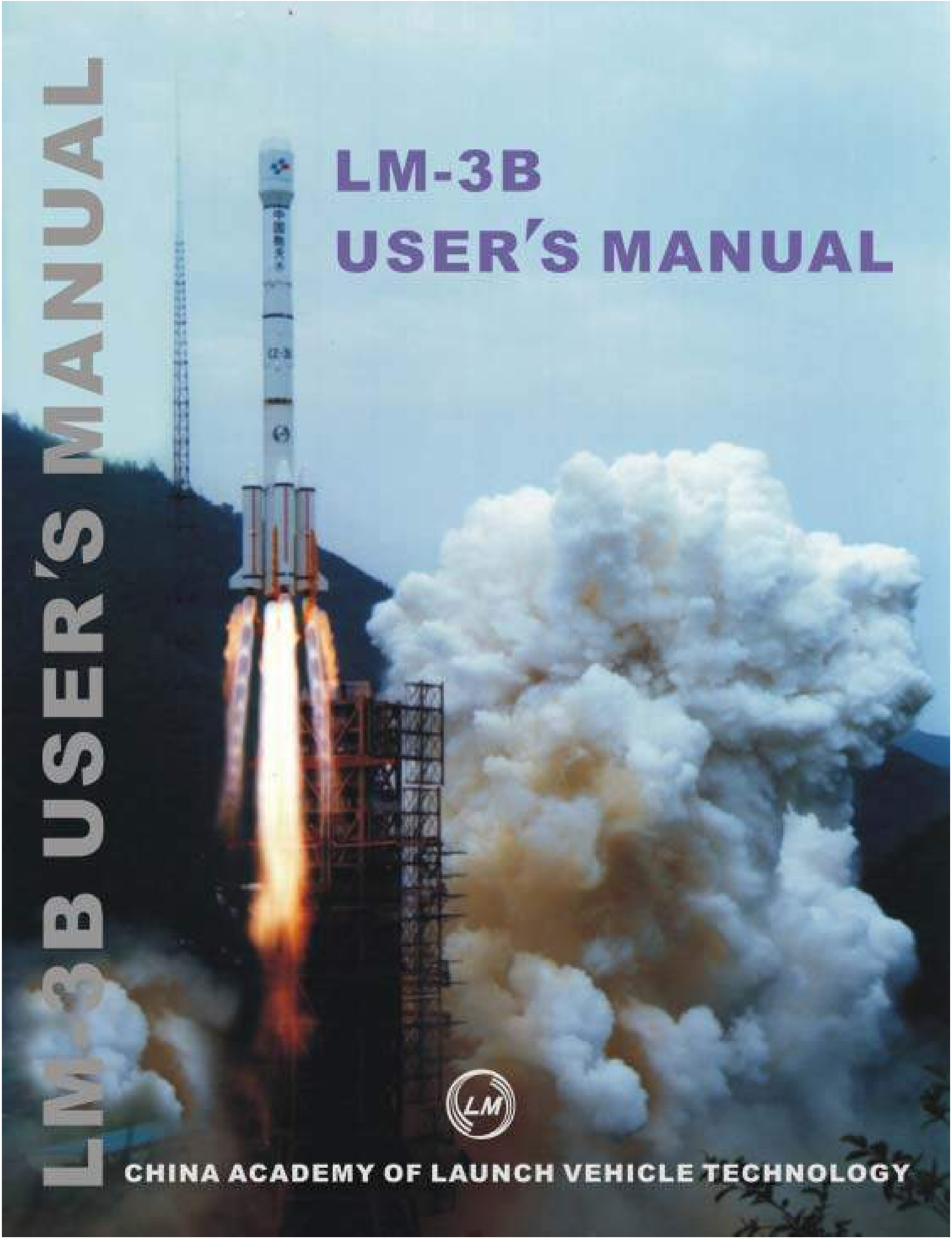
LM-3B USER'S MANUAL
LM-3B
USER'S MANUAL
LM
CHINA ACADEMY OF LAUNCH VEHICLE TECHNOLOGY

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ABBREVIATIONS

ADS	Automatic Destruction System
BL	Launch Vehicle Processing Building
BL1	Launch Vehicle Transit Building
BL2	Launch Vehicle Testing Building
BM	Solid Rocket Motor Testing and Processing Buildings
BMX	Solid Rocket Motor X-ray Building
BS	SC Processing Buildings
BS2	SC Non-hazardous Operation Building
BS3	SC Hazardous Operation Building
CALT	China Academy of Launch Vehicle Technology
CDS	Command Destruction System
CLA	Coupled Load Analysis
CLTC	China Satellite Launch and Tracking Control General
CS	Commanded Shutdown
EDC	Effect Day of the Contract
EGSE	Electrical Ground Support Equipment
GEO	Geo-synchronous Orbit
GSE	Ground Support Equipment

GTO	Geo-synchronous Transfer Orbit
IFD	In-Flight-Disconnector
JSLC	Jiuquan Satellite Launch Center
LCC	Launch Control Console
LEO	Low Earth Orbit
LH_2/LH	Liquid Hydrogen
LM	Long March
LOX	Liquid Oxygen
LV	Launch Vehicle
MCCC	Mission Command and Control Center
MEO	Medium Earth Orbit
MRS	Minimum Residue Shutdown
PLF	Payload Fairing
PUS	Propellant Utilization System
RF	Radio Frequency
RMS	Root Mean Square
SC	Spacecraft
SRM	Solid Rocket Motor
SSO	Sun synchronous Orbit
TSLC	Taiyuan Satellite Launch Center
TT&C	Tracking and Telemetry and Control
UDMH	Unsymmetrical Dimethyl Hydrazine
UPS	Uninterrupted Power Supply
VEB	Vehicle Equipment Bay
XSCC	Xi'an Satellite Control Center
XSLC	Xichang Satellite Launch Center

CHAPTER 1

INTRODUCTION

1.1 Long March Family and Its History

The development of Long March (LM) launch vehicles began in mid-1960s and a family suitable for various missions has been formed now. The launch vehicles (LV) adopt as much same technologies and stages as possible to raise the reliability. Six members of Long March Family, developed by China Academy of Launch Vehicle Technology (CALT), have been put into the international commercial launch services, i.e. LM-2C, LM-2E, LM-3, LM-3A, LM-3B and LM-3C, see **Figure 1-1**. The major characteristics of these launch vehicles are listed in **Table 1-1**.

Table 1-1 Major Characteristics of Long March

	LM-2C	LM-2E	LM-3	LM-3A	LM-3B	LM-3C
Height (m)	40.4	49.7	44.6	52.5	54.8	54.8
Lift-off Mass (t)	213	460	204	241	425.8	345
Lift-off Thrust (kN)	2962	5923	2962	2962	5923	4443
Fairing Diameter (m)	2.60/ 3.35	4.20	2.60/ 3.00	3.35	4.00/ 4.20	4.00/ 4.20
Main Mission	LEO	LEO/ GTO	GTO	GTO	GTO	GTO
Launch Capacity (kg)	2800	9500/ 3500	1500	2600	5100	3800
Launch Site	JSLC/ XSLC/ TSLC	JSLC/ XSLC	XSLC	XSLC	XSLC	XSLC

LM-2 is a two-stage launch vehicle, of which the first launch failed in 1974. An upgraded version, designated as LM-2C, successfully launched in November 1975. Furnished with a solid upper stage and dispenser, LM-2C/SD can send two Iridium satellites into LEO (h=630 km) for each launch. The accumulated launch times of LM-2C have reached 20 till December 1998.

LM-2E takes modified LM-2C as the core stage and is strapped with four boosters (Φ2.25m$\times$15m). LM-2E made a successful maiden flight in July 1990 and seven launches have been conducted till December 1995.

LM-3 is a three-stage launch vehicle, of which the first and second stages are developed based on LM-2C. The third stage uses LH_2/LOX as cryogenic propellants and is capable of re-start in the vacuum. LM-3 carried out twelve flights from January 1984 to June 1997.

LM-3A is also a three-stage launch vehicle in heritage of the mature technologies of LM-3. An upgraded third stage is adopted by LM-3A. LM-3A is equipped with the newly developed guidance and control system, which can perform big attitude adjustment to orient the payloads and provide different spin-up operations to the satellites. Till May 1997, LM-3A has flown three times, which are all successful.

LM-3B employs LM-3A as the core stage and is strapped with four boosters identical to those on LM-2E. The first launch failed in February 1996, and other four launches till July 1998 are all successful.

LM-3C employs LM-3A as the core stage and is strapped with two boosters identical to those on LM-2E. The only difference between LM-3C and LM-3B is the number of the boosters.

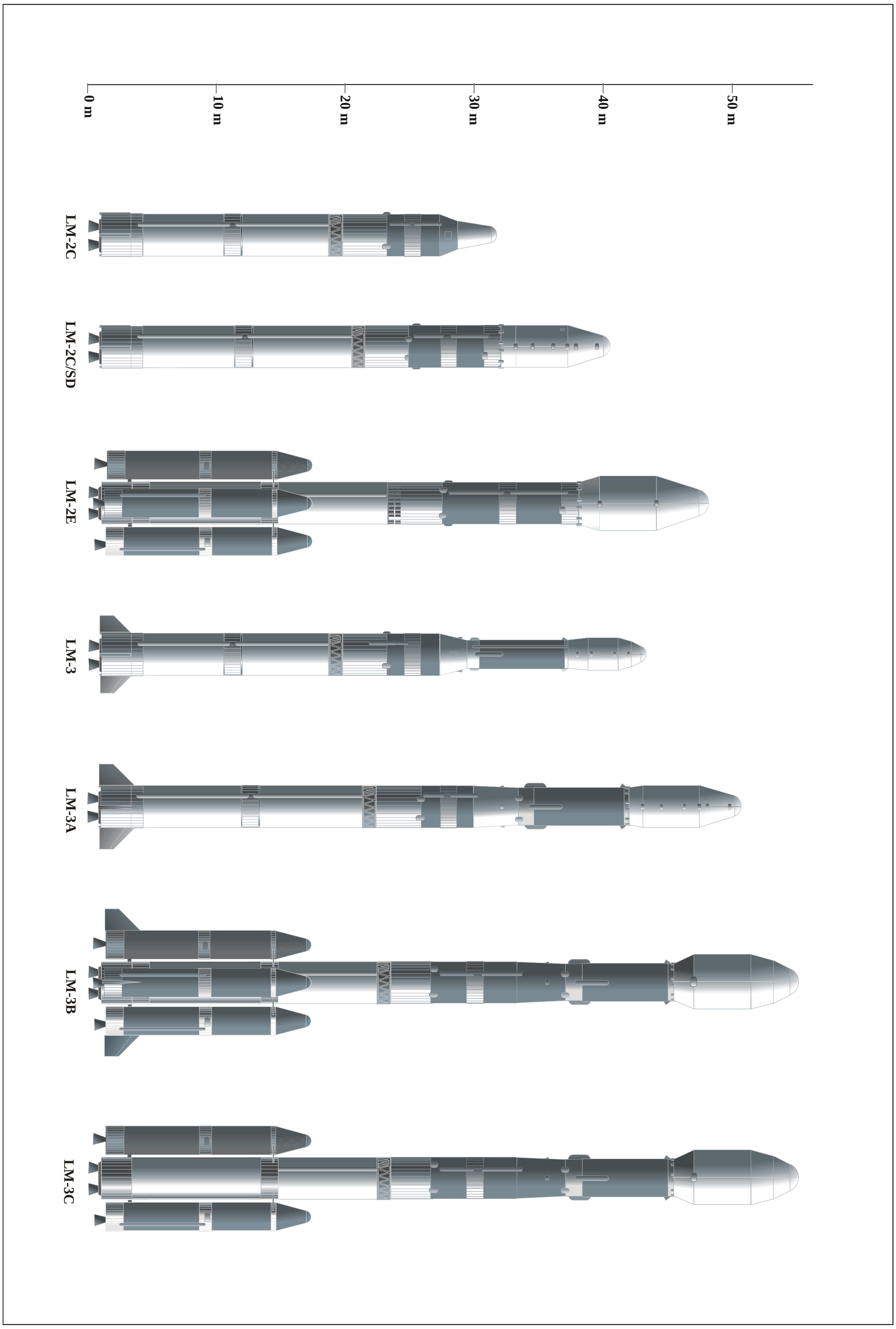


Figure 1-1 Long March Family

1-3

1.2 Launch Sites for Various Missions

There are three commercial launch sites in China, i.e. Xichang Satellite Launch Center (XSLC), Taiyuan Satellite Launch Center (TSLC) and Jiuquan Satellite Launch Center (JSLC). Refer to **Figure 1-2** for the locations of the three launch sites.

Figure 1-2 Locations of China's Three Launch Sites

1.2.1 Xichang Satellite Launch Center

Xichang Satellite Launch Center (XSLC) is located in Sichuan Province, southwestern China. It is mainly used for GTO missions. There are processing buildings for satellites and launch vehicles and buildings for hazardous operations and storage in the technical center. Two launch complexes are available in the launch center, Launch Complex #1 for LM-3 and LM-2C, and Launch Complex #2 for LM-3A, 3B & 3C as well as LM-2E.

The customers' airplanes carrying the Spacecraft (SC) and Ground Support Equipment (GSE) can enter China from either Beijing or Shanghai with customs exemption according to the approval from Chinese Government. The SC team can connect their journey to XSLC by plane or train at Chengdu after the flights from Beijing, Shanghai, Guangzhou or Hong Kong.

1.2.2 Taiyuan Satellite Launch Center

Taiyuan Satellite Launch Center (TSLC) is located in Shanxi province, Northern China. It is mainly used for the launches of LEO satellites by LM-2C.

The customer's airplanes carrying the SC and GSE can clear the Customs in Taiyuan free of check and the SC and equipment are transited to TSLC by train. The SC team can connect their journey to TSLC by train.

1.2.3 Jiuquan Satellite Launch Center

Jiuquan Satellite Launch Center (JSLC) is located in Gansu Province, Northwestern China. This launch site has a history of near thirty years. It is mainly used for the launches of LEO satellites by LM-2C and LM-2E.

The customer's airplanes carrying the SC and GSE can clear the Customs in Beijing or Shanghai free of check. The SC team can connect their flight to Dingxin near JSLC.

1.3 Launch Record of Long March

Table 1-2 Flight Record of Long March till March 25, 2002

NO.	LV	Date	Payload	Mission	Launch Site	Result
1	LM-1 F-01	70.04.24	DFH-1	LEO	JSLC	Success
2	LM-1 F-02	71.03.03	SJ-1	LEO	JSLC	Success
3	LM-2 F-01	74.11.05	FHW-1	LEO	JSLC	Failure
4	LM-2C F-01	75.11.26	FHW-1	LEO	JSLC	Success
5	LM-2C F-02	76.12.07	FHW-1	LEO	JSLC	Success
6	LM-2C F-03	78.01.26	FHW-1	LEO	JSLC	Success
7	LM-2C F-04	82.09.09	FHW-1	LEO	JSLC	Success
8	LM-2C F-05	83.08.19	FHW-1	LEO	JSLC	Success
9	LM-3 F-01	84.01.29	DFH-2	GTO	XSLC	Failure
10	LM-3 F-02	84.04.08	DFH-2	GTO	XSLC	Success
11	LM-2C F-06	84.09.12	FHW-1	LEO	JSLC	Success
12	LM-2C F-07	85.10.21	FHW-1	LEO	JSLC	Success
13	LM-3 F-03	86.02.01	DFH-2A	GTO	XSLC	Success
14	LM-2C F-08	86.10.06	FHW-1	LEO	JSLC	Success
15	LM-2C F-09	87.08.05	FHW-1	LEO	JSLC	Success
16	LM-2C F-10	87.09.09	FHE-1A	LEO	JSLC	Success
17	LM-3 F-04	88.03.07	DFH-2A	GTO	XSLC	Success
18	LM-2C F-11	88.08.05	FHW-1A	LEO	JSLC	Success
19	LM-4 F-01	88.09.07	FY-1	SSO	TSLC	Success
20	LM-3 F-05	88.12.22	DFH-2A	GTO	XSLC	Success
21	LM-3 F-06	90.02.04	DFH-2A	GTO	XSLC	Success
22	LM-3 F-07	90.04.07	AsiaSat-1	GTO	XSLC	Success
23	LM-2E F-01	90.07.16	BARD-1/DP1	LEO	XSLC	Success
24	LM-4 F-02	90.09.03	FY-1/A-1, 2.	SSO	TSLC	Success
25	LM-2C F-12	90.10.05	FHW-1A	LEO	JSLC	Success
26	LM-3 F-08	91.12.28	DFH-2A	GTO	XSLC	Failure
27	LM-2D F-01	92.08.09	FHW-1B	LEO	JSLC	Success
28	LM-2E F-02	92.08.14	Aussat-B1	GTO	XSLC	Success
29	LM-2C F-13	92.10.05	Freja/FHW-1A	LEO	JSLC	Success
30	LM-2E F-03	92.12.21	Optus-B2	GTO	XSLC	Failure
31	LM-2C F-14	93.10.08	FHW-1A	LEO	JSLC	Success
32	LM-3A F-01	94.02.08	SJ-4/DP2	GTO	XSLC	Success
33	LM-2D F-02	94.07.03	FHW-1B	LEO	JSLC	Success

NO.	LV	Date	Payload	Mission	Launch Site	Result
34	LM-3 F-09	94.07.21	APSTAR-I	GTO	XSLC	Success
35	LM-2E F-04	94.08.28	Optus-B3	GTO	XSLC	Success
36	LM-3A F-02	94.11.30	DFH-3	GTO	XSLC	Success
37	LM-2E F-05	95.01.26	APSTAR-II	GTO	XSLC	Failure
38	LM-2E F-06	95.11.28	AsiaSat-2	GTO	XSLC	Success
39	LM-2E F-07	95.12.28	EchoStar-1	GTO	XSLC	Success
40	LM-3B F-01	96.02.15	Intelsat-7A	GTO	XSLC	Failure
41	LM-3 F-10	96.07.03	APSTAR-IA	GTO	XSLC	Success
42	LM-3 F-11	96.08.18	ChinaSat-7	GTO	XSLC	Failure
43	LM-2D F03	96.10.20	FHW-1B	LEO	JSLC	Success
44	LM-3A F-03	97.05.12	DFH-3	GTO	XSLC	Success
45	LM-3 F-12	97.06.10	FY-2	GTO	XSLC	Success
46	LM-3B F-02	97.08.20	Mabuhay	GTO	XSLC	Success
47	LM-2C F-15	97.09.01	Iridium-DP	LEO	TSLC	Success
48	LM-3B F-03	97.10.17	APSTAR-IIR	GTO	XSLC	Success
49	LM-2C F-16	97.12.08	Iridium-D1	LEO	TSLC	Success
50	LM-2C F-17	98.03.26	Iridium-D2	LEO	TSLC	Success
51	LM-2C F-18	98.05.02	Iridium-D3	LEO	TSLC	Success
52	LM-3B F-04	98.05.30	ChinaStar-1	GTO	XSLC	Success
53	LM-3B F-05	98.07.18	SinoSat-1	GTO	XSLC	Success
54	LM-2C F-19	98.08.20	Iridium-R1	LEO	TSLC	Success
55	LM-2C F-20	98.12.19	Iridium-R2	LEO	TSLC	Success
56	LM-4 F-03	99.05.10	FY-1	SSO	TSLC	Success
57	LM-2C F-21	99.06.12	Iridium-R3	LEO	TSLC	Success
58	LM-4 F-04	99.10.14	ZY-1	SSO	TSLC	Success
59	LM-2F F-01	99.11.20	Shenzou-1 Ship	LEO	JSLC	Success
60	LM-3A F-04	2000.01.26	ChinaSat-22	GTO	XSLC	Success
61	LM-3 F-13	2000.06.25	FY-2	GTO	XSLC	Success
62	LM-4 F-05	2000.09.01	ZY-2	SSO	TSLC	Success
63	LM-3A F-05	2000.10.31	Beidou Nav.	GTO	XSLC	Success
64	LM-3A F-06	2000.12.21	Beidou Nav.	GTO	XSLC	Success
65	LM-2F F-02	2001.01.10	ShenZou-2 Ship	LEO	JSLC	Success
66	LM-2F F-03	2002.03.25	ShenZou-3 Ship	LEO	JSLC	Success

CHAPTER 2

GENERAL DESCRIPTION TO LM-3B

2.1 Summary

Long March 3B (LM-3B) is a powerful three-stage launch vehicle using liquid propellants. LM-3B is mainly used for Geo-synchronous Transfer Orbit (GTO) missions. LM-3B takes the mature LM-3A as the core stage with 4 strap-on boosters.

China Academy of Launch Vehicle Technology (CALT) started to design LM-3A in mid-1980s. LM-3A is also a three-stage launch vehicle with the GTO capability of 2600kg. Its third stage is fueled with cryogenic propellants, i.e. liquid hydrogen and liquid oxygen. Three consecutive successful launches have been made since its maiden mission in February 1994.

The GTO launch capability of LM-3B reaches 5100kg by using strap-on boosters and the longer second stage.

LM-3B provides four types of fairing, (see **Chapter 4**), and four different payload interfaces, which provide the users with more flexibility.

2.2 Technical Description

2.2.1 Major Characteristics of LM-3B

Table 2-1 shows the major characteristics of LM-3B.

Table 2-1 Technical Parameters of LM-3B

Stage	Booster	First Stage	Second Stage	Third Stage
Lift-off Mass (t)	426			
Propellant	N_2O_4/UDMH			LOX/LH_2
Mass of Propellant (t)	37.746×4	171.775	49.605	18.193
Engine	DaFY5-1	DaFY6-2	DaFY20-1(Main) DaFY21-1(Vernier)	YF-75

Thrust (kN)	740.4×4	2961.6	742 (Main) 11.8×4(Vernier)	78.5×2
Specific Impulse (N.s/kg)	2556.2	2556.2	2922.57(Main) 2910.5(Vernier)	4312
Stage Diameters (m)	2.25	3.35	3.35	3.0
Stage Length (m)	15.326	23.272	9.943	12.375
Fairing Length (m)	9.56			
Fairing Diameter (m)	Φ4.0			
Total Length (m)	54.838			

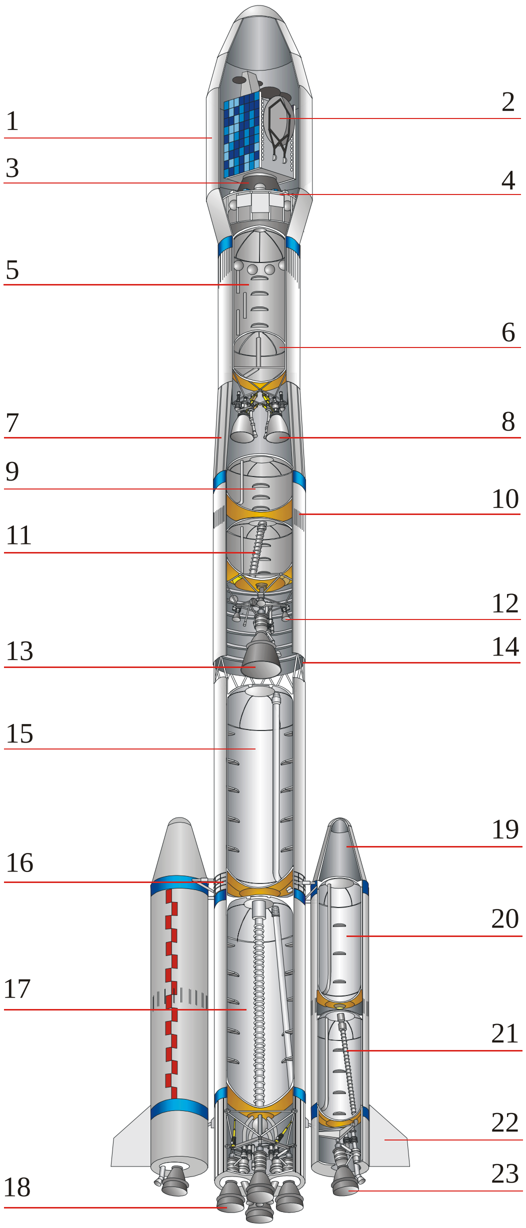
There are two different fairing encapsulation methods for LM-3B, i.e. Encapsulation-on-Pad and Encapsulation-in-BS3. They are described in **Chapter 8**. The statements inside this Manual are applicable for Encapsulation-on-Pad, if there is no special notice.

2.3 LM-3B System Composition

LM-3B consists of rocket structure, propulsion system, control system, telemetry system, tracking and safety system, coast phase propellant management and attitude control system, cryogenic propellant utilization system, separation system and auxiliary system, etc.

2.3.1 Rocket Structure

The rocket structure functions to withstand the various internal and external loads on the launch vehicle during transportation, hoisting and flight. The rocket structure also combines all sub-systems together. The rocket structure is composed of boosters, first stage, second stage, third stage and payload fairing. See **Figure 2-1**.



1. Fairing
2. SC
3. Payload Adapter
4. Vehicle Equipment Bay
5. LH_2 Tank
6. LOX Tank
7. Inter-stage Section
8. Third Stage Engine
9. Second Stage Oxidizer Tank
10. Inter-tank Section
11. Second Stage Fuel Tank
12. Second Stage Vernier Engine
13. Second Stage Main Engine
14. Inter-stage Section
15. First Stage Oxidizer Tank
16. Inter-tank Section
17. First Stage Fuel Tank
18. First Stage Engine
19. Booster's Nose
20. Booster's Oxidizer tank
21. Booster's Fuel Tank
22. Stabilizer
23. Booster's Engine

Figure 2-1 LM-3B Configuration

The booster consists of nose, oxidizer tank, inter-tank, fuel tank, rear transit section, tail section, stabilizer, valves and tunnels, etc.

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

The second stage includes oxidizer tank, inter-tank, fuel tank, valves and tunnels, etc..

The third stage contains payload adapter, vehicle equipment bay (VEB) and cryogenic propellant tank. The payload adapter connects the payload with LM-3B and conveys the loads between them. The interface ring on the top of the adapter can be 937B, 1194, 1194A or 1666 international standard interfaces. The VEB for Encapsulation-on-pad method is a circular plate made of metal honeycomb and truss, where the launch vehicle avionics are mounted. See **Figure 2-2**. If the fairing is encapsulated in BS3, the VEB will be a cylinder-shaped structure of 900mm high seated on the third stage. See **Figure 2-3**. The propellant tank of stage three is thermally insulated with a common bulkhead, convex upward in the middle. The common bulkhead structurally takes dual-layer honeycomb vacuum thermal insulation. Liquid hydrogen is fueled in the upper part of the tank and liquid oxygen is stored inside the lower part.

The payload fairing consists of dome, bi-conic section, cylindrical section and reverse cone section.

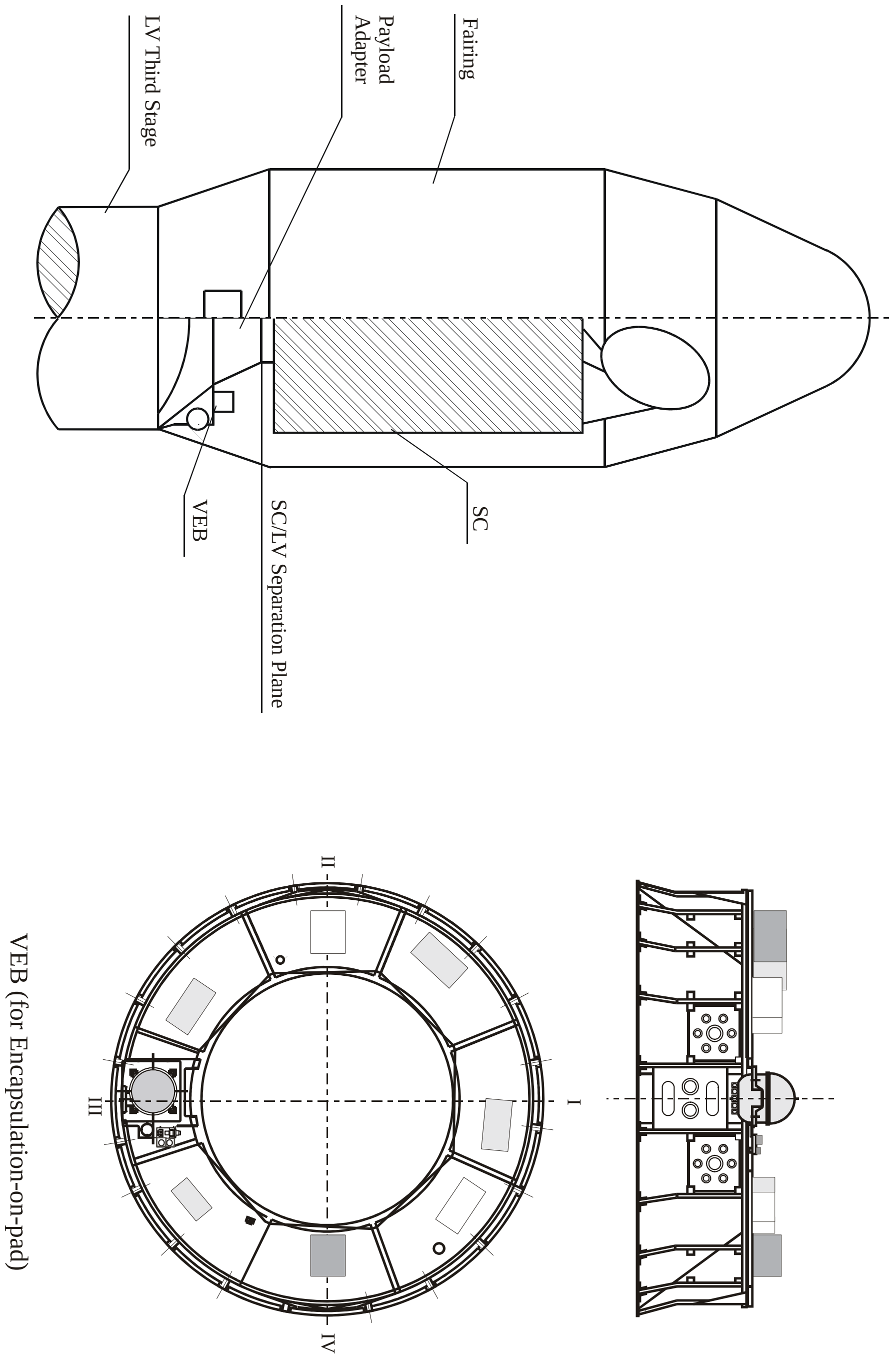


Figure 2-2 VEB Configuration (for Encapsulation-on-pad)

2-5

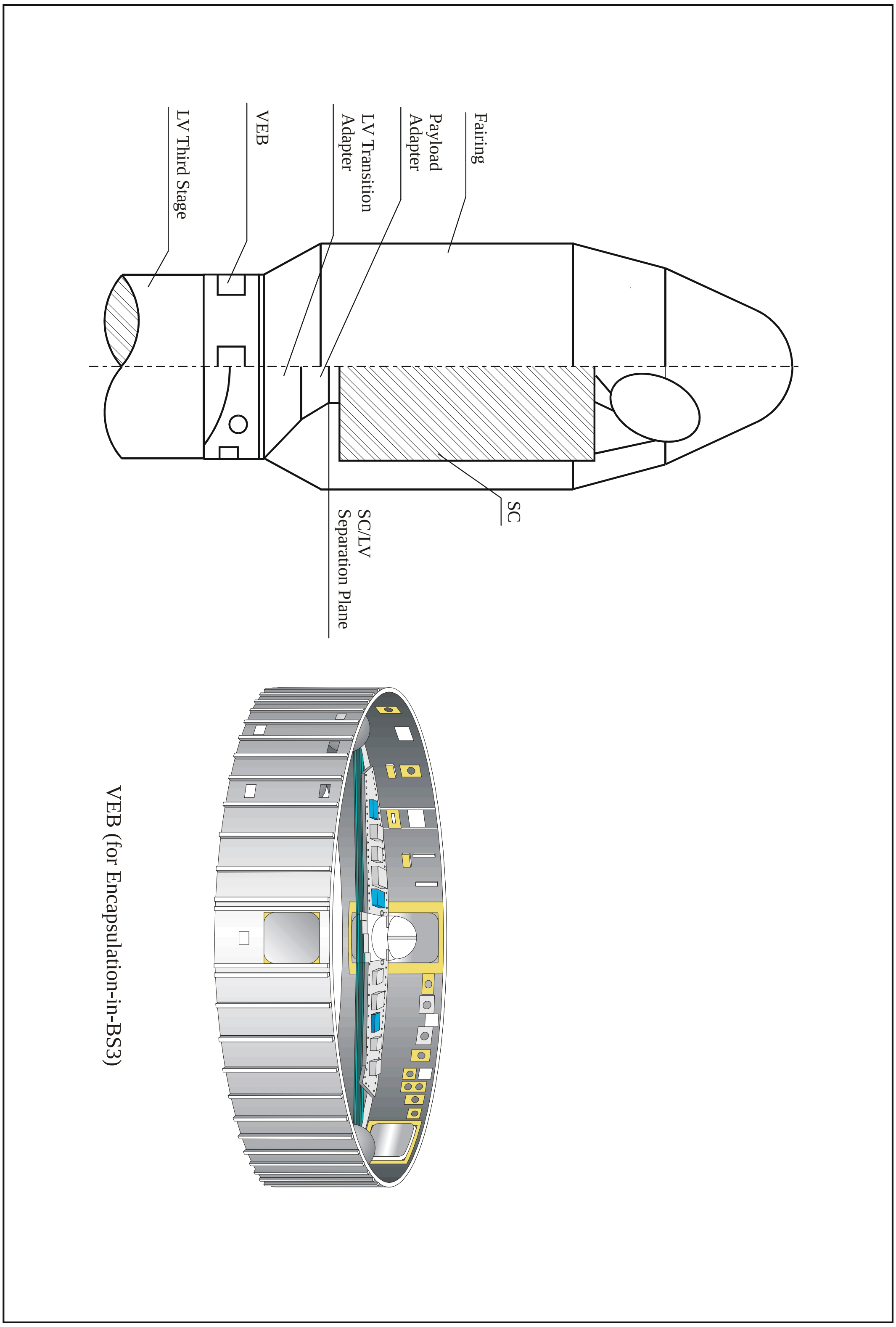


Figure 2-3 VEB Configuration (for Encapsulation-in-BS3)

2-6

2.3.2 Propulsion System

The propulsion system, including engines and pressurization/feeding system, generates the forward flight thrust and control force. Refer to **Figure 2-4(a,b&c).**

The first stage, boosters and second stage employ storable propellants, i.e. nitrogen tetroxide (N_2O_4) and unsymmetrical dimethyl hydrazine (UDMH). The propellant tanks are pressurized by the regenerated pressurization systems. There are four engines in parallel attached to the first stage. The four engines can swing in tangential directions. The thrust of each engine is 740.4kN. The four boosters use the same engines. There are one main engine and four vernier engines on the second stage. The total thrust is 789.1kN.

