
<tr><td>Telemetry Command Transmitter</td><td>550~750</td><td>1 W</td><td>/</td><td>/</td></tr>
</table>

The locations of the onboard radio equipment are shown in Figure 6-2.

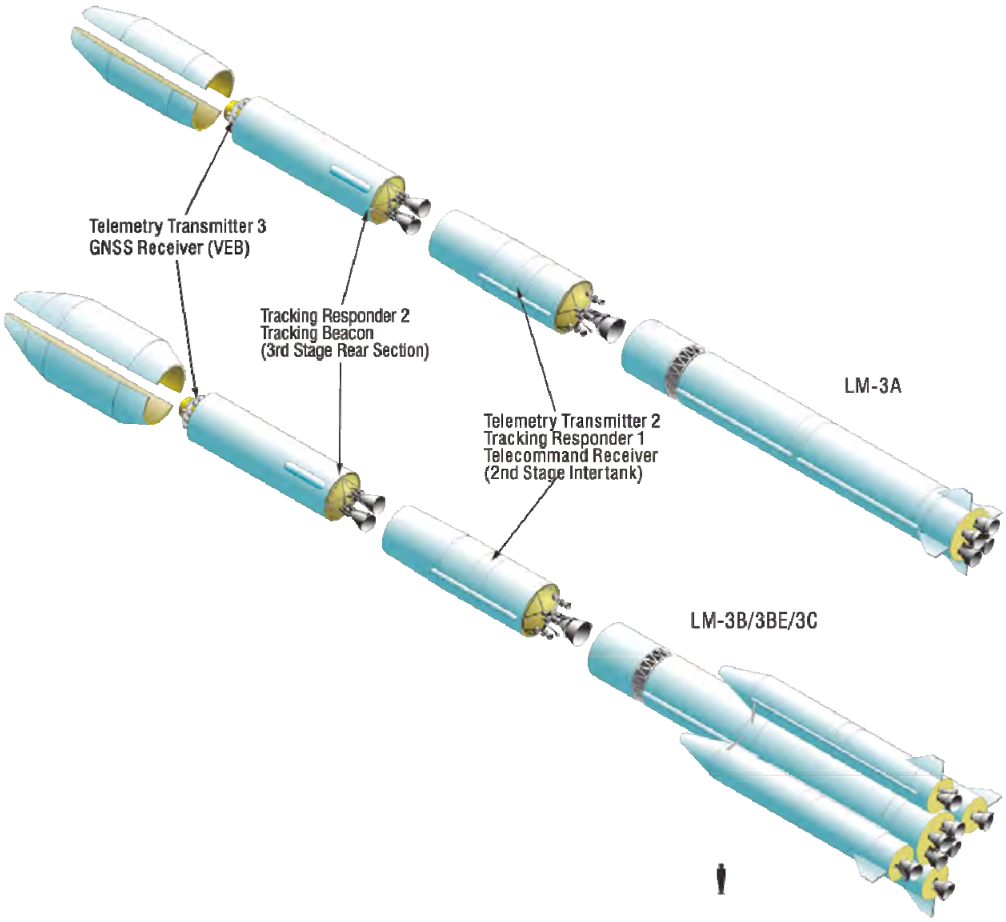


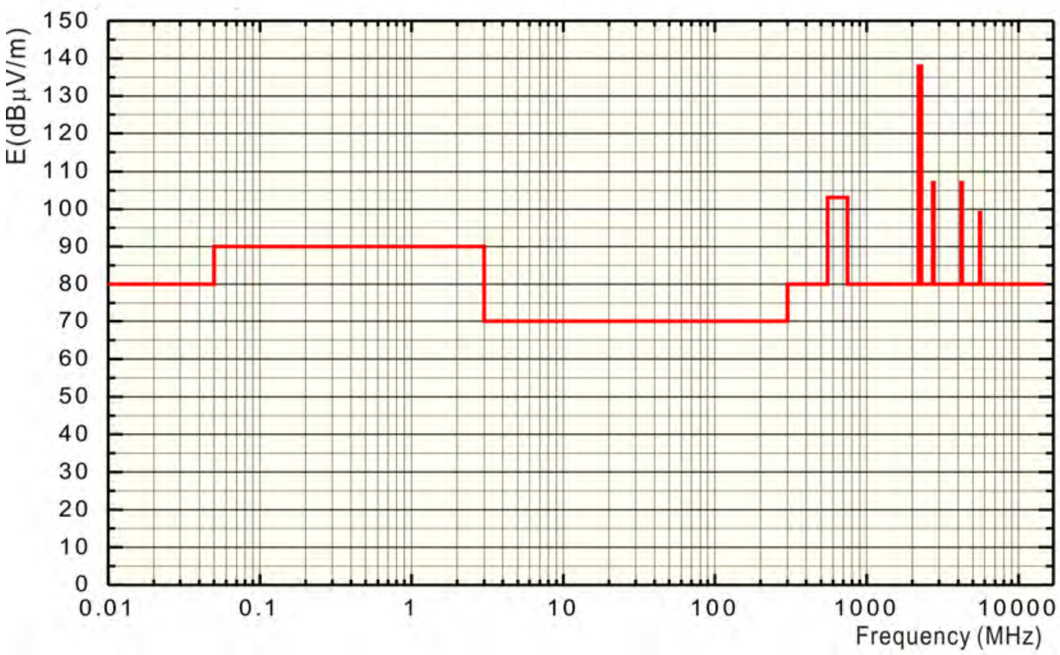
Figure 6-2 Locations of On-board Radio Equipment

6.4.2 RF Equipment and Radiation Strength at XSLC

- Working frequency: 5,577 ~ 5,617 MHz
- Antenna diameter: 4.2 m
- Impulse power: <1,500 kW
- Impulse width: 0.0008 ms
- Minimum pulse duration: 1.25 ms
- Average power: <1.2 kW

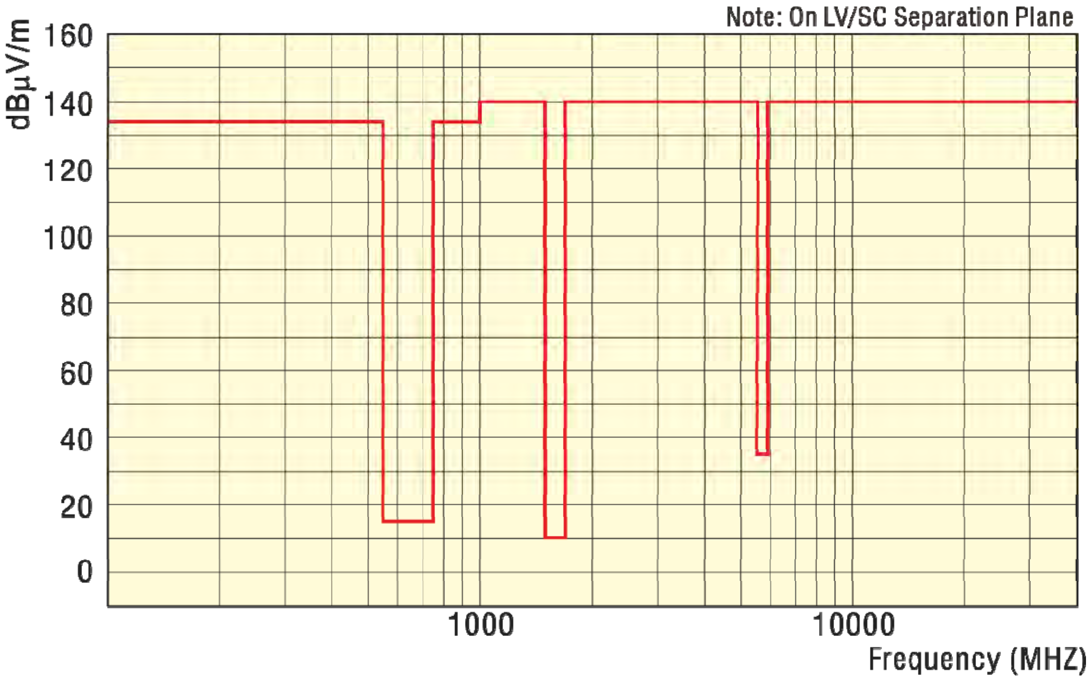
6.4.3 Launch Vehicle Electromagnetic Radiation and Susceptibility

The electromagnetic radiation levels generated by the launch vehicle and the launch site equipment will not exceed those shown in Figure 6.3. The launch vehicle electromagnetic susceptibility is shown in Figure 6.4. The energy levels of launch vehicle electromagnetic radiation and susceptibility are measured at 1 m above VEB. The electromagnetic radiation of satellite shall not exceed the values shown in Figure 6-4.



Frequency (MHz)	Field Strength (dBμV/m)
0.01 - 0.05	80
0.05 - 3	90
3 - 300	70
300 - 550	80
550 - 750	103
750 - 2200	80
2200 - 2300	138
2300 - 2730	80
2730 - 2770	107
2770 - 4200	80
4200 - 4250	107
4250 - 5580	80
5580 - 5620	99
5620 - 6000	80
6000 - 6500	80
6500 - 13500	80
13500 - 15000	80
15000 -	80

Figure 6-3 Electromagnetic Radiation from LV and XSLC



Frequency (MHz)	Field Strength (dBμV/m)
0.01 - 550	134
550 - 750	15
750 - 1000	134
1000 - 1500	140
1500 - 1700	10
1700 - 5580	140
5580 - 5910	35
5910 - 100000	140

Figure 6-4 Launch Vehicle Electromagnetic Radiation Susceptibility

6.4.4 EMC Analysis

CALT and the customer shall jointly conduct an EMC analysis for the satellite, launch vehicle and launch site to verify their compatibility. The customer shall use the data provided in this User's Manual and shall provide the following information, as required in the ICD, to CALT for analysis:

- Satellite RF system configuration, characteristics, operating and radiating time periods, antenna position and its transmission direction, etc.
- Values and curves of the electric field of intentional and parasitic radiation generated by the satellite RF system at satellite separation plane
- The values and curves of the electromagnetic susceptibility of the satellite.

6.5 Mechanical Environments

6.5.1 Steady State Acceleration

The launch vehicle flight generates external forces on the satellite due to the engine thrust and aerodynamic forces. The typical maximum longitudinal steady state acceleration during the launch vehicle powered flight is shown in Table 6-5. It can be seen that the maximum longitudinal static acceleration occurs during the first stage flight. The maximum static acceleration will vary slightly with the satellite mass.

Table 6-5 Typical Maximum Static Longitudinal Acceleration

	LM-3A	LM-3B	LM-3C
During First Stage Flight	+5.0 g	N/A	N/A
During First Stage Booster Flight	N/A	+5.3 g	+5.3 g
During First Stage Core Flight	N/A	+3.6 g	+3.6 g
During Second Stage Flight	+2.9 g	+2.8 g	+2.8 g
During Third Stage first powered flight	+1.6 g	+1.2 g	+1.2 g
During Third Stage second powered flight	+2.7 g	+2.5 g	+2.5 g

Note: "+" means the direction of the acceleration coincides with the launch vehicle +X axis.

6.5.2 Vibration Environments

6.5.2.1 Sinusoidal Vibration

Low level sinusoidal vibration is present during the flight, but the significant vibration events occur during engine ignition and engine shut-off, transonic flight and the stage separations. The sinusoidal vibration (zero-peak value) at the satellite separation plane is shown in Table 6-6 below.

Table 6-6 Sinusoidal Vibration Levels

Direction	Frequency Range	Amplitude & Acceleration
Longitudinal	5 - 8 Hz	3.11 mm
	8 - 100 Hz	0.8 g
Lateral	5 - 8 Hz	2.33 mm
	8 - 100 Hz	0.6 g

6.5.2.2 Random Vibration

The maximum random vibration levels are primarily generated by the noise during the launch vehicle lift-off and transonic flight periods. The acoustic spectrum defined in Paragraph 6.5.3 covers excitations produced by random vibration.

6.5.3 Acoustic Noise

The acoustic noise spectrum includes the engine noise and aerodynamic noise during flight, with the maximum acoustic noise being experienced by the satellite during the lift-off and the transonic flight phase. The values in Table 6-7 below are the maximum noise levels inside the fairing from the launch and transonic flight phase.

Table 6-7 Acoustic Noise in the Fairing

Central Frequency of Octave Bandwidth (Hz)	Acoustic Pressure Level (dB)
31.5	124
63	129
125	134
250	138
500	133
1000	129
2000	128
4000	127
8000	122
Total Acoustic Pressure Level	141.5

Note: 0 dB corresponds to 2×10^{-5} Pa.

6.5.4 Shock Environment

The maximum shock experienced by satellite occurs at SC/LV separation. The shock response spectrum (Q=10) at the separation plane is shown in Figure 6-5 for the C100 clampband and Figure 6-6 for C60 clampband.

Additionally, CGWIC could also support the customer to procure low shock level separation system (clampband and the pyros) developed by European suppliers, if needed.

Frequency (Hz)	Shock Response Spectrum (Q=10)
100~1000	10.5 dB/octave
1000~4000	4000 g

Figure 6-5 Shock Response Spectrum at SC/LV Separation Plane - C100 Clampband

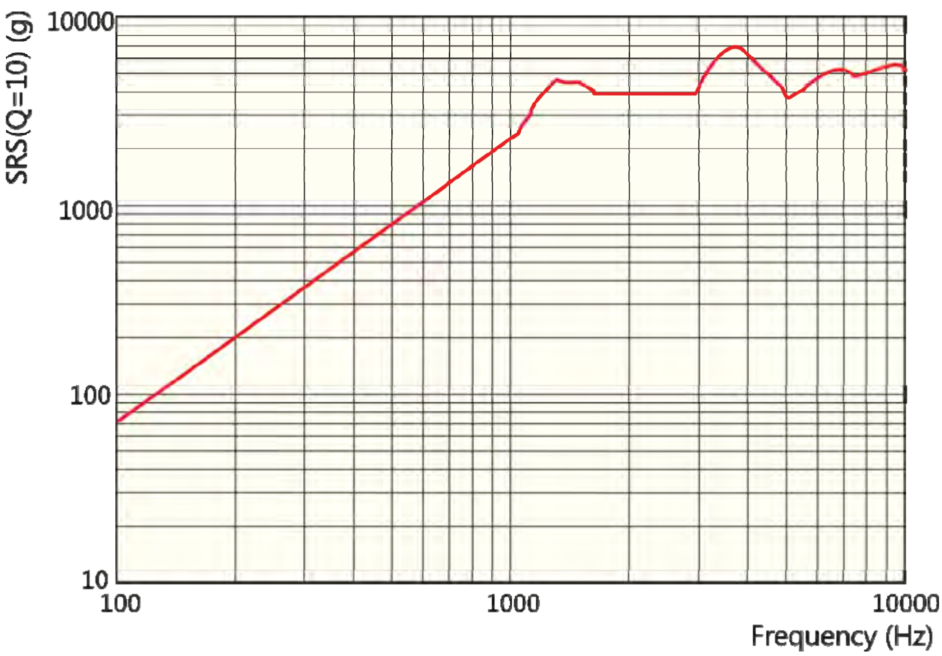


Figure 6-6 Shock Response Spectrum at SC/LV Separation Plane - C60 Clampband

6.6 Thermal Environment

This section covers the thermal environment during the launch vehicle flight up to separation, which is described separately for the two flight phases, i.e. before fairing jettison and after fairing jettison.

6.6.1 Thermal Environment prior to Fairing Jettison

During the ascent, the net thermal flux density radiated by the fairing does not exceed 500 W/m^2 at any point.

This does not include any thermal input from the satellite due to power dissipation by the satellite electronics.

6.6.2 Thermal Environment Post Fairing Jettison

The free molecular heating flux upon fairing jettison is not greater than 1,135 W/m^2. This flux is calculated as the free molecular flow acting on a plane surface perpendicular to the velocity vector of the launch vehicle. The typical free molecular thermal flux after fairing jettisoning is shown in Figure 6-7. The thermal effects caused by Sun radiation, Earth infrared radiation and Earth albedo are also considered in the thermal analysis and will be determined through the ICD and Mission Review inputs.

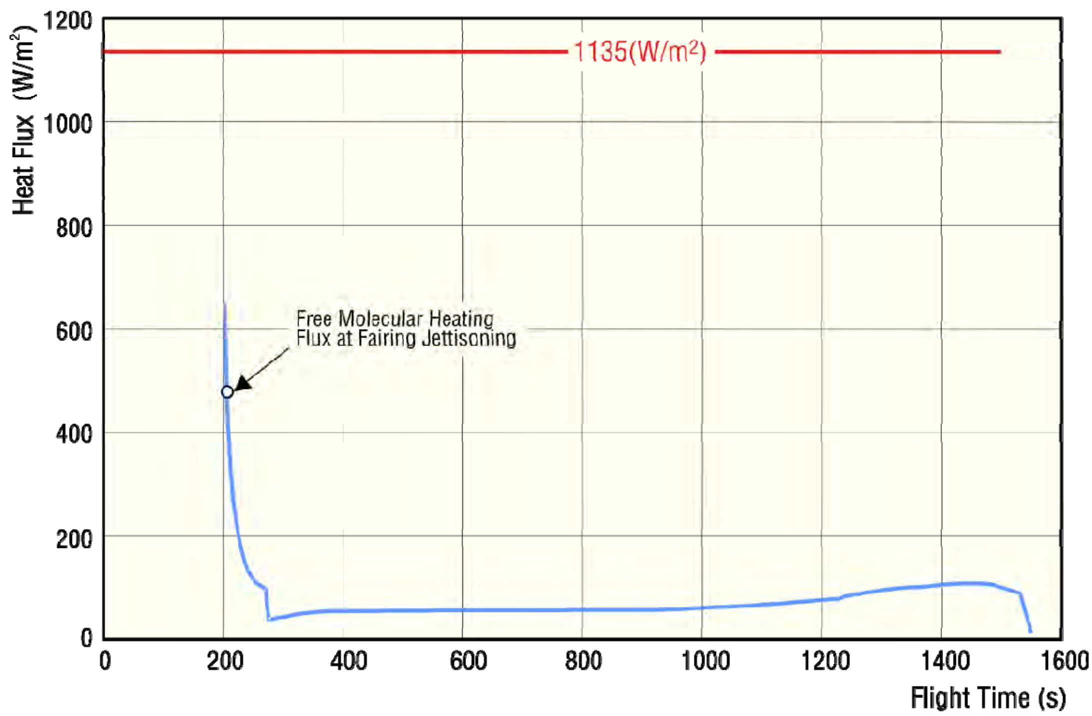


Figure 6-7 Free Molecular Heating Flux of LM-3A/3B/3BE/3C

6.6.3 Launch Vehicle Generated Heat Flux

The second stage retro-rockets burn for approximately 1.5 s and will generate a heat flux of < 300 W/m^2 at the satellite separation plane.

The heat flux with the third-stage engines in operation will not exceed 350 W/m^2 at the satellite separation plane.

6.7 Pressure Environment

During the ascent phase of launch vehicle flight, the fairing is vented in order to balance the pressure inside and outside the fairing and ensure there is no significant pressure difference. The maximum depressurization rate inside fairing during launch vehicle flight will not exceed 6.9 kPa/s.

The typical design range for fairing internal pressure is shown in Figure 6-8.

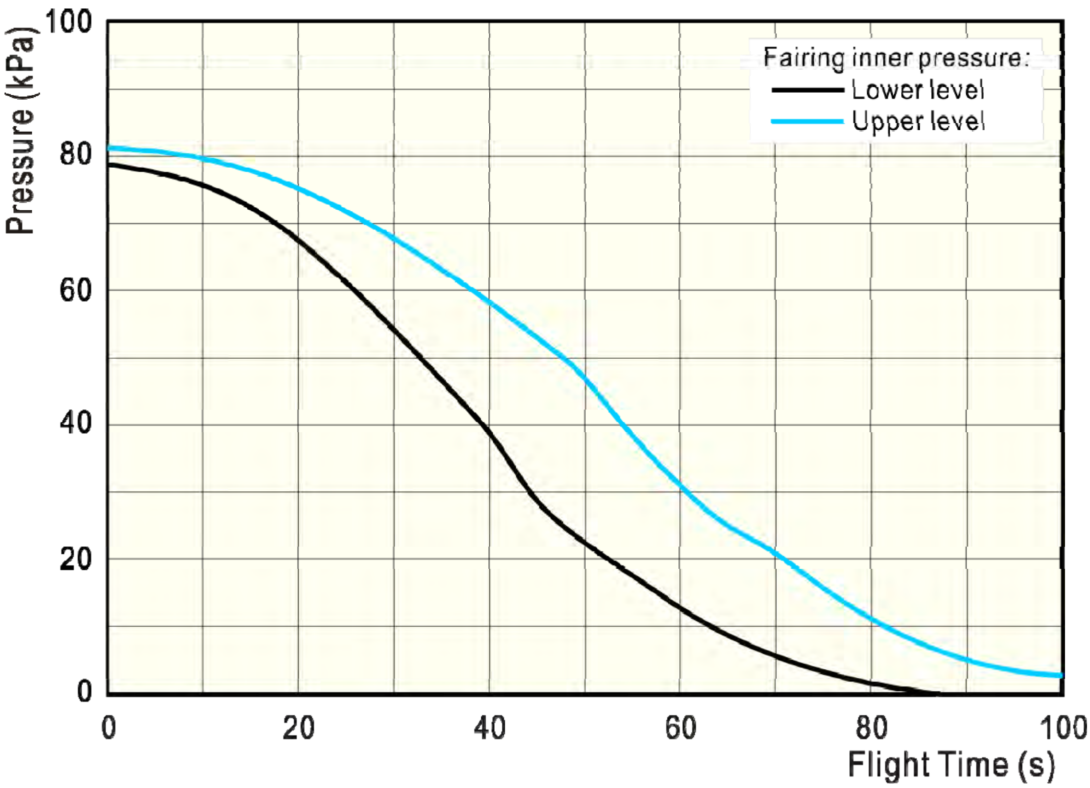


Figure 6-8 Fairing Internal Pressure

6.8 Contamination and Cleanliness Control

6.8.1 Contamination Control

During the satellite processing at XSLC, the maximum organic non-volatile contamination on the satellite shall not exceed 2 mg/m^2/week from opening of the satellite container in BS up to launch.

The materials used in the clean room facilities and the parts of the launch vehicle in the fairing have been chosen to minimize outgassing and ensure that the total organic non-volatile contamination on the satellite does not exceed 4 mg/m^2 from the satellite initial encapsulation up to its separation from the launch vehicle.

6.8.2 Cleanliness Control

The cleanliness of satellite processing facilities is maintained to class 100,000. Any hardware has to be subjected to a cleaning process followed by an inspection before it enters the clean rooms.

All the materials used on the launch vehicle in the vicinity of the satellite are designed not to accumulate dust and selected to be non-shedding during ground processing.

Prior to encapsulation of the satellite, the fairing, SC Container and Payload Adapter (PLA) are cleaned and inspected.

CHAPTER 7 LAUNCH SITE

7.1 General Description

This Chapter provides an overview of the facilities and services available at the Xichang Satellite Launch Center (XSLC) for LM-3A Series launch vehicles. The detailed information relating to the facilities and services is described in the *XSLC User's Manual (Issue 2009)*.

Figure 7-1 Xichang Satellite Launch Center

XSLC is mainly used to launch broadcast satellites, communication satellites and meteorological satellites. XSLC is located in Xichang region, Sichuan Province, southwestern China with the launch center headquarters being located in Xichang City, 65 km from the launch site. Figure 7-1 and Figure 7-2 shows the location of XSLC.

Xichang has a subtropical climate and its annual average temperature is 14.2ºC. The ground wind in the area is usually very gentle in all the four seasons.

XSLC provides full domestic and international telephone, fax and internet services for the user via a cable and satellite communication network.

XSLC includes the Headquarters (located in Xichang City), Launch Center (technical center and two launch complexes), Communication Center, Mission Command and Control Center (MCCC), tracking stations and other logistic support systems.

Figure 7-2　Local Map of XSLC

7.1.1 Xichang Airport

Located in the northern suburb of Xichang City, Xichang Airport is 15 km away from XSLC headquarters and 50 km away from the launch site. The 3,600 m long and 50 m wide runway runs from south to north. The large parking apron can hold planes of various kinds, and is fully capable of accommodating jumbo cargo aircraft such as the Boeing 747 and

Antonov-124 (See Figure 7-3 and Figure 7-4).

Figure 7-3   Antonov-124 Landing at Xichang Airport

Figure 7-4   Unloading Operation at Xichang Airport

7.1.2 Transfer to XSLC

The Cheng-Kun Railway and the Sichuan-Yunnan National Highway pass by XSLC. The distance between Chengdu (Capital of Sichuan Province) and XSLC is 535 km by railway. There is a dedicated railway branch and a highway branch leading to the Technical Center and the launch pads of XSLC. In addition, there is a major highway, the Lu-Huang Expressway, which links Manshuiwan (the town closest to XSLC) and Xichang City with a dedicated highway from the Lu-Huang Expressway to XSLC. This is the primary transportation route for the satellite from the airport to launch site, with the Sichuan-Yunnan National Highway and the XSLC old dedicated road as a back-up route (See Figure 7-5).