The third stage uses cryogenic propellants, i.e. liquid hydrogen (LH_2) and liquid oxygen (LOX). Two universal gimballing engines provide the total thrust of 157kN. The expansion ratio of the engines is 80:1 and the specific impulse is 4312N·s/kg. The LH_2 tank is pressurized by helium and regeneration system, and the LOX tank is pressurized by heated helium and regeneration system.

2.3.3 Control System

The control system is to keep the flight stability of launch vehicle and to perform navigation and/or guidance according to the preloaded flight software. The control system consists of guidance unit, attitude control system, sequencer, power distributor, etc. The control system adopts four-axis inertial platform, on-board computer and digital attitude control devices. Some advanced technologies are applied in the control system, such as programmable electronic sequencer, triple-channel decoupling, dual-parameter controlling, real-time compensation for measuring error. These technologies make the launch vehicle quite flexible to various missions. Refer to **Figure 2-5(a,b&c)**.

2.3.4 Telemetry System

The telemetry system functions to measure and transmit some parameters of the launch vehicle systems. Some measured data can be processed in real time. The telemetry system is locally powered considering sensor distribution and data coding. The measurements to the command signals are digitized. The powering and testing are performed automatically. The on-board digital converters are intelligent. Totally about 700 parameters are measured. Refer to **Figure 2-6**.

2.3.5 Tracking and Range Safety System

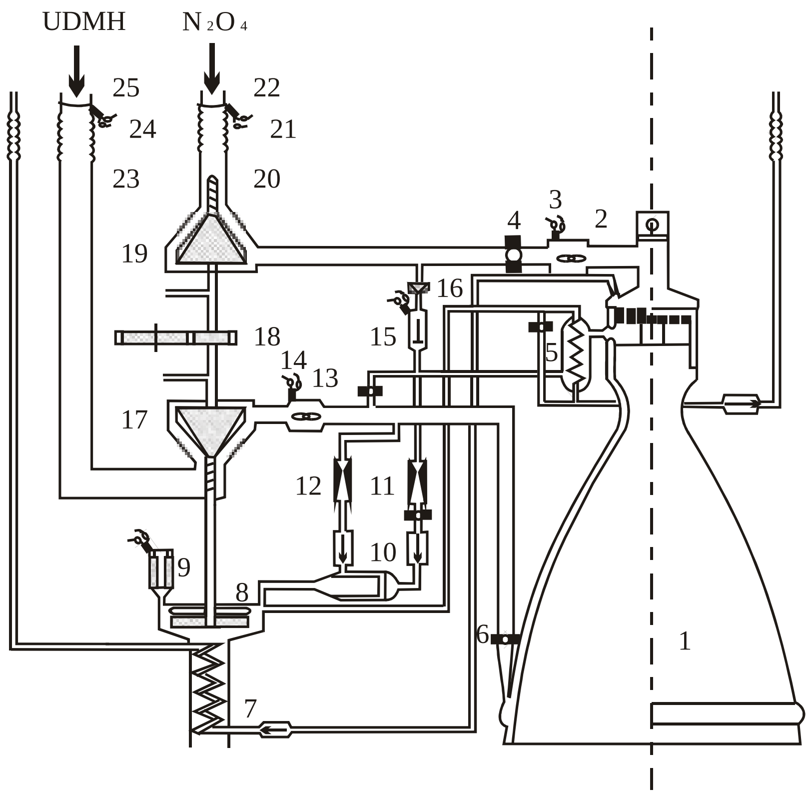
The tracking and range safety system works to measure the trajectory dada and final injection parameters. The system also provides safety assessment information. A self-destruction would be remotely controlled if a flight anomaly occurred. The trajectory measurement and safety control design are integrated together. A sampling check system is equipped on the ground part. Refer to **Figure 2-7**.

2.3.6 Coast Phase Propellant Management and Attitude Control System

This system is to carry out the attitude control and propellant management during the coast phase and to re-orient the launch vehicle prior to payload separation. An engine fueled by squeezed hydrazine works intermittently in the system. The system can be initiated repeatedly according to the commands. See **Figure 2-8**.

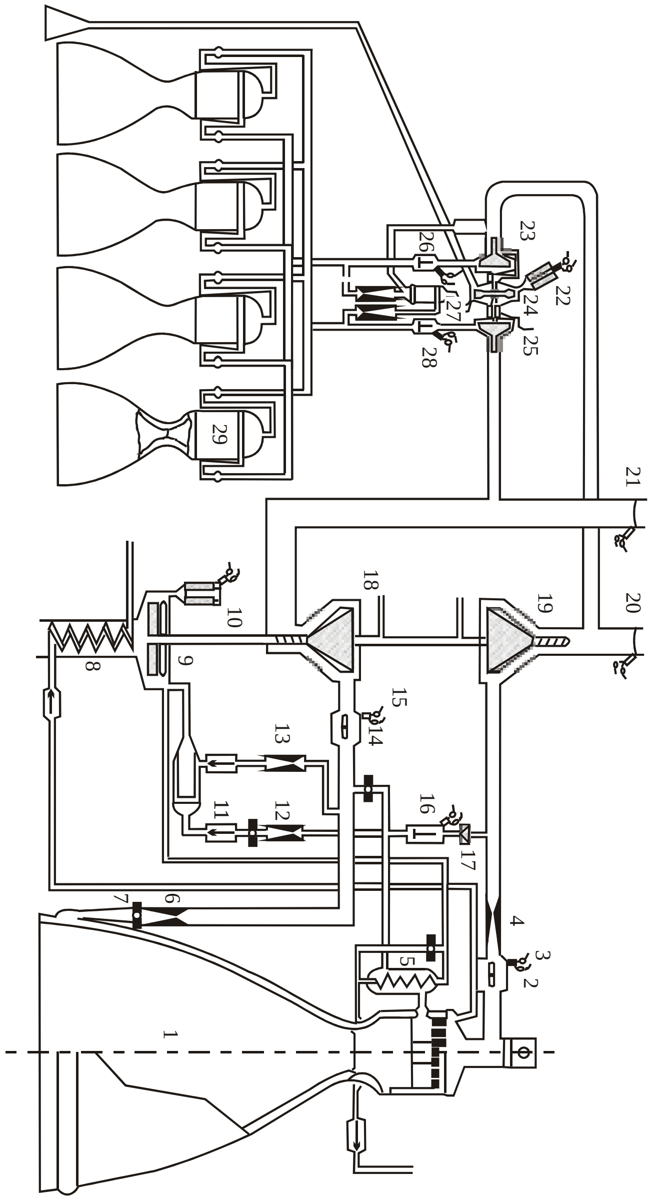
2.3.7 Cryogenic Propellant Utilization System

The propellant utilization system measures in real time the level of propellants inside the third stage tanks and adjusts the consuming rate of liquid oxygen to make the residual propellants in an optimum proportion. The adjustment is used to compensate the deviation of engine performance, structure mass, propellant loading, etc, for the purpose to get a higher launch capability. The system contains processor, propellant level sensors and adjusting valves. Refer to **Figure 2-9**.



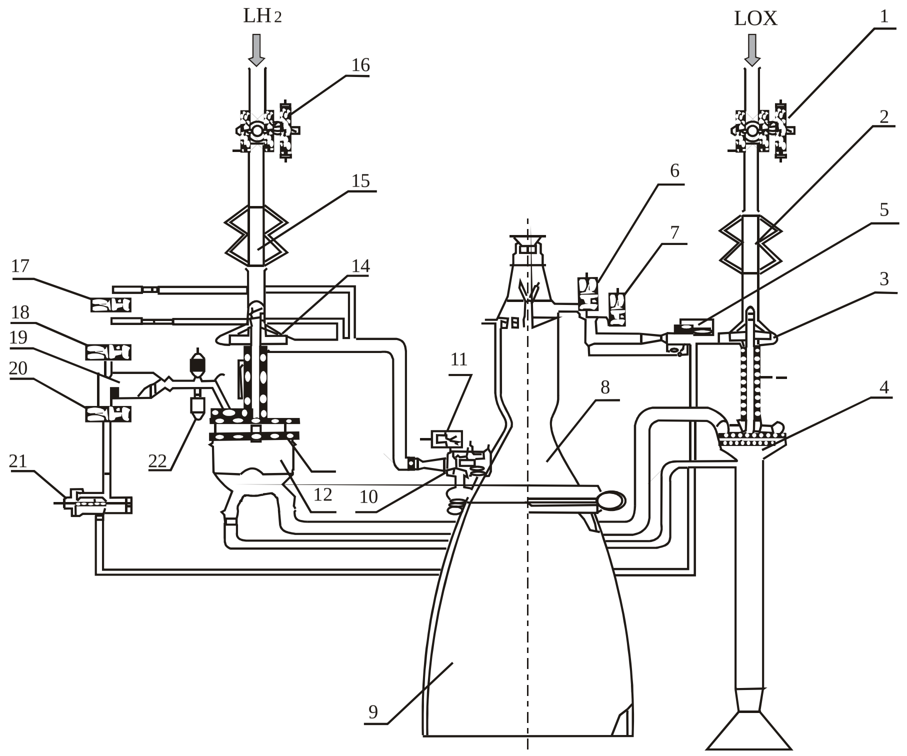
1 Thrust Chamber
2 Oxidizer Main Valve
3 Electric Squib
4 Oxidizer Main Throttling Orifice
5 Cooler
6 Fuel Main Throttling Orifice
7 Vapourizer
8 Turbine
9 Solid Start Cartridge
10 Gas Generator
11 Oxidizer Subsystem Cavitating Venturi
12 Fuel Subsystem Cavitaing Venturi
13 Fuel Main Valve
14 Electric Squib
15 Subsystem Cut-off Valve
16 Filter
17 Fuel Pump
18 Gear Box
19 Oxidizer Pump
20 Swing Hose
21 Electric Squib
22 Oxidizer Starting Valve
23 Swing Hose
24 Electric Squib
25 Fuel Starting Valve

Figure 2-4a First Stage Propulsion System Schematic Diagram 2-9



1 Thrust Chamber
2 Oxidizer Main Valve
3 Electric Squib
4 Oxidizer Main Venturi
5 Cooler
6 Fuel Main Venturi
7 Throttling Orifice
8 Vapourizer
9 Turbine
10 Solid Start Catridge
11 Gas Generator
12 Oxidizer Subsystem Venturi
13 Fuel Subsystem Venturi
14 Fuel Main Valve
15 Electric Squib
16 Subsystem Cut-off Valve
17 Filter
18 Fuel Pump
19 Oxidizer Pump
20 Oxidizer Starting Valve
21 Fuel Starting Valve
22 Solid Start Cartridge
23 Oxidizer Pump
24 Turbine
25 Fuel Pump
26 Oxidizer Cut-off Valve
27 Gas Generator
28 Fuel Cut-off Valve
29 Vernier Combustion Chamber

Figure 2-4b Second Stage Propulsion System Schematic Diagram



1. LOX Pump Front Valve
2. LOX Swinging Hose
3. LOX Pump
4. LOX Pump Turbine
5. Propellant Utilization Valve
6. LOX Main Valve
7. LOX Precooling Drain Valve
8. Thrust Chamber
9. Nozzle
10. LOX Main Valve
11. LH Precooling Drain Valve
12. LH and Helium Heater
13. LH Pump Turbine
14. LH Pump
15. LH Pump Front Swinging Hose
16. LH Pump Front Valve
17. LH Subsystem Bypass Valve
18. LH Subsystem Control Valve
19. Gas Generator
20. LOX Subsystem Control Valve
21. LOX Pressure Regulator
22. Solid Ignitor

Figure 2-4c Third Stage Propulsion System Schematic Diagram

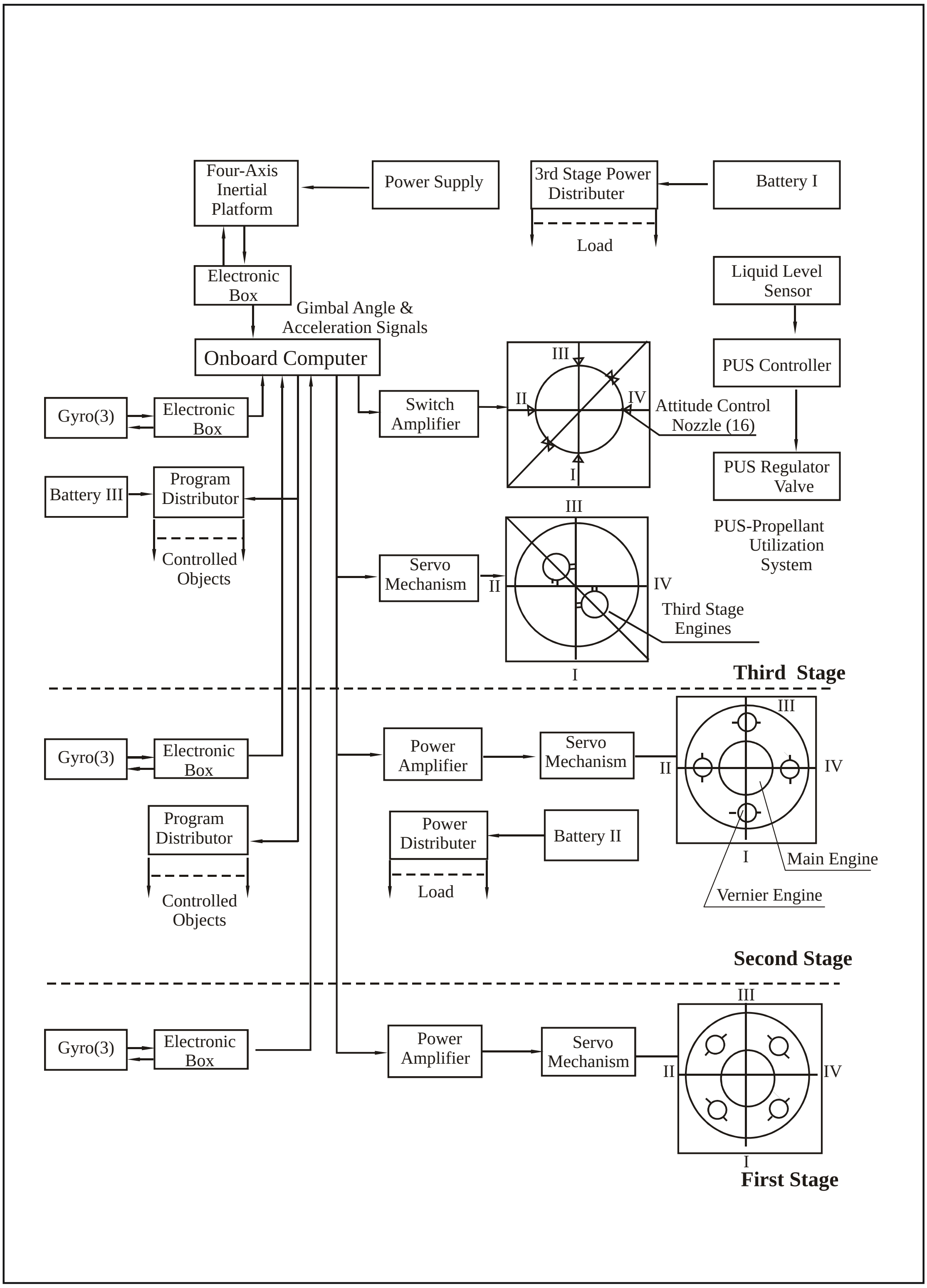


Figure 2-5a Control System Schematic Diagram

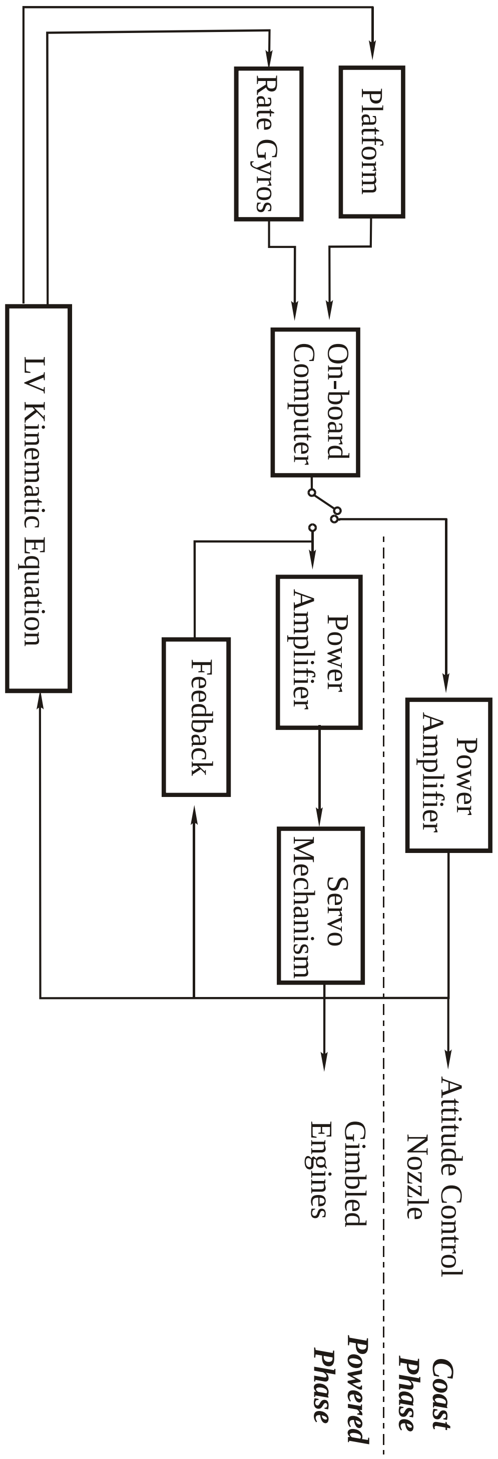


Figure 2-5b Attitude-control System Schematic Diagram

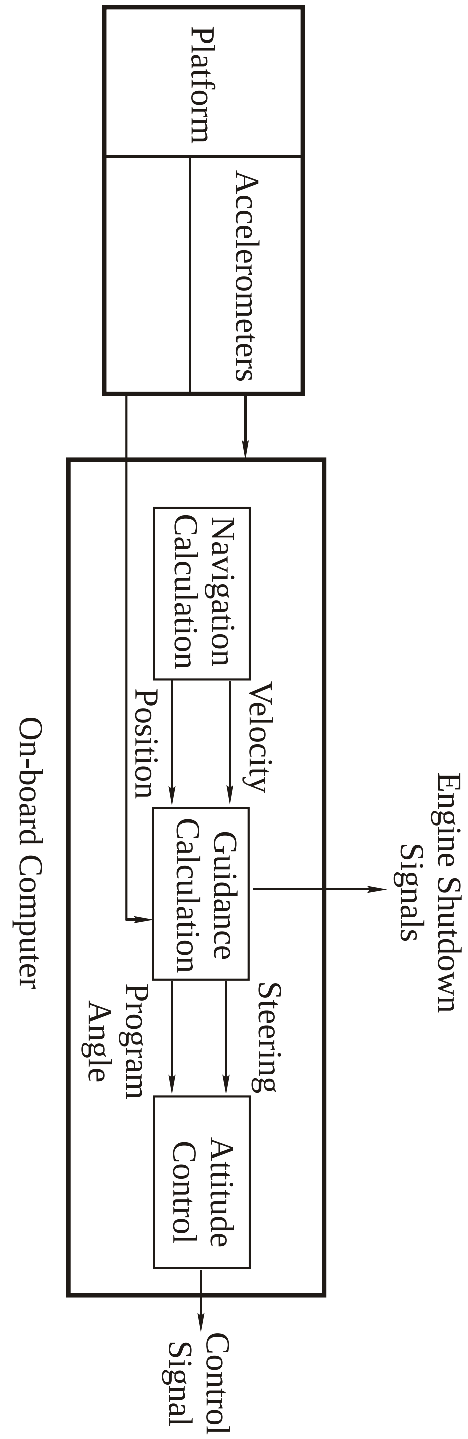


Figure 2-5c Guidance System Schematic Diagram

2-14

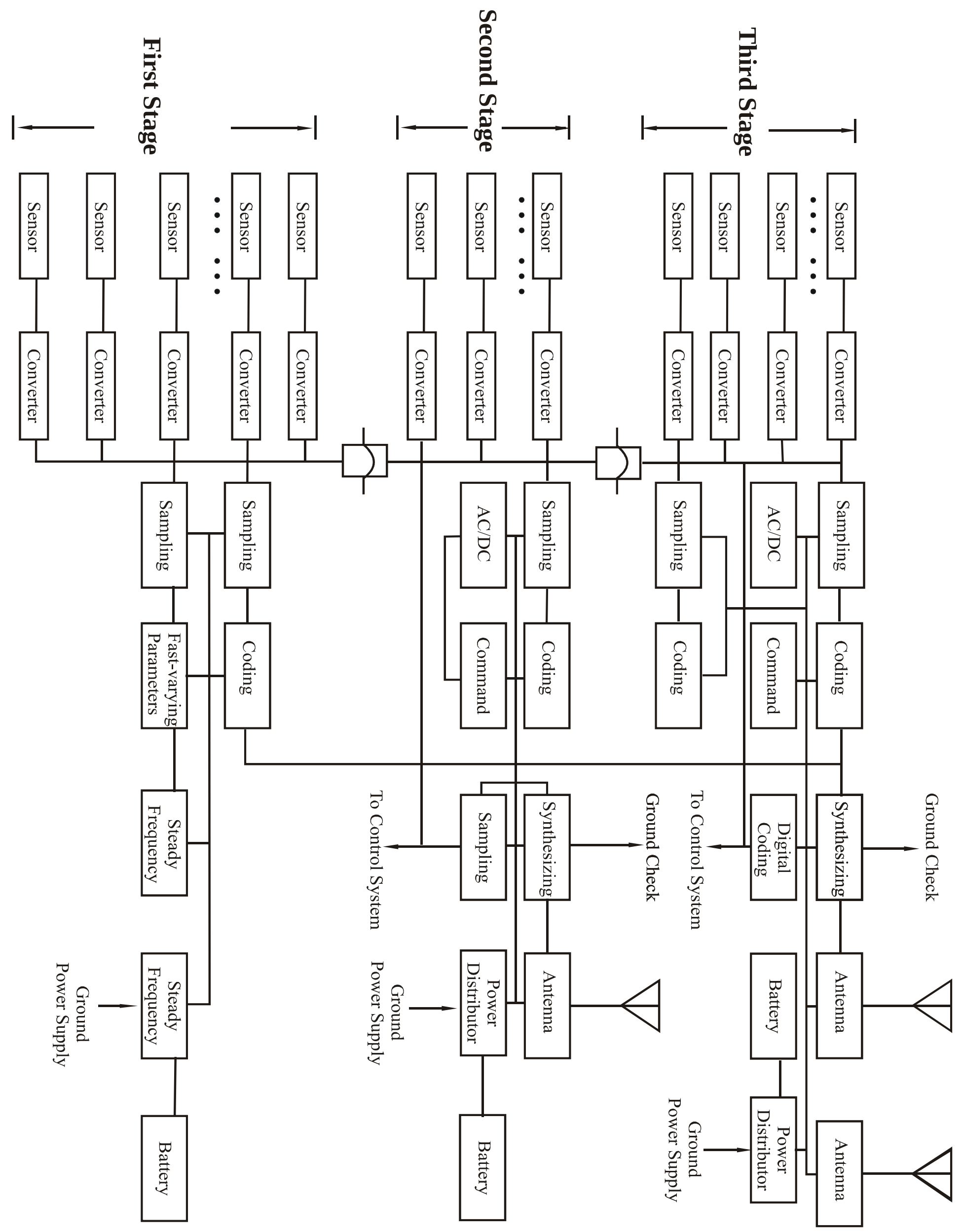


Figure 2-6 Telemetry System Schematic Diagram

2-15

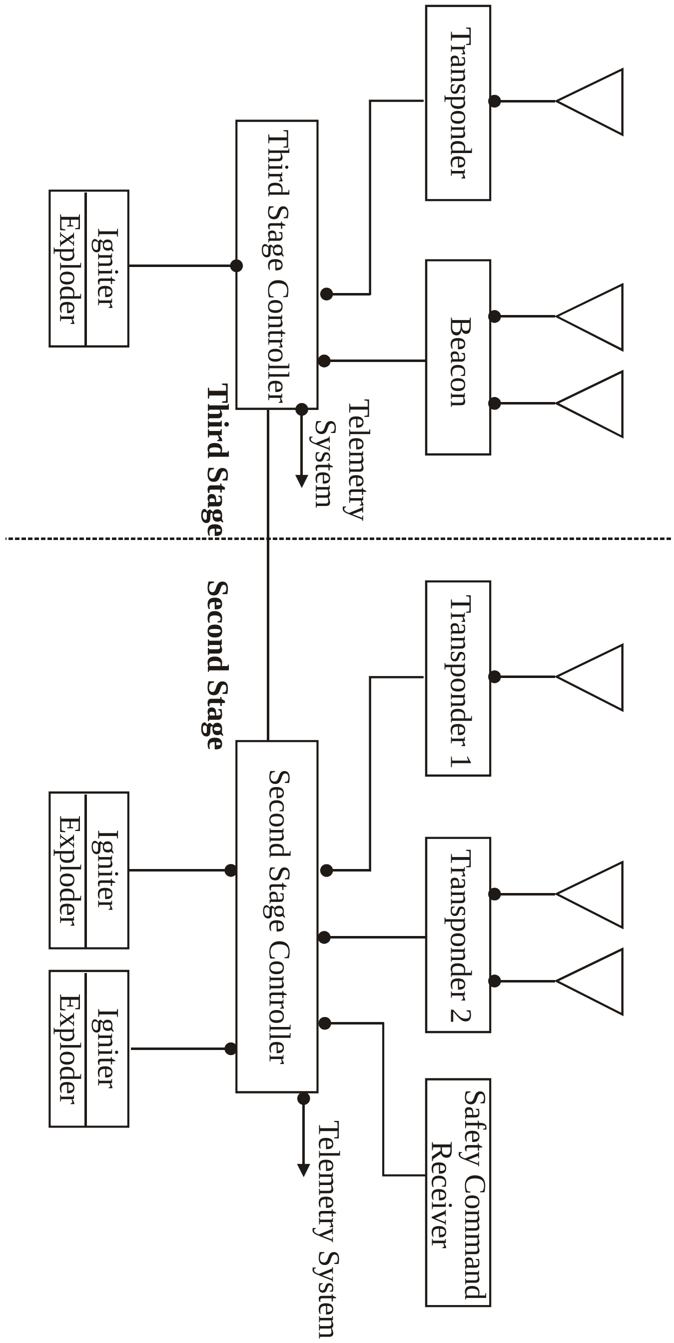


Figure 2-7 Tracking and Range Safety System Schematic Diagram

2-16

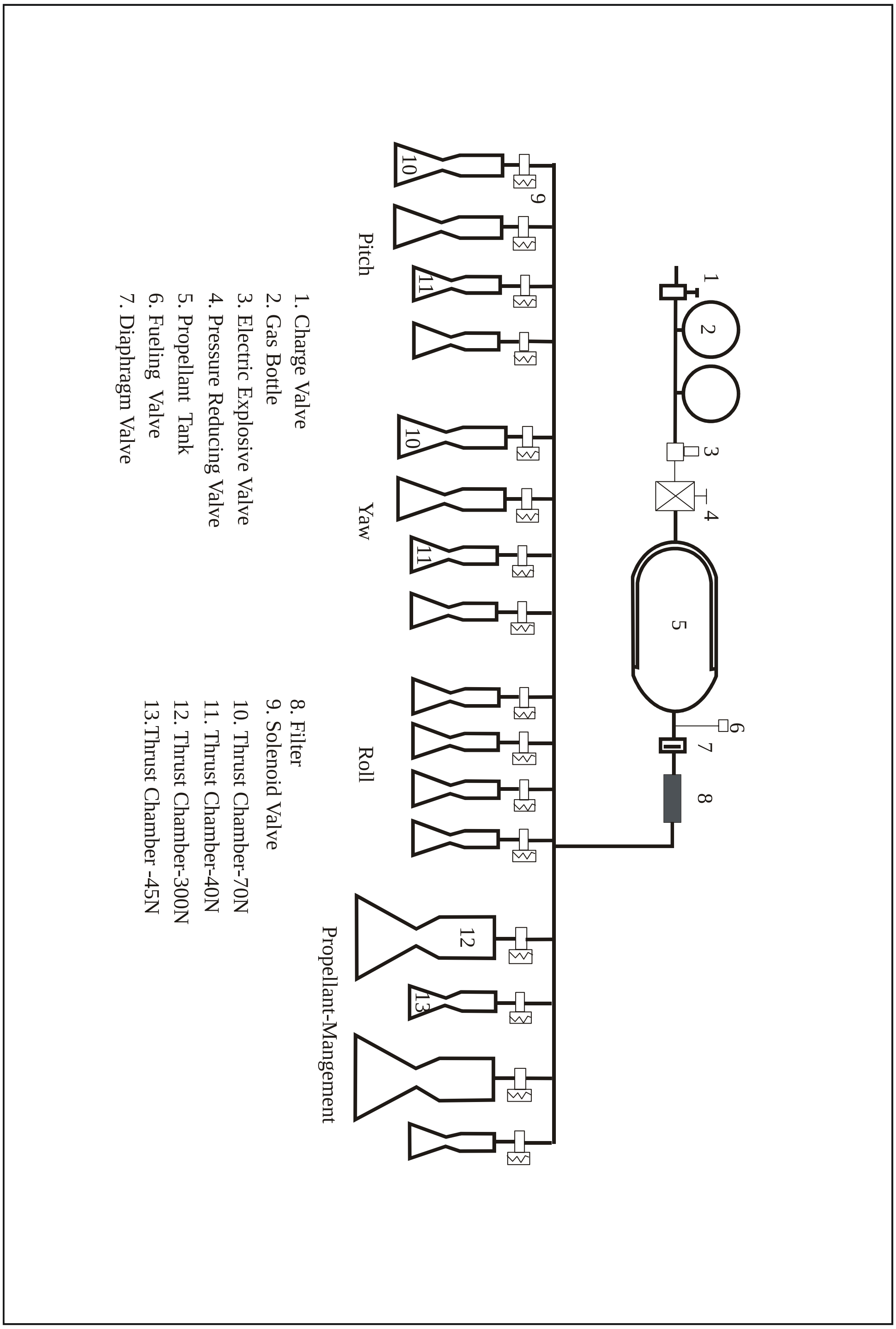


Figure 2-8 Coast Phase Propellant Management and Attitude Control System

2-17

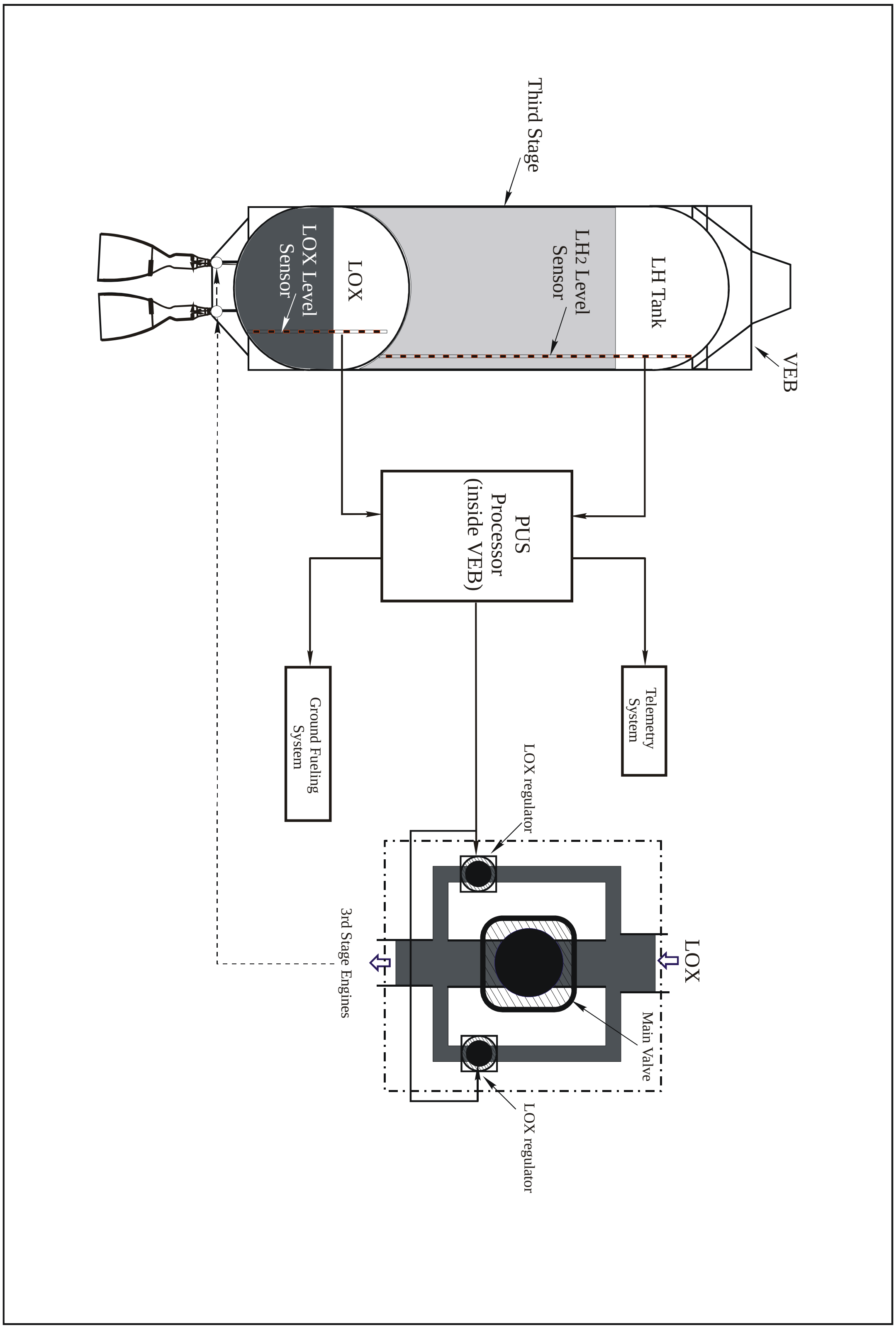


Figure 2-9 Cryogenic Propellant Utilization System Schematic Diagram

2-18

2.3.8 Separation System

There are five separation events during LM-3B flight phase, i.e. booster separations, first/second stage separation, second/third stage separation, fairing jettisoning and SC/LV separation. See **Figure 2-10**.

- **<u>Booster Separations:</u>** The boosters are mounted to the core stage through three pyro-mechanisms at the front section and separation mechanism at the rear section. Four small rockets generate outward separation force following the simultaneous unlocking of the separation mechanisms.

- **<u>First/Second Stage Separation:</u>** The first/second stage separation takes hot separation, i.e. the second stage is ignited first and then the first stage is separated away under the jet of the engine after the 14 explosive bolts are unlocked.

- **<u>Second/Third Stage Separation:</u>** The second/third stage separation is a cold separation. The explosive bolts are unlocked firstly and then the small retro-rockets on the second stage are initiated to generate separation force.

- **<u>Fairing Jettisoning:</u>** During the payload fairing separation, the explosive bolts connecting the fairing and the third stage unlocked firstly and then all the pyrotechnics connecting the two fairing shells are ignited, and the fairing separated longitudinally. The fairing turn outward around the hinges under the spring force.

- **<u>SC/LV Separation:</u>** The SC is bound together with the launch vehicle through clampband. After separation, the SC is pushed away from the LV by the springs.

2.3.9 Auxiliary System

The auxiliary system works before the launch vehicle lift-off, which includes ground monitoring and measuring units such as the propellant loading level and temperature, air-conditioner to fairing and water-proof measure, etc.

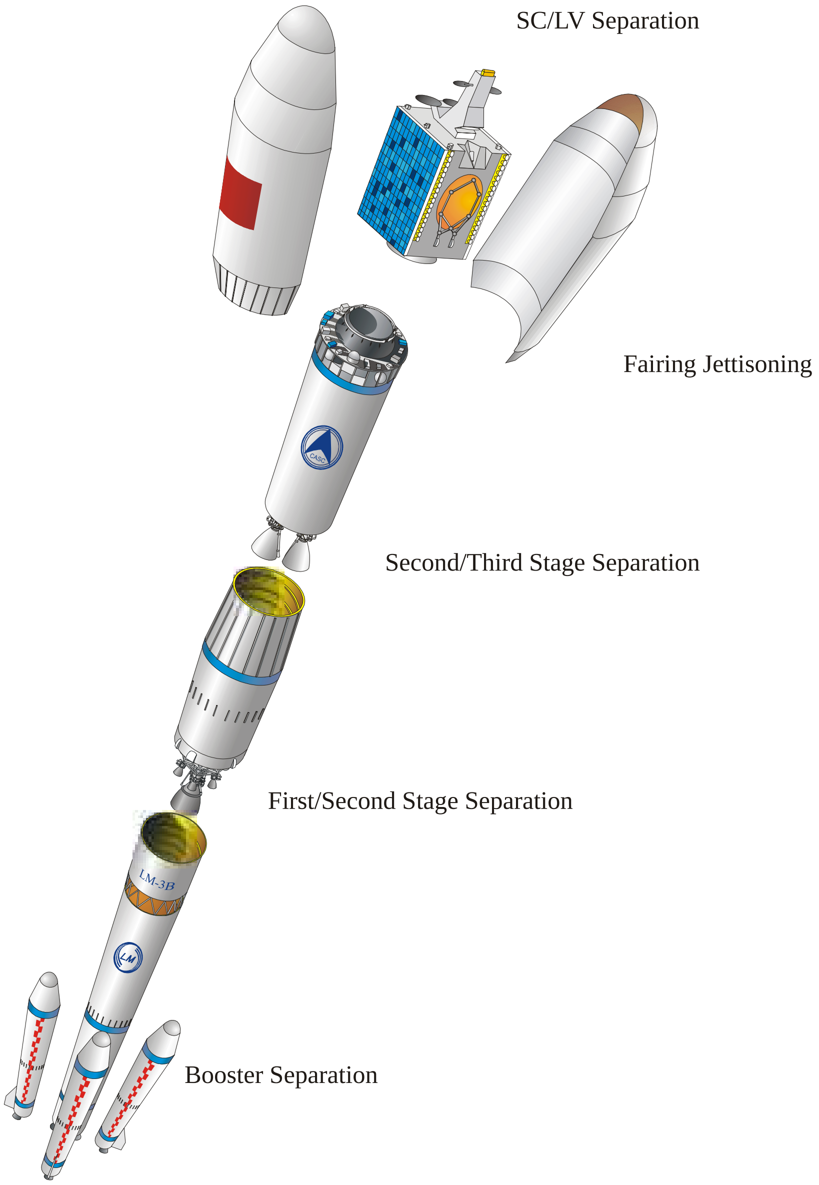


Figure 2-10 LM-3B Separation Events

2.4 Definition of Coordinate Systems and Attitude

The Launch Vehicle (LV) Coordinate System OXYZ origins at the LV's instantaneous mass center, i.e. the integrated mass center of SC/LV combination including adapter, propellants and payload fairing, etc if applicable. The OX coincides with the longitudinal axis of the launch vehicle. The OY is perpendicular to axis OX and lies inside the launching plane 180° away to the launching azimuth. The OX, OY and OZ form a right-handed orthogonal system.

The flight attitude of the launch vehicle axes is defined in **Figure 2-11**. Satellite manufacturer will define the SC Coordinate System. The relationship or clocking orientation between the LV and SC systems will be determined through the technical coordination for the specific projects.

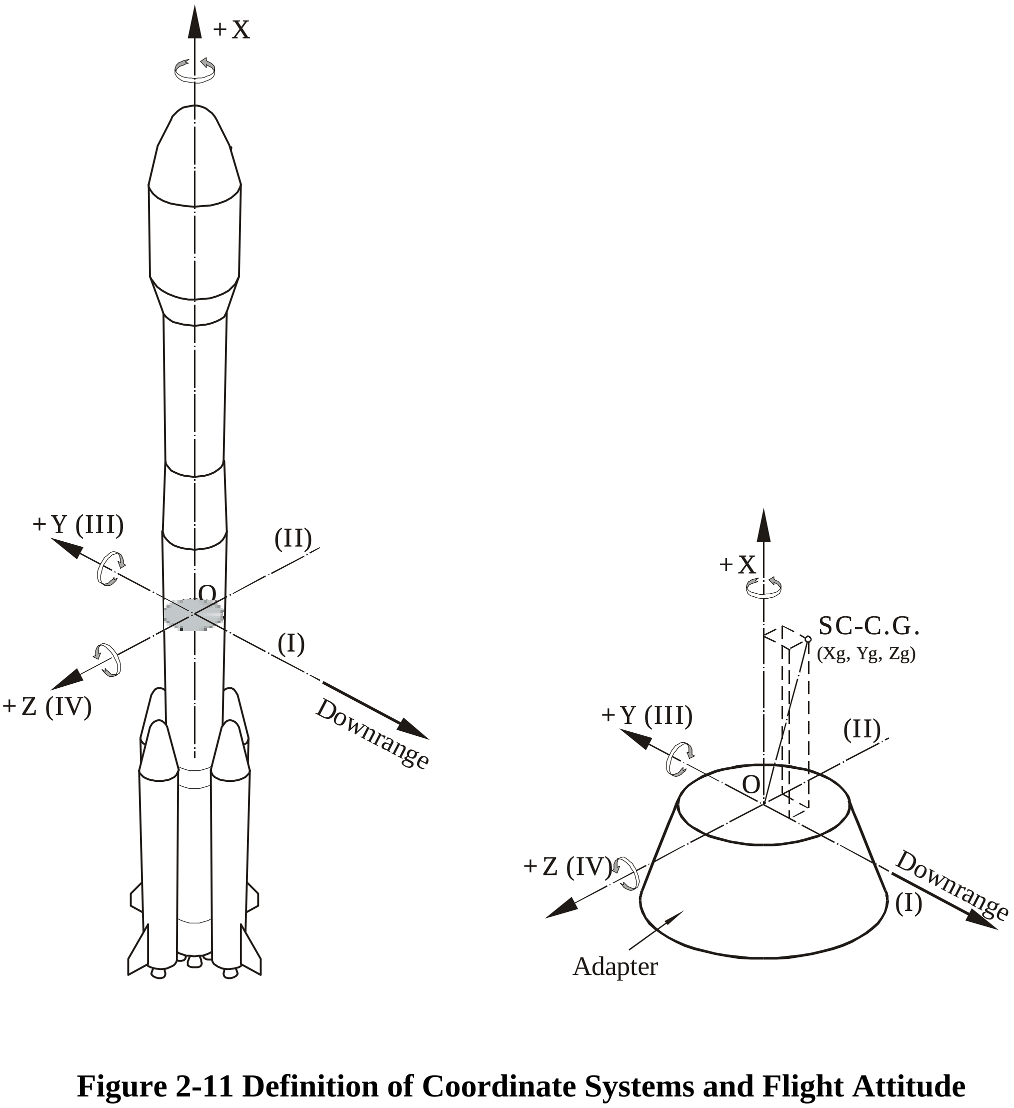


Figure 2-11 Definition of Coordinate Systems and Flight Attitude

2.5 Missions To Be Performed by LM-3B

LM-3B is a powerful and versatile rocket, which is able to perform the following missions.

- To send payloads into geo-synchronous transfer orbit (GTO). This is the primary usage of LM-3B and its design objectives. Following the separation from LM-3B, the SC will transfer from GTO to Geo-synchronous Orbit (GEO). GEO is the working orbit, on which the SC has the same orbital period as the rotation period of the Earth, namely about 24 hours, and the orbit plane coincides with the equator plane; See **Figure 2-12**.
- To inject payloads into low earth orbit (LEO) below mean altitude of 2000km;
- To project payloads into sun synchronous orbits (SSO). SSO plane is along with the rotation direction of the Earth rotation axis or points to the earth rotation around the Sun. The angular velocity of the SC is equal to the average angular velocity of the Earth around the Sun;
- To launch spaceprobes beyond the earth gravitational field (Escape Missions).

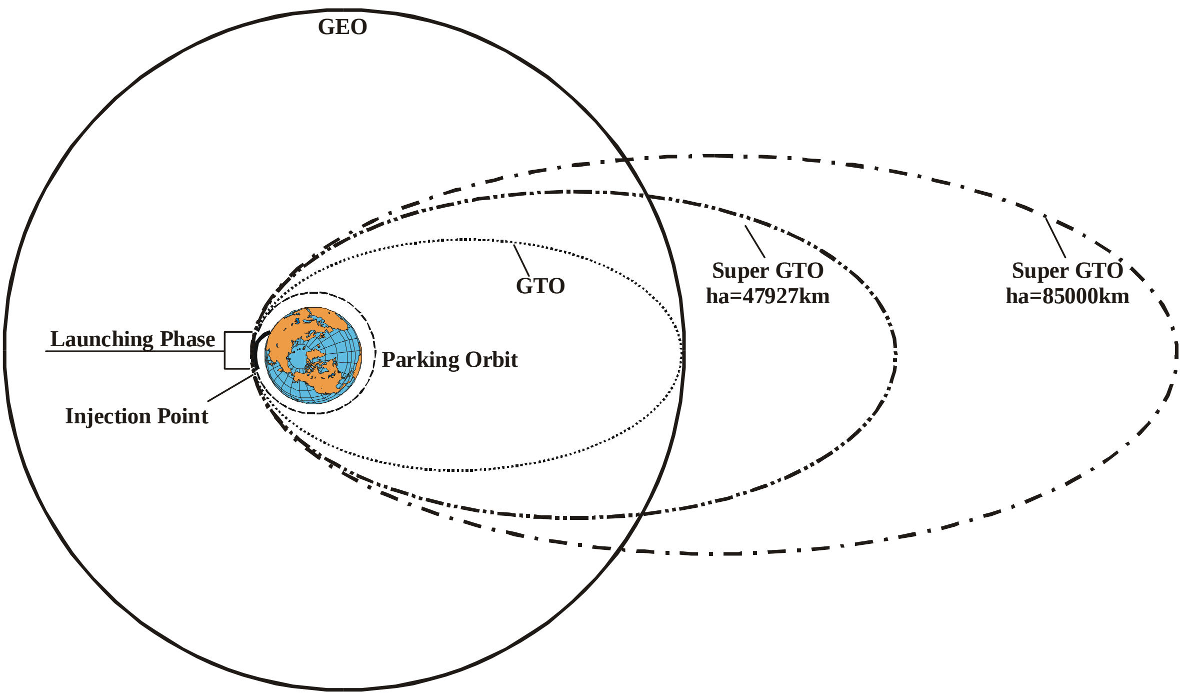


Figure 2-12 Launching Trajectory

2.6 Satellites Launched by LM-3B

Till July 18, 1998, LM-3B has launched five payloads from different manufacturers in the world. The successes of the missions indicate that LM-3B is compatible with all the commercial satellites in the launch service market. **Table 2-2** lists the payloads and launch requirements.

Table 2-2 Satellites Launched by LM-3B

Flight No.		1	2	3	4	5
Payload		Intelsat-708	MABUHAY	Apstar-IIR	ChinaStar-1	SINOSAT
Builder		SS/Loral	SS/Loral	SS/Loral	LMCO	Aerospatiale
Platform		FS1300	FS1300	FS1300	A2100	SpaceBus3000
Launch Date		02/15/96	08/20/97	10/17/97	05/30/98	07/18/98
Mass		4593.7	3775.1	3746	2916.8	2832
Required Injection Data	i	24.5	24.5	24.5	19	24.5
	Hp	200	200	200	600	200
	Ha	35786	47924	47924	35786	85000

See **Figure 2-13**.

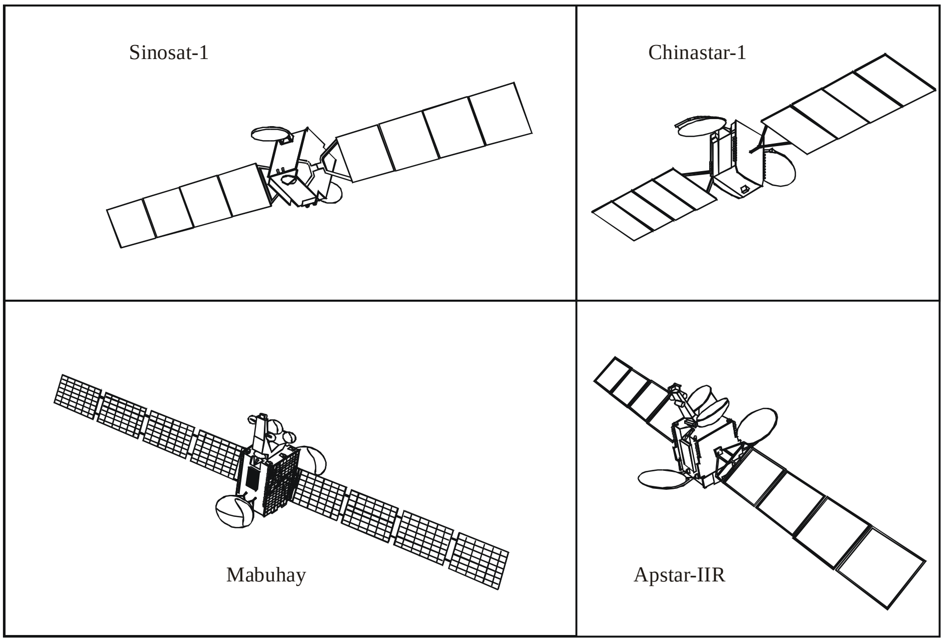


Figure 2-13 Satellites Launched by LM-3B

CHAPTER 3

PERFORMANCE

3.1 Introduction

The LM-3B performance figures given in this chapter are based on the following assumptions:

- Launching from XSLC (Xichang Satellite Launch Center, Sichuan Province, China), taking into account the relevant range safety limitations and ground tracking requirements;
- Initial launch azimuth being 97.5°;
- Mass of the payload adapter and the separation system not included in the payload mass;
- The third stage of LM-3B launch vehicle carrying sufficient propellant to reach the intended orbit with a probability of no less than 99.73%;
- At fairing jettisoning, the aerodynamic flux being less than 1135 W/m^2;
- Orbital altitude values given with respect to a spherical earth with a radius of 6378 km.

3.2 Mission Description

3.2.1 Standard Geo-synchronous Transfer Orbit (GTO)

LM-3B is mainly used for conducting GTO mission. The standard GTO is recommended to the User. LM-3B launches Spacecraft (SC) into the standard GTO with following injection parameters from XSLC.

Perigee Altitude	Hp	=200 km
Apogee Altitude	Ha	=35954 km
Inclination	i	=28.5°
Perigee Argument	ω	=178°

✧ The above data are the parameters of the instant orbit that SC runs on when SC/LV separation takes place. *Ha* is equivalent to true altitude of 35786 km at first apogee, due to perturbation caused by Earth oblateness.

3.2.2 Flight Sequence

The typical flight sequence of LM-3B is shown in **Table 3-1** and **Figure 3-1**.

Table 3-1 Flight Sequence

Events	**Flight Time (s)**
Liftoff	0.000
Pitch Over	10.000
Boosters Shutdown	127.211
Boosters Separation	128.711
Stage-1 Shutdown	144.680
Stage-1/Stage-2 Separation	146.180
Fairing Jettisoning	215.180
Stage-2 Main Engine Shutdown	325.450
Stage-2 Vernier Engine Shutdown	330.450
Stage-2/Stage-3 Separation, and Stage-3 First Start	331.450
Stage-3 First Shutdown	615.677
Coast Phase Beginning	619.177
Coast Phase Ending, and Stage-3 Second Start	1258.424
Stage-3 Second Shutdown, Velocity Adjustment Beginning	1437.673
Velocity Adjustment Ending	1457.673
SC/LV Separation	1537.673

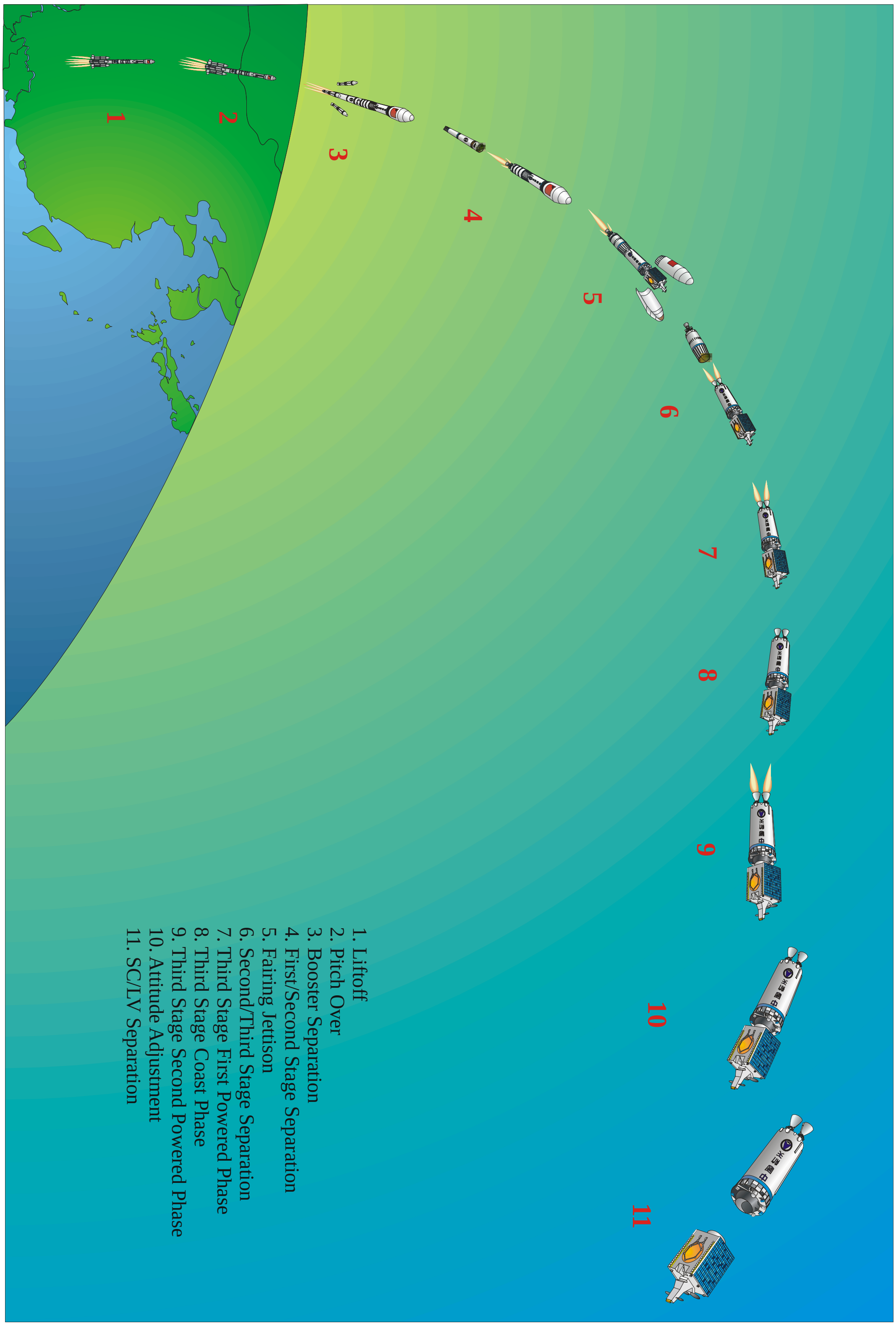


Figure 3-1 LM-3B Flight Sequence

3-3

3.2.3 Characteristic Parameters of Typical Trajectory

The characteristic parameters of typical trajectory are shown in **Table 3-2**.The flight acceleration, velocity, Mach numbers and altitude vs. time are shown in **Figure 3-2a** and **Figure 3-2b**.

Table 3-2 Characteristic Parameters of Typical Trajectory

Event	**Relative Velocity (m/s)**	**Flight Altitude (km)**	**Ground Distance (km)**	**Ballistic Inclination (°)**	**SC projection Latitude (°)**	**SC projection Longitude(°)**
Liftoff	0.000	1.825	0.000	90.000	28.246	102.027
Booster Shutdown	2242.964	53.944	68.716	24.804	28.161	102.720
Boosters Separation	2282.754	55.360	71.777	24.509	28.157	102.751
Stage-1 Shutdown	2735.779	70.955	108.172	21.711	28.110	103.117
Stage-1/Stage-2 Separation	2740.492	72.466	111.953	21.480	28.105	103.155
Fairing Jettisoning	3317.843	131.512	307.187	12.479	17.829	105.115
Stage-2 Main Engine Shutdown	5148.022	190.261	744.771	4.334	27.090	109.464
Stage-2 Vernier Engine Shutdown	5164.813	192.145	769.756	4.096	27.043	109.711
Stage-2/Stage-3 Separation	5164.493	192.509	774.756	4.047	27.034	109.760
Stage-3 First Shutdown	7358.010	204.340	2466.220	-0.003	22.800	125.868
Coast Phase Beginning	7362.949	204.322	2491.177	0.006	22.724	126.096
Stage-3 Second Start	7373.724	200.109	7061.323	-0.033	4.363	164.098
Stage-3 Second Shutdown	9792.292	219.913	8531.117	3.025	-2.348	175.503
Terminal Velocity Adjustment Ending	9791.531	231.622	8719.973	3.806	-3.195	176.979
SC/LV Separation	9724.207	304.579	9466.105	6.879	-6.514	182.839

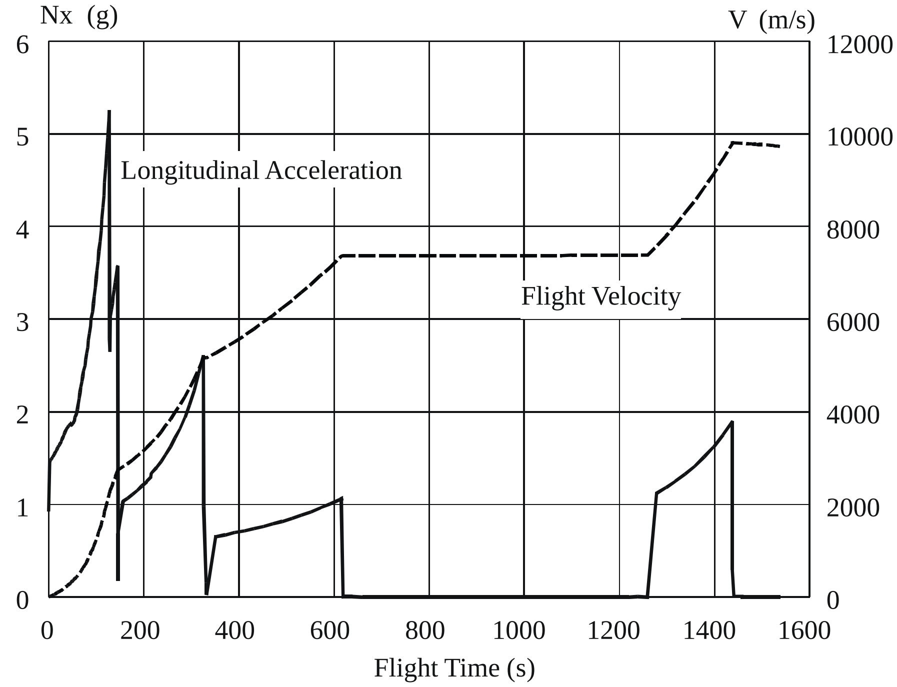


Figure 3-2a LV Flight Acceleration and Flight Velocity vs. Flight Time

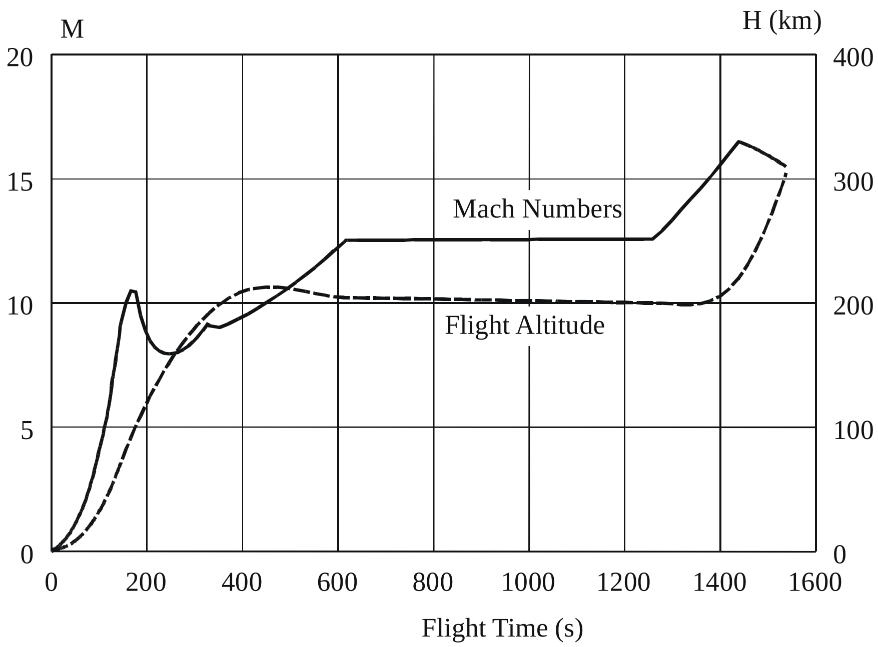


Figure 3-2b LV Flight Altitude and Mach Numbers vs. Flight Time

3.3 Standard Launch Capacities

3.3.1 Basic Information on XSLC

LM-3B launch vehicle conducts GTO mission from Xichang Satellite Launch Center (XSLC), which is located in Sichuan Province, China. LM-3B uses Launch Pad #2 of XSLC. The geographic coordinates are listed as follows:

Latitude:	28.2 °N
Longitude:	102.02 °E
Elevation:	1826 m

Launch Direction is shown in **Figure 3-3**.