Figure 7-5 Satellite Transfer from Xichang Airport to XSLC

7.2 Xichang Satellite Launch Center

XSLC includes the LV Processing Building (BL), SC Processing Buildings (BS2 and BS3), Launch Complex No. 2 (LC-2) and Launch Complex No. 3 (LC-3). The ground support systems are comprised of the Mission Command and Control Center (MCCC), Tracking Stations and Communication Center.

7.3 Technical Center

The Technical Center (Figure 7-6) consists of the LV Processing Building (BL), SC Processing Buildings (BS2 and BS3), Solid Propellant Motor (SPM) Testing and Processing

Buildings (BM), X-ray Building (BMX), Propellant Storage Rooms (BM1 and BM2), Power Station, etc. The LV and SC will be processed, tested, checked, assembled and stored in the technical center. Refer to Figure 7-6 for the arrangement of the Technical Center.

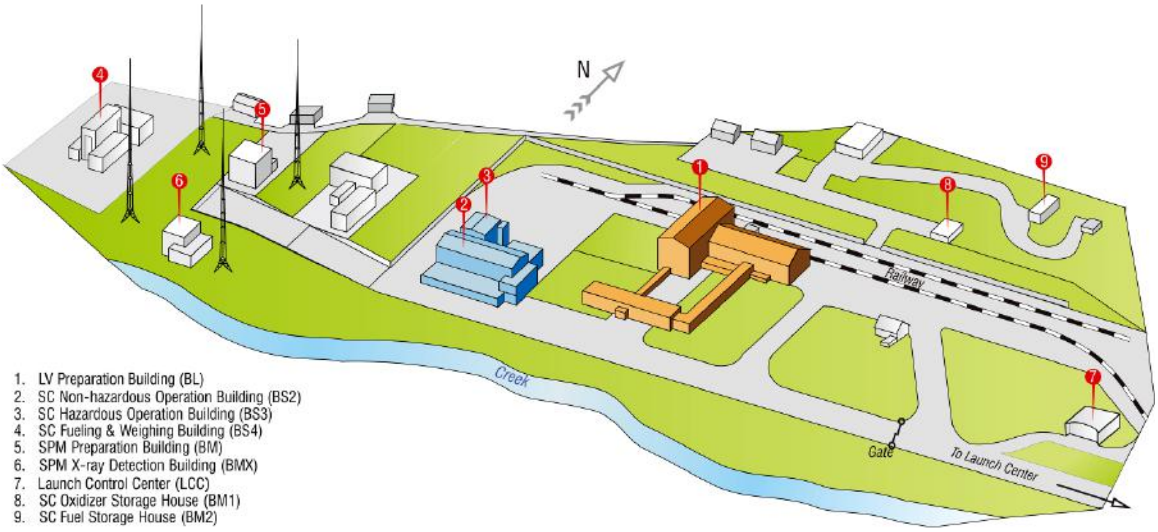


Figure 7-6 Technical Center of XSLC

7.4 LV Processing (Test) Building (BL)

The LV Processing Building (BL) is composed of the Transit Building (BL1) and Testing Building (BL2).

7.4.1 Transit Building (BL1)

BL1 is mainly used for loading and unloading the LV and other large ground equipment prior to transiting into the test buildings. BL1 is 54 m long, 30 m wide, 13.9 m high and the railway branch passes through BL1 to facilitate unloading. BL1 is equipped with a movable overhead crane that has two hooks with a capability of 50 tons and 10 tons respectively. The crane's maximum lifting height is 9.5 m (See Figure 7-7).

Figure 7-7 Transit Building (BL1)

7.4.2 Testing Building (BL2)

BL2 (Figure 7-8) is mainly used for the test operations, assembly and storage of the launch vehicle. This building is 90 m long, 27 m wide and 15.58 m high, with the capability of processing one launch vehicle and storing another one at the same time. BL2 is equipped with a two-hook overhead movable crane with a lifting capability of 20 tons and 5 tons respectively. The lifting height is 12 m. There are test rooms and offices inside the hall.

Figure 7-8 Testing Building (BL2)

7.5 SC Processing Buildings

The SC Processing Buildings include the Test and Fueling Building (BS) (Figure 7-9), Solid Propellant Motor (SPM) Testing and Processing Building (BM), X-ray Building (BMX), Propellant Storage Rooms (BM1 and BM2).

The SC Test and Fueling Building (BS) include a Non-Hazardous Operations Building (BS2) and a Hazardous Operations Building (BS3). All of the SC pre-transportation testing, assembly, fuelling and SC/PLA operations will be performed in BS2 and BS3. Refer to Figure 7-10 and Figure 7-11 for the layout of BS2 and BS3, and its area and environment conditions are shown in Table 7-1.

Figure 7-9　SC Processing Building (BS)

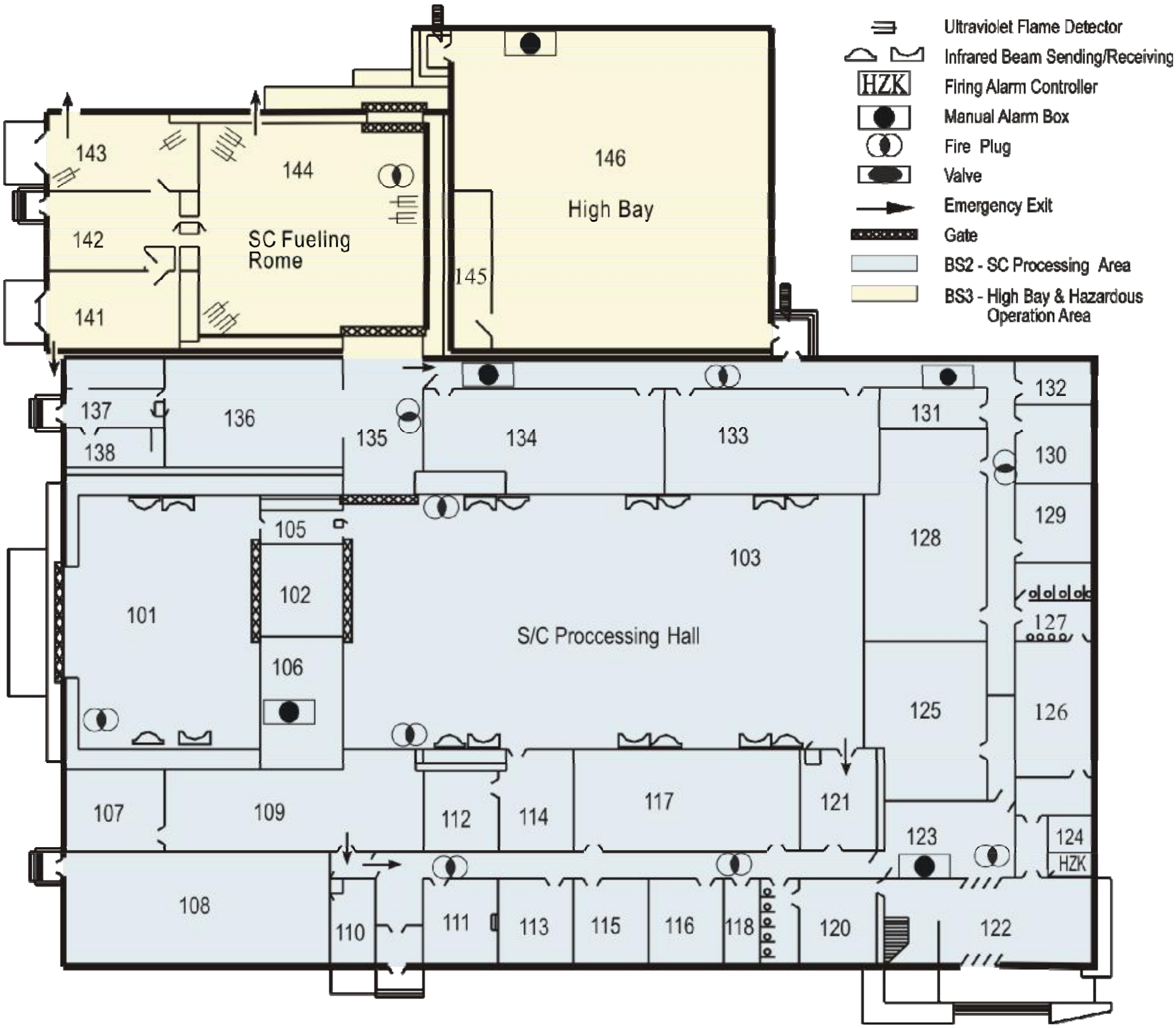


Figure 7-10 Layout of BS First Floor

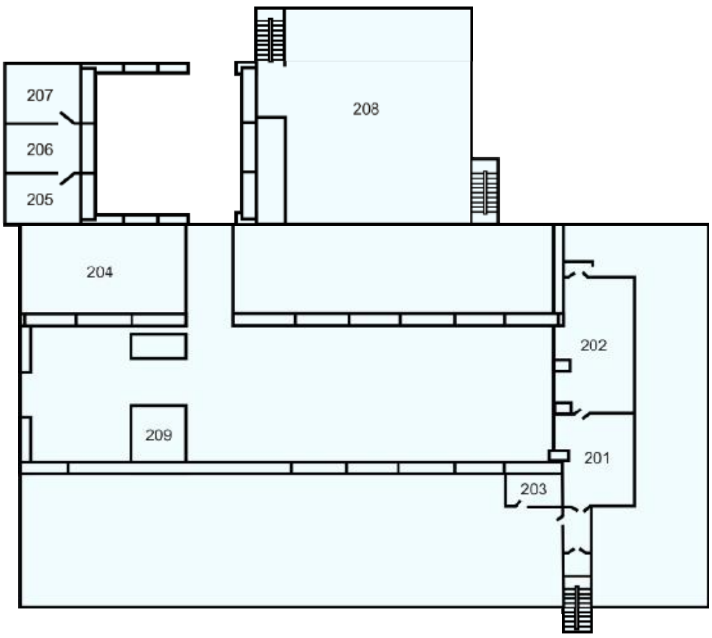


Figure 7-11 Layout of BS Second Floor

Table 7-1 Room Area and Environment in BS2

Room	Function	Dimensions		Door	Environment		
		L×W×H (m× m×m)	Area (m^2)	W×H (m×m)	Temperature (°C)	Relative Humidity (%)	Cleanness level
101	Transit Hall	12×18×18	216	5.4×13	18~28	50±10	100,000
102	Air-lock Room	6×5.64×13	33.8	5.4×12.5	18~28	50±10	100,000
103	SC Test Hall	42×18×18	756	5.4×12.5	(17~23)±2	35~55	100,000
105	Aisle			1.0×2.1			
106	Compressor Room*			1.0×2.1			
107	Clean Rooms	6×6.9	41.4	1.5×2.1	22±2	35~55	100,000
108	Air-conditioning Equipment Room	18×8.4	151.2	1.5×2.1			
109	Clean Rooms	18×6.9	124.2	1.5×2.1	22±2	35~55	100,000
111	Air-conditioning Equipment Room	9×6×3	54	1.5×2.1	20~25	35~55	
112	Storage Room	6.9×6×3	41.4	1.5×2.1	20~25	35~55	10,000
113	Office	3×6×3	18	1.5×2.1	20~25	35~55	
114	Storage Room	6.9×6×3	41.4	1.5×2.1	15~25	35~55	10,000
115	Office	6×6×3	36	1.5×2.1	18~28	≤70	
116	Clinic	6×6×3	36	1.5×2.1	18~28	≤70	
117	Test Room	18×6.9×3.0	124.2	1.5×2.1	18~28	≤70	
118	Boiler Room		15.7	1.0×2.1			
119	Lady’s Rest Room		20	1.5×2.1			
121	Change Room & Wind Shower Room	6×6.9×3.0	41.4	1.5×2.1			
122	Entrance Hall		72	1.5×2.1			

Room	Function	Dimensions		Door	Environment		
		L×W×H (m× m×m)	Area (m^2)	W×H (m×m)	Temperature (°C)	Relative Humidity (%)	Cleanness level
123	Hall Way	9.3×3.75	52.5	1.5×2.1			
124	Duty Room			1.0×2.1			
125	Office	10.5×6.9×3	72.5	1.5×2.1	18~28	≤70	
128	Office	15.9×6.9×3	110	1.5×2.1	18~28	≤70	
129	Security Equipment	6×6×3.0	36	1.5×2.1	18~28	≤70	
130	Communication Terminal Room*	6×6×3.0	36	1.5×2.1			
131	Battery Refrigerator	6.9×3.9×3.0	27	1.5×2.1	18~28	≤60	
132	Communications Rack Room*	6×4.25×3.0	25.5	1.5×2.1			
133	Test Equipment Room	18×6.9×3.0	124.2	1.5×2.1	18~28	30~60	
134	Test Equipment Room	18×6.9×3.0	124.2	1.5×2.1	18~28	30~60	
135	Asile	6.9×6×13	41.4	5.0×12.5	18~28		
136	Leakage Test	12×9.3×7	111.6	3.8×6	20~25	30~60	
137	Leakage Control Room	6×3.62	21.7	1.5×2.1	18~28	≤70	
138	Vacant Room	6×3.9	23.4	1.5×2.1			
141	Oxidizer Fueling Equipment Storage Room	8.1×6×3.5	48.6	2.8×2.7	18~23	≤60	
142	SC Fueling Control Room	8.1×6×3.5	48.6	1.5×2.1	18~28	≤60	
143	Fuel Fueling Equipment Room	8.1×6×3.5	48.6	2.8×2.7	18~28	≤60	
144	Fueling/Assembly Hall	18×18×18	324	5.4×13	(17~23) ± 2	35~55	100,000
145	Power Distribution Room*			1.5×2.1			
146	Air-conditioning Equipment Room*			1.0x2.1			

Room	Function	Dimensions		Door	Environment		
		L×W×H (m× m×m)	Area (m^2)	W×H (m×m)	Temperature (°C)	Relative Humidity (%)	Cleanness level
201	Meeting Room	10.5x6.9	72.5				
202	Meeting Room	15.9x6.9					
203	Pipe line Room						
204	Air-conditioning Equipment Room*						
205	Air-conditioning Equipment Room*			1.5×2.1			
206	Duty Room*			1.5×2.1			
207	Air-conditioning Equipment Room*			1.5×2.1			
208	Air-conditioning Equipment Room*						

Note:* Referring rooms reserved by XSLC for operatio

7.5.1 Non-Hazardous Operation Building (BS2)

7.5.1.1 General Description

The Non-Hazardous Operation Building (BS2) (Figure 7-12 and Figure 7-13) consists of the following parts:

Transit Hall (101), Air-lock Room (102), Satellite Test Hall (High Bay, 103), System Test Equipment (STE) rooms (133, 134), Clean Rooms (107, 109), Battery Refrigerator (131), Leakage Test Rooms (136, 137), etc.

Figure 7-12　Non-Hazardous Operation Building (BS2)

Figure 7-13　Non-Hazardous Operation Building (BS2)

7.5.1.2 Transit Hall (101)

Lifting Capability of the crane provided in the Transit Hall is as follows:

Main Hook: 16 tons
Subsidiary Hook: 3.2 tons
Lifting Height: 15 m

7.5.1.3 Satellite Testing Room (High Bay 103)

This is used for the satellite electric testing, integrating the solar-panels, antenna, etc. The SC weighing and dry-dynamic-balancing are also performed in high bay 103. The High Bay is equipped with a two hook crane that has the following lifting capability:

Main hook: 16 tons
Subsidiary hook: 3.2 tons
Lifting height: 15 m
Maximum capacity of dynamic balance instrument: 7,700 kg

A mounting fixture for the antenna is attached to the inner wall and is accessible via a ladder and a platform to facilitate the installation of the antenna. The High Bay also has a viewing area fitted with large glass windows for watching the testing procedure from outside. A hydra-set is also available for the SC lifting during assembly and test.

7.5.2 Hazardous Operation Building (BS3)

The Hazardous Operation Building (BS3) (Figure 7-14) is a clean room that can support the satellite assembly and test under hazardous conditions, such as monopropellant or bi-propellant fuel and oxidizer fueling, the integration of the satellite solid rocket motors and final pyrotechnic installation. The facility also supports spin balancing and weighing of the fully loaded satellite.

7.5.2.1 General Description

The Hazardous Operation Building (BS3) comprises the following parts: SC fueling and assembly hall (144); Oxidizer fueling-equipment room (141); Fuel fueling-equipment room (143); Fueling operation room (142). Refer to Figure 7-14 and Table 7-1.

7.5.2.2 SC Fueling and Assembly Hall (144)

This room is used for the fueling of hydrazine or bi-propellant, the integration of the satellite and SPM, wet satellite dynamic balancing, leakage check and SC/LV combined operations.

An explosion-proof movable crane is equipped in this hall. The crane's specifications are as follows:

Main hook: 16 tons
Subsidiary hook: 5 tons
Lifting height: 15 m

The power supply, power distribution and the illumination devices are all explosion-proof.

The walls between the fueling operation room and the assembly room, leakage test room, air-conditioning equipment room are all reinforced concrete walls for safety and protection. The door between the fueling and assembly hall and the high-bay 103 in BS2 can withstand the overpressure incase of an incident. A hydra-set is available for satellite assembly and lifting.

Inside Hall 144, there are eye-wash, poisonous gas alarms and shower devices for emergency.

Figure 7-14 Hazardous Operation Building (BS3)

7.5.2.3 Test Equipment Room (133 & 134)

Room 133 is for system-level test equipment and room 134 is for storage of supporting test equipment.

An RF system is provided so that the SC test equipment (STE) in BS2 can be used to monitor the satellite whether it is in BS3, at the LC-2 or LC-3. Both uplink and downlink RF channels are provided.

7.5.3 Solid Propellant Motor Checkout and Processing Building (BM)

7.5.3.1 General Description

The Solid Propellant Motor (SPM) Checkout and Processing Building (BM) is used for the storage of the SPM and pyrotechnics, SPM assembly, pyrotechnics test, preparation for X-ray inspection of the SPM, etc.

The BM consists of the following areas: Checkout and Processing Hall, SPM Storage Room, Pyrotechnics Storage and Checkout Room, Offices, Locker Room and air-conditioning Room. Refer to Figure 7-15. The room area and environment are listed in Table 7-2.

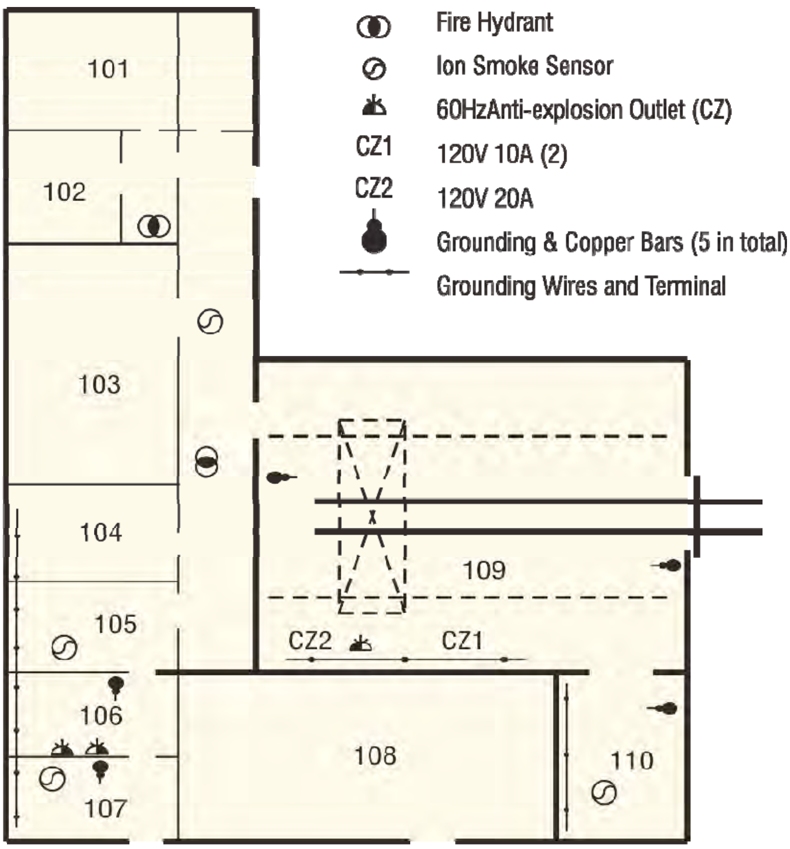


Figure 7-15 Solid Propellant Motor Processing Buildings (BM)

Table 7-2 Room Area and Environment in BM

Room	Usage	Measurement		Door W×H (m)	Environment	
		L×W×H (m×m×m)	Area (m^2)		T (°C)	Humidity (%)
101	Duty Room	5.1×3×3.5	15.3	0.8×2.0		
102	Break Room	3.5×3×3.5	10.5	0.8×2.0		
103	Office	6.0×5.1×3.5	30.6	1.4×2.0		
104	Spare Room	5.1×3×3.5	15.3	0.8×2.0		
105	Spare Room	5.1×3×3.5	15.3	1.4×2.0		
106	Pyro Check	5.1×3×3.5	15.3	0.8×2.0	21±5	<55
107	Pyro Storage	5.1×3×3.5	15.3	0.8×2.0	21±5	<55
108	Air-Conditioning	10.6×6×3.5	63.6	1.4×2.2		
109	Preparation for SPM test and X-ray inspection	12×9×9.5	108	3.2×4.5	21±5	<55
110	SPM Storage	6×3.9×3.5	23.4	3.2×4.5	21±5	<55

7.5.3.2 Preparation Room for SPM Test and X-Ray Detection (109)

This hall is equipped with an explosion-proof movable crane that has a lifting capacity of 5 t and a lifting height of 7 m.

There is a railway spur (1,435 mm of rail gap) in the hall leading to the SPM X-ray inspection hall (BMX) and the cold soak chamber.

7.5.4 SPM X-ray Detection Building (BMX)

7.5.4.1 General Description

The BMX is used for X-ray inspection and cold-soak of solid motors. The BMX consists of the following areas: cold soak room, X-ray operation hall, control room, detecting equipment room, modulating cabinet room, film operation, processing and interpretation rooms, chemical and instrument room, offices, locker room and air-conditioning equipment room. Refer to Figure 7-16. The area and environment of each room are listed in Table 7-3.

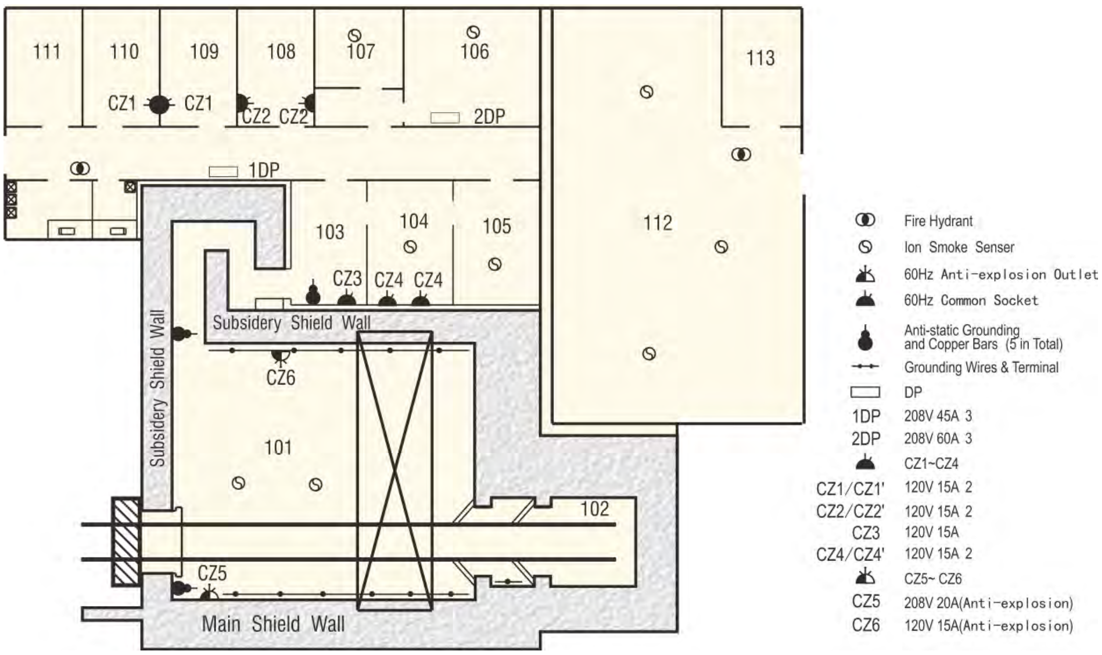


Figure 7-16 Solid Propellant Motor X-ray Building (BMX)

Table 7-3 Room Area and Environment in BMX

Room	Function	Dimensions		Door	Environment	
		L×W×H (m× m×m)	Area (m^2)	W×H (m×m)	Temperature (°C)	Humidity (%)
101	X-ray Detection Hall	12.5×10×15	125	3.2×4.5	(23~24)±2	35~55
103	X-ray Control Room	5×3.6×3.7	18	0.8×2.0	(23~24)±2	40~60
105	Modulating Cabinet Room	5×3.3×3.7	16.5	1.5×2.4	(23~24)±2	40~60
106	Film Processing Room	6×5.1×3.7	30.6	1.0×2.0	18~22	<70
107	Film Preparation Room	3.6×5.1×3.7	18.36	0.8×2.0		
108	Chemical /Instrument Room	5.1×3.3×3.7	16.83	0.8×2.0		
109	Film Evaluation Room	5.1×3.3×3.7	16.83	0.8×2.0		

7.5.4.2 X-ray Detection Room (101)

This hall is for x-ray inspection of the SPM and uses a Linatron 3000A linear accelerator. The nominal electron beam energy is 6, 9 and 11 million electronic volts (mev). The continuous duty-rated output and nominal energy at one meter on the central axis of the X-ray is 3,000 rad/min.