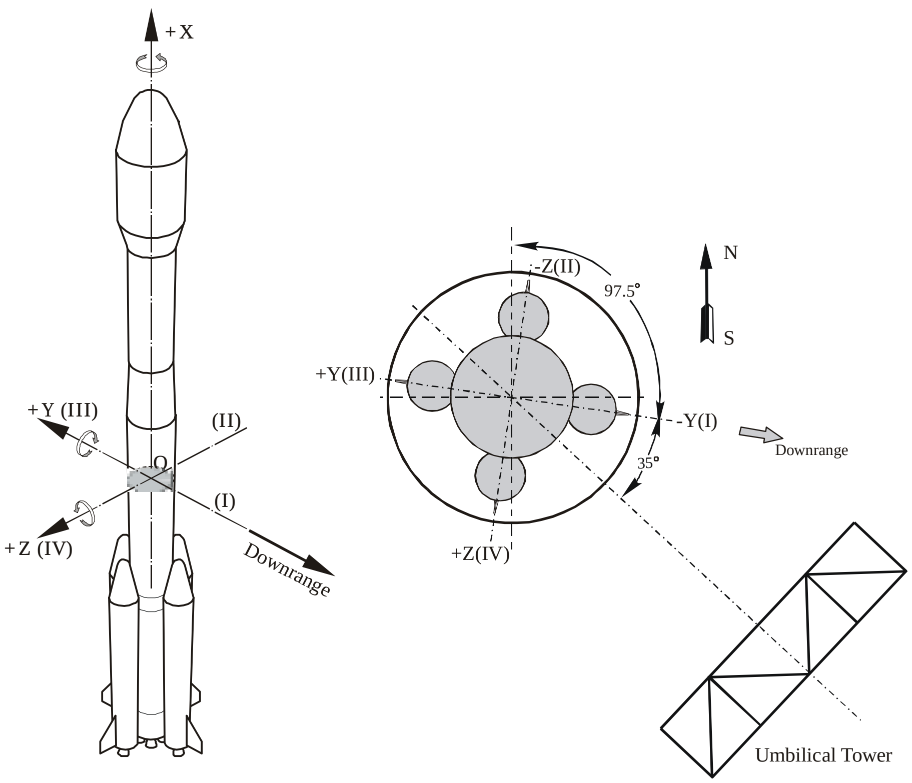


Figure 3-3 Launch Direction

3.3.2 Launch Capacity to Standard GTO

The LM-3B Standard GTO is defined in **Paragraph 3.2.1**, and see also **Figure 2-12** of **Chapter 2**.

LM-3B provides two kinds of fairing encapsulation methods: Encapsulation-on-pad and Encapsulation-in-BS3. Refer to **Chapter 8**. Therefore, LM-3B has different launch capacities corresponding to different encapsulation methods.

The launch capabilities corresponding to different Encapsulation Methods are listed as follows:

Encapsulation-on-pad: 5100 kg (recommended)

Encapsulation-in-BS3: 5000 kg

LM-3B provides 4 different types of fairings with different diameters (Φ4m and Φ4.2m) and different encapsulation methods. Refer to **Chapter 4**. For same encapsulation methods, the launch capacities will remain unchanged, because the structure mass difference between the Φ4m fairing and Φ4.2m fairing can be ignored.

If there is no special explanation, the standard GTO launch capacity (5100kg) stated in this User's Manual is corresponding to the LV with Encapsulation-on-pad method.

3.3.3 Mission Performance

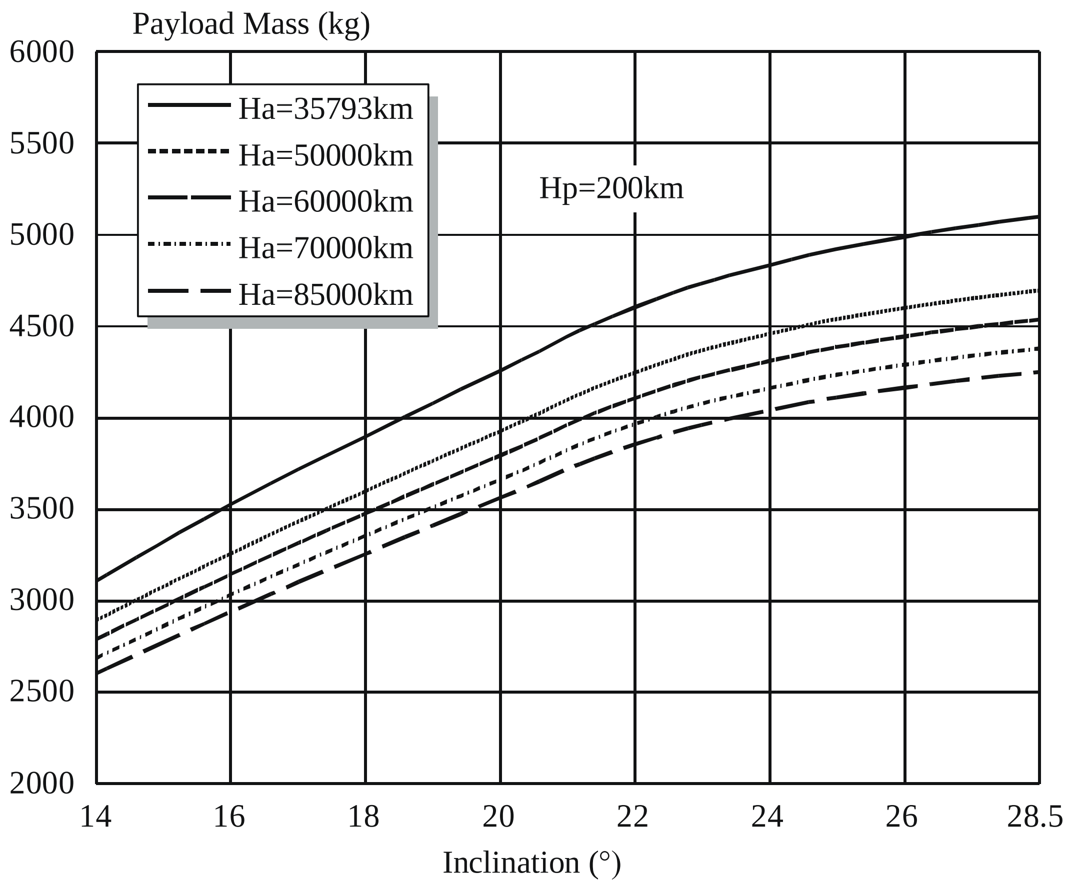
LM-3B can conduct various missions. The launch capacities for the four typical missions are introduced as follows, in which GTO mission is the prime mission.

- **GTO Mission**

The launch capacity of LM-3B for standard GTO mission is 5100kg (by Encapsulation-on-pad) and 5000kg (by Encapsulation-in-BS3). The different GTO launch capabilities vs. different inclinations and apogee altitudes are shown in **Figure 3-4** and **Figure 3-5**.

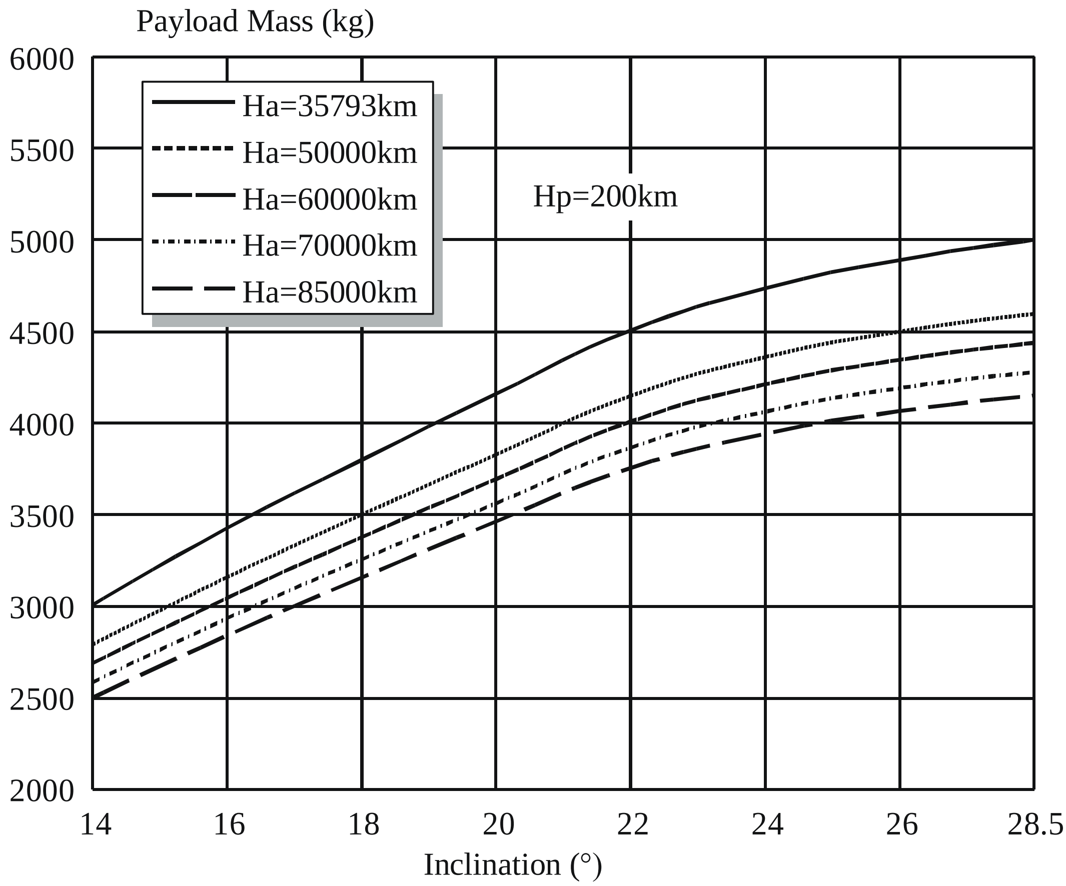
- **Low-Earth Orbit (LEO) Mission**

The Launch Capacity of LM-3B for LEO Mission (h=200 km, i=28.5°) is 11,200 kg.



Inclination (°)	Apogee Altitude (km)				
i	Ha=35793	Ha=50000	Ha=60000	Ha=70000	Ha=85000
14	3109	2893	2790	2687	2603
16	3527	3259	3146	3034	2941
18	3899	3600	3478	3357	3257
20	4259	3928	3795	3663	3564
22	4605	4248	4108	3967	3855
24	4835	4460	4311	4162	4042
26	4990	4600	4445	4291	4165
28.5	5100	4696	4537	4378	4251

Figure 3-4 LM-3B GTO Launch Performance
(Encapsulation-on-Pad)



Inclination (°)	Apogee Altitude (km)				
i	Ha=35793	Ha=50000	Ha=60000	Ha=70000	Ha=85000
14	3009	2793	2690	2587	2503
16	3427	3159	3046	2934	2841
18	3799	3500	3378	3257	3157
20	4159	3828	3695	3563	3464
22	4505	4148	4008	3867	3755
24	4735	4360	4211	4062	3942
26	4890	4500	4345	4191	4065
28.5	5000	4596	4437	4278	4151

Figure 3-5 LM-3B GTO Launch Performance
(Encapsulation-in-BS3)

- **Sun-Synchronous Orbit (SSO) Mission**

LM-3B is capable of sending SC to SSO directly. The launch performance of LM-3B for SSO Mission is shown in **Figure 3-6**.

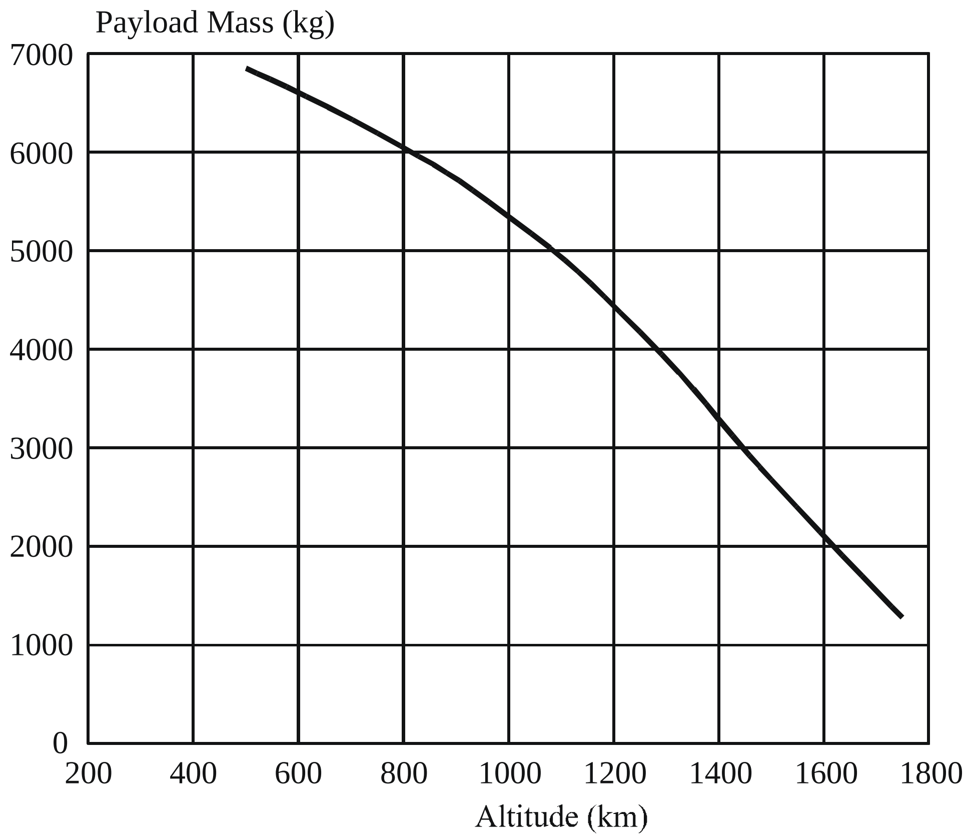


Figure 3-6 LM-3B SSO Launch Performance

- **Earth-Escape Mission**

The Earth-Escape Performance of LM-3B is shown in **Figure 3-7**. C3 is the square of the velocity at unlimited distance with unit of km^2/s^2.

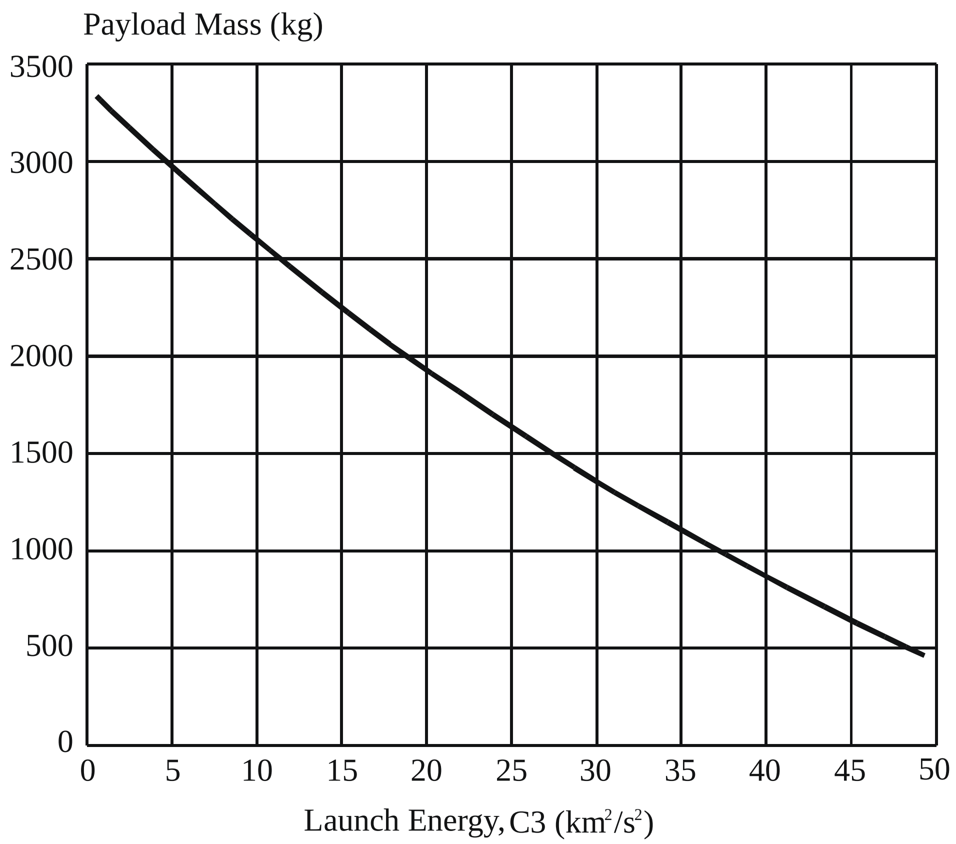


Figure 3-7 LM-3B Earth-Escape Mission Performance

3.4 Optimization Analysis on Special Missions

3.4.1 Ways to Enhance Mission Performance

3.4.1.1 Minimum Residual Shutdown (MRS)

The launch capacities given in **Paragraph 3.3** are gotten under condition of Commanded Shutdown (CS). Commanded Shutdown means, the third stage of LM-3B launch vehicle carries sufficient propellant allowing the payload to enter the predetermined orbit with probability no less than 99.73%. Commanded Shutdown is the main shutdown method that LM-3B adopts.

If the reserved propellants are reduced, the propellants will be used adequately, and the launch capability will be increased. However, the commanded shutdown probability will also be lower. The relationship between commanded shutdown probability and corresponding increased launch capability are shown in the following table.

Table 3-3 Relationship between Shutdown Probability and Launch Capability

Commanded Shutdown Probability	Increased Launch Capability (kg)
99.7%	0
95.5%	33
68.3%	67
50%	78

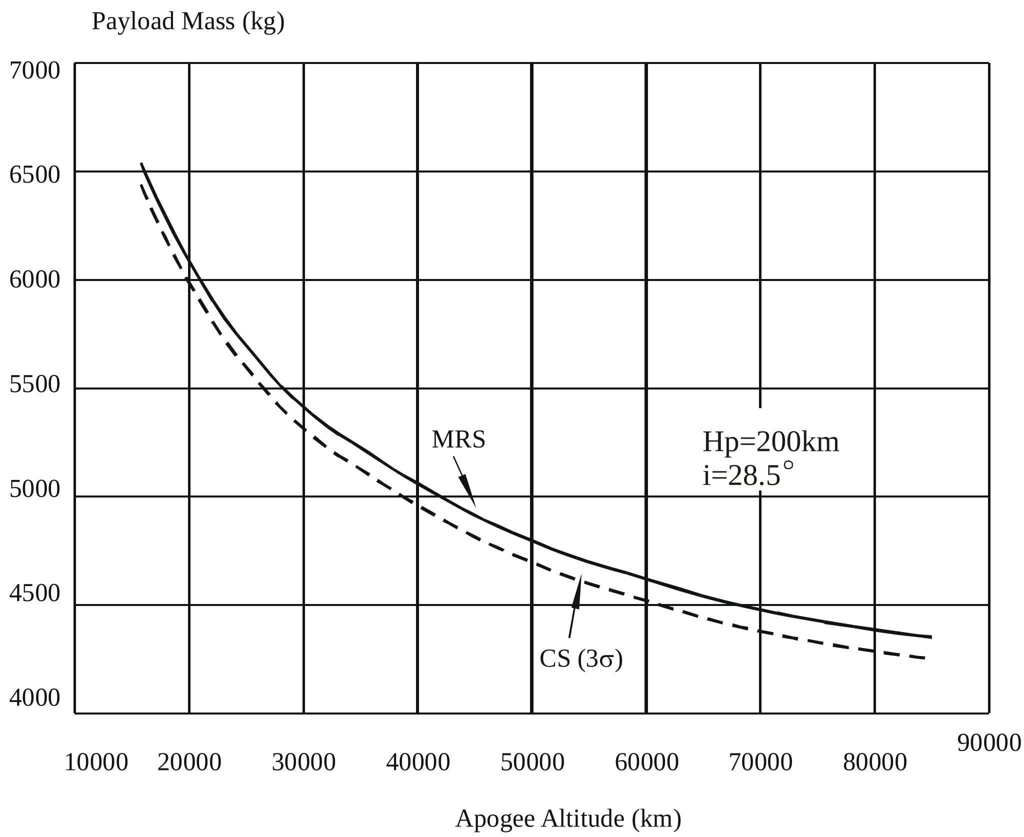
Minimum Residual Shutdown (MRS) means, the propellants of third stage is burned to minimum residuals for a significant increase in nominal performance capability. MRS is the designed capability of LM-3B. It is applicable and qualified though the LM-3B/Mabuhay mission.

The third stage of LM-3B is equipped with Propellant Utilization System (PUS). The deviation of LOX/LH2 mixture ratio can be compensated by PUS. The propellants can be consumed adequately, and the LV is under control and reliable. In this case, if the SC carries liquid propellants, it can flexibly execute orbit maneuver according to ground tracking data after SC/LV separation. Therefore, the third stage of LM-3B may be burned to minimum residuals to provide more LV energy to SC and to reduce the maneuver velocity of SC from GTO to GEO.

By using MRS and CS method, the different launch capacities of LM-3B with Encapsulation-on-pad configuration for GTO (i=28.5°) mission are shown in **Figure 3-8**.

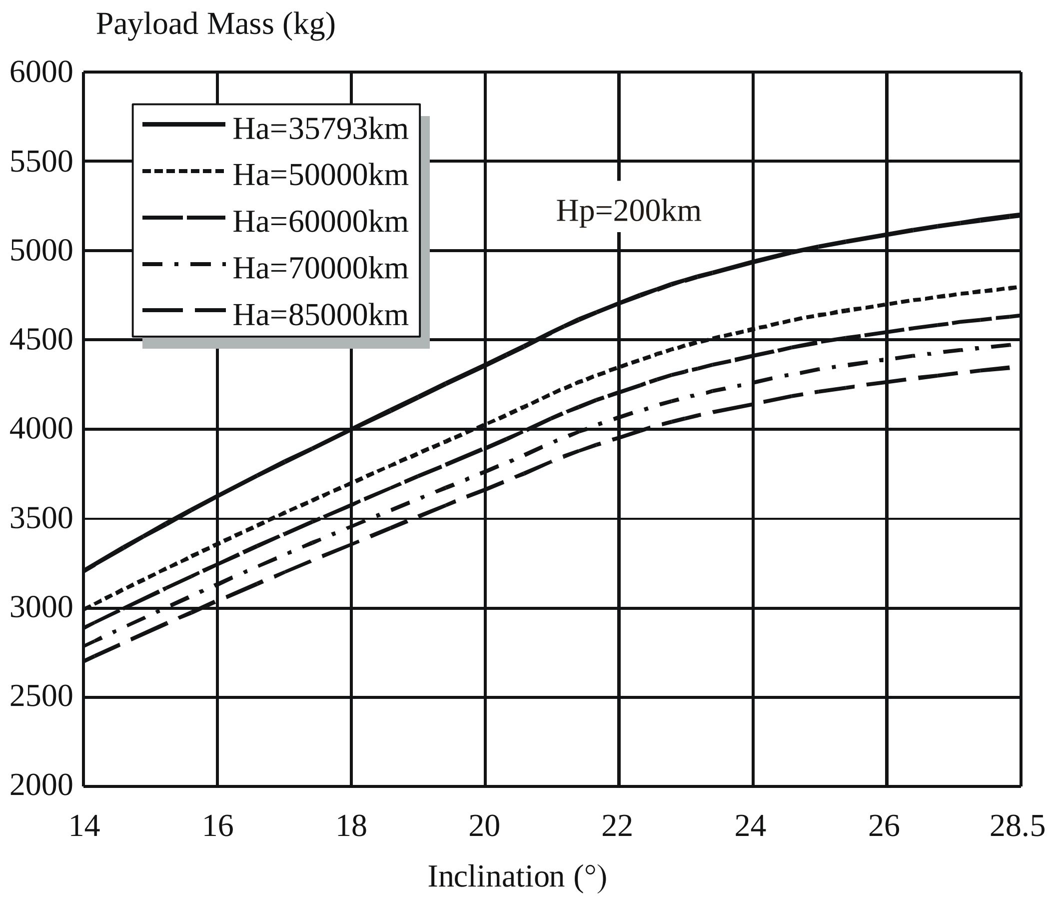
Under the condition of adopting MRS method, the launch capacity of LM-3B with Encapsulation-on-pad configuration for standard GTO mission is 5200kg, see **Figure 3-9**, and the launch capacity of LM-3B with Encapsulation-in-BS3 configuration is 5100kg, see **Figure 3-10**.

Under the condition of adopting MRS method, LM-3B provides users with more LV launch capacity. However, the orbital injection accuracy should be tolerated. If user is interested in this shutdown method, please contact CALT.



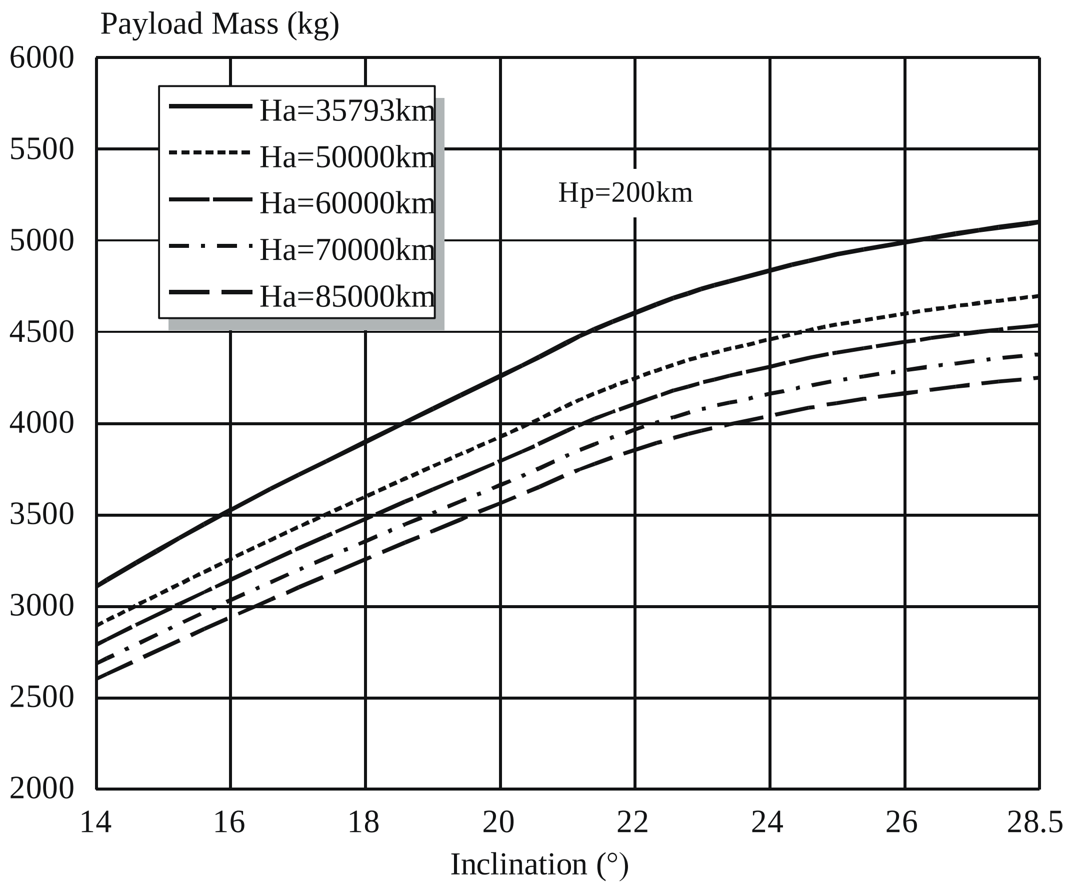
Apogee Altitude (km)	**SC Mass (kg)**	
Ha	CS (3σ)	MRS
15786	6440	6540
20786	5917	6017
25786	5547	5647
30786	5280	5380
35786	5100	5200
40000	4960	5060
50000	4696	4796
60000	4520	4620
70000	4378	4478
85000	4251	4351

Figure 3-8 Launch Capacities under Different Shutdown Method (Encapsulation-on-pad)



Inclination (°)	Apogee (km)				
i	Ha=35793	Ha=50000	Ha=60000	Ha=70000	Ha=85000
14	3209	2993	2890	2787	2703
16	3627	3359	3246	3134	3041
18	3999	3700	3578	3457	3357
20	4359	4028	3895	3763	3664
22	4705	4348	4208	4067	3955
24	4935	4560	4411	4262	4142
26	5090	4700	4545	4391	4265
28.5	5200	4796	4637	4478	4351

Figure 3-9 LM-3B GTO Mission Launch Capacity Under the Condition of MRS (Encapsulation-on-pad)



Inclination (°)	Apogee Altitude (km)				
i	Ha=35793	Ha=50000	Ha=60000	Ha=70000	Ha=85000
14	3109	2893	2790	2687	2603
16	3527	3259	3146	3034	2941
18	3899	3600	3478	3357	3257
20	4259	3928	3795	3663	3564
22	4605	4248	4108	3967	3855
24	4835	4460	4311	4162	4042
26	4990	4600	4445	4291	4165
28.5	5100	4696	4537	4378	4251

Figure 3-10 LM-3B GTO Mission Launch Capacity Under the Condition of MRS (Encapsulation-in-BS3)

3.4.1.2 Super GTO Performance

For the same launch mission, different launch trajectories can be selected. For example, one method is to decrease the inclination by keeping apogee altitude unchanged, and the other method is to increase the apogee altitude i.e. "Super GTO launching method".

Because the velocity of SC is relative low when the SC travels to the apogee of Super GTO, it is easier for SC to maneuver to 0°-inclination orbit. In this case, the propellants in SC are consumed less, and the lifetime of SC is longer. LM-3B has successfully launched Mabuhay, Apstar-IIR, ChinaStar-1 satellites to Super GTO.

When the SC mass is relative light, the remaining launch capacity of LM-3B can be used either for increasing apogee altitude or for reducing inclination. The injection accuracy for such a mission is different from that of Standard GTO mission.

The LM-3B launch capacities for Super GTO mission are shown in **Figure 3-4**, **Figure 3-5, Figure 3- 9 and Figure 3-10**.

3.4.2 Special Mission Requirements

The prime task of LM-3B is to perform standard GTO mission. However, LM-3B can be also used for special missions according to user's requirement, such as Super GTO mission, SSO mission, LEO mission or lunar mission, Martian mission etc.

LM-3B is capable of Dual-launch and piggyback for GTO mission and multiple-launch for LEO mission.

3.5 Injection Accuracy

The injection accuracy for Standard GTO mission is shown in **Table 3-4a**.

Table 3-4a Injection Accuracy for Standard GTO Mission (1σ)

Symbol	Parameters	Deviation
Δa	Semi-major Axis	40 km
Δi	Inclination	0.07°
Δω	Perigee Argument	0.20°
ΔΩ	Right Ascension of Ascending Node	0.20°*
ΔHp	Perigee Altitude	10 km

Note: * the error of launch time is not considered in determining ΔΩ.

The covariance matrix of injection for Injection Accuracy of Standard GTO mission is shown **Table 3-4b**:

Table 3-4b covariance matrix of injection for Standard GTO mission

	a (Semi-major axis)	e (eccentricity)	i (inclination)	ω (argument of perigee)	Ω (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

The injection accuracy of two Super GTO missions conducted by LM-3B are introduced as example:

Super GTO Mission 1: *i*=24.5°, *hp*=200km, *ha*=47924km.