The X-ray protection in the hall is defined according to the calculation based on the specifications of the Linatron 3000A. The main concrete wall is 2.5 m thick.

The doors between the hall and the control room and the large protection door are equipped with safety locking devices. The hall is provided with dosimeter and warning device, high-voltage emergency cut-off button for X-ray equipment, X-ray beam indicator and additional protection systems to assure the safety of the operators.

The hall is equipped with an explosion-proof movable overhead crane with lifting height of 8 m and a telescopic arm that supports the head of the X-ray machine. A railway (1,435 mm in width) is laid in the hall and leads to the cold-soak room and the SPM checkout and processing hall (BM).

7.5.5 Storehouse of Hazardous Substances

Storehouses for hazardous substances are used for the storage of flammable and explosive articles. BM1 and BM2 are for the storage of satellite propellants. There are additional facilities for the test and storage of LV pyrotechnics.

7.5.6 Power Supply, Grounding, Lightning Protection, Fire-Detection & Alarm

7.5.6.1 Power Supply System

All SC processing hall and rooms, such as 103, 144, 133 and 134 etc., are equipped with two types of UPS working at 60Hz and 50Hz respectively.

(a) 60 Hz UPS

Voltage: 208 / 120V ± 1%

Frequency: 60 ± 0.5Hz

Power: 64 kVA

(b) 50 Hz UPS

Voltage: 380 / 220V ± 1%

Frequency: 50 ± 0.5Hz

Power: 130 kVA

Four kinds of power distributors are available in all SC processing halls and rooms. Each of them has a panel with both Chinese and English descriptions indicating its frequency, voltage, rated current, etc.

All of the sockets inside Hall 144 and other hazardous operation areas are explosion-proof.

7.5.6.2 Lightning Protection and Grounding

In the technical areas, there are three kinds of grounding, namely technological grounding, protection grounding and lightning grounding. All grounding resistance is lower than 1Ω.

Copper grounding bars are installed to eliminate static at the entrance of the fueling and assembly hall, in the oxidizer fueling equipment room and the propellant fueling equipment room.

The SPM checkout room (109), SPM storage room (110), pyrotechnics storage and checkout rooms (106, 107) are also equipped with a copper grounding bar at the entrance to eliminate static. In BMX and the terminal room, there are also copper grounding bars to eliminate static electricity.

The SPM checkout and processing building is equipped with a grounding system for lightning protection. There are two separate lightning rods outside SPM.

7.5.6.3 Fire Detection and Alarm System

The SPM checkout room (109), SPM storage room (110), pyrotechnics storage/checkout rooms (106, 107), and air-conditioning equipment room (108) are all equipped with ionic smoke detectors. The office (103) is equipped with an automatic fire alarm system. When the detector detects smoke, the automatic fire alarm system will give an audible warning to notify the safety personnel of a problem so they can take the necessary measures. The X-ray operation hall, control room, equipment room, modulating cabinet room, film preparation and processing room, air conditioning room are all equipped with smoke sensors. The control room is equipped with a fire alarm system, and in case of a fire, the alarm system will give an audible warning to notify the safety personnel of a problem so they can take the necessary measures.

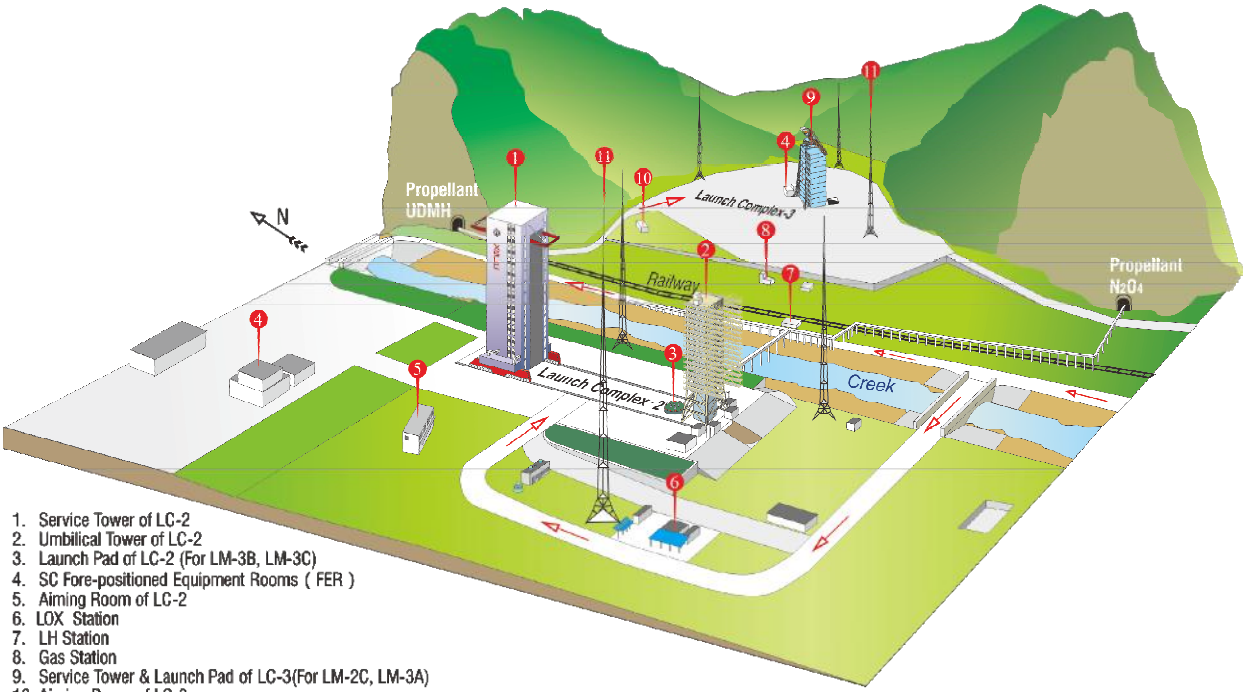
7.5.7 Launch Control Center (LCC)

The Launch Control Center (LCC) is the command and information center for the test of the launch system during the launch campaign, from which the integrated test, functional test and ignition and launch control are performed via the LV remote launch control ground support system and command & monitoring equipment, and the satellite remote test station. The Launch Control Center (LCC) is an explosion-proof blockhouse structure, and is a 3,900 m^2 three-floor building.

7.6 Launch Complexes

7.6.1 General Description

The launch site is 2.2 km (via a dedicated path) away from the Technical Center. Facilities in the launch area consist of Launch Complex No.2 (LC-2) and Launch Complex No.3 (LC-3). Refer to Figure 7-17.



1. Service Tower of LC-2
2. Umbilical Tower of LC-2
3. Launch Pad of LC-2 (For LM-3B, LM-3C)
4. SC Fore-positioned Equipment Rooms (FER)
5. Aiming Room of LC-2
6. LOX Station
7. LH Station
8. Gas Station
9. Service Tower & Launch Pad of LC-3(For LM-2C, LM-3A)
10. Aiming Room of LC-3
11. Lightning Rods

Figure 7-17 Launch Complexes of XSLC

Figure 7-18 Two Launch Pads in XSLC (Left: LC-2; Right: LC-3)

7.6.2 No.3 Launch Complex (LC-3)

LC-3 (Figure 7-18 and Figure 7-19) is for the LM-3A launch vehicle, and includes the launch pad, a fixed service tower, fueling system, gas supply system, water supply system, power supply system, lightning-proof tower, etc.

Figure 7-19   No. 3 Launch Complex (LC-3)

7.6.3 No.2 Launch Complex (LC-2)

LC-2 (Figure 7-20) is about 300 m northward from LC-3.

LC-2 includes the launch pad, a mobile service tower, a fixed umbilical tower, fueling system, gas supply system, water supply system, power supply system, lightning-proof tower, etc.

Figure 7-20   No. 2 Launch Complex (LC-2)

The Service Tower is composed of tower crane, running gear, platforms, elevators, power supply and distributor, fueling pipeline for storable propellant, fire detectors and extinguishers, etc.

This tower is 90.6 m high with two cranes mounted on the top of the tower. The effective lifting height is 84 m and the lifting capability is 20 tons (main hook) and 12.5 tons (subsidiary hook). There are two elevators (capacity 1.5 tons) for the lifting of the personnel and test equipment. The tower has platforms for the checkout and test operations of the launch vehicle and the satellite.

The upper part of the tower is an environment-controlled clean area with a cleanness class of 100,000. The temperature within this clean room, which is the satellite operation area, can be controlled in the range of 15 ~ 25 °C. SC/LV mating, SC test, fairing encapsulation and close-out activities will be performed in this area. A telescopic/rotating overhead crane is provided for these operations. This crane can rotate in a range of 110 degrees and its lifting capability is 12.5 tons.

In the Service Tower, Room 812 is exclusively prepared for SC operations and 60 Hz and 50 Hz UPS (single phase 120 V, 5 kW) are provided. The grounding resistance is less than 1 Ω. The room area is 8 m^2.

Besides a hydrant system for fire suppression in the Service Tower, it is also equipped with a powder suppression system and 1,211 fire extinguishers.

The Umbilical Tower supports the electrical conduit, gas pipelines and liquid pipelines between SC and LV in addition to the connectors. The Umbilical Tower uses a swinging-arm system, platforms and cryogenic fueling pipelines through which the cryogenic propellant fueling is performed.

The ground power supply cables will be connected to the satellite and the launch vehicle via the Umbilical Tower. The ground air conditioning pipelines will also be connected to the fairing via the Umbilical Tower to provide clean air into the fairing. The cleanliness of the conditioned fairing air is of class 100,000, the temperature is 15~25°C and the humidity is 35~55%.

Umbilical Tower Room 722 is exclusively for the use of the SC team. Its area is 8 m^2 and it is equipped with a 60 Hz and 50 Hz UPS (single phase 120 V/220 V, 15 A). The grounding resistance is lower than 1 Ω.

7.6.4 Power Supply for Launch Pad

There are two kinds of power supplies at the launch pad:

380V / 220V (50 Hz for both) from transformer station.
120V (60 Hz) from power generators.

7.6.5 SC Fore-positioned Equipment Room (FER)

7.6.5.1 General Description

The SC FER is located in an explosion-proof building that is 150 m away from the launch pad. The total usable area of the building is 1,000 m^2, which includes LV subsystems test rooms, SC operation rooms, air-conditioning system and emergency escape system, etc. Figure 7-21 shows the layout.

7.6.5.2 Satellite Working Room (104,105)

There are two working rooms in LC-2 for the satellite team, see Figure 7-21. The area of each room is 48.6 m^2. The inside temperature is 18~28°C and the relative humidity is less then 70%. The grounding resistance is less than 1 Ω. 380V / 220V, 50 Hz UPS are provided in each room. An additional 120V/208V, 60 Hz UPS is provided in Room 104.

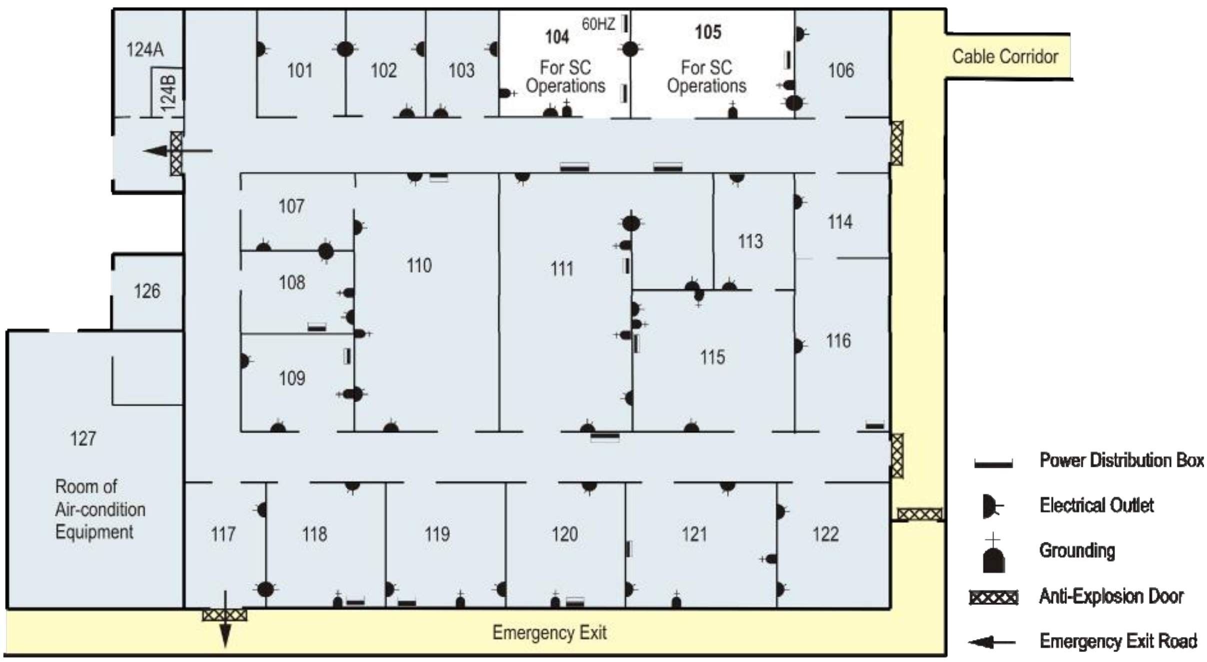


Figure 7-21 SC Test Rooms

7.7 Mission Command & Control Center (MCCC)

7.7.1 General Description

The MCCC (Figure 7-22, Figure 7-23 and Figure 7-24) is located in Xichang City and includes the Command & Control Hall, Safety Control Center, SC team room, subsystem operation rooms and offices. The MCCC is the command, safety control, communications and data processing center for XSLC. The MCCC has data links with the Xi'an Satellite Control Center (XSCC) and Beijing Aerospace Control Center for the exchange of data. Figure 7-24 shows the layout of MCCC.

Figure 7-22 XSLC Mission Command & Control Center (MCCC)

Figure 7-23 XSLC Mission Command & Control Center (MCCC)

7.7.2 Functions of MCCC

a) Execute instructions as the master command center;

b) Instruct and monitor the performance and status of all units of XSLC;

c) Perform range safety control;

d) Record and display LV liftoff status in real-time;

e) Transmit display information and data to Beijing Aerospace Control Center (BACC) and Xi'an Satellite Control Center (XSCC);

f) Transmit guidance information to every tracking station along the range;

g) Provide SC orbit parameters to customer;

h) Perform post-launch data processing.

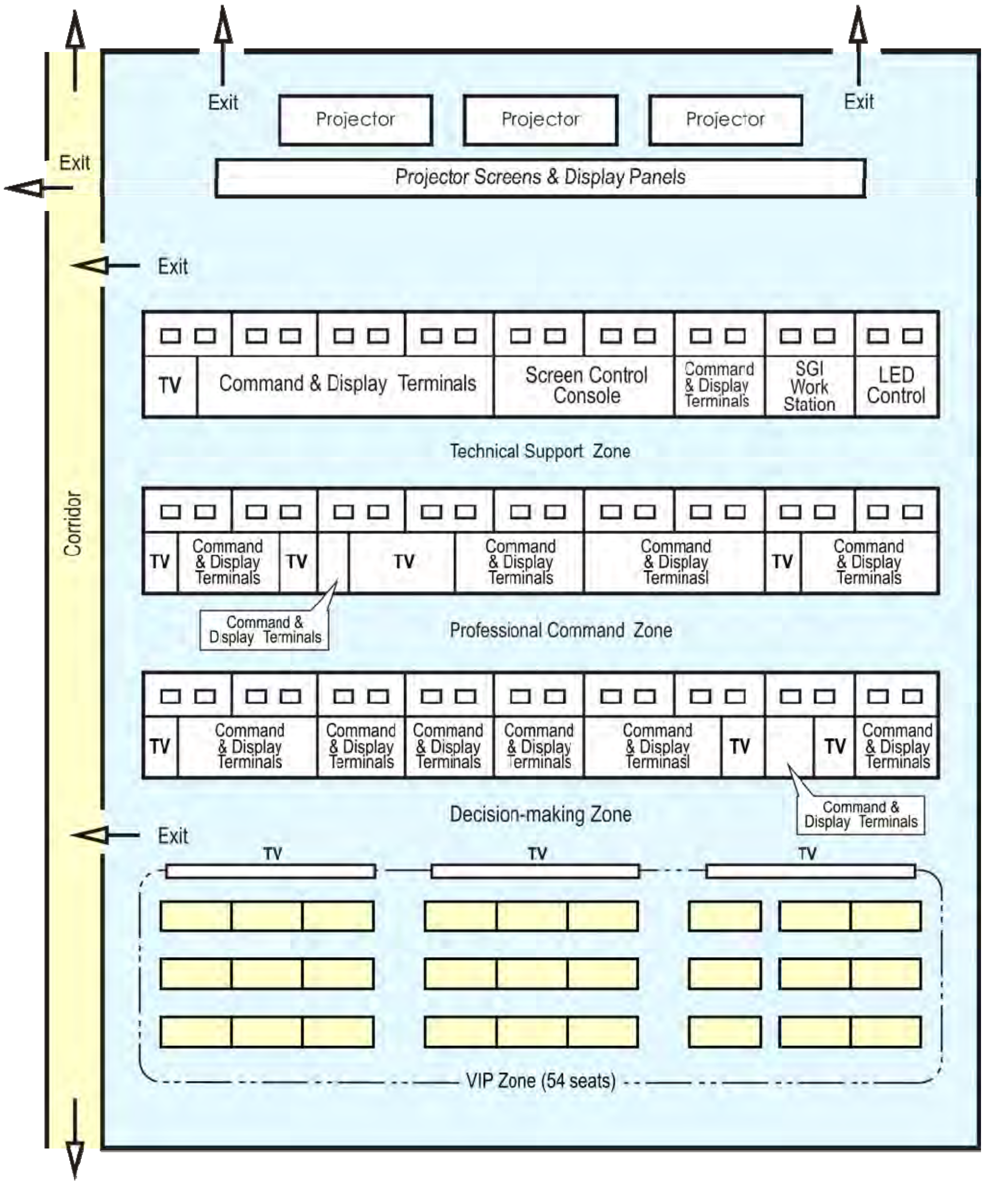


Figure 7-24 Mission Command & Control Center (MCCC)

7.7.3 Configuration of MCCC

a) Command and control system
b) Real-time and post-mission computer processing system
c) Monitor and display for safety control, including computers, D/A and A/D converters, TV display, X-Y recorders and multi-pen recorders
d) Remote command system
e) Communications system
f) Timing system
g) Data transmission system
h) Film developing and printing equipment

7.8 Tracking, Telemetry and Control System (TT&C)

7.8.1 General Description

The TT&C system of XSLC and TT&C system of XSCC comprise a TT&C network for all launch missions.

The TT&C system (Figure 7-25) at XSLC includes optical, radar, telemetry and remote control equipment. It is responsible for measuring and processing the launch vehicle flight data, and also the data for the range safety control. Data received and recorded by the TT&C systems are used for post-mission processing and analysis.

7.8.2 Main Functions of TT&C

a) Record the initial launch vehicle flight data in real time.
b) Measure the trajectory of the launch vehicle in real time.
c) Receive, record, transmit and process the telemetry data of the launch vehicle and the satellite.
d) Make flight range safety decisions.
e) Compute the parameters of orbit injection and SC/LV separation status.

7.8.3 Composition of TT&C

The TT&C system of XSLC mainly consists of:

a) Xichang Tracking Station
b) Yibin Tracking Station
c) Guiyang Tracking Station

Figure 7-25 Antennas of TT&C System

The TT&C system of Xi'an Satellite Control Center (XSCC) mainly consists of:

a) Weinan tracking station
b) Xiamen tracking station
c) Ocean going ships. Refer to Figure 7-26.

7.8.4 Tracking Sequence of TT&C System

After LV lift-off, the optical, telemetry and radar equipment around the launch site immediately track the LV. The received data will be sent to the MCCC. These data will be initially processed, and sent to the relevant stations. The station computers receive these data and conduct the coordinate conversion and use the obtained data to guide the TT&C system to acquire and track the flight target.

After the tracking station acquires the flight target, the measured data are sent to the computers at the stations and MCCC at XSLC for data processing. The processed data are used for the flight safety control. The results of computation are sent to XSCC and BACC in real time via the data transmission system.

In case of a failure during the first and second stage flight phases, the range safety officer will make a decision based on the range safety criteria.

The orbit injection of the SC is tracked at the XSCC facilities. The tracking data are sent to MCCC at XSLC for processing and monitoring. The tracking operations for LM-3A, LM-3B, LM-3BE and LM-3C launch vehicles are shown in Figure 7-26.

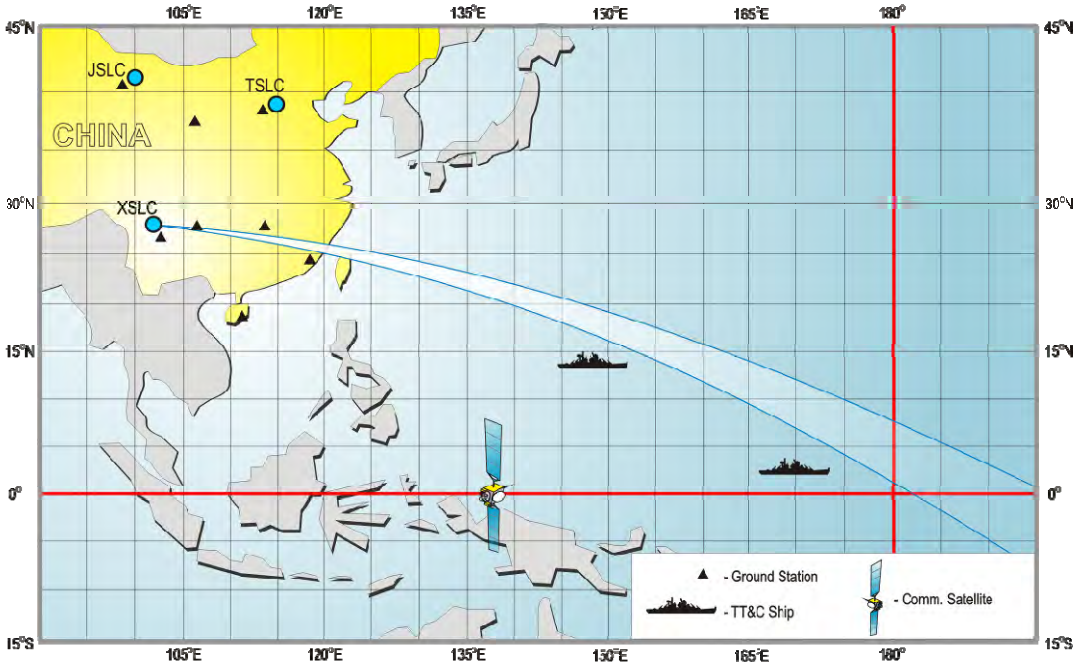


Figure 7-26　TT&C Operations of LM-3A/3B/3BE/3C GTO Launch Missions

7.9 Transportation and Handling

XSLC has various types of transportation vehicle and loading/unloading equipment as well as encapsulation handling and transportation equipment applicable for the launch vehicles such as LM-3A, LM-3B, LM-3BE and LM-3C, etc. The technical specification of vehicles and equipment are shown in Table 7-4.

Table 7-4　Specification of vehicle and loading/unloading equipment

No.	Vehicle	Quantity	Function	Main specification
1	3.5 tons concave wagon	1	SC encapsulation container transportation	Loading capacity: 3.5 tons Concave length: 3.58 m Ground clearance: 0.92 m
2	13.5 tons concave wagon	1	SC encapsulation container or fairing transportation	Loading capacity: 13.5 tons Concave length: 4.1 m Ground clearance: 1.05 m Concave circular base: Φ4.1 m
3	12 tons SC container trailer	1	SC container transportation	Dead weight: 6.5 tons Loading capacity: 12 tons Effective width: 3,600 mm Effective length: 12,960 mm No-load height: 1,650 mm
4	30 tons SC container trailer	1	SC container transportation	Dead weight: 15 tons Loading capacity: 30 tons Effective width: 4,100 mm Effective length: 15,000 mm No-load height: 600 mm

No.	Vehicle	Quantity	Function	Main specification
5	Air-ride flatbed	1	SC container transportation	Loading capacity: 5 tons Ground clearance: 1.4 m
6	"Benz" trailer	1	SC container transportation	Loading capacity: 30 tons Length: 12.2 m Weight: 2.83 m Ground clearance: 1.15 m
7	"Benz" tractor	3	SC container transportation	Maximum pull: 50 tons Vertical loading capacity of connector: 14 tons
8	"Jiefang" truck		Bulk cargo transportation	Loading capacity: 5 tons Carriage length: 4.2 m Width: 2.4 m Ground clearance: 1.35 m
9	"Jiefang" trailer	3	Container transportation	Loading capacity: 8 tons Length: 7.95 m Weight: 2.25 m Ground clearance: 1.38 m
10	"STAIR" truck	1	Container transportation	Loading capacity: 22 tons Ground clearance: 1.45 m
11	"Huanghe" trailers	2	Container transportation	Loading capacity: 19 tons Length: 7.3 m Weight: 2.27 m Ground clearance: 1.45 m
12	15 tons forklift	1	Loading/Unloading	Fork length: 1.8 m (length with extender: 3.5 m) Max lifting height: 4 m Lifting capacity: 15 tons Forks distance: 1.22 m~2.21 m Max speed: 27 km/h
13	5 tons forklift	2	Loading/Unloading	Fork length: 1.2 m Max lifting height: 3 m Lifting capacity: 5 tons Forks distance: 0.15 m~1.3 m Max speed: 22 km/h
14	3 tons electric forklift	1	Loading/Unloading	Fork length: 1 m Max lifting height: 3.5 m Lifting capacity: 3 tons Forks distance: 0.15 m~1 m
15	40t mobile crane	1	Loading/Unloading	Lifting capacity: 40 tons Max working radius: 30 m Arm: 35 m Sling weight: 0.7 tons Lift angle: 20 deg

No.	Vehicle	Quantity	Function	Main specification
16	16 tons mobile crane	2	Loading/Unloading	Lifting capacity: 16 tons Max working radius: 22 m Arm: 24.5 m Sling weight: 0.8 tons Lift angle: 20 deg
17	8 m mobile elevator	2	Operation assistant	Loading capacity: 230 kg (2 people) Max lifting height: 8 m Platform rotation angle: 360 deg Max working slope: 25 deg Ground clearance: 67 mm
18	Mobile elevator	2	Overhead operation	Loading capacity: 200 kg Max lifting height: 13.8 m Platform rotation angle: 360 deg Max elevation: 42 deg
19	Explosion-proof mobile elevator	2	Overhead operation	Max height: 10 m Max operation height: 11.7 m Capacity: 300 kg Platform dimension: 120 x 60 cm^2 Explosion-proof Class: ExdellBT4 Dead weight: 780 kg
20	CDZ32 fire engine	1	Fire fighting/ Installation	Max working height: 32 m Operation range: 18 m Rotation angle: 360 deg Swing angle between main arm and forearm: 0~180 deg Working platform: 360 kg (4 people) Range of water gun: 50 m

7.10 Propellants and Gases

SC propellants and chemicals from the satellite manufacturer are usually transported to the launch site one month prior to the arrival of SC and stored in BM1 and BM2. The satellite contractor packs the SC propellants and chemicals in sea containers and ships them to Huangpu Harbor, Guangzhou in Guangdong Province. CLTC will assist in customs clearance and arrange a special train from Huangpu to Xichang. Fueling of SC propellants is operated by the SC team.

The on-site gas supply system can provide various gases for the launch campaign, such as compressed air, helium and nitrogen. The gases specifications are shown in Table 7-5.

Table 7-5 Specification of Gases

Specification	Nitrogen	Air	Helium
Purity	≥ 98%	/	≥ 99.99%
Dew point	≤ -55℃	≤ -55℃	Water content < 10 ppm
Dust	≤ 50 μm	≤ 50 μm	Solid particle < 10 μm
Oil content	≤ 3×10^{-7} (Volume ratio)	≤ 3×10^{-7} (Volume ratio)	Oxygen content <10 ppm

CHAPTER 8 LAUNCH OPERATIONS

8.1 Overview of Launch Site Operations

The launch operations at XSLC include:

- SC Checkout and Processing
- LV Checkout and Processing
- SC and LV Combined Operations

The typical work flow and requirements of the launch operations are provided in this Chapter. Although all launch missions are similar, each has its own special characteristics, which means the launch operations at XSLC for each mission are unique. The main area where differences occur is the combined operations where the satellite and launch vehicle teams interface directly. Thus combined operations can only be successfully performed if the operational procedures are fully coordinated and approved by both sides.

8.2 SC Operations at the Launch Site

The SC operations are conducted by the SC team with XSLC providing the necessary facilities and support as required.

8.3 Launch Vehicle Launch Operations

The launch vehicle is transported from the CALT facilities in Beijing to XSLC by train, and undergoes various checkouts and processing in the Technical Center and on the launch pad of XSLC. The typical launch vehicle work flow (Encapsulation-on-Pad) for launch operations at the launch site is listed in Table 8-1.

Table 8-1 Typical Launch Vehicle Work Flow (Encapsulation-on-Pad) at XSLC

	Activity	Working day(s)	Accumulative day(s)
Technical Center	LV unloading from train & moving to BL1	1	1
	LV status recovery for system tests	1	2
	Unit tests of subsystem	3	5
	LV status preparation for transport	2	7
Launch Pad	LV transfer, erection & integration	1	8
	Preparation for system tests	1	9
	Tests of subsystems SC/LV combined operations in Technical Center in parallel	4	13
	First and second overall checkouts SC encapsulated with container	2	15
	Transfer SC & fairing to launch pad SC/LV integration & fairing encapsulation	2	17
	SC Test Period	1	18
	Third overall checkout with SC involved	1	19
	Fourth overall checkouts	1	20
	Review on checkout results	1	21
	Functional check before fueling Gas replacement of propellant tanks	1	22
	N_2O_4/UDMH fueling	1	23
	LOX/LH_2 fueling and launch	1	24
Total			**24 days**

Note: After the SC is transferred to the launch pad, some of the SC and LV operations can be performed in parallel as detailed in the combined operation procedures.

If encapsulation is performed in BS3, the SC and fairing are integrated as a complete unit. The integrated SC and fairing are transferred to the launch pad, and mated with the launch vehicle. The SC/LV mating is performed after the second overall LV checkout and before the third overall checkout. In this case, the working procedures for the launch vehicle are substantially the same as encapsulation on the pad.

8.4 SC/LV Combined Operations

8.4.1 General Description

The SC/LV combined operations are conducted at the Technical Center and the launch pad. LM-3A Series launch vehicles offer two options for the SC to LV integration: Encapsulation-on-Pad and Encapsulation-in-BS3.

Encapsulation-on-Pad (Refer to Section 8.4.2):

The Payload Adapter (PLA) and fueled SC are mated inside BS3. The SC/PLA stack is put into the SC Container, which is sealed and then shipped to launch pad. The SC Container and fairing are hoisted to the 8th floor of the Service Tower of Launch Complex No.2 (LC-2). A clean room is established there on the tower following the arrival of SC Container and fairing. The SC/LV integration and fairing encapsulation are performed on the 8th floor of the Service Tower.

Encapsulation-in-BS3 (Refer to 8.4.3):

The Payload Adapter (PLA) and fueled SC are mated in BS3. The SC/PLA stack is then encapsulated with the fairing. The integrated SC/Fairing is shipped to launch pad, and mated with launch vehicle.

The remote SC ground equipment will be moved to the launch complex and the functional checkout will be completed before the SC/LV combined operations commence.

The launch rehearsal and launch countdown procedures are part of the SC/LV combined operations, so the SC team is required to participate in and perform the SC operations and checkouts, as detailed in the procedures.

8.4.2 SC/LV Combined Operations for Encapsulation-on-Pad

8.4.2.1 SC Container

SC Container is a dedicated container used for transferring the SC from BS3 to the launch pad (Figure 8-1 and Figure 8-2).

The SC Container is 4,120 mm in diameter, 8,070 mm in height and the usable envelope of SC Container is 3,650 mm in diameter and 6,650 mm in height for the 1194/1194A PLA. See Figure 8-1. The SC Container is composed of a base pad and five cylindrical sections. The five sections can be assembled together one by one. Two guide poles are provided outside the SC Container. The core of the wall is made of aluminum, and thermal materials cover the outer surface and inner surface of the wall. This SC Container is only used when the fairing Encapsulation-on-Pad method is adopted.

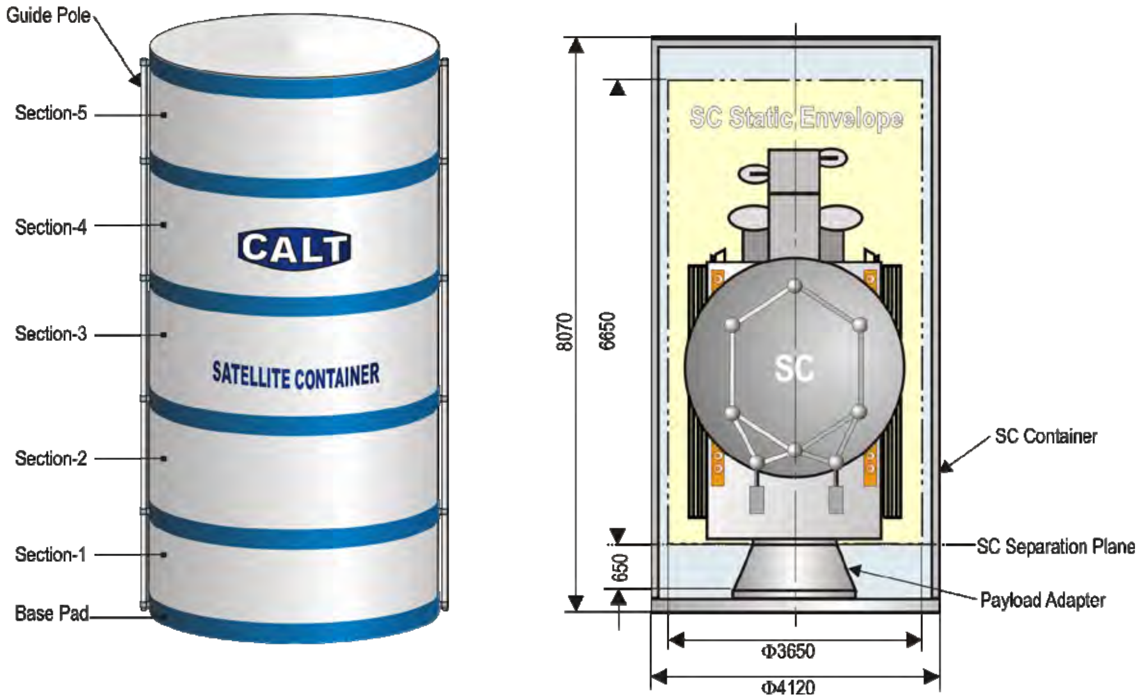


Figure 8-1 SC Container

Figure 8-2 SC Container Transfer

If the satellite dimensions in launch configuration exceed the allowable static envelope of the SC Container, the interference must be reviewed and accepted by CALT in advance of the launch campaign.

In addition, a bigger SC Container with 3,850 mm allowable envelope diameter is also available.

The characteristics of the SC Container are as follows:

a) SC/PLA stack is fastened inside the SC Container;

b) The SC Container is filled and pressurized with dry nitrogen gas (N_2) so that the SC is protected by a positive pressure;

c) The maximum vertical and horizontal overload factor is 0.5 g;

d) The satellite container is fitted with thermal insulation;

e) Temperature, humidity, noise and acceleration, etc. inside the SC Container can be monitored and recorded during the transportation.

8.4.2.2 SC/LV Integration

The PLA and the SC are mated in BS3 after the SC is fueled and weighed. The SC team carries out all the SC operations. CALT is responsible for mating the SC with the PLA and installing SC/LV clampband. The integration procedures are as follows:

a) The Payload Adapter (PLA), with the clampband in the pre-installation position, is installed on a technological stand by the CALT operations team;

b) SC is lifted and mated with PLA by the SC operations team;

c) Clampband is locked and fastened by the CALT operations team;

d) SC/LV separation connectors are mated by the SC operations team;

e) SC/PLA stack is put into the SC container by the SC operations team;

f) SC Container is sealed and filled with dry N_2 by the CALT operations team;

g) SC Container is ready for transfer to Launch Center. Environmental sensors are already installed on the inner side of the container, which can measure and record the inner environmental parameters in real-time during transfer to the Launch Center.

The SC/LV integration process in BS3 is shown in Figure 8-3.

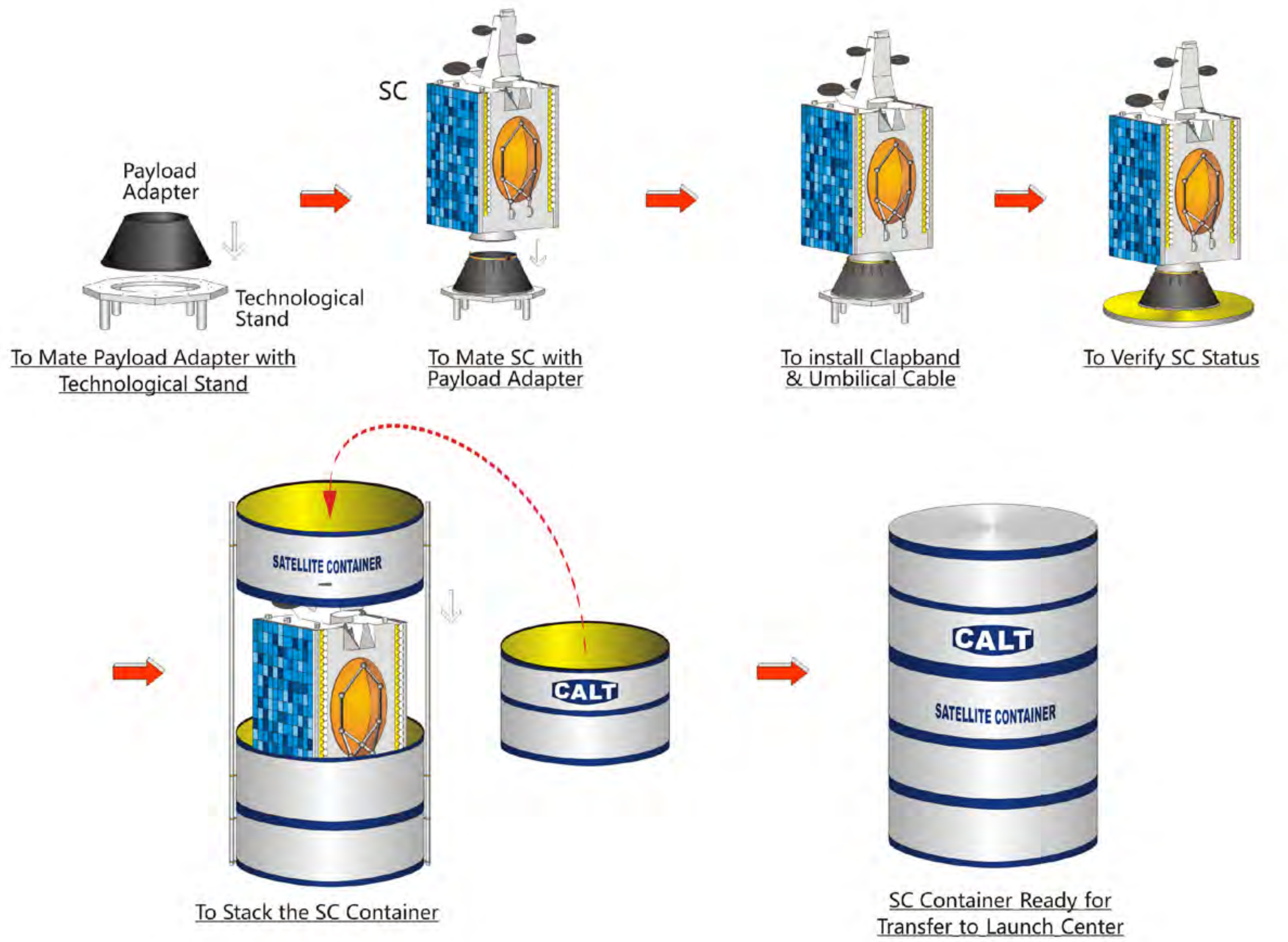


Figure 8-3 SC/LV integration process

8.4.2.3 SC Transfer

XSLC is responsible for using the special vehicle to transfer the SC container to the launch pad. See Figure 8-4 and Figure 8-5. XSLC lifts the SC container, which already contains the SC/PLA stack, onto the special vehicle and fastens the SC container to the vehicle. XSLC drives the special vehicle from BS3 to the Service Tower at the launch pad (Figure 8-6). When in position under the crane, XSLC releases the SC Container from the transfer vehicle and lifts the SC Container up to the 8th floor of the Service Tower. See Figure 8-7 for the arrangement of the SC, Container and the Fairing on the Service Tower. All the doors on the 8th and upper floors are closed to establish the clean room conditions for the SC/LV mating operations; XSLC opens the SC container when the environmental conditions, including temperature, humidity and cleanness, achieve the SC requirements.

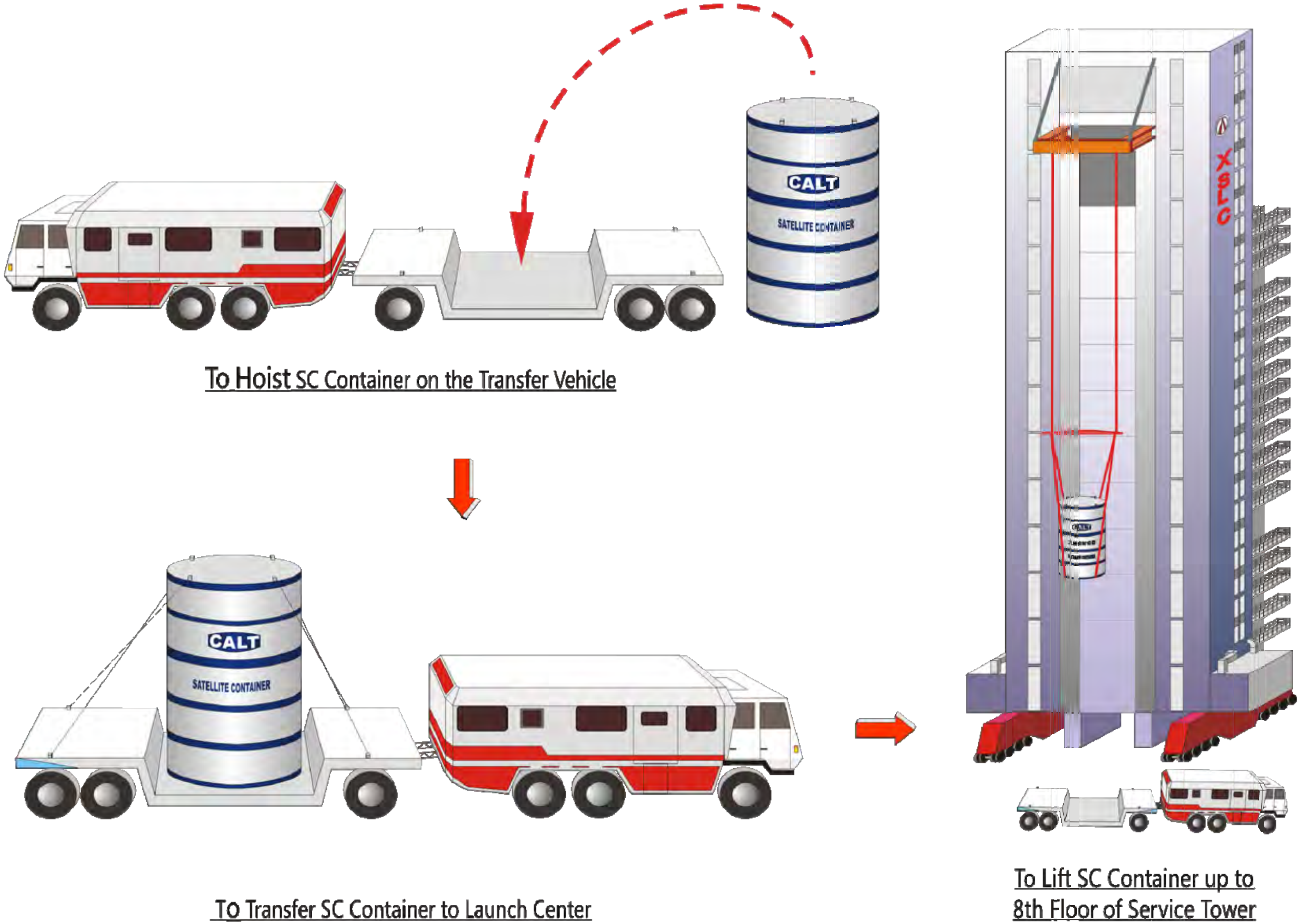


Figure 8-4 Transfer SC Container to the Launch Pad

Figure 8-5 SC Container Transfer to the Launch Pad

Figure 8-6 SC Container Lift

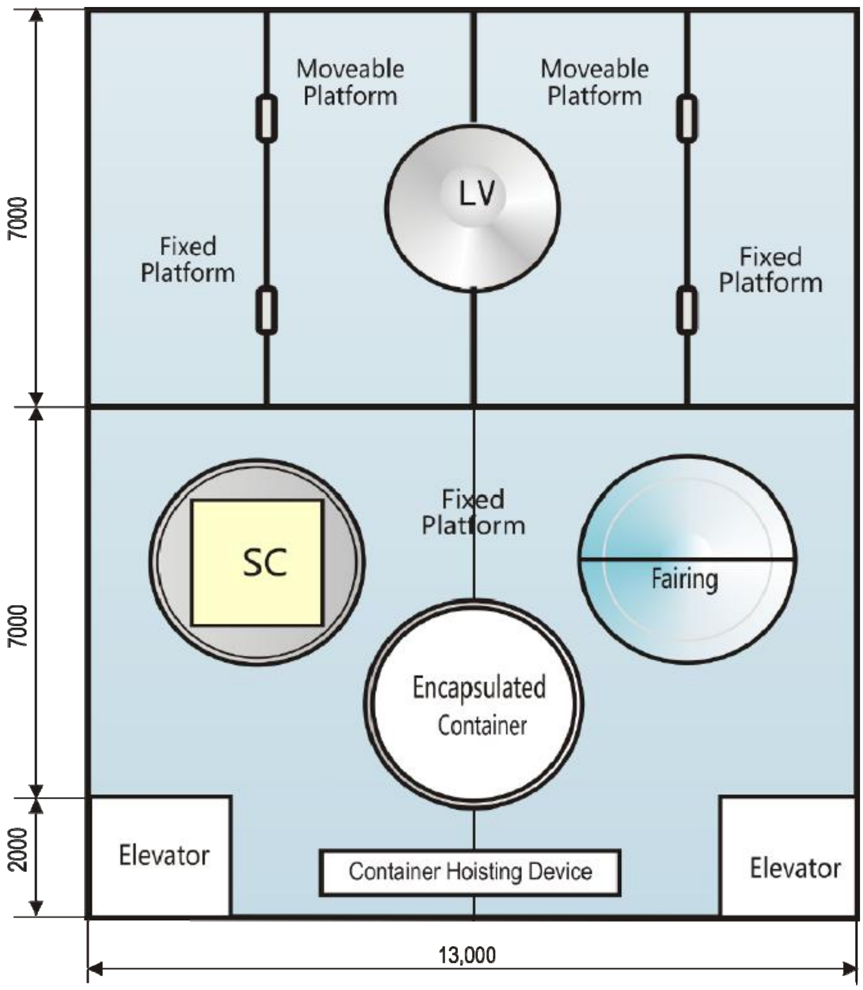


Figure 8-7 Layout on the 8th floor of the Service Tower

8.4.2.4 SC/LV Mating

The SC/LV mating operations at the launch pad include integrating the SC/PLA stack with the launch vehicle third stage, and encapsulating the satellite in the fairing. CALT is responsible for the launch vehicle third stage/PLA mating and fairing encapsulation in the clean room. The SC team is responsible for the SC lifting to the third stage interface. The combined operations procedures are as follows:

a) XSLC team opens the SC Container when the environmental conditions inside the clean room, including temperature, humidity and cleanness, achieve the SC requirements;

b) SC team begins to install the lifting slings on the SC after the container is open;

c) XSLC team unbolts the Payload Adapter (PLA) from the base pad of the SC Container;

d) SC team hoists and moves the SC/PLA stack to a position above the launch vehicle third stage by using the crane in the clean room;

e) CALT mates the SC/PLA stack with launch vehicle third stage;

f) SC team removes the SC lifting slings;

g) XSLC team removes the SC Container from the Service Tower;

h) SC team carries out the SC checkouts prior to the fairing encapsulation;

i) CALT team carries out fairing encapsulation.

Combined operations of fairing encapsulation are shown in Figure 8-8 and Figure 8-9.