Table 3-5a Injection Accuracy for Super GTO Mission (*ha*=47924km) (1σ)

Symbol	Parameters	Deviation
Δa	Semi-major Axis	63 km
Δi	Inclination	0.071°
Δω	Perigee Argument	0.085°
ΔΩ	Right Ascension of Ascending Node	0.19°*
ΔHp	Perigee Altitude	10 km

Note: * the error of launch time is not considered in determining ΔΩ.

Table 3-5b Covariance Matrix of injection for Super GTO Mission (*ha*=47924km)

	a	e	i	ω	Ω
a	3969	0.0281	3.067	3.13	-1.06
e		0.383E-6	-0.603	0.21241E-4	0.2667E-4
i			0.00504	0.230E-2	-0.24602E-2
ω				0.723E-2	0.46666E-2
Ω					0.361E-1

Super GTO Mission 2: i=24.5°, hp=200km, ha=85000km.

Table 3-6a Injection Accuracy for Super GTO Mission (*ha*=85000 km) (1σ)

Symbol	Parameters	Deviation
Δa	Semi-major Axis	252 km
Δi	Inclination	0.12°
Δω	Perigee Argument	0.13°
ΔΩ	Right Ascension of Ascending Node	0.20°*
ΔHp	Perigee Altitude	10 km

Note: * the error of launch time is not considered in determining ΔΩ.

Table 3-6b Covariance Matrix of injection for Super GTO Mission (ha=85000km)

	a	e	i	ω	Ω
a	63504	0.179	21.3	8.60	-3.94
e		8.02E-7	3.33E-5	4.03E-5	-0.591E-5
i			0.0144	5.07E-3	-4.96E-3
ω				0.0169	-0.92126E-2
Ω					0.04

3.6 Pointing Accuracy

3.6.1 Perigee Coordinate System Definition

During the period from 20 seconds after the third stage shutdown to SC/LV separation, the attitude control system on the third stage adjusts the pointing direction of the SC/LV stack to the pre-determined direction. It takes about 80 seconds to complete the attitude-adjustment operation. The pointing requirements are defined by the perigee coordinate system (U, V, and W). The user shall propose the pointing requirements. Before SC/LV separation, the attitude control system can maintain attitude errors of SC/LV stack less than 1°.

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

- The origin of the perigee coordinate system (O) is at the center of the earth,
- 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 system.

See **Figure 3-11**.

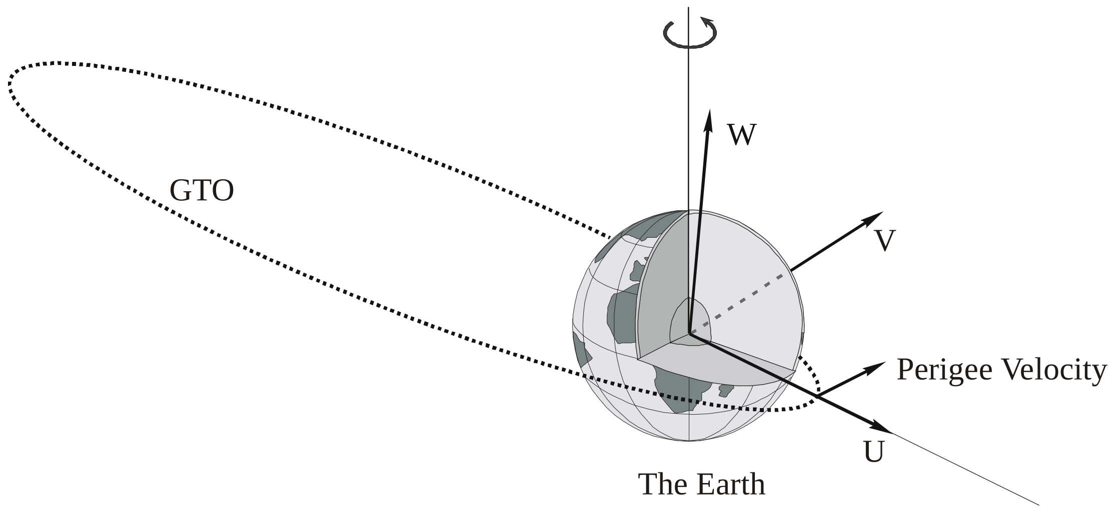


Figure 3-11 Perigee Coordinate System (OUVW)

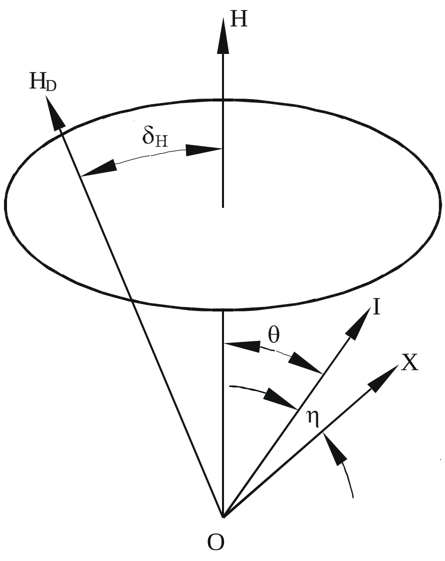
3.6.2 Separation Accuracy

- For the SC needs spin-up rate along LV longitude axis (the spin-up rate from 5 rpm to 10 rpm), the post-separation pointing parameters are as follows:
  If: lateral angular rate: $\omega<2.5°/s$
  Angular momentum pointing direction deviation: δ**H**$<8°$

- For the SC needs spin-up rate along SC lateral axis (the spin-up rate less than 3°/s), the post-separation pointing parameters are as follows:
  If: lateral angular rate: $\omega<0.7°/s$
  Angular momentum pointing direction deviation: δ**H**$<15°$

- For the SC doesn't need spin-up, the post-separation pointing parameters are as follows:
  If: lateral angular rate: ω <1°/s (Combined in two lateral main inertial axes)
  Instant deviation at geometry axis: $\delta x<3°$

See **Figure 3-12**.



H: Actual Angular Momentum;
H_D: Required Angular Momentum;
I: SC Primary Inertial Axis;
δ_H: Deviation of Angular Momentum;
X: SC Geometric Axis;
θ: Nutation Angle;
η: Dynamic Balance Angle;
O: Center of Gravity

Figure 3-12 Separation Accuracy Definition

3.7 Spin-up Accuracy

3.7.1 Longitudinal Spin-up Accuracy

The attitude-control system of the third stage can provide the SC with spin-up rate of up to 10 rpm along LV longitude axis.

For the SC with longitudinal spin-up rate of 10rpm, the spin-up accuracy can be controlled in the range of 0~0.6rpm.

3.7.2 Lateral Spin-up Accuracy

By using of separation springs, the SC/LV separation system can provide SC with lateral spin-up rate of up to 3°/s along later axis of the SC.

For the SC with lateral spin-up rate of 3°/s, the spin-up accuracy can be controlled in the range of 2.2±0.8 °/s.

3.8 Launch Windows

Because the third stage of LM-3B uses cryogenic LH_2 and LOX as propellants and the launch preparation is relative complicated, the SC is expected to have at least one launch window within each day of the launch. In general, each launch window should be longer than 45 min. If the requirements are not complied by the payload, the user can consult with CALT.

CHAPTER 4

PAYLOAD FAIRING

4.1 Fairing Introduction

4.1.1 Summary

The spacecraft is protected by a fairing that shields it from various interference from the atmosphere, which includes high-speed air-stream, aerodynamic loads, aerodynamic heating and acoustic noises, etc., while the LV ascending through the atmosphere. The fairing provides SC with good environment.

The aerodynamic heating is absorbed or isolated by the fairing. The temperature inside the fairing is controlled under the allowable range. The acoustic noises generated by air-stream and LV engines are declined to the allowable level for the SC by the fairing.

The fairing is jettisoned when LM-3B launch vehicle flies out of the atmosphere. The exact time of fairing jettisoning is determined by the requirement that aerodynamic heat flux at fairing jettisoning is lower than 1135 W/m^2.

22 types of tests have been performed during LM-3B fairing development, including fairing wind-tunnel test, thermal test, acoustic test, separation test, model survey test and strength test, etc.

LM-3B provides four types of fairing: Fairing 4000F, Fairing 4000Z, Fairing 4200F, and Fairing 4200Z. (See **Figure 4-1** and **Figure 4-2**) These fairings are introduced in **Table 4-1**.

Table 4-1 LM-3B Fairing Types

Name	Description
4000F	Fairing Diameter 4000mm. Fairing is encapsulated on the launch pad. (Encapsulation-on-pad)
4000Z	Fairing Diameter 4000mm. Fairing is encapsulated in BS3. (Encapsulation-in-BS3)
4200F	Fairing Diameter 4200mm. Fairing is encapsulated on the launch pad. (Encapsulation-on-pad)
4200Z	Fairing Diameter 4200mm. Fairing is encapsulated in BS3. (Encapsulation-in-BS3)

The fairing encapsulation procedures are introduced in **Chapter 8**.

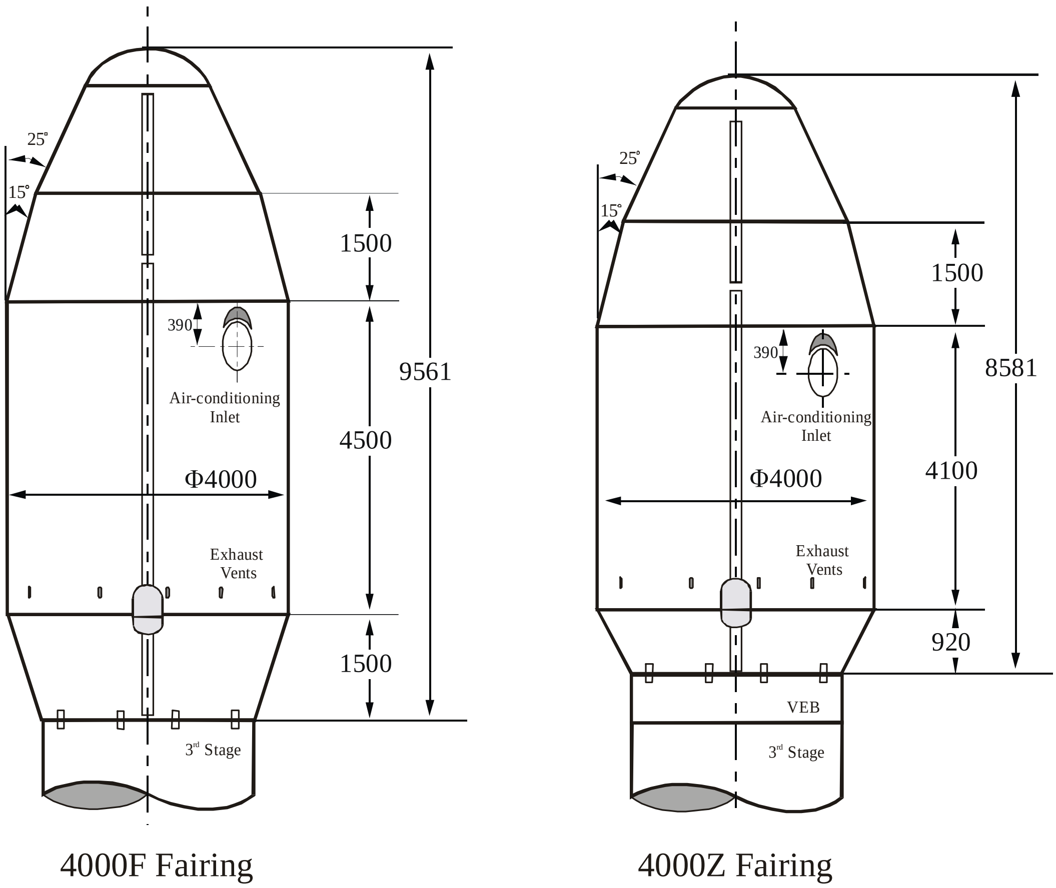


Figure 4-1 Fairing Configurations of 4000F and 4000Z

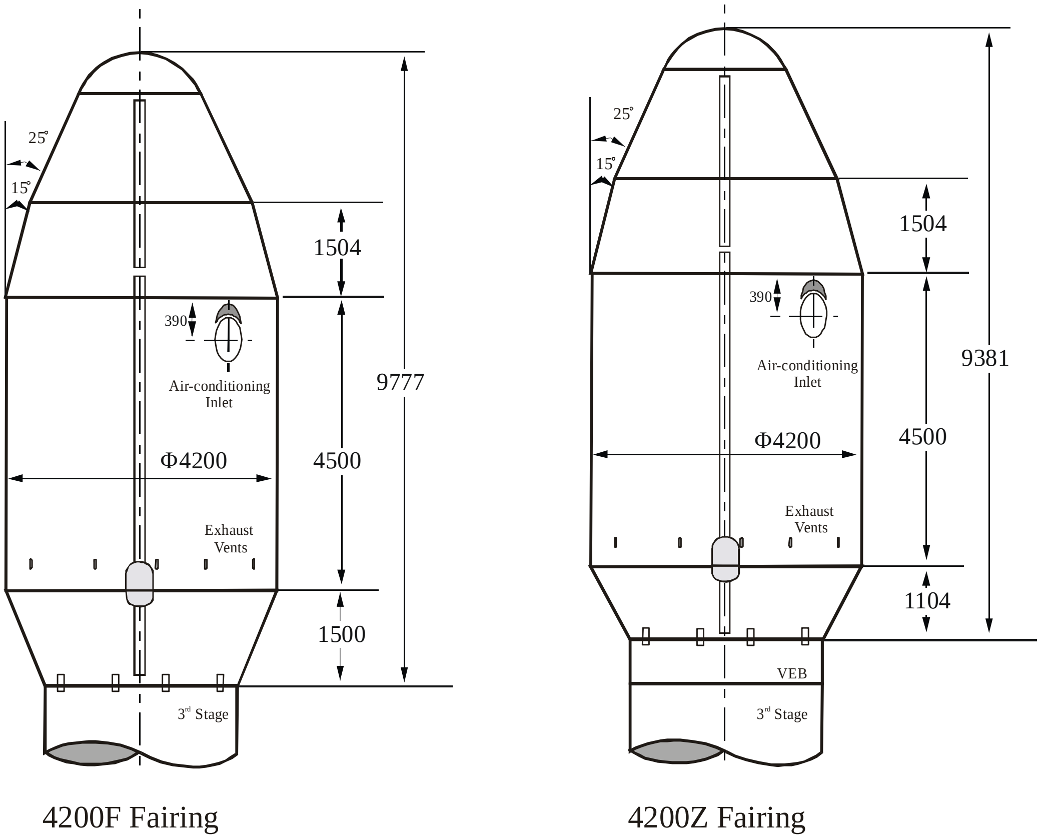


Figure 4-2 Fairing Configurations of 4200F and 4200Z

4.1.2 4000F Fairing

The outer diameter of Fairing 4000F is 4000mm, and its height is 9561mm. It will be encapsulated on the launch pad. The configuration is shown in **Figure 4-1**. The envelope is shown in **Figure 4-3a** and **Figure 4-3b**. The fairing supports 937B, 1194, 1194A and 1666 interfaces.

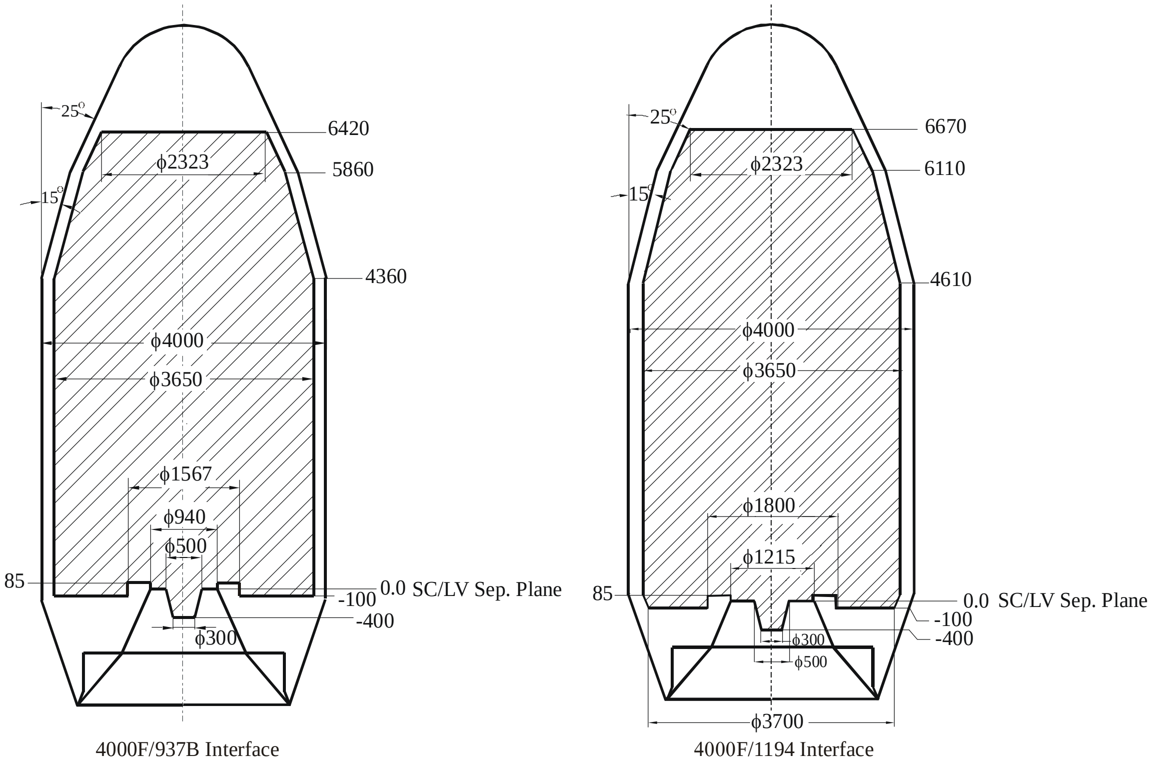


Figure 4-3a 4000F Fairing Envelope (937B Interface and 1194 Interface)

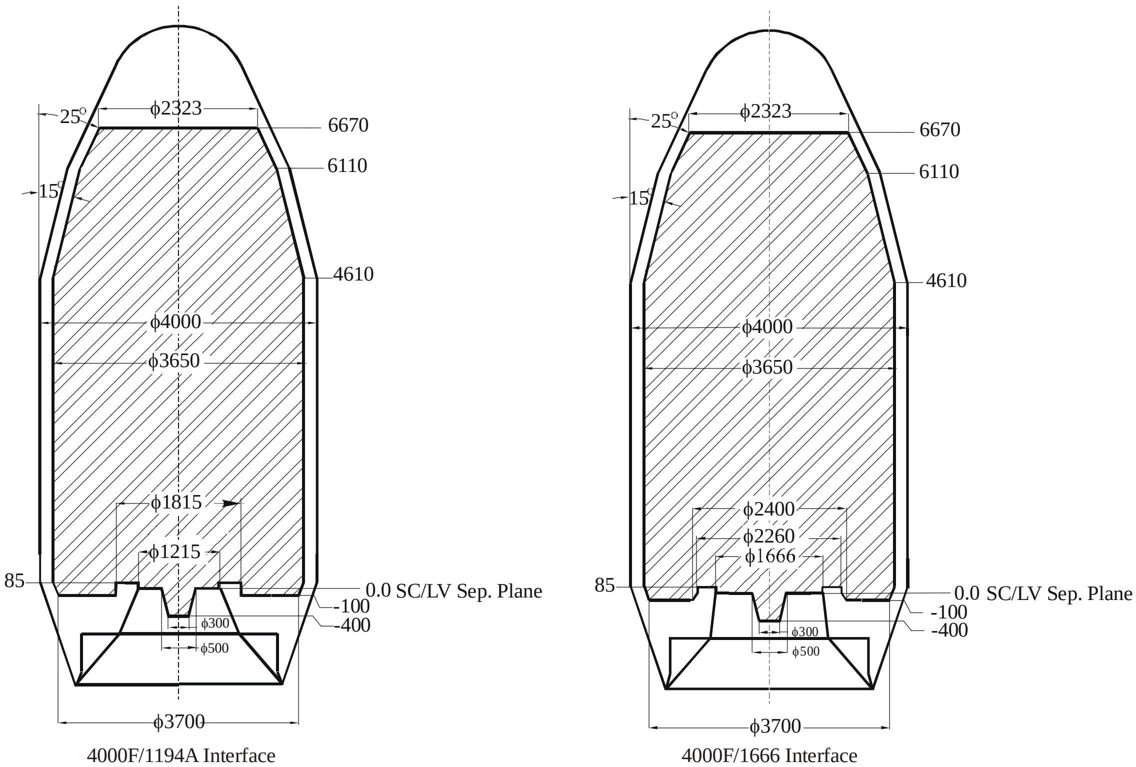


Figure 4-3b 4000F Fairing Envelope (1194A Interface and 1666 Interface)

4.1.3 4000Z Fairing

The outer diameter of Fairing 4000Z is 4000mm, and its height is 8981mm. It will be encapsulated in BS3. The configuration is shown in **Figure 4-1**, and the envelope is shown in **Figure 4-4**. The fairing supports 1194A and 1666 interfaces.

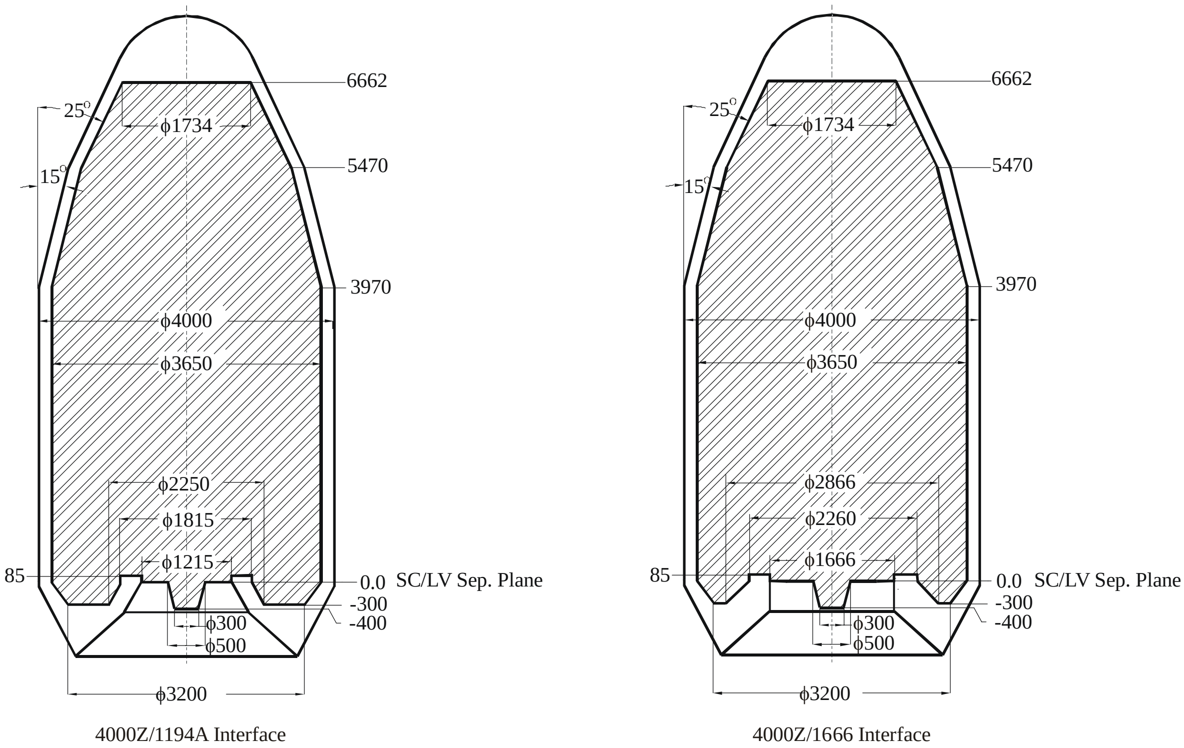


Figure 4-4 4000Z Fairing Envelope (1194A Interface and 1666 Interface)

4.1.4 4200F Fairing

The outer diameter of Fairing 4200F is 4200mm, and its height is 9777mm. It will be encapsulated on the launch pad. The configuration is shown in **Figure 4-2**, and envelope is shown in **Figure 4-5**. The fairing supports 1194A and 1666 interfaces.

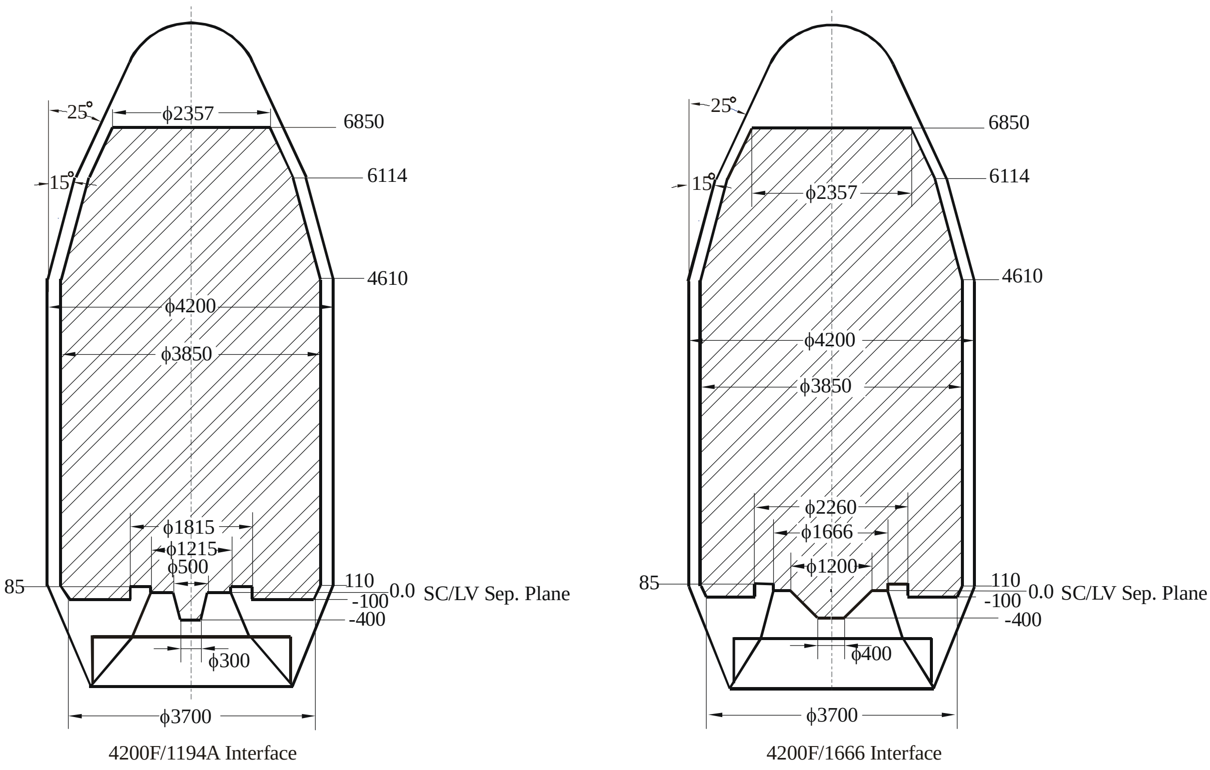


Figure 4-5 4200F Fairing Envelope (1194A Interface and 1666 Interface)

4.1.5 4200Z Fairing

The outer diameter of Fairing 4200Z is 4200mm, and its height is 9381mm. It will be encapsulated in BS3. The configuration is shown in **Figure 4-2**, and envelope is shown in **Figure 4-6**. The fairing supports 1194A and 1666 interfaces.

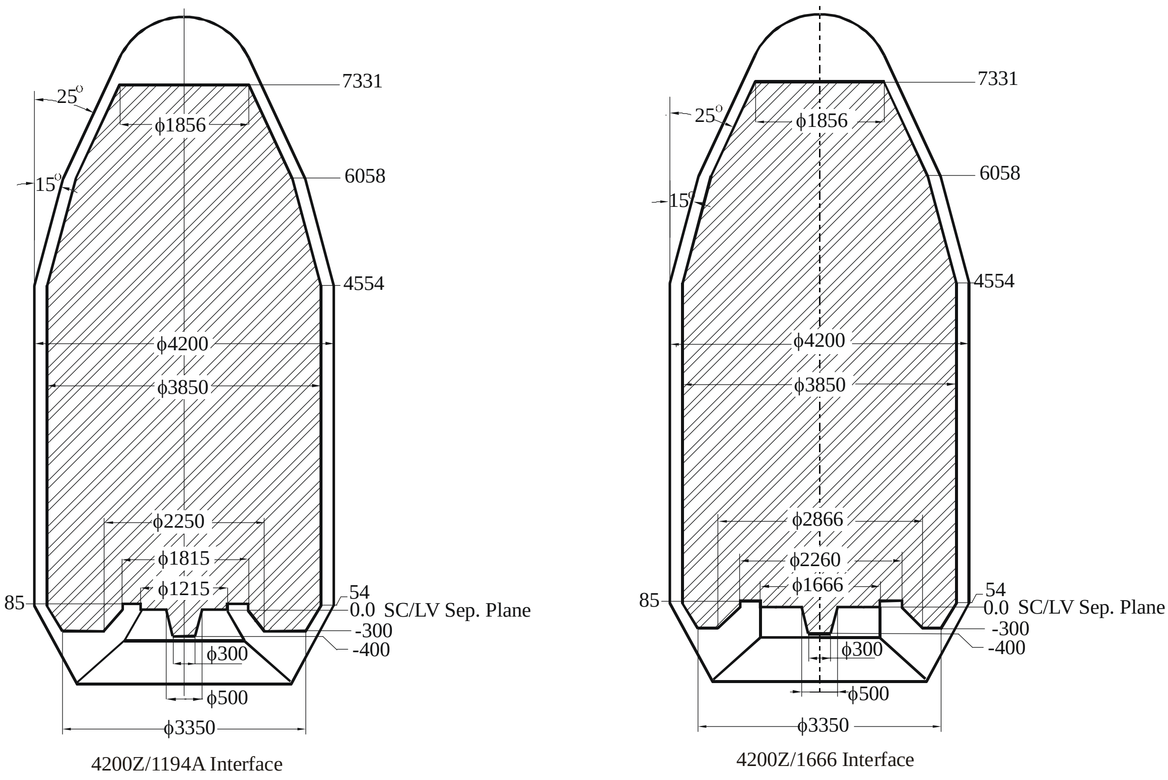


Figure 4-6 4200Z Fairing Envelope (1194A Interface and 1666 Interface)

4.1.6 How to Use the Fairing Static Envelope

The static envelope of the fairing is the limitation to the maximum dimensions of SC configuration. The static envelope is determined by consideration of estimated dynamic and static deformation of the faring/payload stack generated by a variety of interference during flight. The envelopes vary with different fairing and different types of payload adapters.

It is allowed that a few extrusions of SC can exceed the maximum static envelope (Φ3650 or Φ3850) in the fairing cylindrical section. However, the extrusion issue shall be resolved by technical coordination between SC side and CALT.

4.2 Fairing Structure

The structures of 4000F, 4000Z, 4200F and 4200Z fairings are similar. They all consist of dome, biconic section, and cylindrical section and reverse cone section. Refer to **Figure 4-7**.