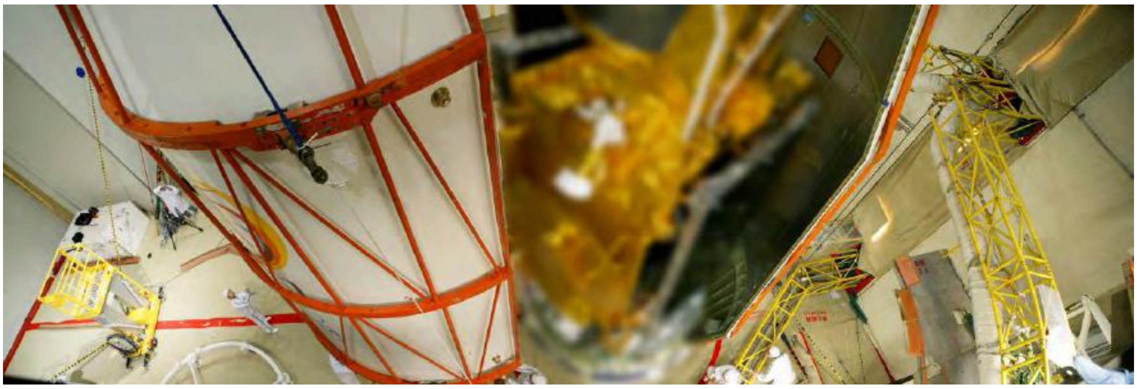


Figure 8-8 Faring Encapsulation-on-Pad

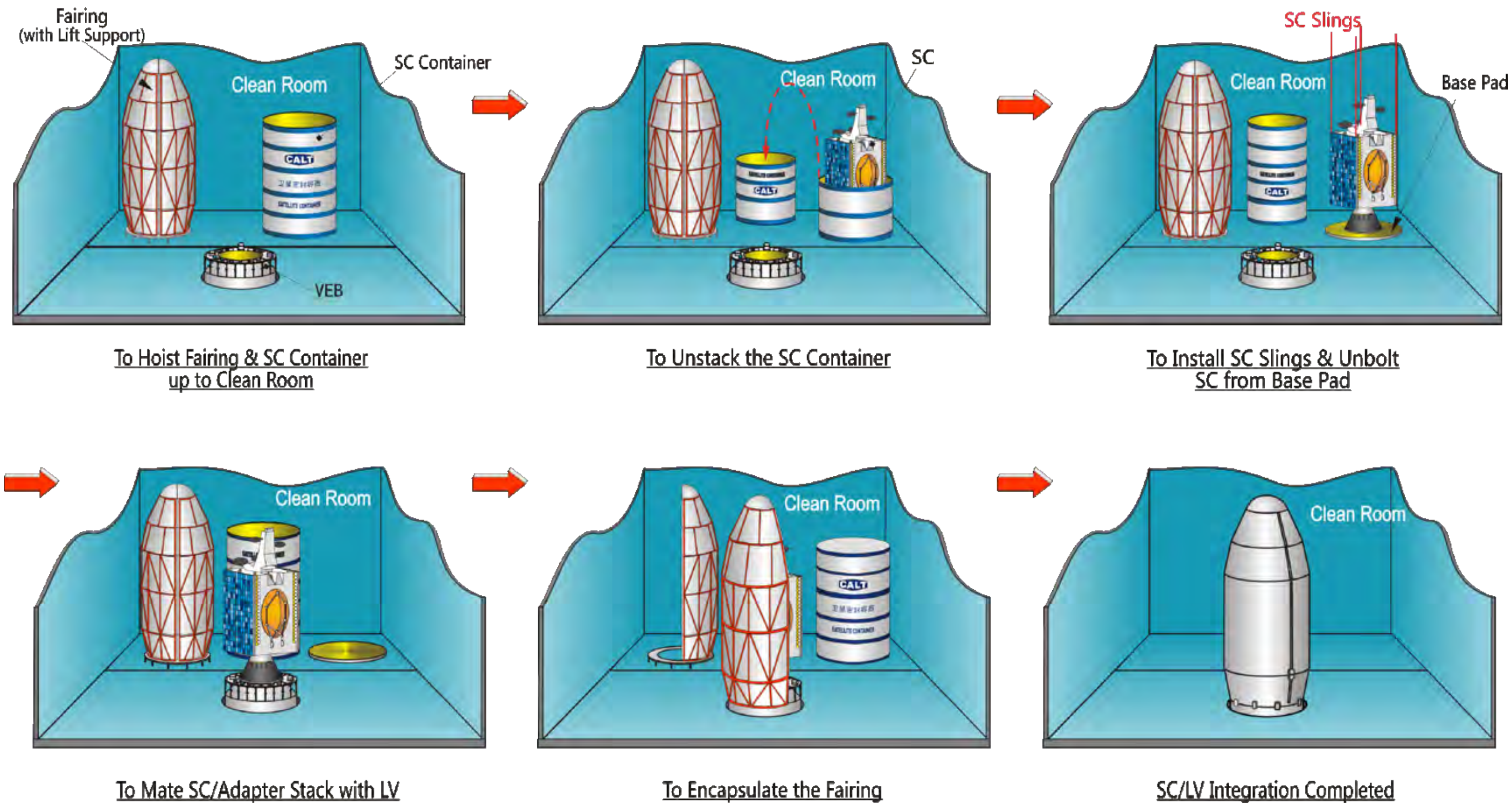


Figure 8-9 Combined operations of fairing Encapsulation-on-Pad

The technical status of SC should be ready for flight before the fairing encapsulation. CALT is responsible for fairing encapsulation after both SC and launch vehicle teams confirm that the SC and the launch vehicle are ready for fairing encapsulation.

After encapsulation of the fairing, the ground umbilical cable for the SC is connected to the onboard cable for the SC, and the fairing air-conditioning duct is connected to the fairing and the air-conditioning is turned on. The air-conditioning system maintains the environmental conditions inside the fairing so the clean room controls on the Service Tower 8th floor are relaxed. The SC team can only perform the limited closeout operations and checkouts for the SC through the access doors on the fairing. All functional testing is performed via the umbilical cable and the RF links. The combined operations procedures define the requirements for launch vehicle accessibility and RF silence time that must be respected by the SC team when performing operations on the SC.

8.4.3 SC/LV Combined Operations for Encapsulation-in-BS3

8.4.3.1 SC/LV Integration

For fairing encapsulation in BS3, the combined operation procedures are as follows:

a) SC team makes the final closeouts on the SC ready for encapsulation in the fairing;

b) CALT team bolts the Payload Adapter (PLA) on a technological stand;

c) SC team lifts the SC up and moves the SC to above the PLA;

d) CALT team mates the SC with the PLA, and then installs the clampband with the support from the SC team;

e) SC team checks the connection of the umbilical cable;

f) CALT team unbolts the PLA from the working stand;

g) SC team lifts up and moves the SC/PLA stack to the Transit Connector;

h) CALT team bolts the SC/PLA stack on the Transit Connector;

i) SC team removes the lifting slings from the SC/PLA stack;

j) CALT team encapsulates the payload fairing on the SC/PLA stack.

The SC/LV integration process in BS3 is shown in Figure 8-10.

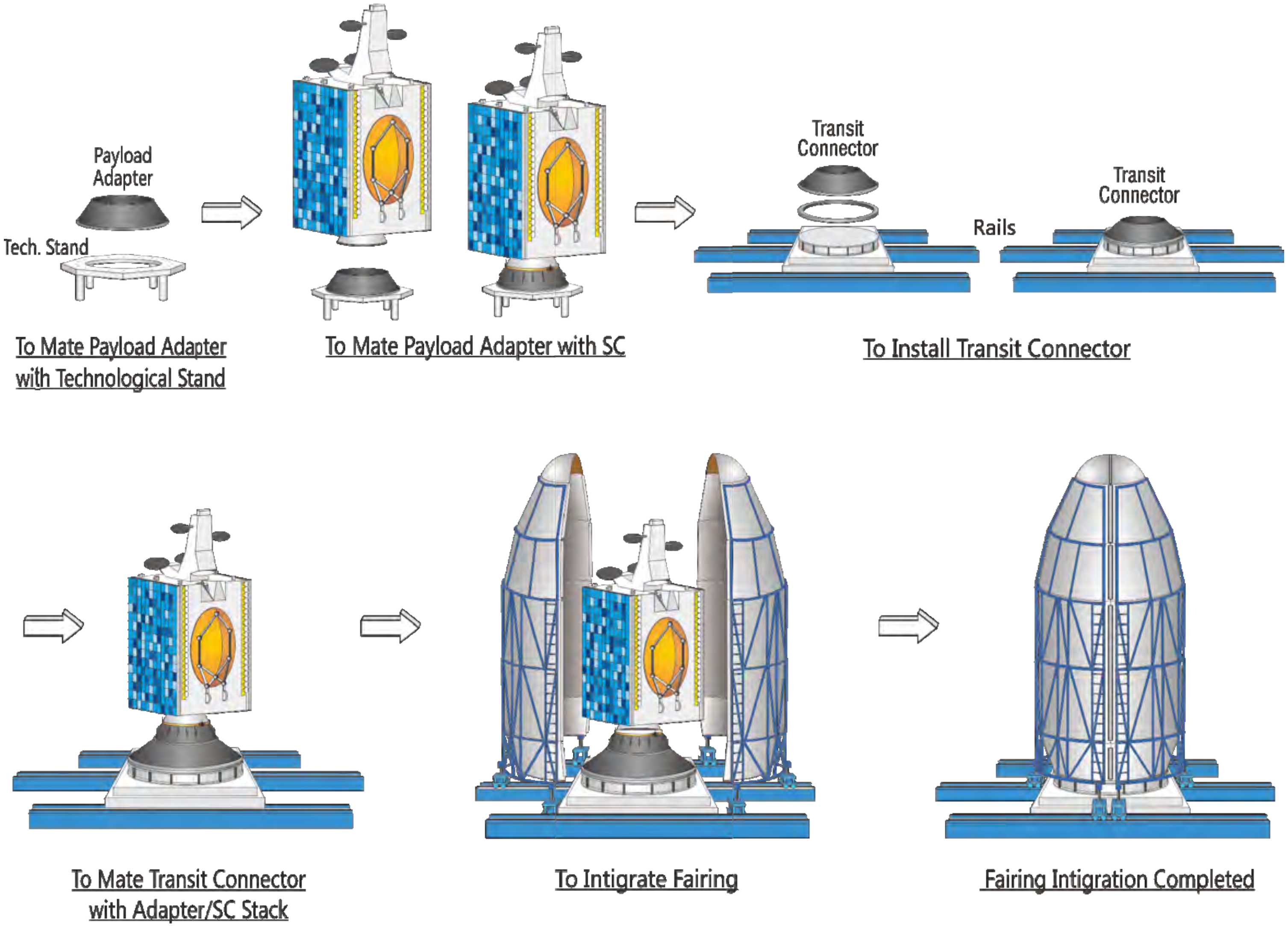


Figure 8-10 SC/LV integration process in BS3

8.4.3.2 SC Transfer to Launch Center

XSLC is responsible for the transport of the SC/PLA/PLF assembly from BS3 to the launch pad using a special vehicle (Figure 8-11). XSLC drives the special vehicle from BS3 to LC-2 in the Launch Center and releases the SC/PLA/PLF stack from the transfer vehicle. The stack is then hoisted up to the 8th floor of the Service Tower.

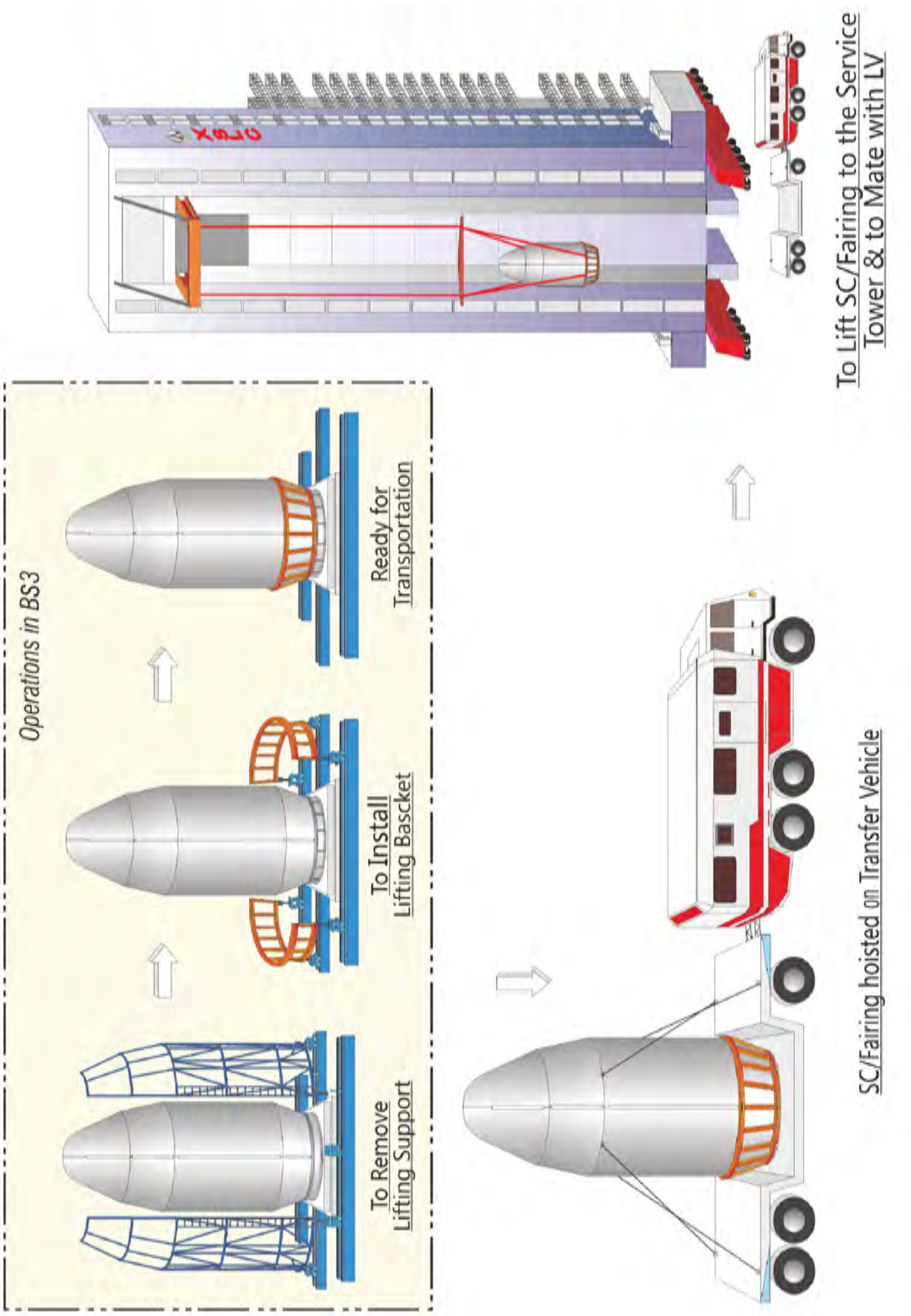


Figure 8-11 Transit of SC/PLA/PLF from BS3 to the Launch Pad

8.4.3.3 SC/LV Integration

The mating of SC/PLA/PLF stack with launch vehicle is carried out on the 8th floor of the Service Tower at LC-2 of Launch Center. The procedures of combined operation of SC/PLA/PLF stack mating with launch vehicle are as follows:

a) XSLC team installs the slings on SC/PLA/PLF stack, lifts the stack to the 8th floor, and moves the stack over launch vehicle;

b) CALT team performs the SC/PLA/PLF stack mating with launch vehicle with the support from XSLC team. The mating is through bolts at the interface plane;

c) XSLC team removes the slings away after Fairing stack/LV integration.

d) Satellite ground umbilical cables are connected to the SC onboard umbilical cable;

e) The air-conditioning duct is connected to the payload fairing and the air-conditioning for fairing is turned on.

The SC/LV mating process is shown in Figure 8-12.

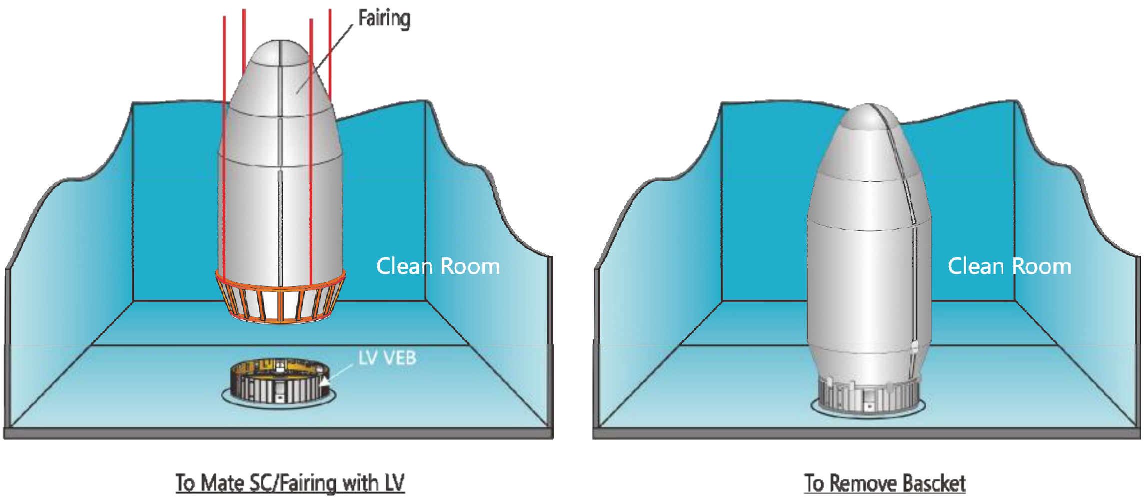


Figure 8-12 SC/LV mating process

8.4.4 SC Preparation and Checkouts

CALT and XSLC are responsible for checking and verifying the umbilical cables and RF links, and SC team may witness the operation if requested.

The SC team can only perform the limited closeout operations and checkouts for the SC through the access doors on the fairing. All functional testing is performed via the umbilical cable and the RF links. The combined operations procedures define the requirements for launch vehicle accessibility and RF silence time that must be respected by the SC team when performing operations on the SC.

8.5 Launch Limitation

Launch Criteria of "GO/NO GO"

a) The average ground wind velocity in the launch area is lower than 10 m/s;

b) The winds aloft limitation: $q\alpha \le 2500\ N/m^2 \bullet rad$ ($q\alpha$ reflects the aerodynamic loads acting on unit cross section area of the launch vehicle, where q is the dynamic pressure, and α is angle of attack of launch vehicle);

c) No thunder and lightning in the area of 10 km around the launch site;

d) The electrical field strength of the atmosphere is less than 10 kV/m.

e) The status of satellite, launch vehicle and ground equipment are normal and ready for launch;

f) All personnel have evacuated the launch complex to the safe area.

8.6 Pre-launch Countdown Procedure

The typical pre-launch countdown procedure on the launch day is listed in the following Table 8-2.

Table 8-2 Typical Pre-Launch Countdown Procedure on the Launch Day

	Time	Events
1	-7 hr	LV Stage-3 LOX Fueling
2	-5 hr	LV Stage-3 LH_2 Fueling
3	-2 hr	LV Control System power-on & functional checkout
4	-80 min	LV Telemetry System power-on & functional checkout
5	-45 min	Stopping & disconnecting of Fairing air-conditioning
6	-40 min	Accurate aiming; Flight data presetting and checking; Gas pipe connectors for Stage-1, Stage-2 & boosters drop-off
7	-22 min	Stage-3 Engines pre-cooling
8	-15~-10 min	SC umbilical disconnection
9	-4 min	Telemetry and Tracking Systems power switch-over; Fueling pipes disconnection of LV Stage-3
10	-2 min	Gas pipes disconnection of LV Stage-3
11	-90 sec	Control System power switch-over
12	-60 sec	Umbilical disconnections of Control System & TT&C System Swinging off the supporting arms of Umbilical Tower
13	0 sec	Ignition

8.7 Post-Launch Activities

CLTC will provide the parameters of the injected orbit to the customer approximately thirty minutes after separation. CALT will provide the launch vehicle flight evaluation report to the customer two months after launch.

CHAPTER 9 RANGE SAFETY CONTROL

This Chapter provides an overview of the range safety controls. The safety management for personnel and facilities during launch site operations, including operations associated with the hazardous materials are detailed in the *XSLC User's Manual (Issue 2009)*.

9.1 Responsibility and Requirements of Range Safety

XSLC designates a range safety officer, whose responsibilities are:

a) To prepare *Launch Vehicle Flight Safety Control Plan* in conjunction with the LV designer in accordance with the safety system concepts previously developed. This includes the safety boundary line derived from the flight trajectory of the LV.

b) To know the distribution of population and major infrastructures in the down range.

c) To guarantee that the measuring equipment provides sufficient flight information for safety control, i.e. a clear display of any flight anomaly or assurance of the normal flight status inside the predetermined safe range parameters.

d) To terminate the flight according to the *Launch Vehicle Flight Safety Control Plan* in cases where the launch vehicle has demonstrated an uncorrectable anomaly such that the flight mission needs to be terminated due to the risk of a ground impact outside the designated safe areas.

9.2 Range Safety Issues for a LV Anomaly

9.2.1 Safety Control Strategy

From the 17th second (for LM-3A/3BE/3C) or 15th second (for LM-3B) following the LV lift off (T_0) to the moment of reaching the theoretical impact area on the open ocean, the launch vehicle must be under the control of the range safety officer so a destruct command can be sent if a flight anomaly occurs. This period of time is called Safety Control Range.

In the period between T_0 and T_0+15 sec (for LM-3B), or T_0 and T_0+17 sec (for LM-3A/3BE/3C), the LV will not be destroyed by ground command even though an anomaly occurs, unless LV explodes itself. This is to ensure that the launch vehicle flies over 400 m (range protection radius) away from the launch pad for the protection of the launch facilities.

Safety Control Ranges of LM-3A Series launch vehicles are defined as follows:

a) Safety Control Range of LM-3A: The period from T_0+17 sec to T2/3 (the time of second/third stage separation);

b) Safety Control Range of LM-3B: The period from T_0+15 sec to T2/3 (the time of second/third stage separation);

c) Safety Control Range of LM-3BE: The period from T_0+17 sec to T2/3 (the time of second/third stage separation);

d) Safety Control Range of LM-3C: The period from T_0+17 sec to T2/3 (the time of second/third stage separation);

9.2.2 Safety Control Procedure

The destruction of the launch vehicle will be implemented by a combination of the Command Destruction System (CDS) and Autonomous Destruction System (ADS).

Command Destruction System

The ground tracking and telemetry system will acquire and interpret the flight information independently. If a flight anomaly reaches the destruction criteria limits, the range safety officer will select the impact area and send the destruction command. The ground control computer can also automatically send a command to the on-board remote control system to destroy the launch vehicle.

Autonomous Destruction System

The on-board ADS is able to make the decision to self destruct based on the deviations of flight attitude and range safety criteria. If the launch vehicle attitude exceeds the safety limits, the ADS will send a destruction signal to the on-board explosive devices. After a delay of 15 seconds, the launch vehicle will self destruct. The range safety officer can use the 15 seconds delay to select an acceptable impact location and send the destruction command, which overrides the automated system. If the range safety officer could not find a suitable area within 15 seconds, the ADS will automatically destroy the LV.

The objective of choosing an impact location is to ensure that launch vehicle debris does little or no damage when it reaches the ground.

The flowchart of range safety control is shown in Figure 9-1.

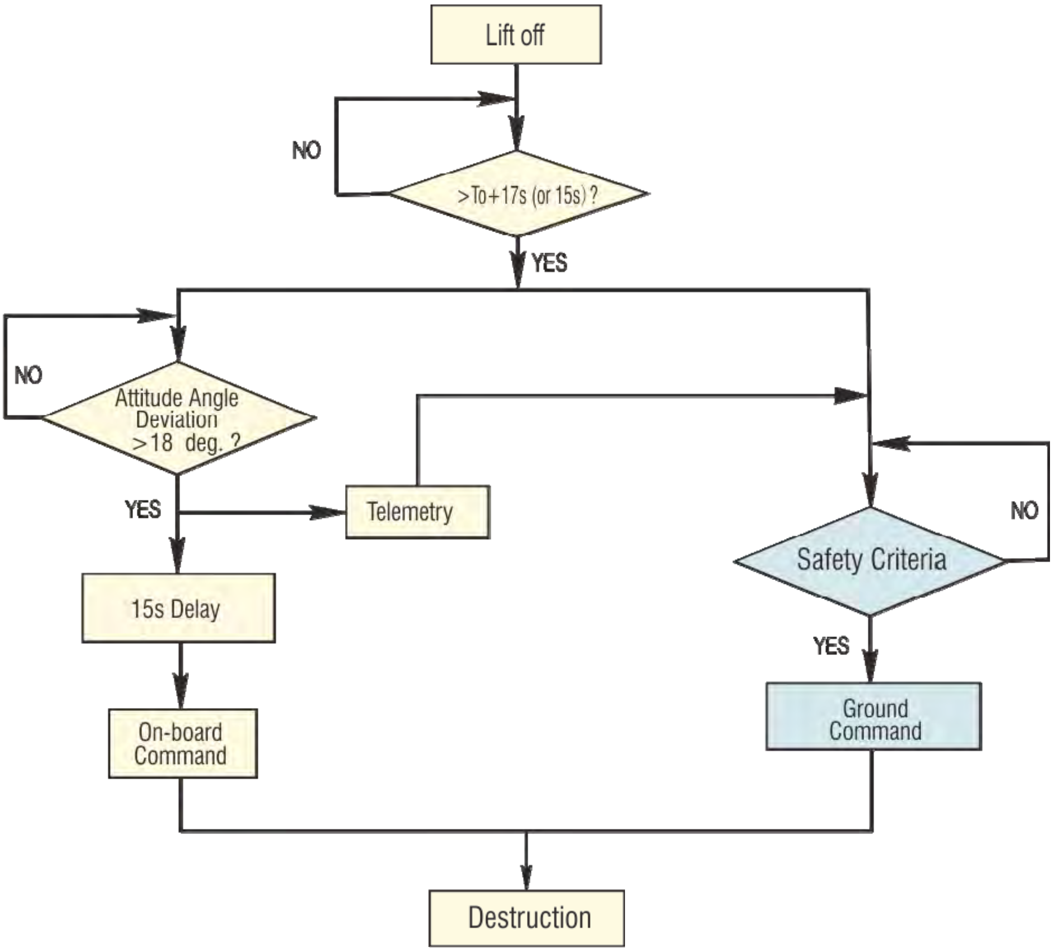


Figure 9-1 Flowchart of Range Safety Control System

9.3 Composition of the Range Safety Control System

The range safety control system includes an on-board segment and a ground segment. The on-board safety segment functions with the onboard tracking system, and jointly is called the Tracking and Safety System. The on-board safety control system consists of the ADS, CDS, explosive devices, tracking system and telemetry system. The ground safety control system consists of the ground remote control station, tracking station, telemetry station and communication system. See Figure 9-2.

The flight data that the safety control system requires includes the flight velocity, flight coordinates, working status of LV subsystems, and the safety command receiving status. The working status of the onboard safety control system is provided by the Telemetry and Tracking system. The safety command to destroy the LV is provided by the ground remote control station (CDS) or the onboard safety control system (ADS).

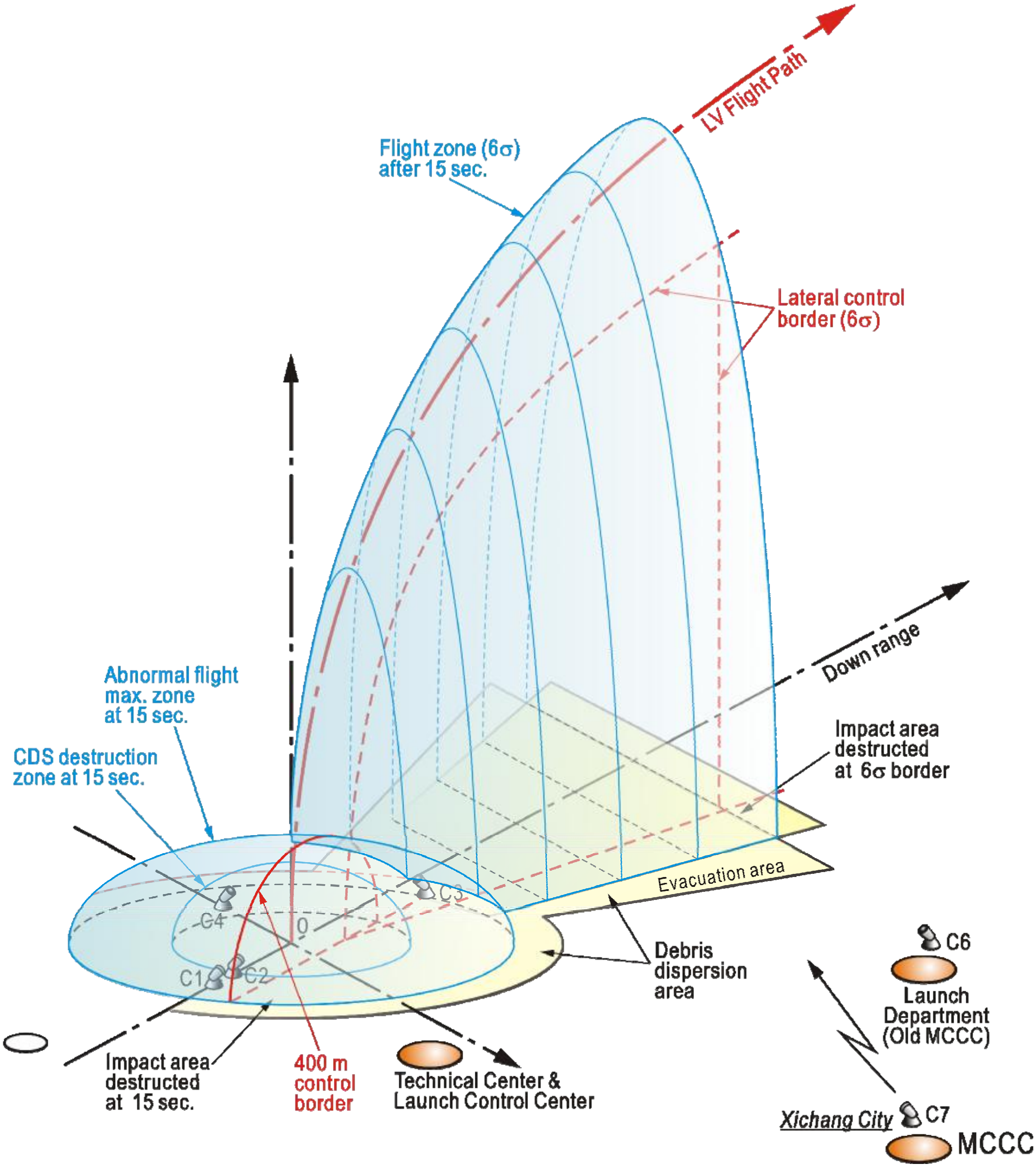


Figure 9-2 Range Safety Control System at XSLC

9.4 Safety Criteria

The range safety criteria are regulations that have been developed to allow the range safety officer to make an informed decision regarding a launch vehicle if the designated flight trajectory deviates from the designed flight path. This may result in the destruction of the launch vehicle when the designated flight zone is exceeded. The criteria are developed based on an overall consideration of the combination of the launch trajectory, regions to be avoided as an impact zone, tracking equipment, mission objectives, etc.

9.4.1 Approval Procedure of Range Safety Criteria

The range safety criteria vary with each launch mission, and are updated before each launch. The criteria are drafted by XSLC, reviewed by CALT and CLTC and then implemented by the range safety officer at each launch.

9.4.2 Common Criteria of Range Safety Control

a) If the launch vehicle flies in the reverse direction, the safety officer will select a suitable time to destroy the launch vehicle considering the impact area.

b) If the launch vehicle flies vertically to the sky rather than pitching over to the predetermined trajectory, it will be destroyed at a certain altitude.

c) If the launch vehicle has demonstrated specific anomalies, e.g. rolling over, fire on the vehicle, it will be destroyed at a certain time.

d) If the launch vehicle flies beyond the predefined destruction limits (including the attitude limits beyond which the launch vehicle becomes seriously unstable), it will be destroyed at a certain altitude considering the impact area.

9.4.3 Special Criteria

a) If the distance between the abnormal launch vehicle and launch pad is less than 400 m, the launch vehicle will not be destroyed in order to protect the launch site.

b) If the launch vehicle leaves the normal trajectory and flies towards the Technical Center during the initial 17 to 30 seconds (LM-3A, LM-3BE, LM-3C) or 15-30 seconds (LM-3B) and $Z \geq 400$ m (in the launch coordinate system), the launch vehicle will be destroyed immediately to protect the Technical Zone. In this case Z is the distance between the abnormal launch vehicle trajectory and the normal trajectory plane.

c) If launch vehicle is flying beyond the predefined safety limit towards the old MCCC during the period of 30-60 seconds, it will be destroyed immediately to protect the old MCCC.

9.5 Emergency Measures

Before the launch takes place, specific facilities and areas within the launch complex will be evacuated of all non-essential personnel in accordance with the predetermined evacuation plan.

XSLC has the following capabilities for implementing emergency procedures:

a) A designated emergency commander

b) First aid team

c) Firemen and ambulances

d) Standby motor vehicles

e) Helicopters

Rescue equipment and food, water, oxygen for one-day usage are available in the Launch Center and the Technical Center.

The customer can check all the emergency equipment and verify the safety measures implemented for range safety before the launch. Any comments or suggestions regarding the range safety can be discussed during the launch campaign and launch site review.

CHAPTER 10 SATELLITE DESIGN REQUIREMENTS

10.1 Introduction

This Chapter introduces the satellite design requirements from the launch vehicle compatibility perspective, which include load conditions, coupled load analysis, safety requirements, satellite mass and CoG, specifications of satellite qualification and acceptance tests.

10.2 Load Conditions for Satellite Design

10.2.1 Frequency Requirement

To avoid the SC dynamic coupling with the launch vehicle, the primary frequency of SC structure should meet the following requirement (under the condition that SC/LV separation plane is considered as a rigid body):

The first order lateral frequency of the main mode: > 10 Hz

The first order longitudinal frequency of the main mode: > 30 Hz

10.2.2 Loads Applied for SC Structure Design

The maximum lateral load occurs when the launch vehicle flies with a transonic speed or under Maximum Dynamic Pressure (MDP).

The maximum longitudinal static load occurs at the first stage engines shutdown for LM-3A. The maximum longitudinal static load occurs at the boosters' engines shutdown for LM-3B, LM-3BE and LM-3C.

The maximum longitudinal dynamic load occurs immediately following the first and second stage separation.

Therefore, the following limit loads corresponding to different flight conditions are recommended for SC design consideration. See Table 10-1 and Table 10-2.

Table 10-1 LM-3A Limit Loads

Flight Condition		Transonic Phase & MDP	Stage-1 Engines Shutdown	1st /2nd Stage Separation
Longitudinal Load Factor (g)	Static	+ 2.0	+ 5.0	+ 1.4
	Dynamic	+ 0.8 - 0.8	+ 0.8 - 5.5	+ 3.0 - 3.8
	Combined	+ 2.8	+ 5.8 - 0.5	+ 4.4 - 2.4
Lateral Load Factor (g)	/	2.0	1.0	1.0

Table 10-2 LM-3B/3BE/3C Limit Loads

Flight Condition		Transonic Phase & MDP	Stage-1 Engines Shutdown	1st /2nd Stage Separation
Longitudinal Load Factor (g)	Static	+ 2.2	+ 5.3	+ 1.0
	Dynamic	+ 0.8 - 0.8	+ 0.8 - 3.6	+ 2.7 - 3.6
	Combined	+ 3.0	+ 6.1	+ 3.7 - 2.6
Lateral Load Factor (g)	/	1.5*	1.0	1.0

Notes for Table 10-1 and Table 10-2:

a) * means that 1.5g is effective only under the following conditions:

i) The SC frequency meets the requirement in Paragraph 10.2.1;

ii) Mass of SC: ≤ 5,100 kg for LM-3B; ≤ 5,500 kg for LM-3BE; ≤ 3,800 kg for LM-3C.

iii) The distance between SC CoG to the SC/LV separation plane: ≤1.6 m.

For specific SC, the "1.5 g" may be larger. The users should consult with CALT to determine the actual load conditions according to the specific SC conditions.

b) Usage of the above loads in the Tables:

Loads for SC design	=	**Limit loads**	x	**Safety Factor****

****** The safety factor is determined by the SC designer. A safety factor ≥1.25 is recommended by CALT.

c) The lateral load means the load acting in any direction perpendicular to the longitudinal axis.

d) For a given flight condition, both lateral and longitudinal loads should be considered simultaneously.

e) The plus sign "+" in longitudinal load factor means compression.

10.3 Coupled Load Analysis

The SC manufacturer should provide its SC mathematical model to CALT for the Coupled Loads Analysis (CLA). CALT will predict the SC maximum dynamic response by coupled load analysis. The SC manufacturer should confirm that the SC can survive the predicted environment and has an adequate safety margin. The safety factor recommended by CALT is ≥ 1.25.

10.4 Safety Requirements

XSLC has implemented a safety program to protect the launch site personnel, the launch site facilities and the visitors to the launch site for the launch services. The program has several facets all based on a typical launch processing schedule for a commercial satellite using conventional propellants and gases. The major aspects of the program are as follows:

a) Launch site safety control;

b) Safety approval based on the satellite safety submissions;

c) Training of the customer and satellite manufacturer's team in safety procedures implemented at XSLC;

d) Safety requirements during hazardous operations;

e) Response to accidents and medical support.

XSLC has overall responsibility for preparing and implementing the safety procedures and is responsible for ensuring that the safety procedures are followed. The customer and satellite manufacturer will have the responsibility for ensuring that their respective teams have all participated in the safety training before being allowed to work within XSLC and are responsible for ensuring that their respective teams observe all the safety regulations at XSLC.

All customer operations at XSLC require the approval of the XSLC safety authorities, in particular the hazardous operations, all transportation at XSLC and combined operations.

The customer is required to demonstrate that the satellite, the support equipment and all operations at XSLC comply with the XSLC safety regulations. This is achieved in a maximum of three stages by the submission of reports detailing all the hazardous subsystems, hazardous materials, hazardous procedures used or implemented at XSLC. The customer submits these reports to CGWIC for review and approval by the relevant authorities and a typical submission schedule, with the requirements at different stages according to the baseline specified in Table 11-2 of this User's Manual.

10.5 Satellite Mass and CoG Requirements

LM-3A Series launch vehicles can accommodate a wide range of satellite mass and CoG positions. See Table 10-3.

Table 10-3 Satellite Mass and CoG Requirement

LV	Mass (kg)	Tolerance of CoG	
		Axis (mm)	Transverse (mm)
LM-3A	2,600	±20	±10
LM-3B	5,100	±20	±10
LM-3BE	5,500	±20	±10
LM-3C	3,800	±20	±10

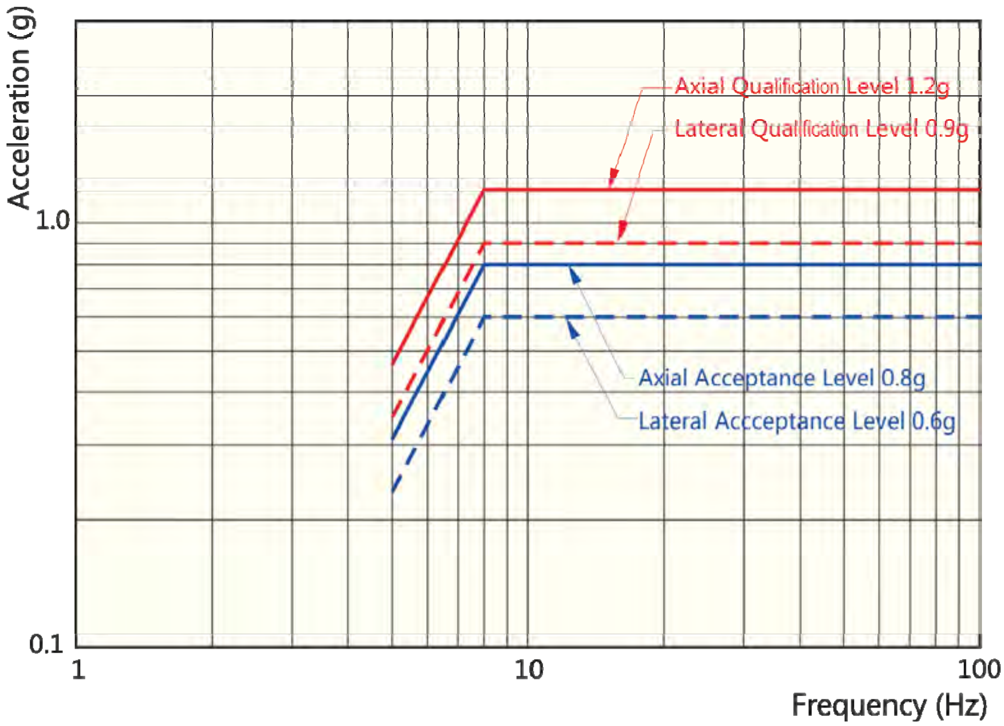
10.6 Qualification and Acceptance Test Specifications

10.6.1 Static Loads Test (Qualification)

The main SC structure should pass the static load qualification tests without damage. The test load level should not be lower than SC design load required in Paragraph 10.2.2.

10.6.2 Sinusoidal Vibration Test

During sinusoidal vibration tests, the SC should be rigidly mounted on the shaker. The table below specifies the vibration amplitude and acceleration level (zero-peak) at the SC/LV interface for the SC qualification and acceptance tests. (See Figure 10-1)



	Frequency (Hz)	Test Load	
		Acceptance	Qualification
Longitudinal	5-8	3.11 mm	4.66 mm
	8-100	0.8 g	1.2 g
Lateral	5-8	2.33 mm	3.50 mm
	8-100	0.6 g	0.9 g
Scan rate (Oct/min)	/	4	2

Notes:

a) Frequency tolerance is allowed to be ±2%

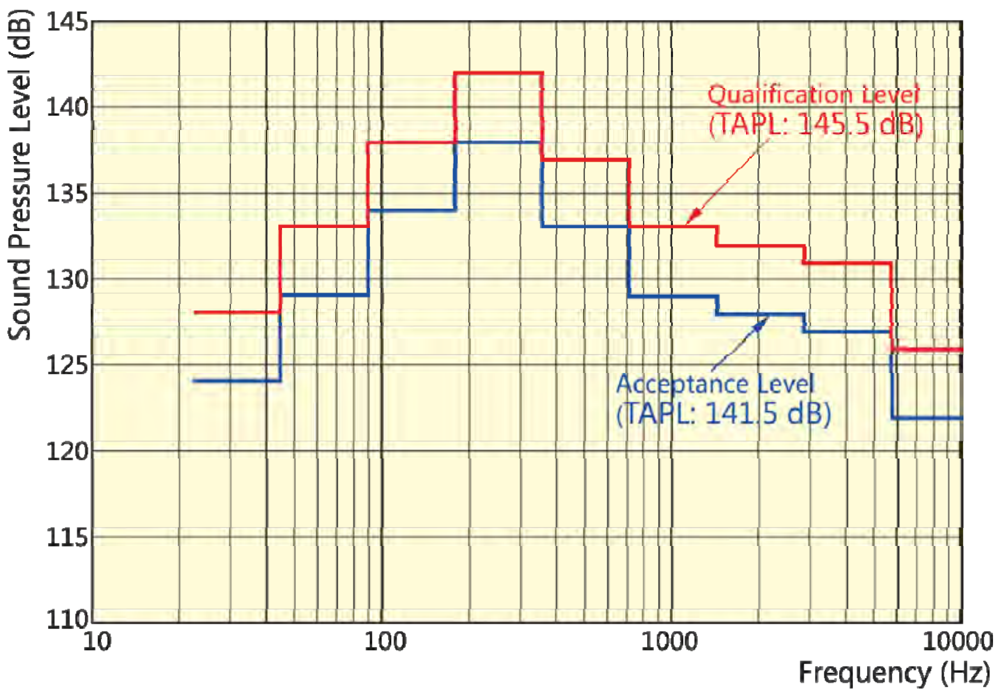
b) Amplitude tolerance is allowed to be ±10%

c) Acceleration notching is permitted after consultation with CALT and concurred by all parties. In no case should the notched accelerations be lower than the results of coupled loads analysis on the interface plane. CALT recommends that the safety factor be ≥1.25.

Figure 10-1 SC Sinusoidal Vibration Test Specification

10.6.3 Acoustic Test

The qualification and acceptance levels of the acoustic test are given in the following table (also see Figure 10-2).



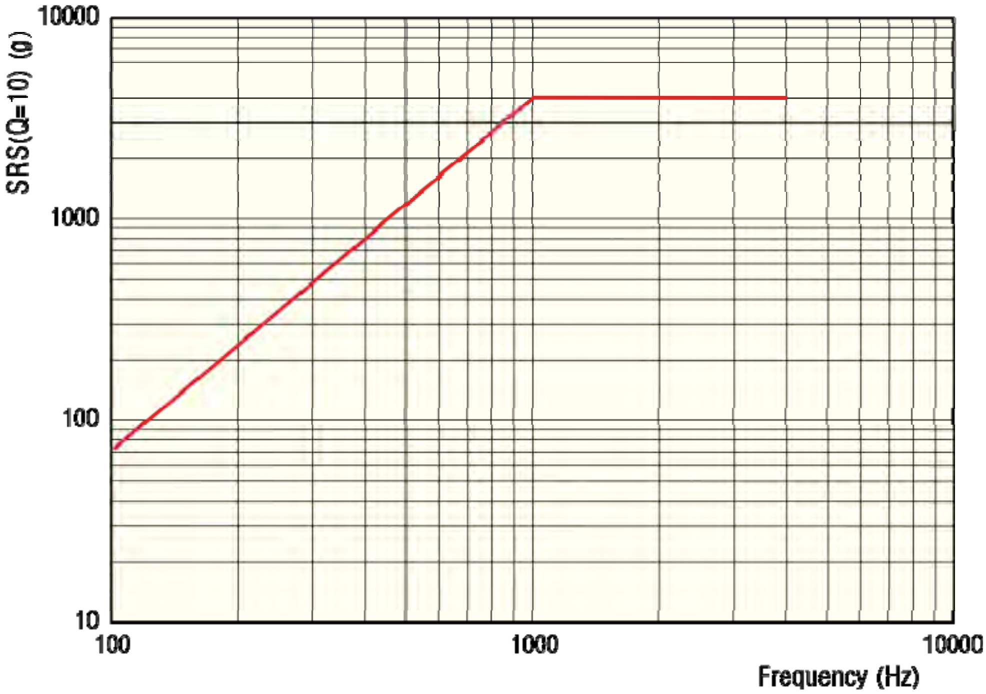
Central Frequency of Octave Bandwidth (Hz)	Acceptance Test Level (dB)	Qualification Test Level (dB)	Deviation of Test Level (dB)
31.5	124	128	-2 / +4
63	129	133	
125	134	138	
250	138	142	
500	133	137	
1000	129	133	
2000	128	132	
4000	127	131	-5 / +4
8000	122	126	-5 / +5
Total Acoustic Pressure Level	141.5	145.5	-1 / +3

Notes:
0 dB referenced to 2×10^{-5} Pa.
Duration of acceptance test: one minute.
Duration of qualification test: two minutes.

Figure 10-2 SC Acoustic Test Specification

10.6.4 Shock Test

The shock test level is specified in this Paragraph (See Figure 10-3 and 10-4). Such test shall be performed once for acceptance, and twice for qualification. A tolerance of ±6.0 dB in test specification is allowed, however, the test levels applied shall ensure that the shock response spectral analysis is at least 1/6 octave above the maximum and the response acceleration values at central frequencies shall be at least 30% greater than or equal to the nominal values given in Figures 10-3 and 10-4.



Frequency (Hz)	Shock Response Spectrum (Q=10)
100~1000	10.5 dB/octave
1000~4000	4000 g

Figure 10-3　Shock Response Spectrum at SC/LV Separation Plane - C100 Clampband

Figure 10-4 Shock Response Spectrum at SC/LV Separation Plane - C60 Clampband

Additionally, CGWIC could also support the customer to procure low shock level separation system (clampband and the pyros) developed by European suppliers, if needed.

Alternatively, the shock test can be performed through a SC/LV separation test by use of flight SC, Payload Adapter (PLA), and separation system, all being flight hardware. This test shall be performed once for acceptance, and twice for qualification.

10.6.5 Proto-flight Test

If the satellite is to be launched by the LM-3A Series launch vehicles for the first time but the same type of satellite has been launched by other launch vehicles and has been environmentally tested to levels that are equal to or greater than the qualification test level described in Paragraph 10.6.1 to Paragraph 10.6.4, CALT will accept the following Proto-flight test conditions:

a) Vibration test should be performed in accordance with the scan rate of the acceptance test and at the qualification test level as specified in Paragraph 10.6.2.

b) Acoustic test should be performed in accordance with the test duration of the acceptance test and at the qualification test level as specified in Paragraph 10.6.3.

c) Shock test should be performed once according to Paragraph 10.6.4.

The test conditions for proto-flight testing should be determined by the satellite manufacturer and CALT, and should be higher than the acceptance test levels but lower than the qualification test levels.

CHAPTER 11 MISSION INTEGRATION AND MANAGEMENT

11.1 Introduction

In order to ensure the launch mission proceeds in a smooth way, CGWIC has implemented a standard approach through a single interface.

This Chapter outlines the management process applied to contract implementation, the customer responsibilities, the interface requirements and documentation required.

11.2 Management Overview

11.2.1 Management Organization

The Launch Services Contract (LSC, or the Contract) is the top level contractual agreement with the Statement of Work (SOW) defining the technical requirements for the program.

The program organization for the customer's program formed by the personnel from CGWIC, CALT and CLTC is shown in Figure 11-1.