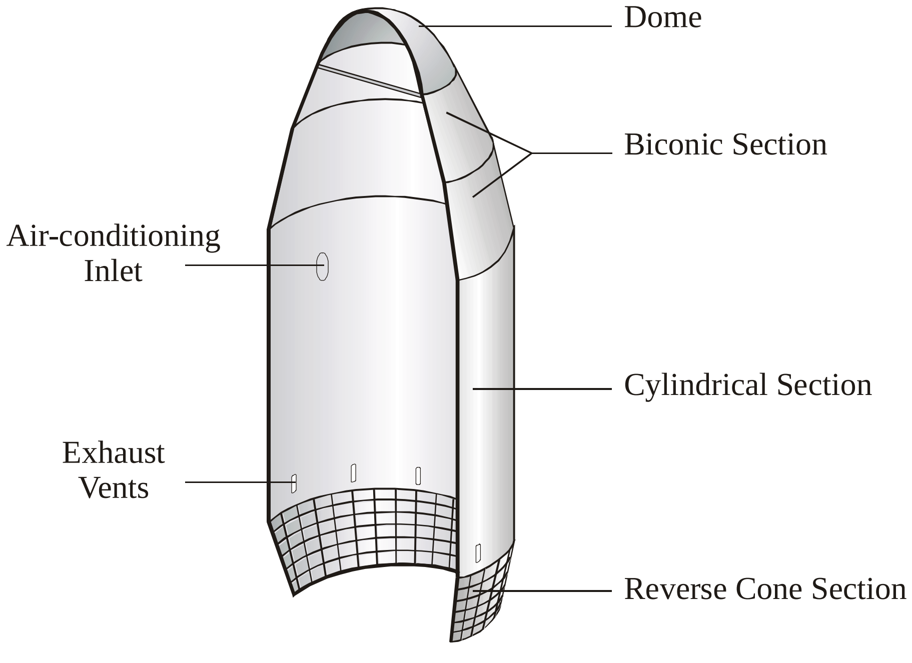


Figure 4-7 Fairing Structure

4.2.1 Dome

The dome is a semi-sphere body with radius of 1000mm, height of 661mm and base ring diameter of ϕ1890mm. It consists of dome shell, base ring, encapsulation ring and stiffeners. Refer to **Figure 4-8**.

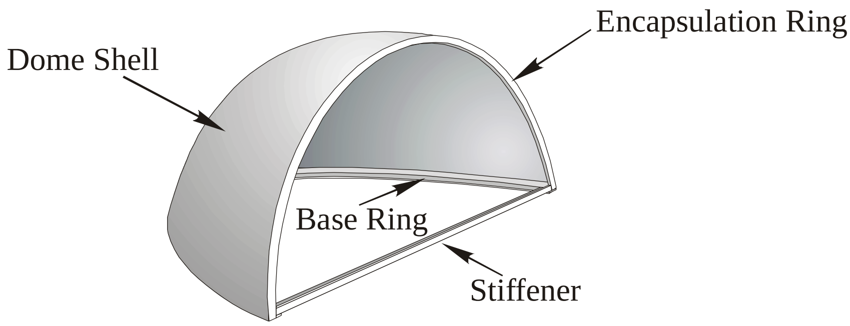


Figure 4-8 Structure of the Fairing Dome

The dome shell is an 8mm-thick fiberglass structure. The base ring, encapsulation ring and stiffener are made of high-strength aluminum alloys. A silica-rubber wind-belt covers on the outside of the split line, and a rubber sealing belt is compressed between the two halves. The outer and inner sealing belts keep air-stream from entering the fairing during launch vehicle flight.

4.2.2 Biconic Section

The upper part of the biconic section is a 25°-cone with height of 1400mm, and the lower part is a 15°-cone with height of 1500mm. The upper part and the lower part are jointed together. The diameter of the top ring is 1890mm, and the diameter of the bottom ring is 4000mm.

4.2.3. Cylindrical Section

The structure of the cylindrical section is identical to that of biconic section, i.e. aluminum honeycomb sandwich. There are two air-conditioning inlets opened on the upper part of the cylindrical section, and 10 exhaust vents with total area of 191cm^2 on the lower part. Refer to **Figure 4-1**, **Figure 4-2**.

4.2.4 Reverse Cone Section

The reverse cone section is a ring-stiffened semi-monocoque structure. It is composed of top ring, intermediate ring, bottom ring, inner longitudinal stiffeners and chemical-milled skin. For fairings 4000F and 4200F, several access doors are available on this section. For fairings 4000Z and 4200Z, there is no access door available on this section.

4.3 Heating-proof Function of the Fairing

The outer surface of the fairing, especially the surface of the dome and biconic section, is heated by high-speed air-stream during LV flight. Therefore, heating-proof measures are adopted to assure the temperature of the inner surface be lower than 80°C.

The outer surface of the biconic and cylindrical sections are covered by special cork panel. The cork panel on the biconic section is 1.2mm thick, and 1.0 mm thick on the cylindrical section.

4.4 Fairing Jettisoning Mechanism

The fairing jettisoning mechanism consists of lateral unlocking mechanism and longitudinal unlocking mechanism and separation mechanism. Refer to **Figure 4-9a,b,c&d**.

4.4.1 Lateral Unlocking Mechanism

For the fairings 4000F and 4200F, the base ring of the fairing is connected with forward short skirt of the third stage cryogenic tank by 12 non-contamination explosive bolts. For the 4000Z and 4200Z fairings, the base ring of the fairing is connected with the top ring of the VEB by 12 non-contamination explosive bolts. The distribution of the explosive bolts is shown in **Figure 4.9b**. The reliability of the explosive bolt is 0.9999.

4.4.2 Longitudinal Unlocking Mechanism

The longitudinal separation plane of the fairing is II-IV quadrant (XOZ). The longitudinal unlocking mechanism consists of notched bolts, hoses with explosive cords and initiators, initiator bracket and two explosive bolts, etc. see **Figure 4.9c**.

The two steel hoses go along the split line of the fairing. Two insensitive initiators are attached at the each end of the explosive cords. When unlocking, the two non-contamination explosive bolts are detonated and cut off firstly. The initiators ignite the explosive cords, and high-pressure gas is generated instantly, which makes the steel hoses expand, and the notched bolts are broken. In that sequence, the fairing separates into two halves. The gas generated by the explosive cords is sealed in the steel hoses, so there is no contamination to the SC.

One of the two explosive cords can be ignited only if one of the four attached initiators is fired. If one explosive cord works, all the notched bolts can be broken, i.e. fairing can separate. Therefore, the reliability of the longitudinal separation is very high.

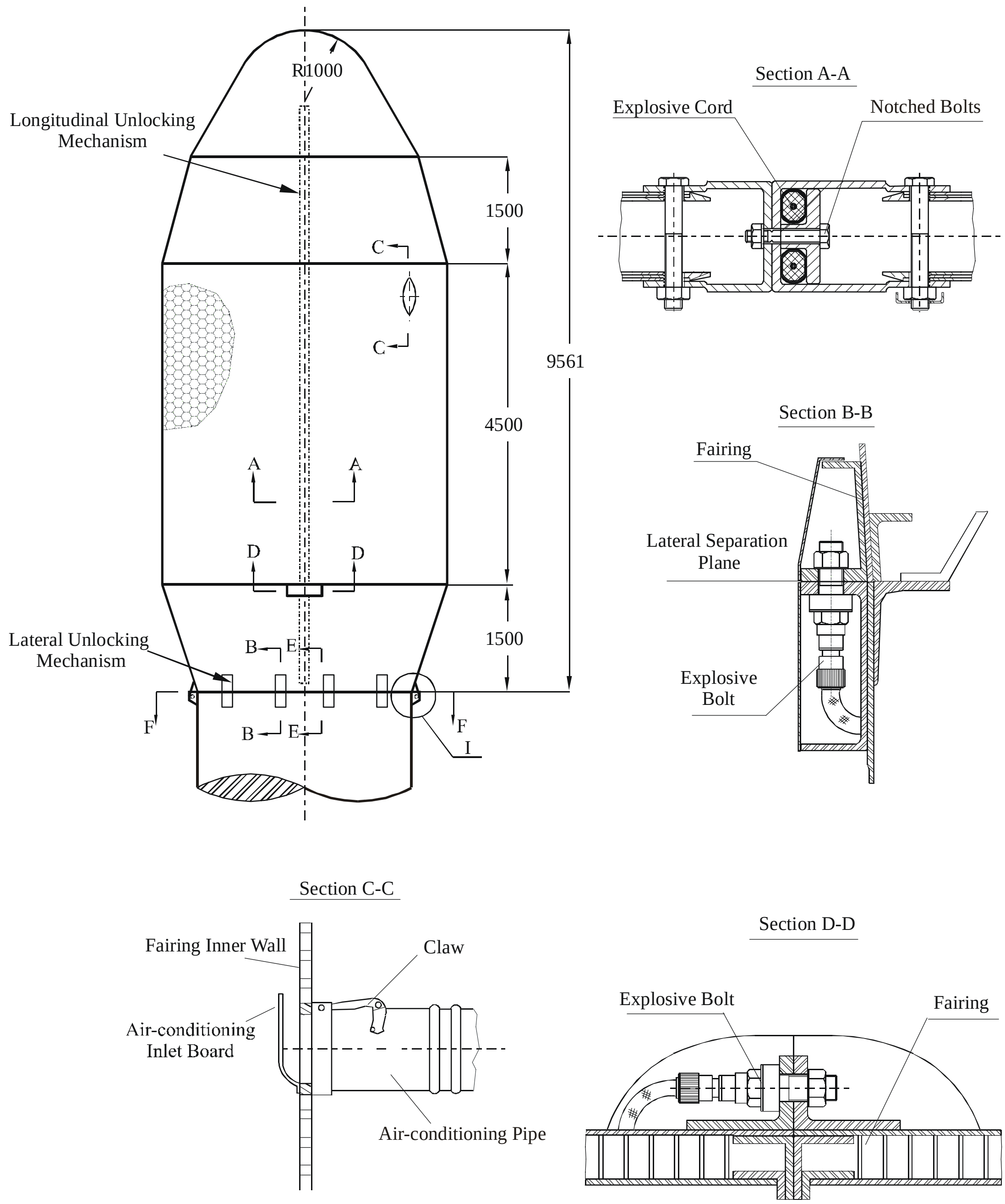


Figure 4-9a Fairing Unlocking Mechanism

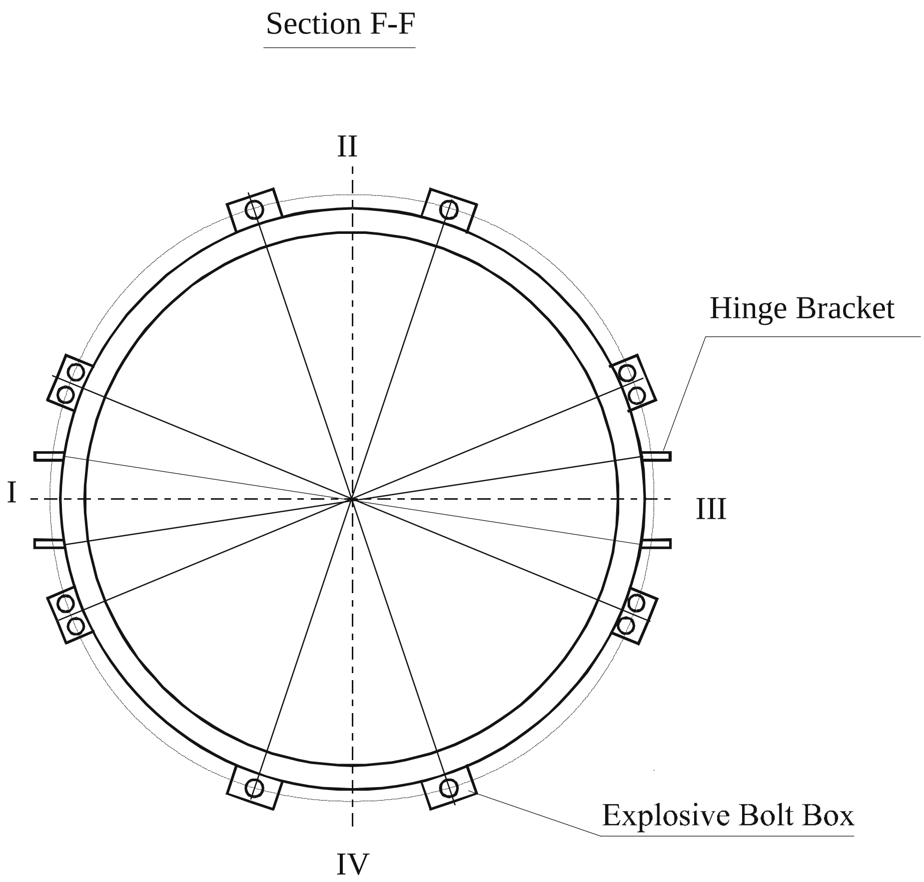


Figure 4-9b Distribution of the LV Lateral Unlocking Explosive Bolts

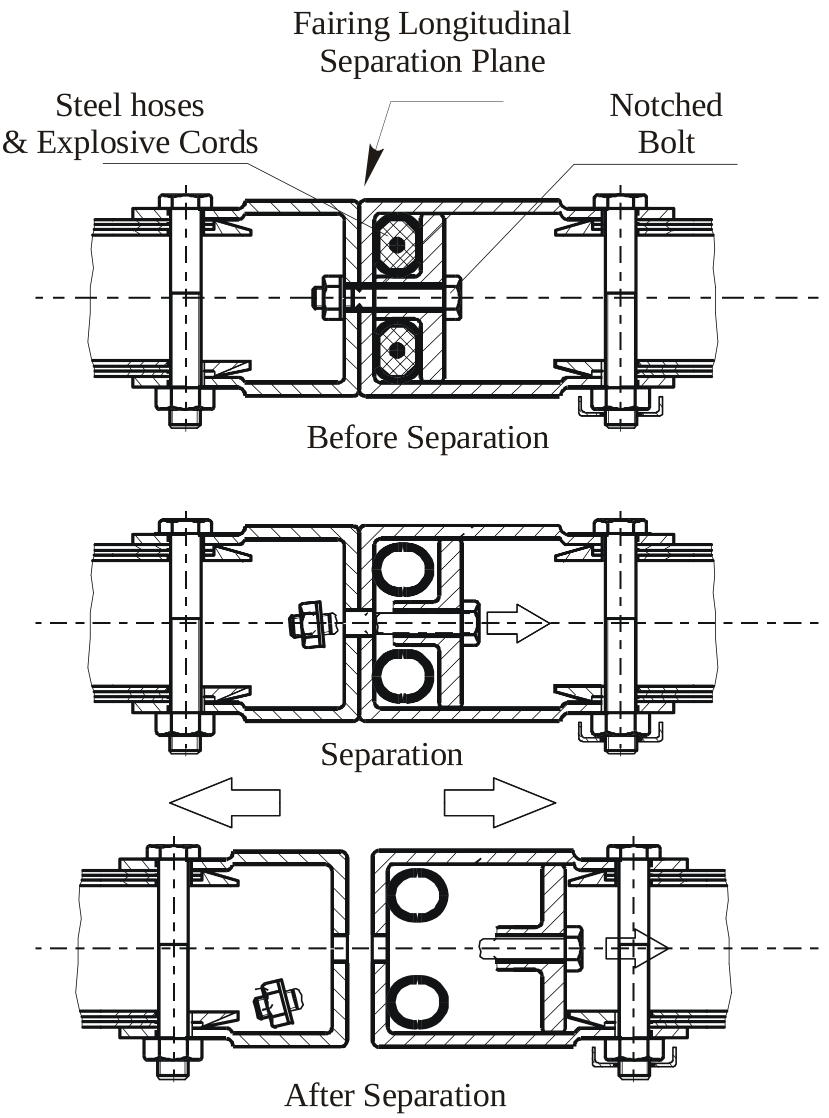


Figure 4-9c LV Longitudinal Unlocking Illustration

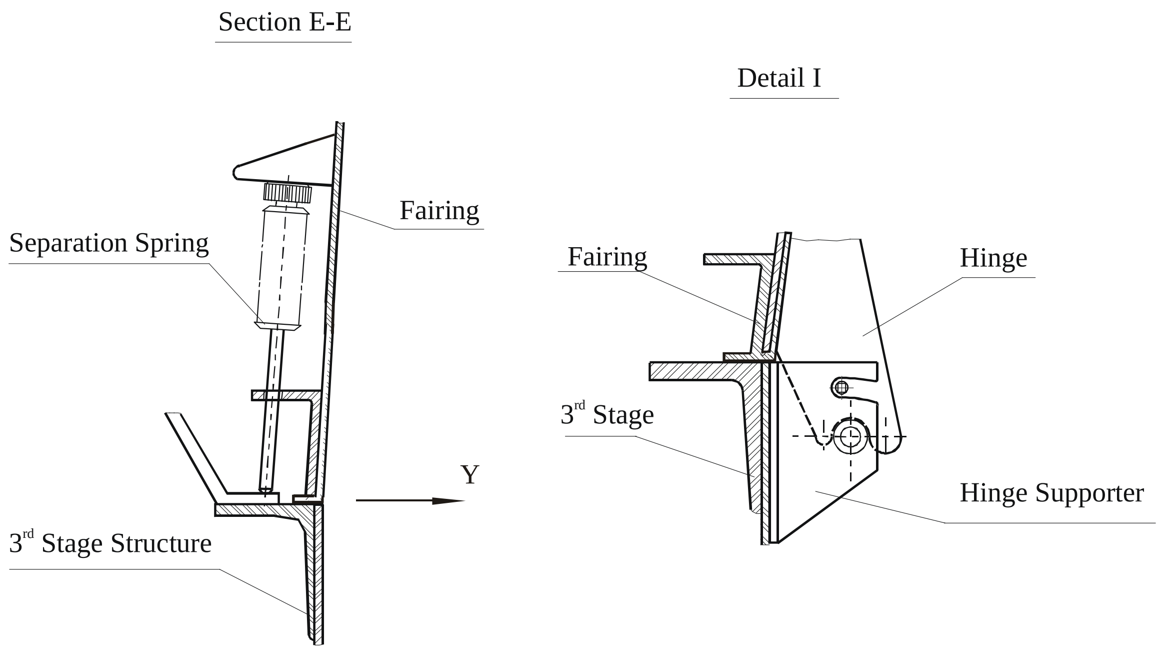


Figure 4-9d Fairing Separation Mechanism

4.4.3 Fairing Separation Mechanism

The fairing separation mechanism is composed of hinges and springs, see **Figure 4-9a,c&d**. Each half of the fairing is supported by two hinges, which locate at quadrant I and III. There are 6 separation springs mounted on each half of the fairing, the maximum acting force of each spring is 37.8kN. After fairing unlocking, each half of the fairing turns around the hinge. When the roll-over rate of the fairing half is larger than 18°/s, the fairing is jettisoned. The kinematical process is shown in **Figure 4-10**.

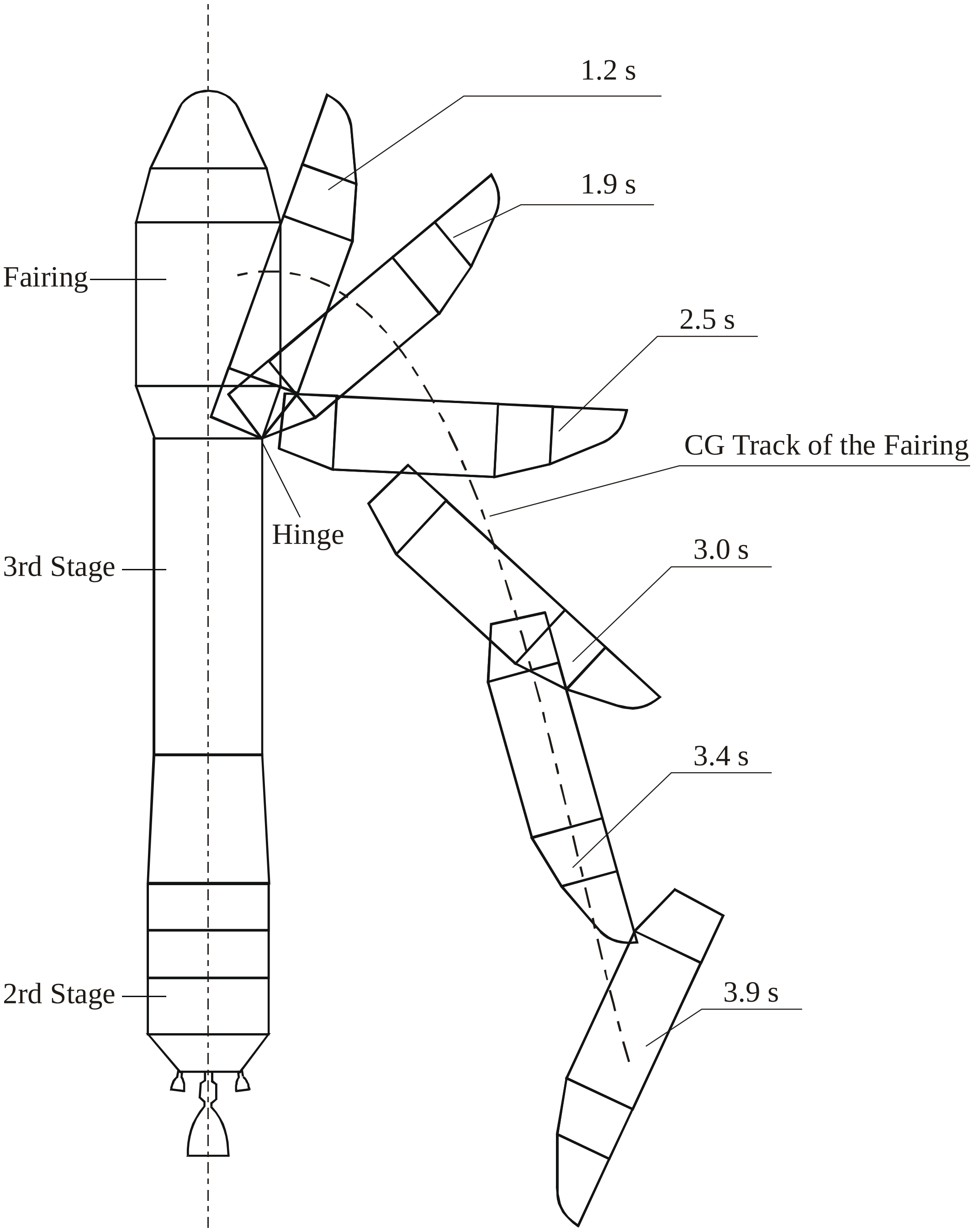


Figure 4-10 Fairing Separation Dynamic Process

4.5 RF Windows and Access Doors

Radio frequency (RF) transparent windows can be incorporated into the fairing biconic section and cylindrical section to provide SC with RF transmission through the fairing, according to user's needs. The RF transparent windows are made of fiberglass, of which the RF transparency rate is shown in the **Table 4-2**.

Table 4-2 RF Transparent Rate

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 spacecraft after the fairing encapsulation, according to user's needs. Some area on the fairing can not be selected as the locations of RF windows and access doors, see **Figure 4-11**. User can propose the requirements on access doors and RF windows to CALT. However, such requirements should be finalized 8 months prior to launch.

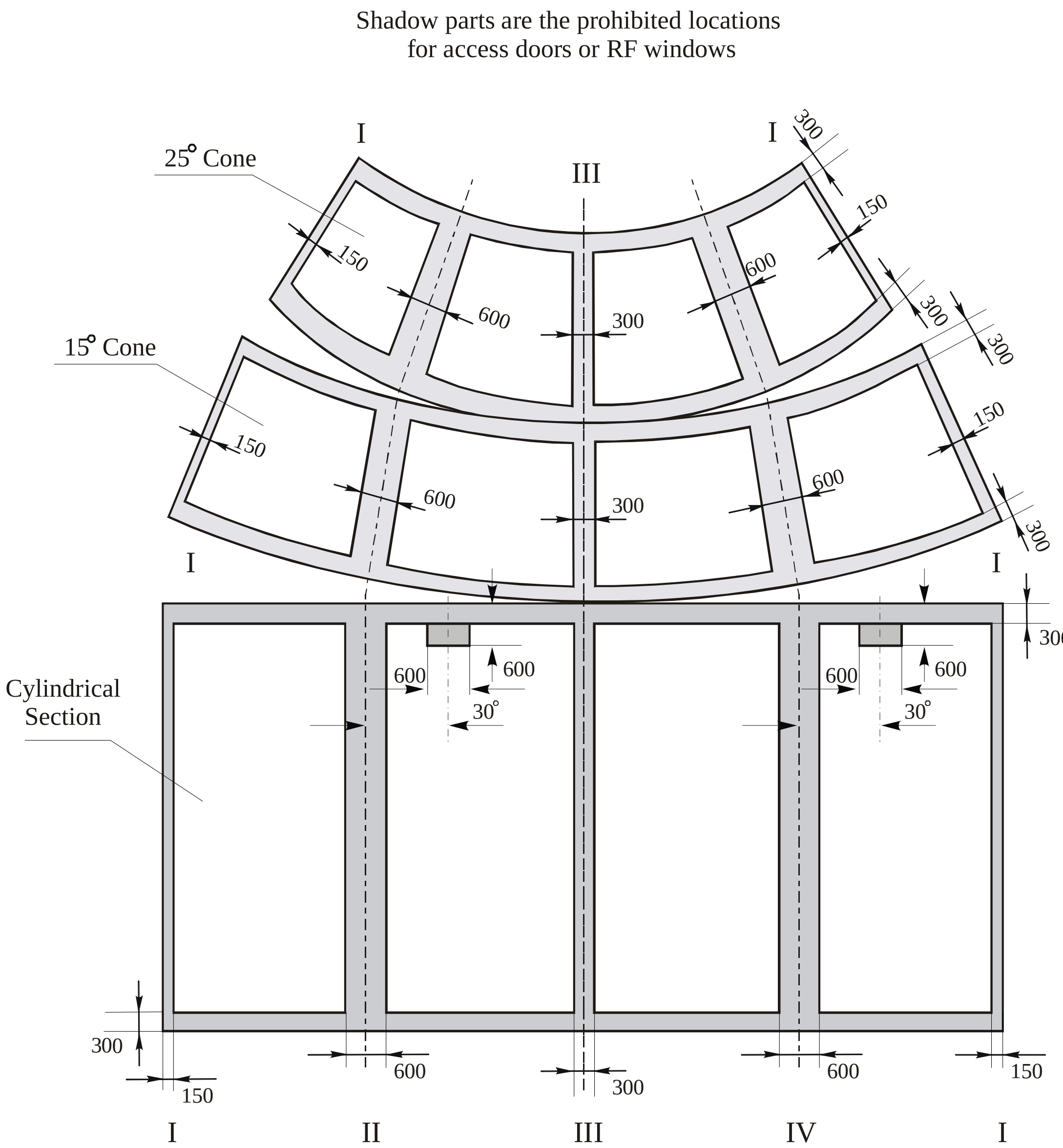


Figure 4-11 Prohibited Locations for Access Doors and RF Windows

CHAPTER 5

MECHANICAL/ELECTRICAL INTERFACE

5.1 Description

The interface between LV and SC consists of mechanical and electrical interfaces. Through mechanical interface, the payload is mated with the LV mechanically, while the electrical interface functions to electrically connect the LV with SC.

5.2 Mechanical Interface

5.2.1 Composition

The SC is mounted on the launch vehicle through a payload adapter. The bottom ring of the adapter mates with the VEB of LM-3B by bolts. The top ring of the adapter is mated with the interface ring of the SC through a clampband. On the payload adapter, there are separation springs for the LV/SC separation, cables and connectors mainly used by SC.

5.2.2 Payload Adapter

5.2.2.1 Summary

The top ring of the adapter, without any chemical treatment, connects with the interface ring of the SC through an international widely-used interface. The bottom ring of the adapter is 1497mm in diameter and it is connected with the VEB via 70 bolts. LM-3B provides four types of mechanical interfaces, which are 937B, 1194, 1194A and 1666 respectively. User should contact CALT if other interface is needed.

5.2.2.2 937B Interface (Encapsulation-on-pad)

The 937B interface adapter is a 900mm-high truncated cone, whose top ring diameter is 945.26mm and bottom ring diameter is 1748mm. Refer to **Figure 5-1a** and **Figure 5-1b**. The top ring, for mating with the SC, is made of high-strength aluminum alloy.

The adapter is a composite honeycomb sandwich structure. The core of the sandwich is made of aluminum honeycomb. The facesheets are made of carbon fiber composite. The total mass of the adapter is 55kg, including the separation springs, cables and other accessories.

5.2.2.3 1194 Interface (Encapsulation-on-pad)

The 1194 interface adapter is a 650mm-high truncated cone, whose top ring diameter is 1215mm and bottom ring diameter is 1748mm. Refer to **Figure 5-2a** and **Figure 5-2b**.The top ring, for mating with the SC, is made of high-strength aluminum alloy.

The adapter is a composite honeycomb sandwich structure. The core of the sandwich is made of aluminum honeycomb. The facesheets are made of carbon fiber composite. The total mass of the adapter is 53kg, including the separation springs, cables and other accessories.

5.2.2.4 1194A Interface (Encapsulation-on-pad)

The adapter is 450mm high, see **Figure 5-3a** and **Figure 5-3b**.

5.2.2.5 1194A Interface (Encapsulation-on-BS3)

The adapter is 450mm high, see **Figure 5-4a** and **Figure 5-4b**.

5.2.2.6 1666 Interface (Encapsulation-on-pad)

The adapter is 650mm high, see **Figure 5-5a** and **Figure-5b**.