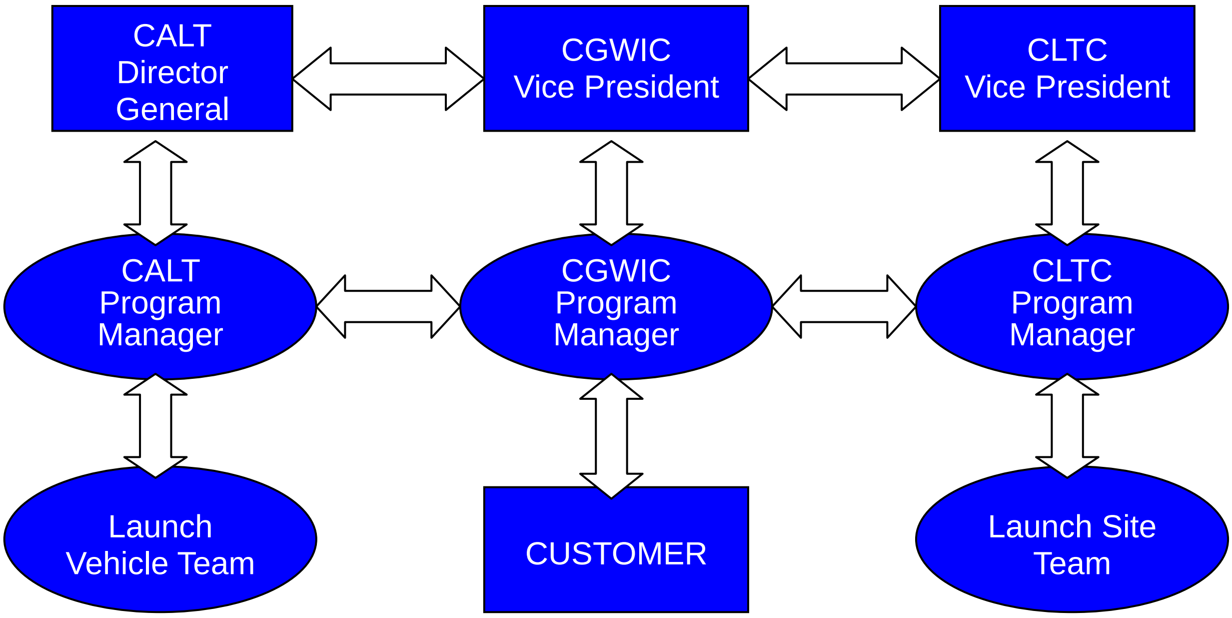


Figure 11-1 Program Organization

Generally, the Program Manager of CGWIC and the customer are to supervise and coordinate the contract implementation through consultation. The Program Managers will call upon other individuals from their respective organizations, as well as their contractors and consultants, to participate, as necessary and appropriate, in such consultations. The CGWIC Program Manager will process all the documentation, organize the meetings and keep the customer advised of the schedule status.

The liaison concerning all commercial and contractual aspects of the program will be directly established between the CGWIC Program Manager and the customer Program Manager. Technical matters which are the responsibilities of CALT or CLTC will be passed immediately to their nominated Program Managers.

The CGWIC Program Manager reports to the Vice President of CGWIC and is responsible for the launch services. He or she is authorized to coordinate with the customer in implementing the contract. The Program Manager is also responsible for all commercial affairs concerning the launch services. He or she also directs the program management office of CGWIC according to the instructions of the Vice President of CGWIC.

The Program Manager of CALT directly reports to the Director General of the launch vehicle and interfaces with CGWIC to coordinate with the customer in all matters relating to the launch vehicle and is responsible for planning launch vehicle preparation and supervising the implementation of the instructions from the Director General of the launch vehicle.

The CLTC Program Manager, who reports to the Vice President of CLTC, interfaces with CGWIC to coordinate with the customer in all matters concerning launch preparation activities. He or she also directs the CLTC work team.

11.2.2 Approach for Successful Implementation of the Program

In establishing the organization for the program, CGWIC emphasizes the following:

a) Assignment of highly competent, experienced personnel with demonstrated capability for each responsibility;

b) Strong engineering direction and performance verification through a dedicated team of systems engineers;

c) Close engineering and management relationships between partners and subcontractors, in order to minimize risk versus program schedule.

11.2.3 Program Management Reviews

The program status will be reviewed by the customer and CGWIC through documentation and scheduled face-to-face meetings. The meetings and reviews will be organized along with the Technical Interchange Meetings (TIM) and can be held as required. The conclusions of the reviews and any actions items will be agreed by CGWIC (CALT and CLTC) and the customer. Notes or minutes documenting the agreements and actions will be prepared and jointly signed by both parties at the end of each review. The following program management reviews will be conducted:

a) Contractual and Mission Integration Kick-Off Meeting

b) ICD reviews

c) Preliminary and Final Mission Analysis Reviews (PMAR & FMAR)

d) Technical Interchange Meetings (if needed)

e) Quality Reviews

f) Site Survey

g) LV Pre-shipment Review

h) Launch Site meetings

i) Launch Facilities Acceptance Review

j) Combined Operations Review

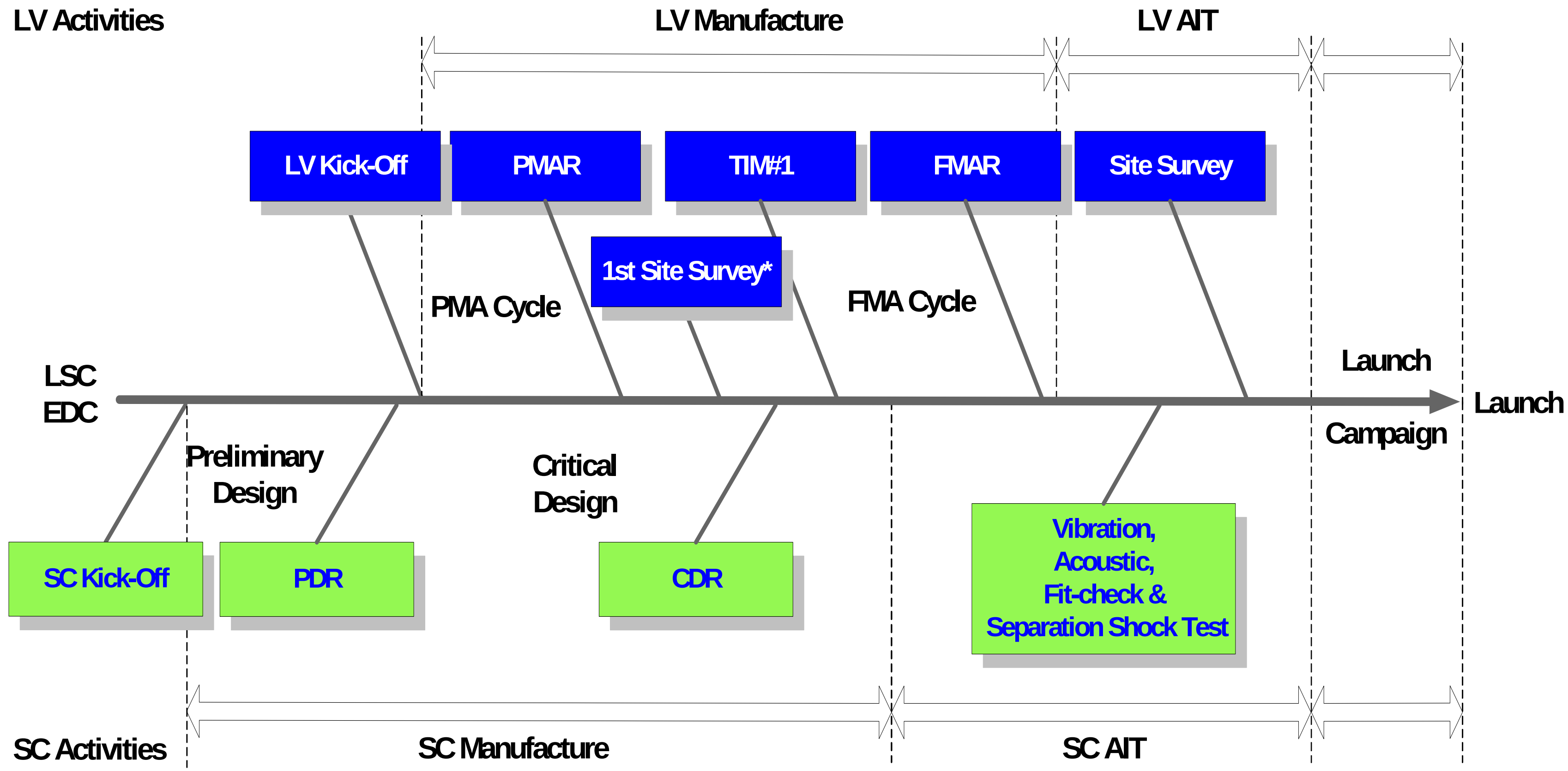
k) Launch Readiness Review

11.2.4 SC/LV Interface Control

The SC/LV interface is controlled by the Interface Control Document (ICD) based on the template provided by CGWIC and details all of the customer interfaces, the customer's technical, documentation and the schedule requirements.

11.2.5 Launch Services Schedule

The launch services schedule should be in line with the SC mission process, the typical program schedule is shown in Figure 11-2 and Figure 11-3.



* for SC manufacturers that first work with LM-3A Series launch vehicles

Figure 11-2 Typical Launch Services Program Schedule

The typical schedule is based on a 24 month procurement schedule although the launch vehicle can be delivered on a shorter schedule by special arrangement.

There is a typical schedule for the provision of the customer interface data based on a 24 month schedule, which is shown in Figure 11-3. The schedule for the specific launch is developed in conjunction with the customer and satellite manufacturer based on the satellite schedule.

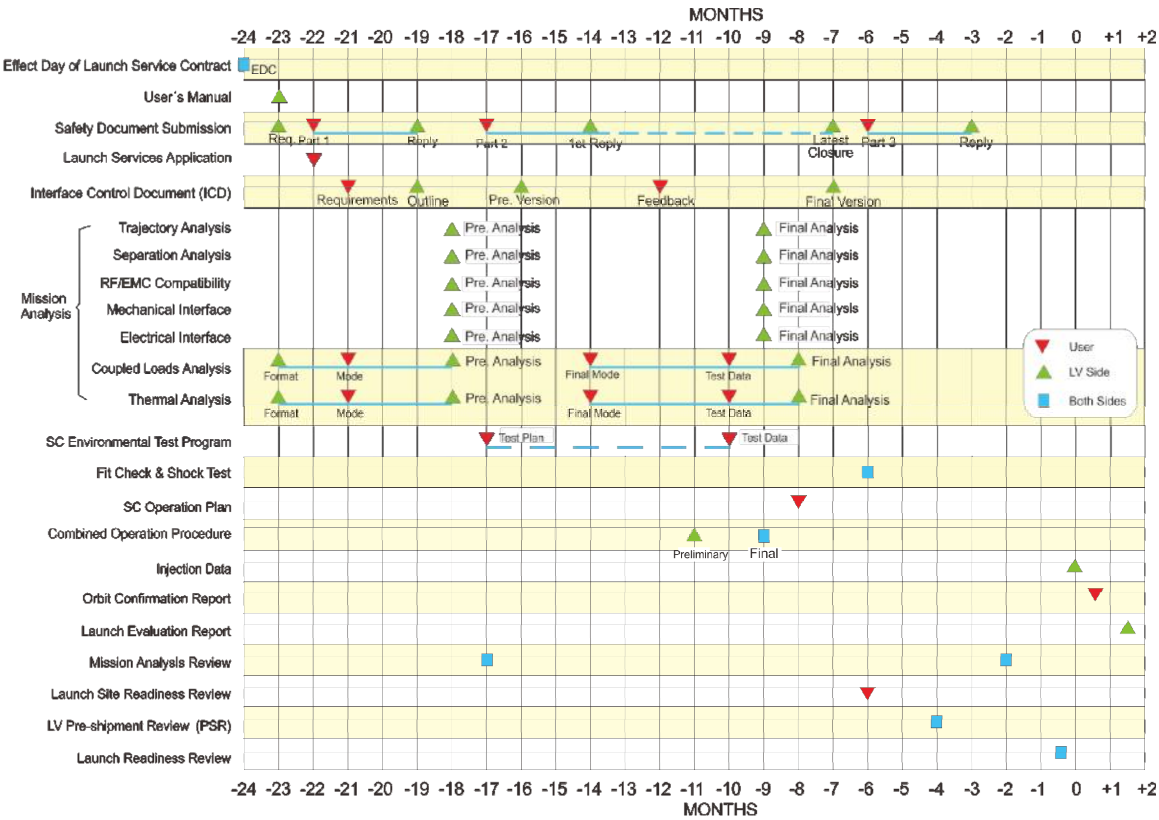


Figure 11-3 The Typical Schedule

The typical schedule can be shorter if requested and supported by the customer.

11.2.6 Launch Campaign Schedule

The typical Launch Campaign period for LM-3A Series launch vehicle in XSLC is 24 days. The activities assigned to each day are described in Chapter 8, Launching Operations, of this *User's Manual*.

11.2.7 Launch License and Permits

CGWIC shall be responsible for ensuring that all the requisite Chinese government permits and approvals for the launch services and the launch of the customer's satellite have been obtained and are in place.

11.2.8 Satellite Technology Safeguard

CGWIC commits to meet customer's requirement to ensure the satellite technical security during the whole process of contract implementation.

CGWIC is responsible for obtaining customs clearance without inspection and assisting in arrangement of transportation (on a charter rented by the customer) between the China airport of entry and Xichang airport for the satellite and its support equipment.

When the SC arrives at XLSC, the satellite processing facility is handed over to and will be exclusively controlled by the customer during the whole launch campaign.

11.3 Launch Services Program

The launch services will include a launch vehicle dedicated for the customer, launch operations, meetings & reviews during the whole program cycle and other related services.

The launch vehicle will be completed with Payload Fairing (PLF), Payload Adapter (PLA), separation system and umbilical interface plus the provision of a customer designed logo on the fairing.

There are a series of standard reviews during the LSC implementation and those the customer may participate in are detailed in this section.

11.4 Interface Control Document (ICD)

The ICD is based on the standard ICD developed by CGWIC and is revised to indicate the specific requirements for the mission as supplied by the customer. The inputs required from the customer are defined in Paragraph 11.9 of this Chapter.

The ICD defines all the interfaces between the satellite and the launch vehicle, the documentation requirements, the design verification requirements for the satellite, the launch campaign requirements, and the mission parameters.

The ICD is developed jointly by the customer and CGWIC and formally signed by the parties. Although the ICD can be updated as required, there are two planned revisions, the first after the Preliminary Mission Analysis Review (PMAR) and the second after the Final Mission

Analysis Review (FMAR). All revisions are jointly agreed and signed by the customer and CGWIC.

The ICD is the master document for the launch services program and takes precedence over all other technical documents.

11.5 Mission Analysis

11.5.1 Introduction

The launch services are based on a standard mission profile as defined in the User Manual, however, each mission is tailored to the specific customer's requirements. A brief and preliminary assessment will be made to ensure that the customer's injection requirements are compatible with the launch vehicle capability.

The mission analysis process has two major stages, the completion of the preliminary mission analysis following the SC PDR and the final mission analysis after the SC CDR that finalizes the flight configuration.

The two stages culminate in two mission analysis reviews, the Preliminary Mission Analysis Review (PMAR) and the Final Mission Analysis Review (FMAR), but this does not preclude additional Mission Reviews, should the customer request them as optional services according to the LSC.

11.5.2 Preliminary Mission Analysis

The preliminary mission analysis is based on the initial injection requirements according to the Interface Requirement Document (IRD, see Paragraph 11.12) and ICD, and will assess the following:

a) Define the compliance of the satellite to the launch vehicle interfaces

b) Initially assess the satellite environment during the launch

c) Review and assess the satellite design compliance

d) Review and assess the satellite test program

e) Document and agree all deviations from the *User's Manual* requirements, including those identified in the ICD

f) Document all open issues relating to the mission and agree a closure plan that resolves all these issues prior to the FMAR.

The results of the preliminary mission analysis are used to define the mission profile, the launch site requirements, the changes required to the satellite test program and any interface issues that impact the satellite design. The ICD will be updated and agreed based on the agreements made during the PMAR.

The key areas included in the preliminary mission analysis and reviewed at the PMAR are as follows.

11.5.2.1 Trajectory Analysis

The preliminary launch profile to injection and the injection accuracy will be derived from the standard mission injection profile and assess the following topics:

a) Verification of launch trajectory for this specific mission

b) Flight sequence up to SC/LV separation

c) Predicted vehicle performance

d) Satellite mass margin against contracted lift-off mass

e) Propellant reserves

f) Predicted injection accuracy

g) Review of satellite attitude requirements for the flight

11.5.2.2 Separation Analysis

The preliminary separation analysis and launch vehicle reorientation will also be presented at the PMAR and assess the following topics:

a) Verification of the satellite attitude at SC/LV separation

b) Review of the SC/LV separation velocity

c) Review of the collision avoidance maneuver

d) Verification of the separation dynamics, including fuel slosh

11.5.2.3 Coupled Loads Analysis (CLA)

This is the preliminary CLA using the preliminary satellite dynamic model as provided by the customer. The preliminary CLA will address the following:

a) Modal analysis of the satellite and launch vehicle

b) The preliminary satellite dynamic loads under the worst case of launch vehicle environmental loads

c) The preliminary loads and accelerations responses of the satellite at the satellite model nodes over the launch mission

d) Notching requirements requested by the customer

The results of the CLA and its review at the PMAR will allow the customer to preliminarily review the notching requirements and verify that the satellite qualification loads encompass the predicted loads with adequate margin.

11.5.2.4 EMC and RF Compatibility Analysis

The EMC and RF compatibility analysis is required to verify the compatibility among the satellite, the launch vehicle and the launch site during processing; to verify the compatibility between the launch vehicle and satellite during the flight. The ICD is used as the baseline for this analysis and allows CALT and XSLC to verify that the values provided in the ICD are correct.

11.5.2.5 Electrical Interface Analysis

The Electrical Interface Analysis is conducted to verify the compatibility between SC/LV Electrical Ground Support Equipment (EGSE) interfaces and SC/LV on-board interfaces, and to design the specific umbilical cables, such as connectors' pin allocation, shielding specification and umbilical signal definition, according to the inputs from the satellite manufacturer.

11.5.2.6 Mechanical Interface Analysis

The Mechanical Interface Analysis is performed to verify the compatibility of the mechanical interface between the satellite and launch vehicle relating to the fairing, adapter, envelope, access door and RF window in the fairing. The ICD will provide the baseline input, however, the customer and satellite manufacturer will be required to validate the satellite dimensions based on the actual hardware.

11.5.2.7 Thermal Analysis

The thermal analysis uses the thermal model provided by the customer as an input to the launch vehicle thermal model to predict SC temperatures during the mission. The thermal analysis relates to the launch mission from lift-off to separation providing a time phased thermal profile of the thermal model nodes selected by the customer. The analysis also covers the ground operations so that the thermal environment of the satellite from leaving BS to lift-off can be verified and the fairing cooling requirements can be defined.

11.5.2.8 Venting Analysis

The venting analysis is conducted to verify whether the requirement defined for the satellite depressurization in the fairing can be satisfied during the flight, especially in the transonic period.

11.5.3 Final Mission Analysis

The Final Mission Analysis is based on the final mission plan and injection predictions so it becomes the formal mission baseline. The objectives of the Final Mission Analysis Review (FMAR) are to verify the mission baseline so that the final flight software can be prepared, to verify that the mission meets the customer requirements and to review the satellite test program for compliance with the ICD requirements. The completion of the FMAR freezes the mission plan and results in an update of the ICD to reflect the new agreements.

The final mission analysis will assess the following:

a) Confirm the compliance of the satellite to the launch vehicle interfaces

b) Confirm the satellite environment during the launch

c) Review and assess the satellite design compliance

d) Review and assess the satellite test program

e) Document and agree all deviations from the User's Manual requirements, including those identified in the ICD

f) Document all open issues relating to the mission from the PMAR and confirm that they are closed

The key areas included in the final mission analysis and reviewed at the FMAR are as follows.

11.5.3.1 Trajectory Analysis

The final launch profile to injection and the injection accuracy will be reviewed to confirm the following:

a) Verification of launch trajectory for this specific mission

b) Flight sequence up to SC/LV separation

c) Predicted vehicle performance

d) Satellite mass margin against the contracted lift-off mass

e) Predicted orbital parameters of the satellite at separation

f) Predicted injection accuracy

g) Review of satellite attitude requirements for the flight

11.5.3.2 Separation Analysis

The final separation analysis and launch vehicle reorientation is updated and the following topics confirmed:

a) Verification of the satellite attitude at SC/LV separation

b) Review of SC/LV separation velocity

c) Review of the collision avoidance maneuver

d) Verification of the separation dynamics, including fuel slosh

11.5.3.3 Coupled Loads Analysis (CLA)

This is the final CLA using the satellite dynamic model as updated and validated by the customer. The final CLA will address the following:

a) Modal analysis of the satellite and launch vehicle

b) The final satellite dynamic loads under the worst case of launch vehicle environmental loads

c) The final loads and accelerations responses of the satellite at the satellite model nodes over the launch mission

d) Notching requirements requested by the customer

The results of the CLA and its review at the FMAR will allow CALT to review the final notching requirements, verify that the satellite qualification loads encompass the predicted loads with adequate margin and confirm that the satellite test program is adequate.

11.5.3.4 Electromagnetic Compatibility (EMC) Analysis

The final EMC and RF compatibility analysis verifies the complete compatibility among the satellite, the launch vehicle and the launch site during processing as well as the compatibility between the launch vehicle and satellite during the flight. This includes the final launch configuration and the final satellite testing at the launch pad. The ICD is used as the baseline for this analysis and allows the CALT and XSLC to verify that the values provided in the ICD are correct.

11.5.3.5 Electrical Interface Analysis

The Final Electrical Interface Analysis is conducted to verify the compatibility between SC/LV Electrical Ground Support Equipment (EGSE) interfaces and SC/LV on-board interfaces, and to verify the specified umbilical cable design, such as connectors' pin allocation, shielding specification and umbilical signal definition, according to the inputs from the customer.

11.5.3.6 Mechanical Interface Analysis

The Mechanical Interface Analysis is performed to verify the compatibility of the mechanical interface between the satellite and launch vehicle relating to the fairing, adapter, envelop, access door and RF window in the fairing, etc. The ICD will provide the baseline input, however, the customer will be required to validate the satellite dimensions based on the actual hardware.

11.5.3.7 Thermal Analysis

The thermal analysis uses the thermal model provided by the customer as an input to the launch vehicle thermal model. The thermal analysis relates to the launch mission from lift-off to separation providing a time phased thermal profile of the thermal nodes selected by the customer. The analysis also covers the ground operations so that the thermal environment of the satellite from leaving BS to lift-off can be verified and the fairing cooling requirements can be defined.

11.6 Verification of Satellite Design

In support of the mission analysis, the customer will be required to demonstrate that the satellite design is able to survive the launch vehicle environment during the mission. The customer shall be required to deliver the following test reports for CALT review and approval.

11.6.1 Satellite Environmental Test Plan

The customer shall provide a comprehensive satellite test plan that clearly shows how they will comply with the environmental requirements defined in this User's Manual. The plan shall detail the satellite manufacturer's overall test philosophy and how this is translated into a qualification and acceptance test program. The plan shall provide an overview of the environmental testing to be performed to clearly demonstrate that the satellite can meet the ground processing and flight loads. The plan shall also include the test objectives, the acceptance criteria, the satellite configuration for the tests with its applicability to the launch configuration, the test methodology including the monitoring requirements, and the test schedule showing that all testing will be completed such that the final CLA can be performed before the FMAR. It should be noted that this is a test plan and the test specifications and procedures are not required unless there is an issue with the test plan.

11.6.2 Satellite Environmental Test Program

A SC/PLA fit check shall be performed to verify the interface and may be combined with a separation shock test.

CALT reserves the right to monitor the satellite environmental testing directly should there be concerns with the margins to the dynamic environment or the notching selected.

11.6.3 Satellite Environmental Test Report

The customer shall provide a comprehensive environmental test report following the satellite dynamic testing so that compliance with the environmental requirements of this User's Manual can be verified. The test report shall include the theoretical analysis required to validate the dynamic testing, the results of the static load tests, and the dynamic test results. The test report shall provide a summary of the test program with any anomalies clearly identified and completed with the corrective actions taken or rationale for acceptance. The test report shall provide evidence of adequate margin to the dynamic launch environment. For structural elements not directly tested, an analysis shall be provided clearly showing the assumptions, boundary conditions, results and margins.

11.7 Meetings and Reviews

This section details the formal reviews/meetings to be held between the customer and CGWIC based on the typical launch vehicle processing schedule up to and including the post mission review. All meetings shall be chaired by the CGWIC Program Manager, who shall also coordinate the meeting dates, locations and the agenda with the customer. In addition, CGWIC will issue the invitations to the participants and maintain the minutes. The typical schedule of meetings is included in the typical launch service schedule shown above.

The meetings outlined in this section are the formal meetings required to support the provision of the launch services for a customer that has contracted for the launch of a single satellite. This does not preclude special meetings being held to address specific issues as requested by the customer or CGWIC. The baseline meeting schedule is shown in Table 11-1.

Unless otherwise stated, all dates are in months relative to the first day of the launch period until a launch date is agreed, from which time on they are relative to the launch date.

Table 11-1 Meeting Schedule

Meeting	Estimated Date
Kick Off Meeting (KOM)	after SC PDR
Preliminary Mission Analysis Review (PMAR)	4 months after KOM
Technical Interchange Meeting (TIM)	after SC CDR
Final Mission Analysis Review (FMAR)	4 months after TIM
Launch Site Survey	6 months before launch
Launch Vehicle Pre-shipment Review (PSR)	one month before the start of launch campaign
Combined Operations Procedure Review	During the launch campaign
Launch Readiness Review (LRR)	2 days before launch

11.7.1 Kick-Off Meeting (KOM)

This is the formal start of the launch services program where CGWIC and customer provide an overview of the management organization, the technical status, the program schedule including the meeting schedule and document delivery schedule. KOM will cover the following issues:

a) Program management and schedule

b) Satellite program, launch requirement and SC interface requirements

c) Launch vehicle performance and mission technical specification

d) Launch site operation and safety

e) Outline of ICD for the program

The first issue of the ICD will be jointly drafted by CGWIC/CALT/CLTC and customer after this KOM.