5.2.2.7 1666 Interface (Encapsulation-in-BS3)

The adapter is 450mm high, see **Figure 5-6** and **Figure 5-6b.**

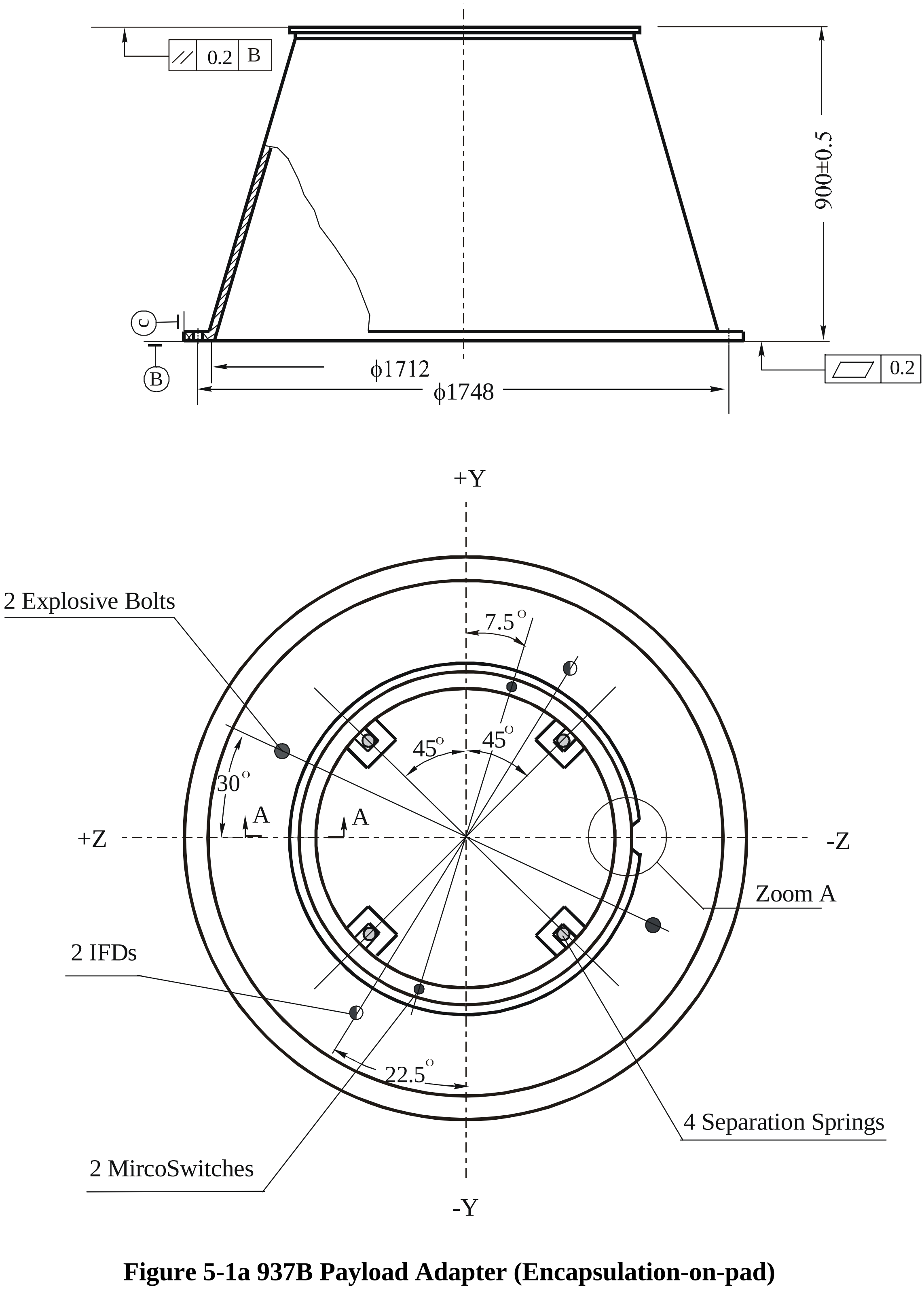


Figure 5-1a 937B Payload Adapter (Encapsulation-on-pad)

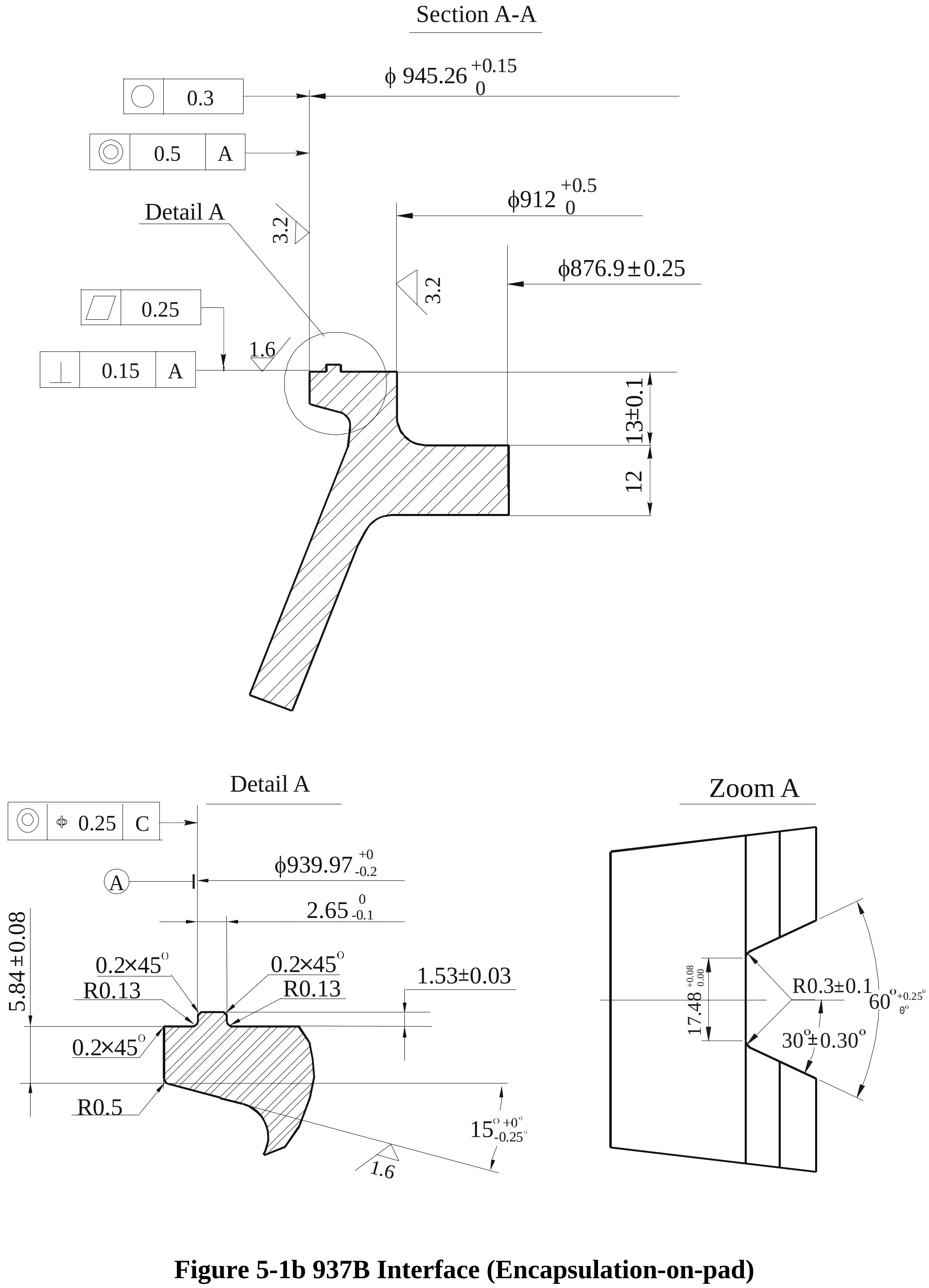
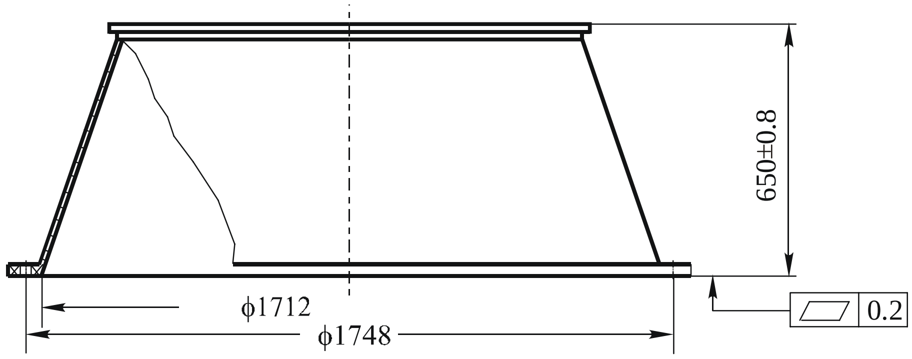


Figure 5-1b 937B Interface (Encapsulation-on-pad)



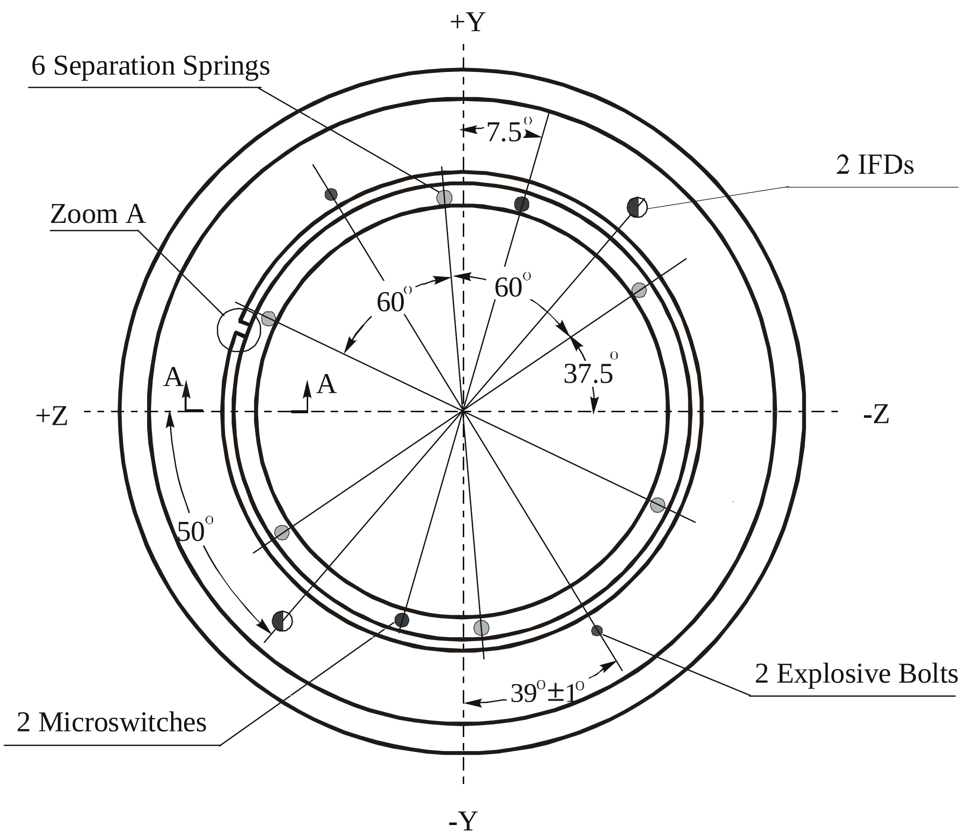


Figure 5-2a 1194 Payload Adapter (Encapsulation-on-pad)

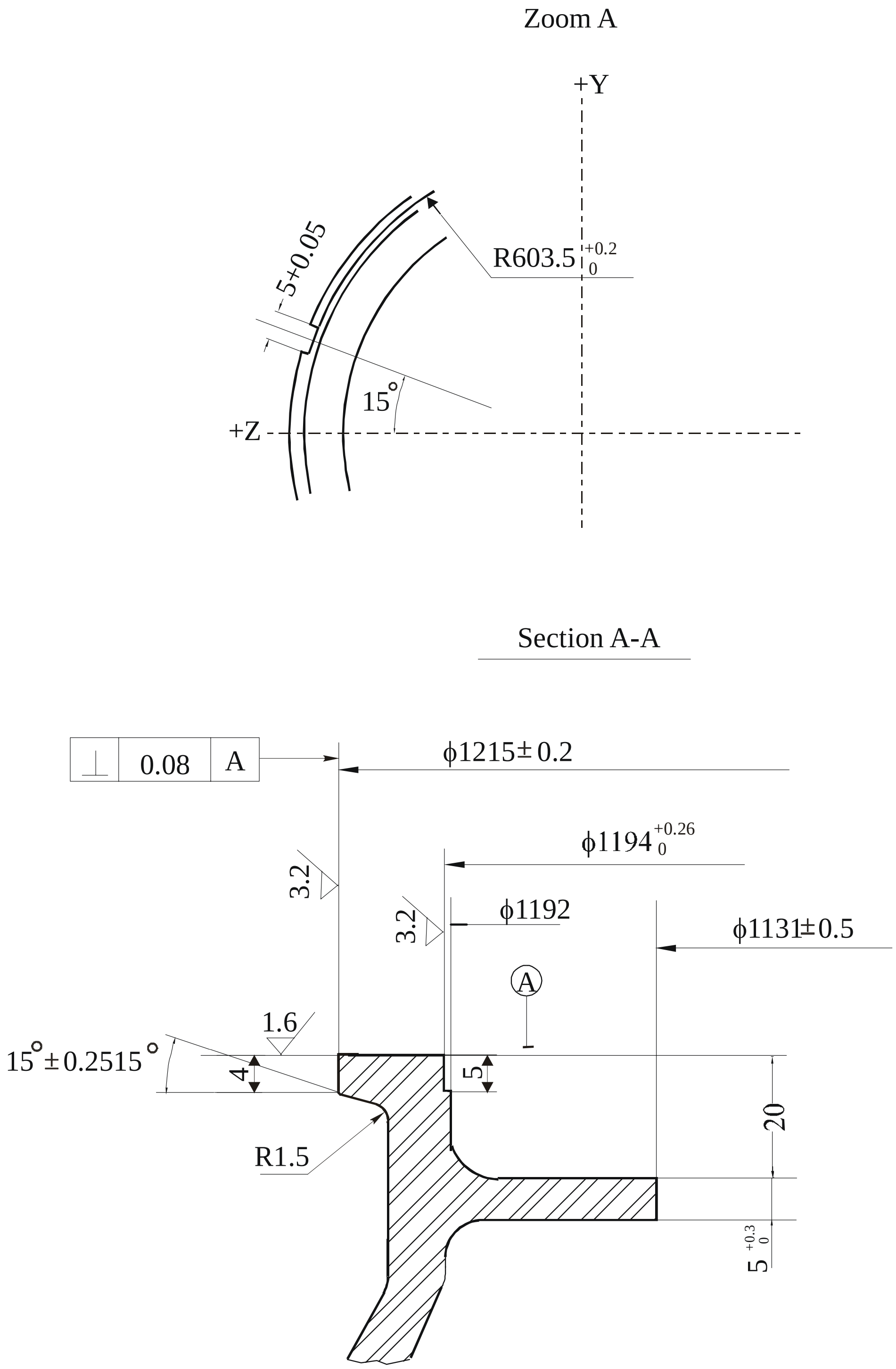


Figure 5-2b 1194 Interface (Encapsulation-on-pad)

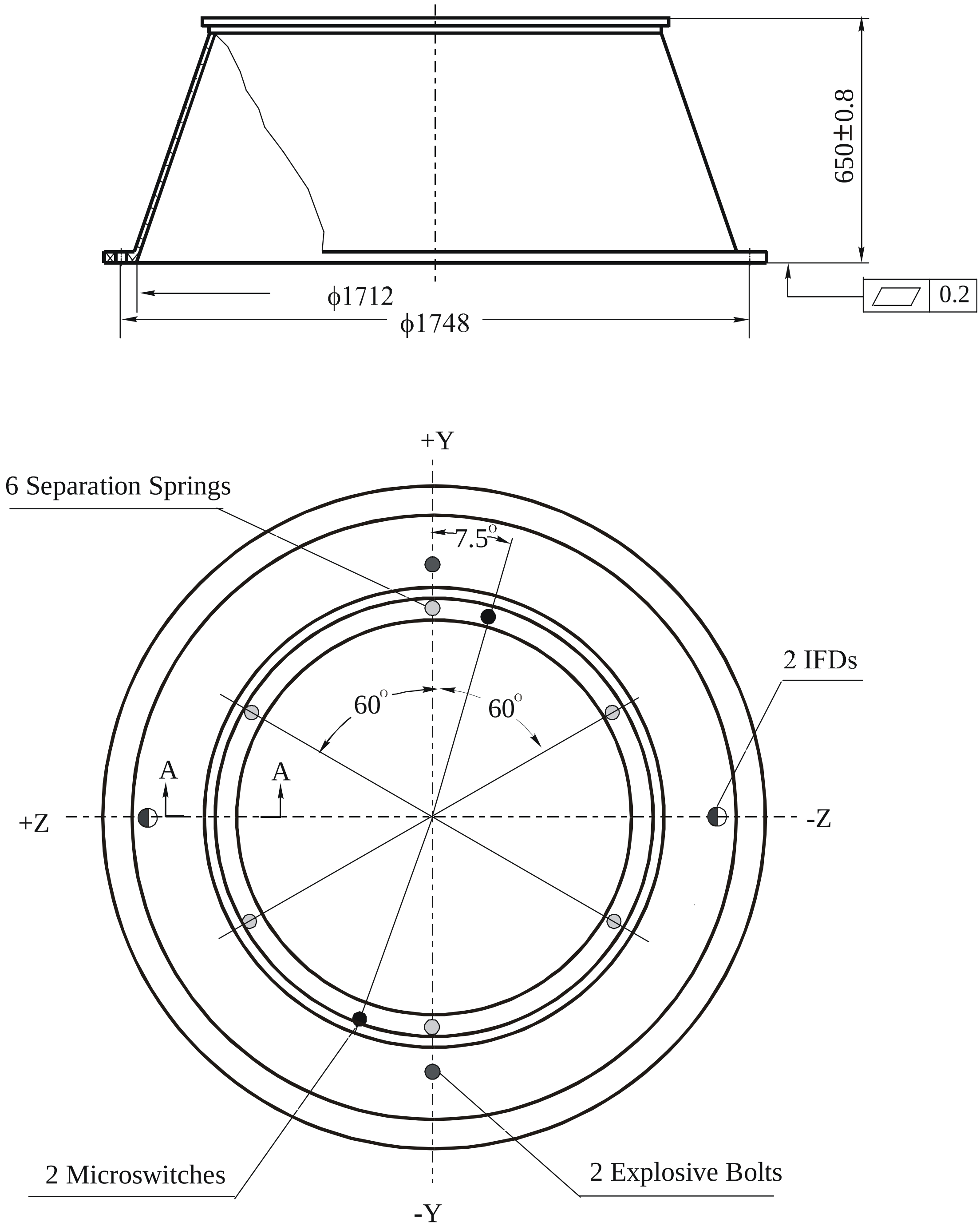
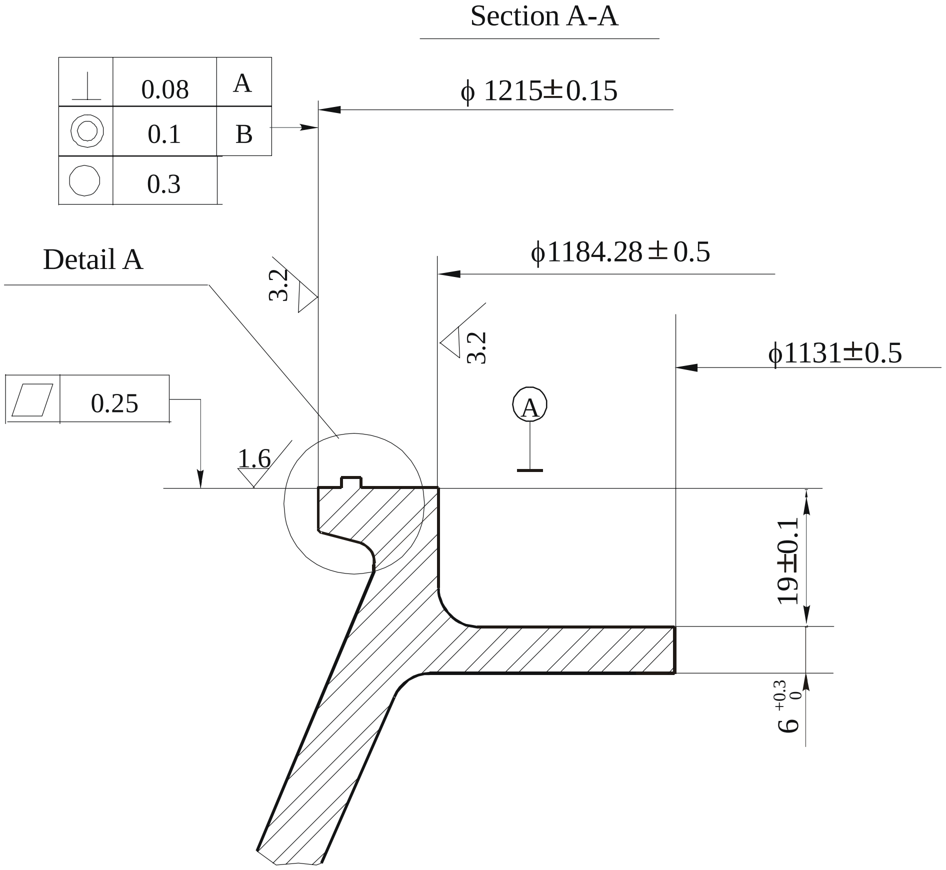


Figure 5-3a 1194A Payload Adapter (Encapsulation-on-pad)



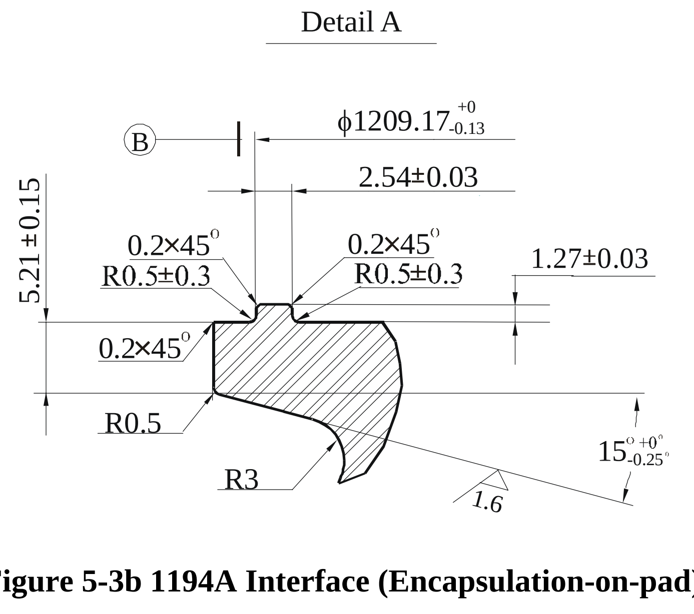
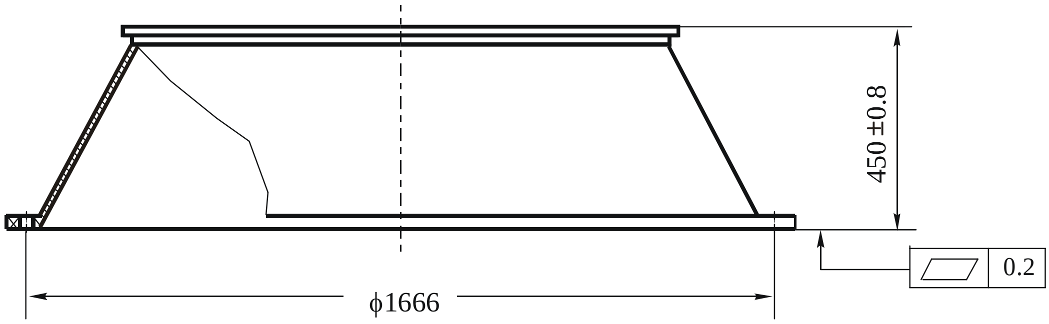


Figure 5-3b 1194A Interface (Encapsulation-on-pad)



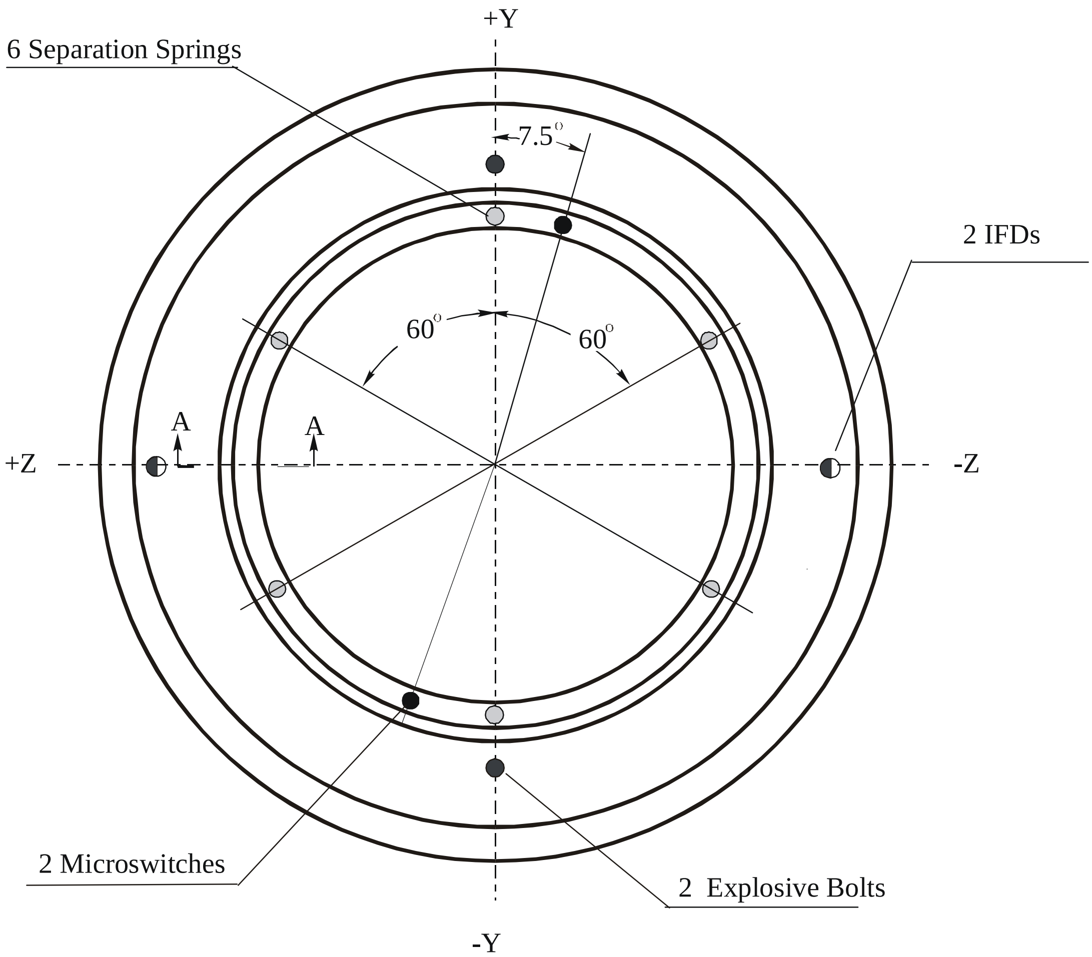


Figure 5-4a 1194A Payload Adapter (Encapsulation-in-BS3)

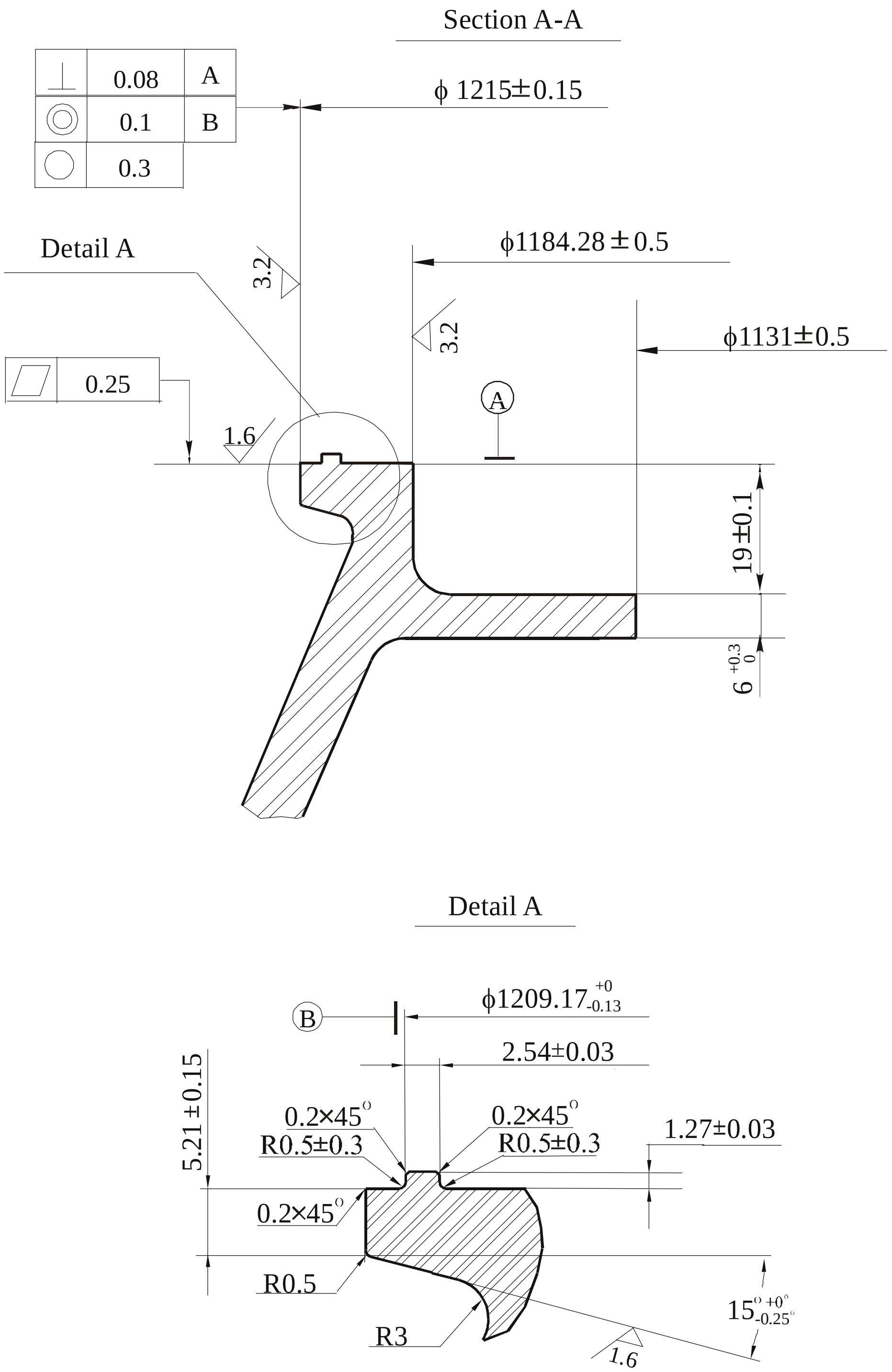


Figure 5-4b 1194A Interface (Encapsulation-in-BS3)

(TO BE ISSUED LATER)

Figure 5-5a 1666 Payload Adapter (Encapsulation-on-pad)

(TO BE ISSUED LATER)

Figure 5-5b 1666 Interface (Encapsulation-on-pad)

(TO BE ISSUED LATER)

Figure 5-6a 1666 Payload Adapter (Encapsulation-in-BS3)

(TO BE ISSUED LATER)

Figure 5-6b 1666 Interface (Encapsulation-in-BS3)

5.2.3 SC/LV Separation System

The SC/LV separation system consists of clampband system and separation springs. The clampband system is used for locking and unlocking the SC. The separation springs is mounted on the adapter, which provides relative velocity between SC and LV.

Figure 5-7a,b,c,d,&e show the SC/LV separation system.

5.2.3.1 Clampband System

The clampband system consists of clampband, non-contamination explosive bolts, V-shoes, lateral-restraining springs, longitudinal-restraining springs, etc. See **Figure 5-7a**.

The clampband has two halves. It is 50mm wide and 1.0mm thick. The clampband is made of high-strength steel.

The clampband system has two non-contamination explosive bolts. Each bolt has two igniters on the two ends, so each bolt can be ignited from both ends. The igniter on the end has two igniting bridge-circuits. As long as one igniter works, and even only one bridge-circuit is powered, the bolt can be detonated and cut off. There are totally 4 igniters and 8 bridge-circuits for the two bolts. Any bridge of these 8 works, the clampband can be definitely unlocked. So the unlocking reliability is very high. The maximum allowable pretension of the explosive bolt is 70kN.

The V-shoes are used for clamping the interface ring of the SC and the top ring of the adapter. The 26 V-shoes for the clampband are symmetrically distributed along the periphery. The V-shoes are made of high-strength Aluminum.

The lateral-restraining springs connect the both ends of the two halves of clampband. The lateral-restraining springs are used for controlling the outward movement of the clampband (perpendicular to LV axial axis) and keep the sufficient payload envelope. Refer to **Figure 5-7b&c**. There are totally 8 lateral-restraining springs in 2 types.

The longitudinal-restraining springs restrict the movement of the separated clampband toward SC. The two halves of the clampband will be held on the adapter and be kept from colliding with the SC.

During the installation of clampband system, 10 strain gauges are installed on the each half of the clampband. Through the gauges and computer, the strain and pretension at each measuring point can be monitored in real time. A special designed tool is used for applying the pretension. Generally, the pretension is 24.2+1.0/-0kN. While the pretension can be adjusted according to the specific requirements of the SC and the coupled load analysis results.

For the convenience and safety of the SC during clampband installation, the bottom of the SC is needed to be 85mm away from the SC/LV separation plane, or there should be a distance of 20mm between the lateral-restraining springs and the bottom of SC. This requirement has been considered in the fairing envelopes.

5.2.3.2 Separation Springs

The separation springs includes springs, bracket, pushing rod, etc. Refer to **Figure 5-7d** and **Figure 5-7e**. The separation springs and their accessories are mounted on the adapter. The system can provide a SC/LV separation velocity higher than 0.5m/sec. It can also provide lateral spinning rate not less than 1.0°/sec according to user's requirement.

5.2.4 Anti-collision Measures

LM-3B has adopted some measures to prevent itself from re-contact with the SC after the SC/LV separation. Two seconds from the instant of separation, the Helium bottle on the third stage of LM-3B will automatically blow out Helium gas in a direction of 45° away from the moving SC. So the reaction thrust will slow down the launch vehicle to make a farther distance between SC and LV.