11.7.2 Phase 1/2/3 Safety Submission

The safety submission is required to show that the satellite and customer operations at the launch site meet all the safety requirements of XSLC and CALT. The safety submission shall contain a description of all the hazardous systems, testing and materials the customer will utilize while processing the satellite at XSLC.

11.7.3 Preliminary Mission Analysis Review (PMAR)

This is a review of the initial mission analysis based on the ICD inputs with the objective of verifying that the customer injection requirements can be met. This meeting will also result in the first issue of the ICD for the program.

11.7.4 Technical Interchange Meeting (TIM)

Generally, customer will introduce the technical status in detail after the satellite Critical Design Review (CDR) so that the Final Mission Analysis can be conducted. A TIM can be held whenever needed during the program when agreed by CGWIC and the customer; however, TIMs do not replace the scheduled technical meetings and are only held when a specific issue requires discussion between scheduled reviews.

11.7.5 Final Mission Analysis Review (FMAR)

The objectives of the Final Mission Analysis Review (FMAR) are to verify the mission baseline so that the flight software can be prepared, to verify if the mission meets the customer requirements and to review the satellite test plans for compliance with the ICD requirements. The completion of the FMAR freezes the mission plan and results in an update of the ICD to reflect the new technical status.

11.7.6 Launch Site Survey

The review is held in XSLC around six months before launch. The satellite team will be invited to this survey to verify that the facilities and equipment of XSLC on-site, such as the MCCC, BS, clinic facility and launch pad, are ready to support the satellite. The review is also to verify that the launch site facilities meet the launch requirements defined in the ICD.

11.7.7 Launch Vehicle Pre-shipment Review (PSR)

This review is held in Beijing at least one month before the launch campaign. The purpose of this review is to confirm that the launch vehicle meets the specific requirements in the process of design, manufacture and testing. The launch vehicle delivery date to XSLC will be discussed in the meeting. CALT provides a detailed report to the customer introducing the technical configuration and quality assurance of the launch vehicle. The review is focused on qualification status of the launch vehicle and the various interfaces and compatibility with the satellite.

11.7.8 Launch Site Operation Meetings

Daily meetings will be held at the launch site at a mutually agreed time. The routine topics are reporting the status of satellite, launch vehicle and launch site, applying for support from launch site and coordinating the activities of all parties.

11.7.9 Combined Operations Procedure Review

This review will be held at XSLC following the submission of the Combined Operation Procedure prepared by XSLC.

The combined operations procedures start with the mate of the satellite and the Payload Adapter (PLA). The procedures will detail the interfaces between the launch vehicle team and the customer's team for the operation including the constraints, safety requirements, handling requirements, personnel requirements and their responsibilities. These procedures are to ensure that the events are coordinated and the teams do not run into facility conflicts. The Combined Operations Procedure will be finalized by incorporating the comments put forward in the review.

11.7.10 Launch Readiness Review (LRR)

This review is held at XSLC after the launch rehearsal and prior to launch vehicle fueling. The review will cover the status of satellite, launch vehicle, launch facilities and TT&C network. The launch campaign will commence the preparation of the launch vehicle fuelling after this review.

11.8 Launch Reports after SC/LV Separation

CGWIC/CLTC/CALT will provide a series of launch reports, some in real time and the final one after analysis of the launch vehicle performance.

11.8.1 Orbit Injection Parameters Report

CLTC will provide the initial injection parameters, including the satellite attitude and orbit parameters to the customer within 30 minutes after SC/LV separation.

11.8.2 Orbit Tracking Report

CGWIC also requires the customer's tracking network to confirm acquisition of the satellite and the orbital parameters as soon as possible after SC/LV separation.

11.8.3 Launch Mission Evaluation Report

CALT will prepare a report on the mission from lift-off to separation and deliver it to the customer within 60 days after a successful launch or a brief introduction 15 days after a launch failure or a launch anomaly. The report will address all the flight events, the launch vehicle performance, the injection orbit and accuracy, the separation attitude and roll rates, and the comparison with the predictions.

11.9 The Customer Commitment

The customer shall assign a dedicated Program Manager no later than one (1) month after the Effective Date of the Contract (EDC). The customer shall be responsible for coordination of technical and programmatic activities related to the execution of the LSC.

The customer shall submit and supply all the documentation and hardware specified hereunder.

11.9.1 Documentation

The following documents shall be provided to CGWIC by customer in accordance with the milestone schedule agreed upon by both parties:

a) Satellite Interface Requirement Document

b) Satellite Dynamic Model

c) Satellite Thermal Model

d) CAD Model

e) Mechanical Interface Drawing

f) Satellite Mechanical Environment Test Plan

g) Satellite Mechanical Environment Test Results

h) Safety Submissions

i) Satellite Mass Properties

j) Satellite Launch Operation Plan

k) Hazardous Satellite Test Procedures at XSLC

l) Orbit Tracking Report

m) Shock Compatibility Analysis (in case the shock test is not included in the Satellite Mechanical Environment Test Plan)

11.9.2 Hardware for Integration and Launch

The customer shall provide the following hardware in support of the mission:

a) Satellite

b) Ground Support Equipment and Test Equipment

c) Propellant

The customer shall also provide the following umbilical connector halves to CGWIC: Two pairs of connectors halves for flight (1 nominal + 1 spare)

11.10 Launch Campaign

11.10.1 Introduction

The launch campaign starts with the arrival of the customer's advance team in XSLC, which is followed by the arrival of the satellite at Xichang airport. The customer's advance team would arrive ahead of the satellite to do the launch site acceptance review so that the team could verify that all the facilities are ready and the transportation is in place for the transfer of the satellite to the launch site.

Prior to starting the launch campaign, all the requisite documentation shall be formally issued and the customer will have completed the acceptance review of the launch site and certified that the launch site is ready to receive the satellite.

The launch campaign has three major phases: satellite preparation, combined operations, and the final preparation and launch. The satellite preparation phase includes all operations up to mating to the Payload Adapter (PLA) and is managed by the customer with XSLC support as required. The combined operations start with the mating of the satellite to the PLA and include all operations up to the mating of the encapsulated satellite with the launch vehicle. These operations are managed by XSLC with the customer's support for interface verification. The final preparation and launch are also managed by XSLC with customer's support.

The typical launch vehicle working period (Encapsulation-on-Pad) for the launch campaign is 24 days. The typical launch campaign flowchart (assuming the launch campaign period for satellite is 35 days) is listed in Table 11-2.

11.10.2 Launch Campaign Preparation

In support of the customers preparation for the launch campaign, CGWIC, CALT and XSLC will issue a series of documents covering the activities and facilities. The key documents are as follows:

a) XSLC User's Manual

b) Combined Operations Plan

c) Combined Operations Procedures

d) Countdown Procedure

e) Go/No Go Criteria

f) Launch Rehearsal Procedures

CGWIC will organize the launch site acceptance review at XSLC so that the customer can review the facilities and certify that the launch site is ready for the satellite processing before the launch campaign starts.

11.10.3 Launch Campaign Documentation

11.10.3.1 Introduction

This section outlines the documents to be prepared by the customer and CLTC/CALT that are required to plan and implement the launch campaign.

11.10.3.2 Input to ICD

The ICD not only defines the satellite to launch vehicle interfaces and injection requirements but also details the satellite support requirements at the launch site. This initial input will cover the basic requirements that will be updated following the Mission Analysis Reviews

Table 11-2 Typical Launch Campaign Flowchart (Encapsulation-on-Pad)

No.	Work Items	-35	-31	-30	-29	-23	-22	-21	-20	-19	-16	-15	-14	-12	-11	-10	-8	-7	-6	-4	-3	-2	-1	0	1	2
1	SC Advance Team Arrival	▌																								
2	Launch Facilities Check & Acceptance Review	▼	▼																							
3	SC arrival			▌																						
4	SC Operations in BS2				▼			▼																		
5	LV arrival					▌																				
6	LV status recovery & unit test in BL						▼			▼																
7	SC Pre Filling Review								▌																	
8	SC Fueling in BS3									▼		▼														
9	LV Transfer, Erection & Integration on Pad										▌															
10	LV Subsystem Test, #1 & #2 Overall Checkout											▼				▼										
11	SC Flight Readiness Review												▌													
12	SC/LV Combined Operation in BS3 (SC mating with Payload Adapter)													▼		▼										
13	SC transfer															▌										
14	SC/LV Combined Operation on Pad (Encapsulation & SC Test)															▼		▼								
15	LV #3 & #4 Overall Checkout, Overall Checkout Result Review																		▼	▼						
16	LV Launch Readiness Review																				▌					
17	LV Functional check before fueling																					▌				
18	LV Fueling (Conventional & Cryogenic)																						▼	▼		
19	Launch																							✦		
20	Post-launch Operations																								▼	▼

11.10.3.3 XSLC User's Manual

The *XSLC User's Manual (Issue 2009)* is a standard document describing the facilities at XSLC available to the customer.

11.10.3.4 Satellite Operations Plan

The Satellite Operations Plan is prepared by the customer and defines all the activities required to handle, test and fuel the satellite from arrival at Xichang airport through to mating to the Payload Adapter (PLA). The plan will also include all the XSLC interface requirements, the support required for the standalone satellite operations and communications requirements. Although the plan is primarily to define the satellite processing requirements, it will also be required to detail the post launch activities that the customer will implement to remove all their equipment from XSLC.

11.10.3.5 Combined Operations Plan

XSLC will prepare a combined operations plan based on the typical launch vehicle processing schedule that will cover all activities from satellite mating to the Payload Adapter (PLA) to the launch. The objective of the plan is to provide an overview of all the activities in sequence between the launch vehicle and satellite with specific emphasis on the following:

a) Operations that involve both satellite and launch vehicle

b) All operations that are standalone and require the satellite or launch vehicle to be inactive

c) All hazardous operations

d) All operational constraints from the satellite and launch vehicle

e) The responsibilities of each party for each operation

f) Reference to an operational procedure for each operation.

The initial release of the plan may not have the actual procedure references but will include all the identified operations. The final version will be released following the final Combined Operational Procedure Review and refer to all the released procedures.

11.10.3.6 Satellite Operational Procedures

These are the procedures that will be used during the launch campaign by the customer in processing the satellite. The hazardous procedures shall detail every step required including the constraints, safety requirements, handling requirements and personnel requirements.

The procedures to be used during combined operations shall also detail every step required including the constraints, safety requirements, handling requirements, personnel requirements and any actions required by the launch vehicle in support of the operation.

The operational procedures will also include those procedures that the customer will use to validate the XSLC interfaces for communications and monitoring the satellite.

11.10.3.7 Combined Operations Procedures

XSLC/CALT will issue the combined operations procedures starting with the mating of satellite to Payload Adapter (PLA). These procedures will detail the interfaces between the launch vehicle team and the customer team for the operation including the constraints, safety requirements, handling requirements, personnel requirements and the responsibilities. These procedures are to ensure that the events are coordinated and the teams do not run into facility conflicts.

11.10.4 Launch Campaign Management

Although CGWIC will coordinate all the formal meetings for the launch campaign, the customer will interface directly with the XSLC team for daily activities during the launch campaign. The customer shall nominate a single point of contact for all interface activities with XSLC, who will also nominate a single point of contact for the launch campaign. The overall control of the launch campaign will be provided by XSLC as the representative of the range.

The responsibilities of the launch campaign key personnel are as follows:

a) Customer Representatives

   Program Manager – In the case of a customer-procured launch, responsible for the satellite launch campaign, primary interface with CGWIC/XSLC and provides formal satellite readiness status for launch.

b) Satellite Manufacturer Representatives

   Satellite Program Manager – The satellite Program Manager has overall responsibility for the satellite program, which includes the launch campaign. He is the sole point of contact with the customer and CGWIC/XSLC for all formal communications.

   Satellite LV Manager – the Satellite LV Manager is the primary working contact with CALT and XSLC for the launch campaign operations.

c) CGWIC Representative

CGWIC Program Manager – the CGWIC Program Manager is the primary interface with the customer Program Manager, CALT and XSLC

d) CLTC and XSLC Representatives

CLTC and XSLC Program Manager

e) CALT Representatives

CALT Program Manager

The launch countdown organization is based on the standard CALT and XSLC launch program with the customer interface for providing the GO/NO GO criteria.

11.10.5 Launch Campaign Working Meetings

11.10.5.1 Introduction

This section covers the meetings required in advance of the launch campaign to plan the activities as well as those held during the campaign to review progress and verify that the key milestones have been achieved. The formal launch program reviews/meetings are covered above and this section addresses those meetings held specifically to plan and manage the launch campaign.

11.10.5.2 XSLC Facility Acceptance Meeting

Prior to the launch campaign start, the customer's advance team will arrive at XSLC earlier than the satellite so as to re-verify that the facilities at XSLC meet the launch requirements and the launch site is ready for the satellite processing.

11.10.5.3 Satellite Transport Meeting

This meeting is to coordinate the transportation of the satellite from the Xichang airport to XSLC.

The meeting will be held in conjunction with the launch site review to plan the off-loading and transfer to the SC processing facility (BS) at XSLC.

11.10.5.4 Daily Progress and Planning Meetings

Daily progress meetings will be held between the key personnel from the customer, the satellite manufacturer, CGWIC, CALT and XSLC. The routine topics are reporting the status of satellite, launch vehicle and launch site, requesting support from the launch site and coordinating the activities of all sides.

The objective of these meetings is to verify that the satellite processing is on schedule, coordinate support for the next few days of satellite processing, arrange services for the satellite team and report on overall launch vehicle status. Weekly planning meetings can be arranged if necessary.

11.10.5.5 Combined Operations Meetings

There are two combined operation meetings to verify that the satellite, the launch vehicle and the XSLC facilities are ready for combined operations. The first Combined Operations Meeting is held before the satellite propellant filling activities and the second is held after the satellite is fuelled.

These meetings will review any special requirements for the satellite transportation and verify that all the required communications links are in place and have been validated.

11.10.5.6 Launch Rehearsal Procedure Review Meeting

XSLC will arrange a dedicated meeting among the parties discussing and finalizing the launch rehearsal procedure.

11.10.5.7 GO/NO GO Criteria Review Meeting

XSLC will arrange a dedicated meeting among the parties discussing and finalizing the GO/NO GO criteria.

11.10.5.8 Countdown Procedure Review Meeting

XSLC will arrange a dedicated meeting among the parties discussing and finalizing the countdown procedure.

11.11 Safety Requirements

11.11.1 Safety Training

Safety training for the SC processing facilities and general launch site safety will be provided before the launch campaign with hands-on training in the facilities when the advance team arrives but before the satellite arrives. The remaining team members will be trained when they arrive to support the launch campaign.

Training for the hazardous operations such as fuelling will be provided as required to the customer team members nominated to participate in these operations.

11.11.2 Safety Requirements for Hazardous Operations

The customer is responsible for all the satellite and ground equipment hazardous operations; however, these require prior approval from XSLC before implementation. XSLC safety representatives will monitor and coordinate all hazardous operations to ensure that the safety requirements are followed and all safety requirements are complied with.

Hazardous operations cannot commence until authorized by the XSLC safety representative. Any incident must be reported immediately so that the XSLC safety representative can activate the emergency response teams.

If the same satellite platform has been launched from XSLC in a previous mission and there are no significant changes in the hazardous systems or components, a shorter safety approval cycle can be implemented.

11.12 Launch Services Documentation

This section addresses the documentation to be provided by either the customer or the LV side during the implementation of the launch services contract. The delivery dates are based on typical program duration of 24 months but may be modified to adapt the customers schedule requirements and satellite schedule.

Unless otherwise stated, all dates are in months relative to the first day of the launch period until a launch date is agreed from which time on they refer to the launch date and are listed in Table 11-3.

Table 11-3 Launch Services Documentation Submission Date

	Documents	Provider	Due Date
1	**Launch Vehicle's Introductory Technical Documents** *Launch March User's Manual* *XSLC User's Manual* *Long March Safety Requirement Documents* *Required Format of Spacecraft Dynamic Model* *Required Format of Spacecraft Thermal Model*	CGWIC	1 month after EDC
2	**Interface Requirement Document (IRD) for Using LM-3A Series LV** The customer shall prepare the *IRD*, which generally includes the following information: *General mission technical requirements* *Launch Safety and Security Requirements* *Special Requirements for LV and Launch site* The IRD is used for the start of the program. Further detailed technical data can be defined during the implementation of the contract.	Customer	2 months after EDC
3	**Spacecraft Dynamic Model (Preliminary and Final)** The customer shall provide hard copies or soft copies (such as a CD) according to *Required Format of Spacecraft Dynamic Model*. CALT will perform the dynamic Coupled Load Analysis (CLA) with the model. The customer shall specify the output requirements in written form. The spacecraft dynamic model could be submitted once or twice according to progress of the program.	Customer	2 months after No.1
4	**Dynamic Coupled Load Analysis (Preliminary and Final)** CALT will integrate the SC model, launch vehicle model and flight characteristics together to calculate loads on SC/LV interface at selected critical points. The customer may get the dynamic parameters inside the spacecraft using the analysis results. Analysis would be carried out once or twice depending on the progress of the program.	CGWIC	3 months after No.3

	Documents	Provider	Due Date
5	**Spacecraft Thermal Model (Preliminary and Final)** The customer shall provide hard copies or soft copies (such as a CD) of the spacecraft thermal model according to *Required Format of Spacecraft Thermal Model.* CALT will use the model for thermal environment analysis. The analysis output requirement should be specified in written form.	Customer	2 months after No.1
6	**Thermal Analysis (Preliminary and Final)** This analysis determines the spacecraft thermal environment from the arrival of the spacecraft to its separation from the launch vehicle.	CGWIC	3 months after No.5
7	**Spacecraft Interface Requirements and Spacecraft Configuration Drawings (Preliminary and Final) cover but are not limited to the documents listed below:** a) Orbital data, Mass properties, launch constraints & separation conditions; b) Detailed information of the spacecraft mechanical interfaces, electrical interfaces and RF characteristics; c) Requirements and constraints for combined operations. The customer shall provide the spacecraft configuration drawings to CGWIC/CALT. For all minimal or potential protrusion out of the fairing envelope, agreement has to be reached with CALT on its acceptability one year before launch.	Customer	3 months after EDC
8	**Safety Phase 1 – Design** This submission is for the design of the spacecraft and ground support equipment with details of all hazardous systems or components. It will provide details of all safety measures implemented, warning devices included and a list clearly showing the risks for each hazardous system and component.	Customer	Before the PMAR

	Documents	Provider	Due Date
9	**Mission Analysis Reports (Preliminary and Final)** f) *Trajectory Analysis* To optimize the launch mission; To determine the launch sequence, flight trajectory and performance margin. *g) Separation Analysis (Statistical Analysis & Far Field Analysis)* To analyze the separation dynamics at SC/LV separation, including fuel slosh; To verify the spacecraft velocity and attitude at SC/LV separation; To review if the LV collision avoidance maneuvers can satisfy the spacecraft requirements. h) *Interface Compatibility Analysis (EMC Analysis, Electrical Interface Analysis and Mechanical Interface Analysis)* To ensure that the SC/LV interfaces are compatible. i) *Venting Analysis (Final Analysis Only)* To verify if the spacecraft design can satisfied and the depressurization requirement in the fairing during the launcher trajectory, especially during transonic period.	CGWIC	3 months after No.7
10	**Safety Phase 2 – AIT and Qualification Status** This submission provides the qualification status, manufacturing status and acceptance verification of all hazardous systems and components for the spacecraft and ground support equipment. This submission will also include the initial spacecraft operations procedures.	Customer	12 months before launch

	Documents	Provider	Due Date
11	**Spacecraft Environmental Test Plan** The customer shall provide a comprehensive spacecraft test plan that clearly shows how they will confirm compliance with the environmental requirements defined in this User's Manual. The plan shall detail the spacecraft manufacturer's overall test philosophy and how this is translated into a qualification and acceptance test program. The plan shall provide an overview of the environmental testing to be performed to clearly demonstrate that the spacecraft can meet the ground processing and flight loads. The plan shall also include the test objectives, the acceptance criteria, the spacecraft configuration for the tests with its applicability to the launch configuration, the test methodology including the monitoring requirements, and the test schedule showing that all testing will be completed such that the final CLA can be performed before the FMAR. It should be noted that this is a test plan so test specifications and procedures are not required unless there is an issue with the test plan.	Customer	One month before the test
12	**Spacecraft Environmental Test Report** The reports provided by the customer should include the detailed environmental test and some related analysis conclusions. The adaptability and the margins of the spacecraft should also be included. The document will be jointly reviewed by both sides to ensure the compatibility of SC and LV.	Customer	15 days after the test
13	**Safety Phase 3 – Final Acceptance and Hazardous Operations** The final submission includes the results of the AIT program for the hazardous systems plus the final details of all hazardous operations to be conducted at the launch site. This includes the spacecraft, ground support equipment and deliveries of hazardous materials.	Customer	6 months before launch

	Documents	Provider	Due Date
14	**Spacecraft Operation Plan** This plan shall describe the spacecraft operations in the launch site, the launch team composition and responsibilities. This plan is prepared by the customer and defines all the activities required to handle, test and fuel the spacecraft from arrival at Xichang airport through to mating to the Payload Adapter (PLA). The plan will also include all the XSLC interface requirements, the support required for the standalone spacecraft operations and communications requirements. Although the plan is primarily to define the spacecraft processing requirements, it will also be required to detail the post launch activities the customer will implement to remove all their equipment from XSLC. Both sides will jointly review this document. Part of the document will be incorporated into ICD and written into *SC/LV Combined Operation Procedure*.	Customer	8 months before launch
15	**Spacecraft Operation Procedure** These are the procedures that will be used during the launch campaign by the customer in processing the spacecraft. The hazardous procedures shall detail every step required including the constraints, safety requirements, handling requirements and personnel requirements. The procedures to be used during combined operations shall also detail every step required including the constraints, safety requirements, handling requirements, personnel requirements and any actions required by the launch vehicle in support of the operation. The operational procedures will also include those procedures that the customer will use to validate the XSLC interfaces for communications and monitoring the spacecraft.	Customer	2 months before launch

	Documents	Provider	Due Date
16	**SC/LV Combined Operations Plan** XSLC will prepare a combined operations plan based on the typical launch vehicle processing schedule that will cover all activities from spacecraft mating to the payload adapter to the encapsulated spacecraft mating with the launcher. The objective is to provide an overview of all the activities in sequence between the launch vehicle and spacecraft with specific emphasis on the following: a) SC/LV joint operations b) All SC or LV stand-alone operations that require the LV or SC to be inactive c) All hazardous operations d) All operational constraints from the SC/LV e) The responsibilities of SC or LV for each operation f) Reference to an operational procedure for each operation.	CGWIC	8 months before launch
17	**SC/LV Combined Operations Procedure** XSLC will issue the combined operations procedures starting with the spacecraft mating to the payload adapter. These procedures will detail the interfaces between the launch vehicle team and the customer team for the operation including the constraints, safety requirements, handling requirements, personnel requirements and the responsibilities. These procedures are to ensure that the events are coordinated and the teams do not run into facility conflicts. The launch vehicle side will work out the *SC/LV Combined Operation Procedure* based on Spacecraft Operation Plan and SC/LV Combined Operations Plan. Both sides will jointly review this procedure.	Both Sides	2 months before launch
18	Approval of the spacecraft and ground support equipment for fuelling and combined operations.	Customer	Before SC fuelling

	Documents	Provider	Due Date
19	**SC's Mass Property Report (Final)** The spacecraft's mass properties are measured and calculated after all tests, fueling and closeout operations are completed. The data shall be provided to CGWIC one day before SC/LV integration.	Customer	After the SC is fueled
20	**Launch Rehearsal Procedure** This document specifies the detailed operation steps during the launch rehearsal.	Both Sides	15 days before launch
21	**GO/NO GO Criteria** This document specifies the baseline criteria for the GO/NO-GO and the orders issued by the relevant Program Managers of the mission team. The Go/No Go criteria for the launch vehicle are standard but the criteria will be updated with the spacecraft requirements. The operation steps have been specified inside *SC/LV Combined Operation Procedure*.	Both Sides	15 days before launch
22	**Countdown Procedure** The countdown procedure details the countdown sequence, the communication links, all communication exchanges, e.g. commands, status reports, test values, etc., as conducted on the launch day. It also details the responsibilities of the various participants and the inputs required from the customer. The contingency procedures will also be included for unplanned launch holds and launch abort.	Both Sides	15 days before launch
23	**Orbit Injection Data Report** The initial orbit injection data of the spacecraft will be provided 30 minutes after SC/LV separation. This document will either be handed to the customer's representative in XSLC or sent via telex, facsimile or e-mail to a destination selected by the customer. Both sides will sign on this document.	CGWIC	30 minutes after SC/LV separation

	Documents	Provider	Due Date
24	**Orbital Tracking Report** The customer is required to provide the first round of orbital tracking data after SC separation. This data is used to verify the launch vehicle performance.	Customer	20 days after launch
25	**Launch Mission Evaluation Report** Using injection parameters and telemetry data obtained from the launch vehicle, the launch vehicle side will provide an assessment of the launch vehicle's performance. This will include a comparison of flight data with preflight predictions. The report will be submitted 60 days after a successful launch or 15 days after a launch failure or a launch anomaly.	CGWIC	60 days after launch

[End of the Manual]

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