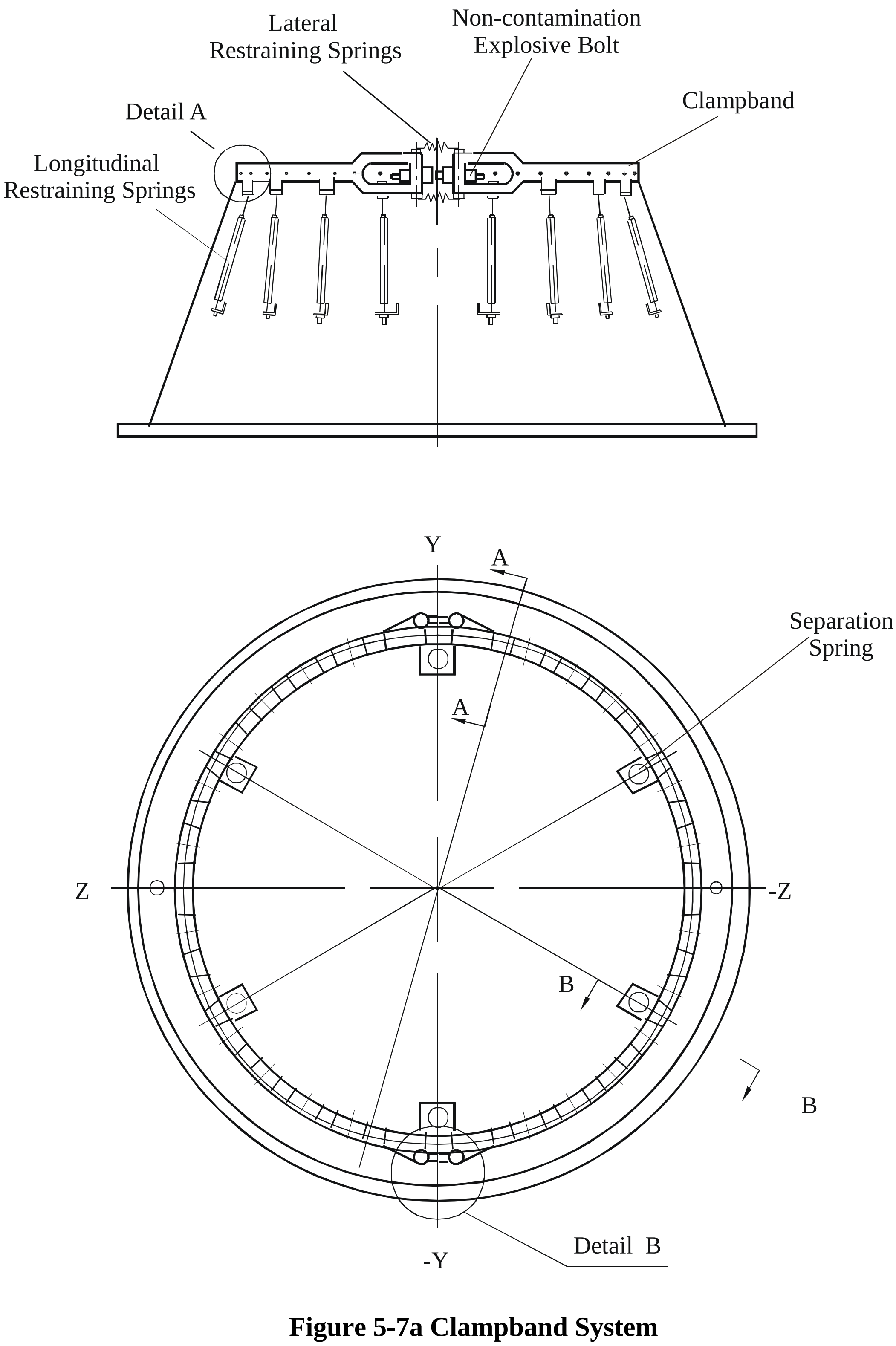


Figure 5-7a Clampband System

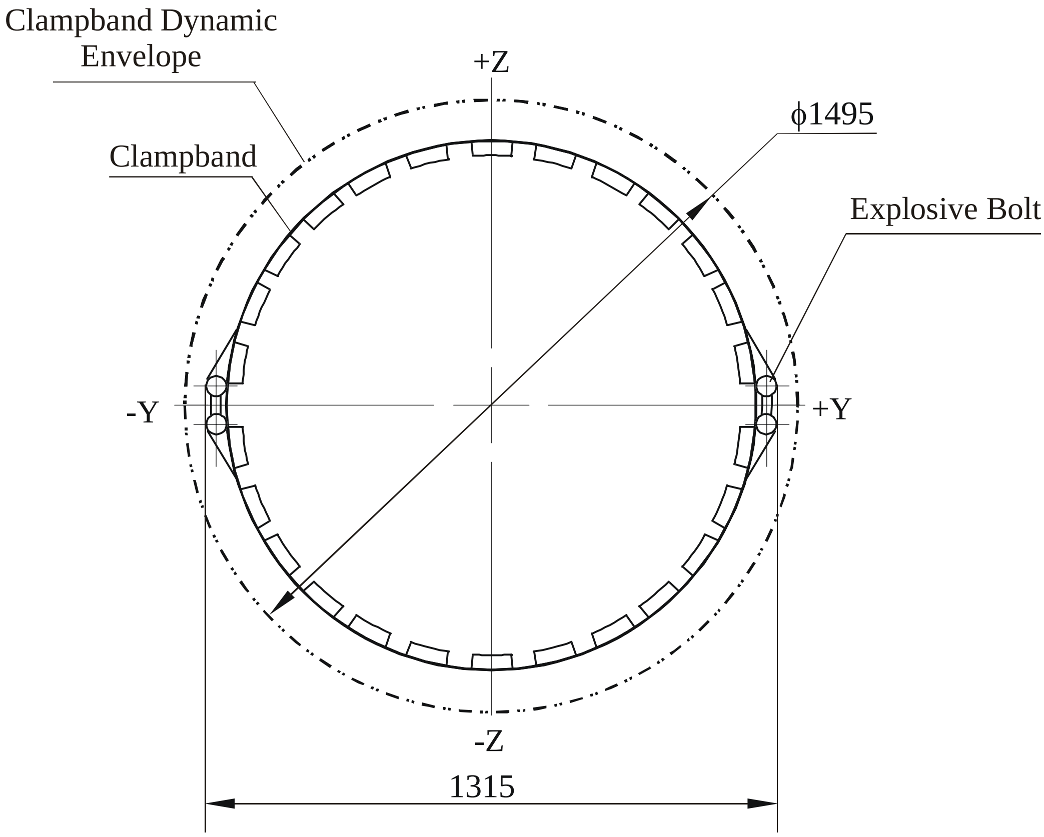


Figure 5-7b Clampband Dynamic Envelope
(For Interface 1194 and 1194A only)

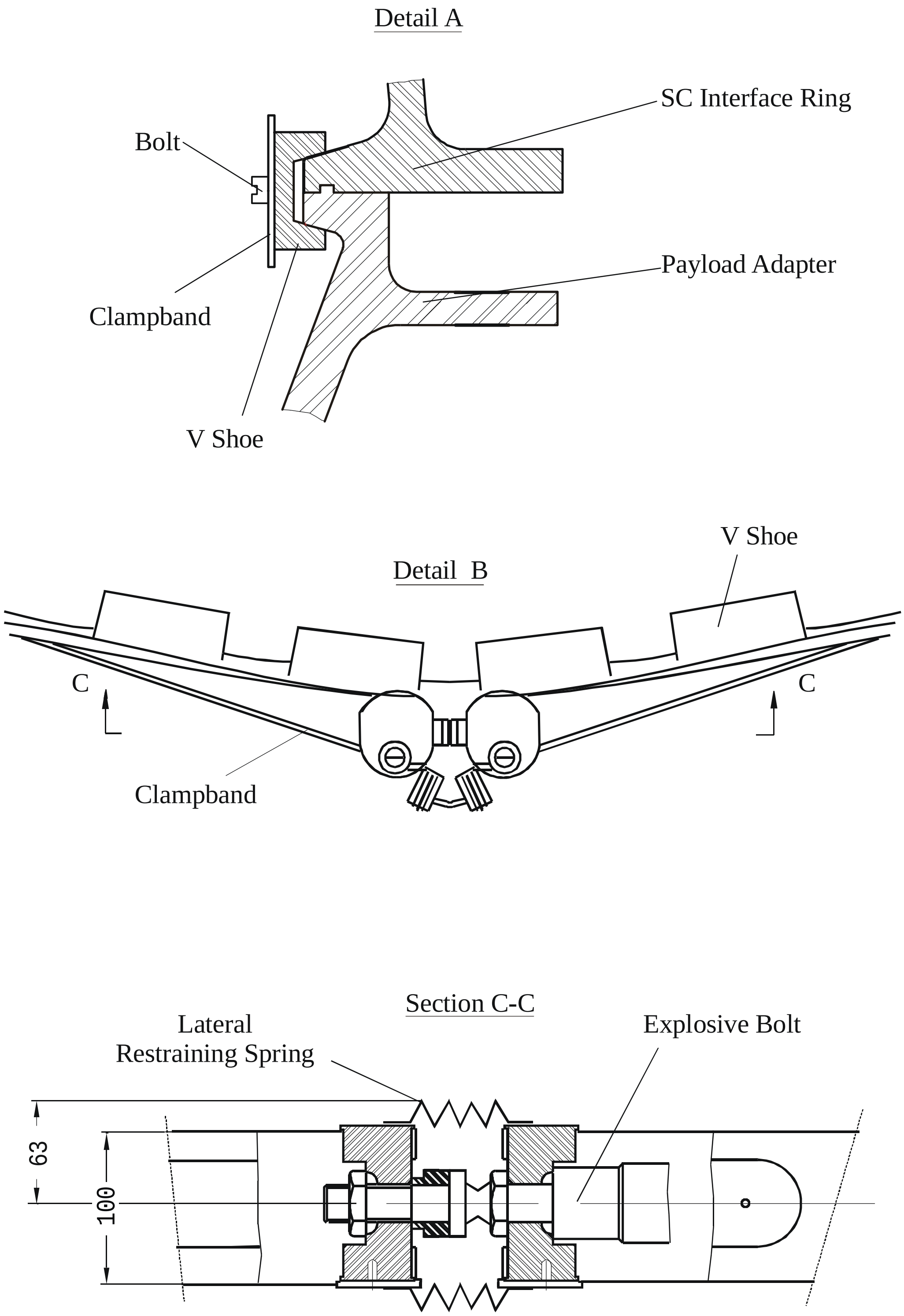


Figure 5-7c Clampband in Detail

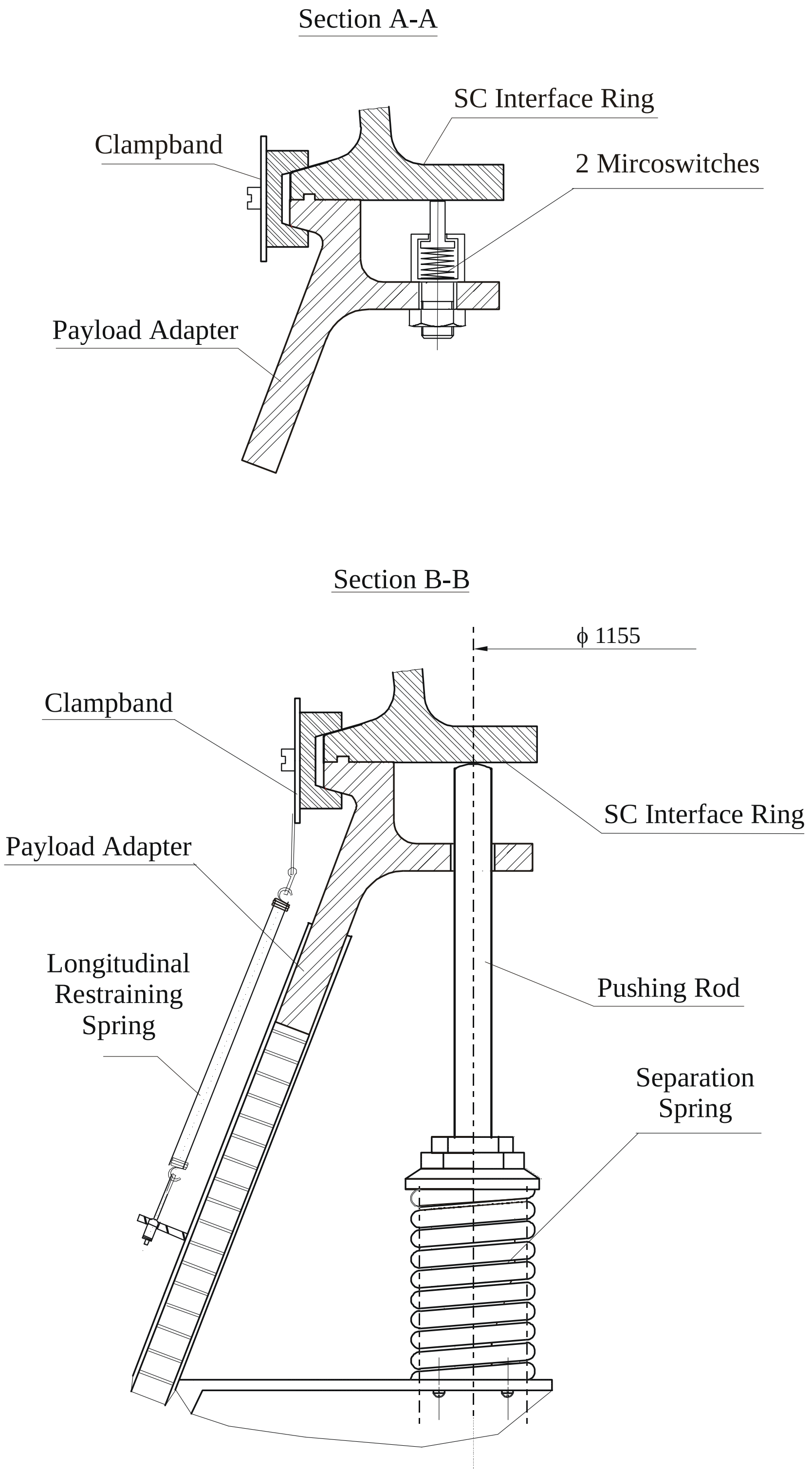
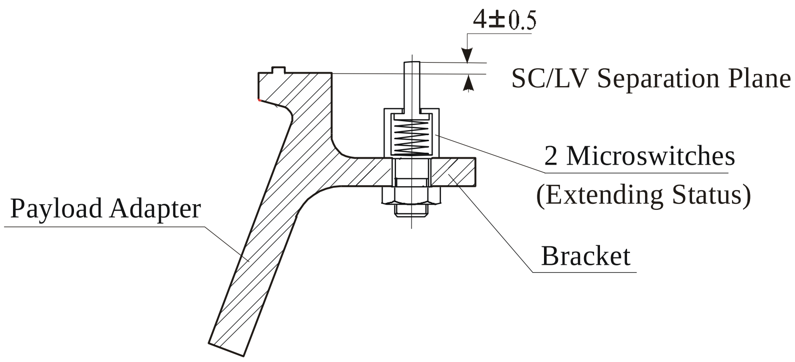


Figure 5-7d SC/LV Separation Spring

Section A-A



Section B-B

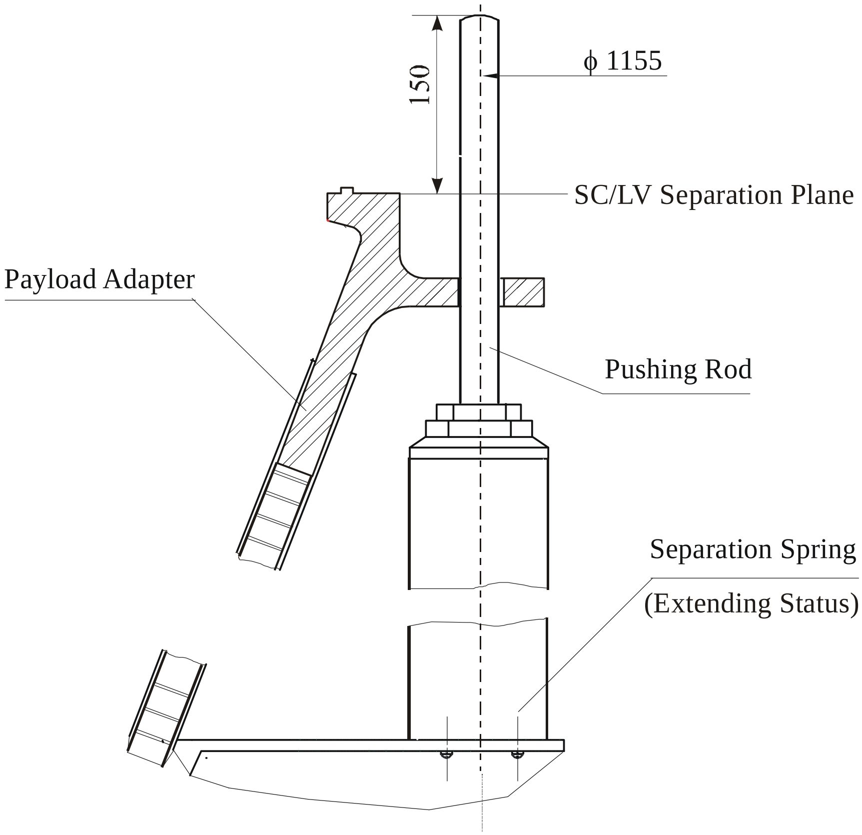


Figure 5-7e SC/LV Separation Spring (Extending Status)

5.3 Electrical Interface

5.3.1 Summary

The SC is electrically connected with SC's electrical ground support equipment (EGSE) through SC/LV electrical interface and umbilical cables provided by LV side. By using of EGSE and the umbilical cables, SC team can perform wired testing and pre-launch control to the SC, such as SC power-supply, on-board battery charging, wired-monitoring on powering status and other parameters.

The umbilical system consists of onboard-LV Parts and ground parts. Refer to **Figure 5-8** and **Figure 5-9**. The 350m-cable from Launch Control Console (LCC) to Umbilical Tower, EB26/EB36, BOX3, BOX4, and Power-supply 1&2 are the common to different missions. The onboard-LV cable, as well as ground cable from WXTC to ED 13,14&15 and BOX1 & BOX2, will be designed for dedicated SC according to User's needs. In order to assure the quality of the product, the umbilical system will be provided to the User after undergoing pre-delivery acceptance test and insulation/conductivity checkouts in the launch site.

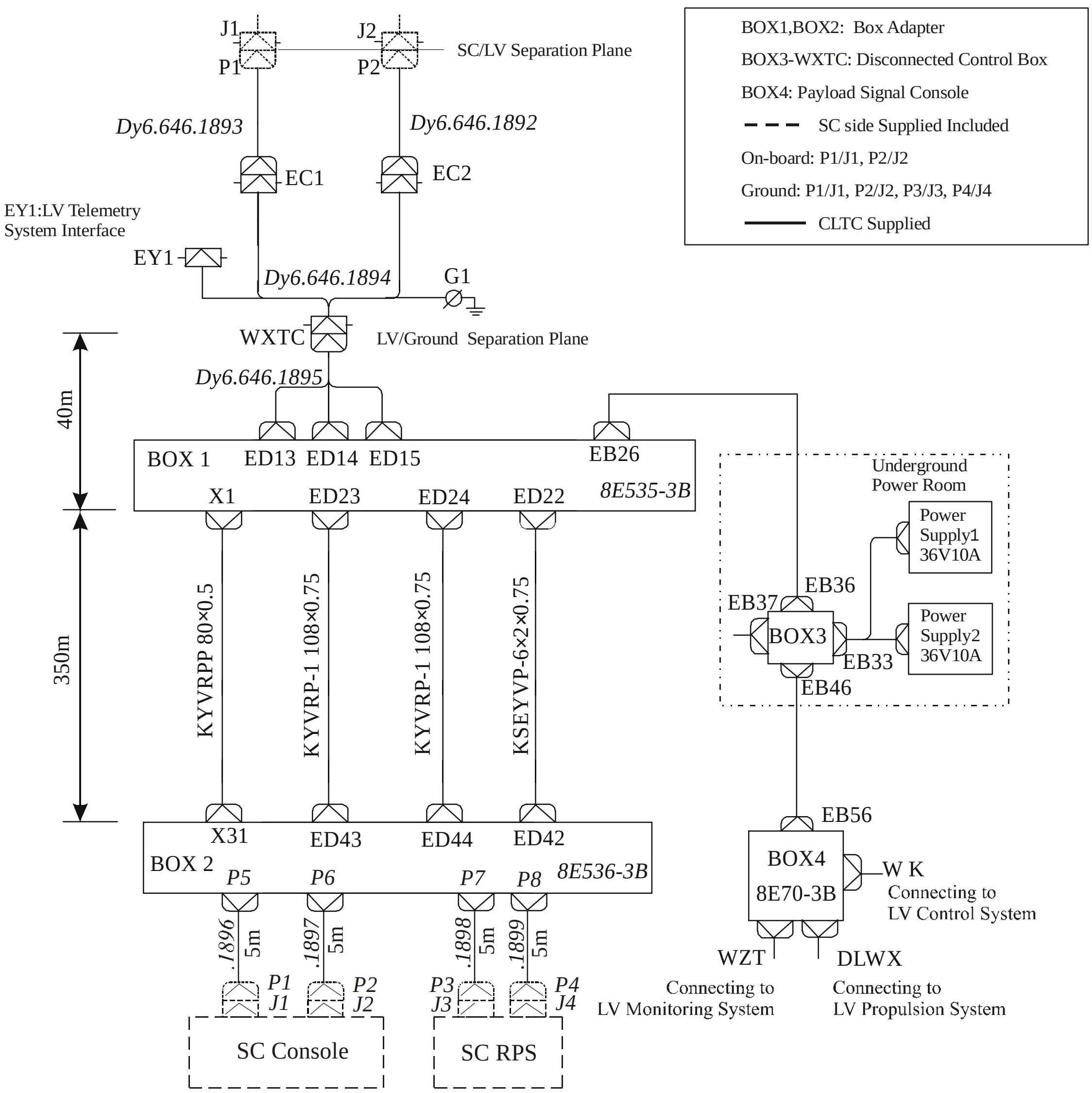


Figure 5-8 Umbilical Cable for SC

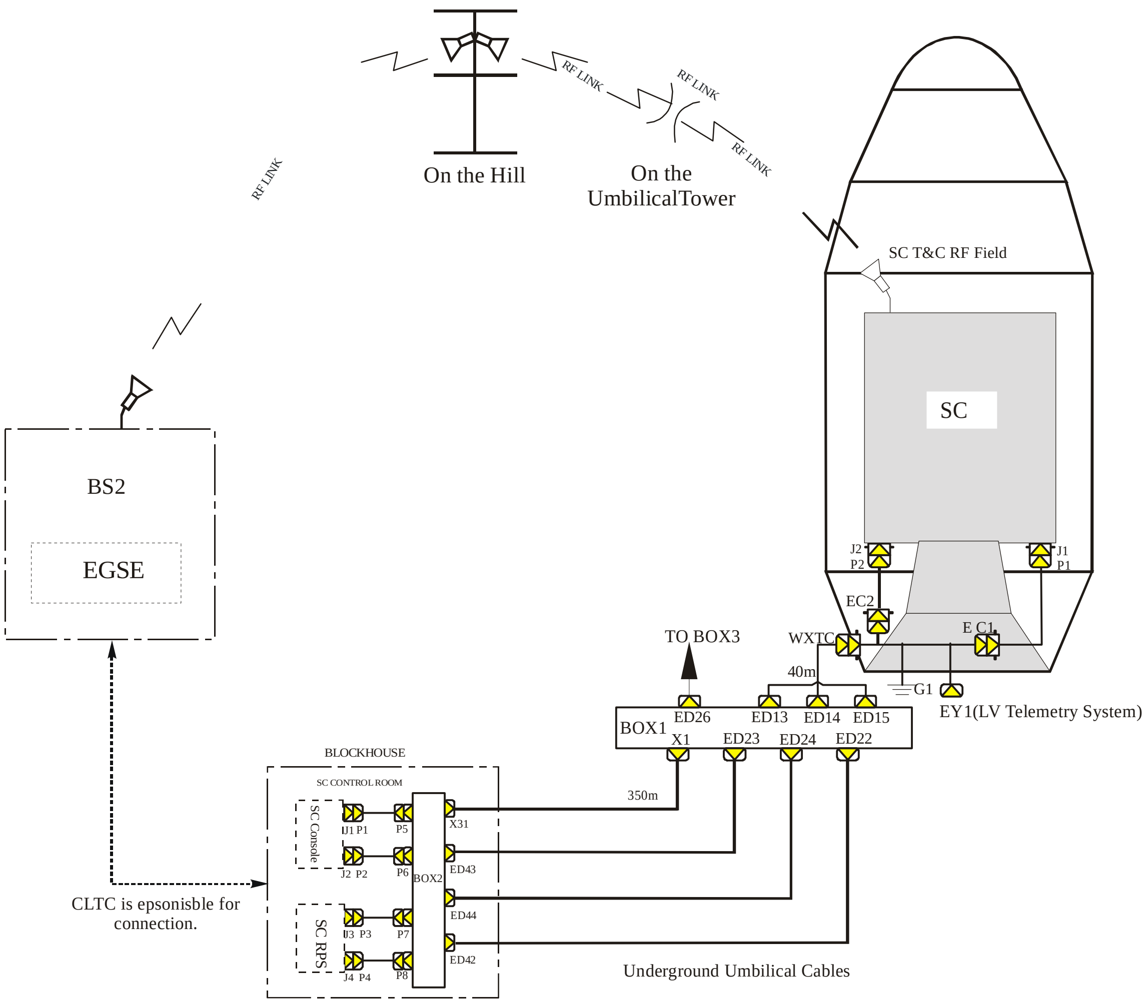


Figure 5-9 On-board and Ground Umbilical Interface

5.3.2 In-Flight-Disconnectors (IFDs)

5.3.2.1 Quantity

There are two IFDs symmetrically mounted outside the top ring of the payload adapter. The detailed location will be coordinated between SC and LV sides and finally defined in ICD. See **Figure 5-10** for typical IFD location.

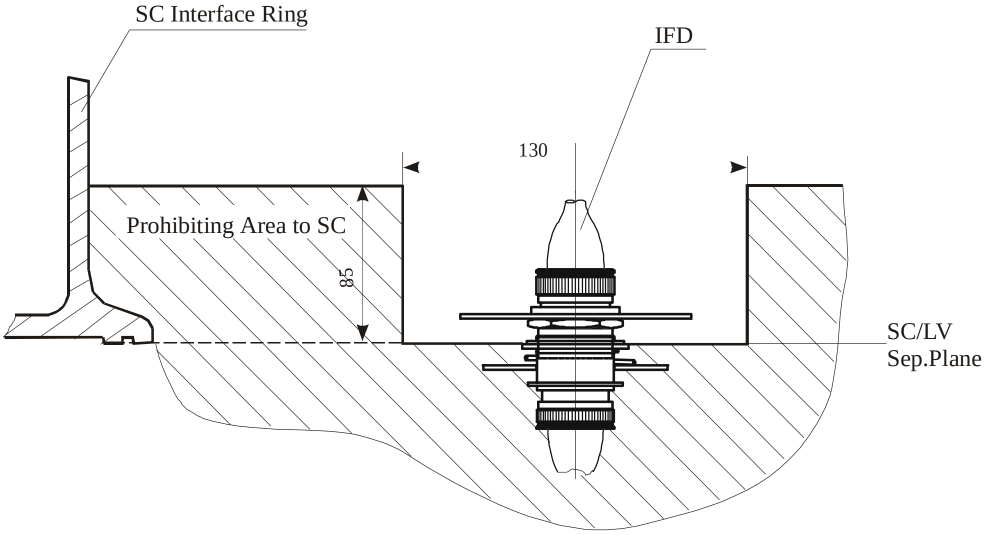


Figure 5-10 Typical IFD Location

5.3.2.2 Types

Generally, the IFDs are selected and provided by the user. It is suggested to use following DEUTSCH products. (DEUTSCH Engineered Connecting Devices, California, US)

LV Side		SC Side	
Code	Type	Code	Type
P2	D8179E37-OPN	J1	D8174E37-OSN
P2	D8179E37-OPY	J2	D8174E37-OSY

Note:

(1) The IFDs will separate when disengagement reaches 13.5mm. User can also select other DEUTSCH product according to its needs, such as DBAS7061.

(2) Following Chinese-made products are also available, YF8-64 (64 pins), FD-

20(20 pins), FD-26(26 pins), FD-50(50 pins), etc.

5.3.2.3 IFD Supply

Generally, User provides the whole set of the IFDs to CALT for the soldering on the umbilical cables. The necessary operation and measurement description shall also be provided. (If the user selects the Chinese-made connectors, CALT will provide the halves installed at the SC side.)

5.3.2.4 Characteristics of IFD

SC side shall specify characteristics of the IFDs. The specific contents are pin assignment, usage, maximum voltage, maximum current, one-way maximum resistance etc. CALT will design the umbilical cable according to the above requirements.

5.3.3 Umbilical System

The umbilical system consists of onboard-LV parts and ground cable parts.

5.3.3.1 Onboard-LV Umbilical Cable

(1) Composition

The Onboard-LV cable net comprises the cables from the IFDs (P1, P2) to WXTC. These umbilical cables will fly with LV.

Whereas:

Code	Description
P1、P2	LV/SC electrical connectors at LV side which is crimp-connected to the cables.
EC1、EC2	Technological interfaces between SC adapter and LV
EY1	Interface between umbilical cable and LV TM system, through which the SC/LV separation signal is sent to LV TM system
WXTC	Umbilical cable connector (LV-Ground)
G1	Grounding points to overlap the shielding of wires and the shell of LV

(2) Circuitry of separation signal

There are four break-wires on the IFDs P1 & P2, which generate SC/LV separation signals. The SC will receive the SC/LV separation signals once the break-wires circuitry break when SC/LV separates.

In the same way, there are two break-wires on the IFDs J1 & J2. The IFDs will send the SC/LV separation signal to LV once the break-wires circuitry break when SC/LV separates. This separation signal will be sent to LV’s telemetry system through EY1 interface. Refer to **Figure 5-11** for the break-wire’s circuitry. The break-wire’s allowable current: ≤100mA, allowable voltage: ≤30V.

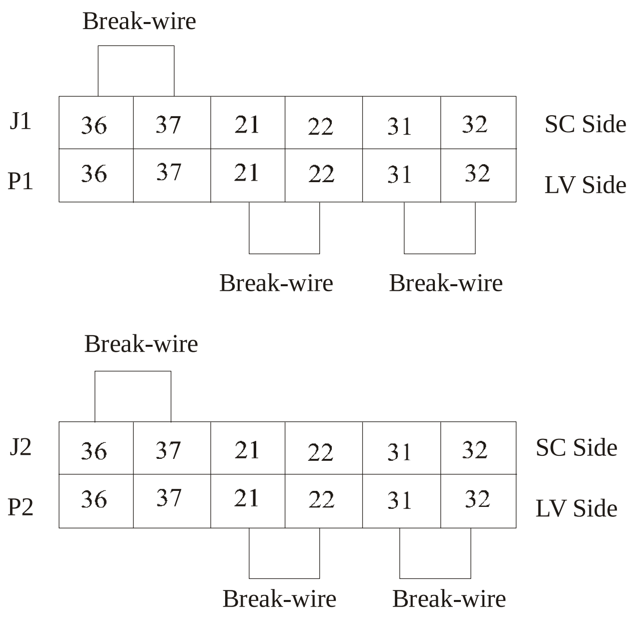


Figure 5-11 Break-wire for SC/LV Separation Signal

There are two microswitches on the payload adapter to give the mechanical separation signal. This separation signal will also be sent to LV’s telemetry system.

5.3.3.2 Ground Umbilical Cable Net

(1) Composition

The ground umbilical cable net consists of umbilical cable connector (WXTC), cables, box adapters, etc. Refer to **Figure 5-8** and **Figure 5-9**.

Whereas:

Code	Description
WXTC	WXTC is umbilical cable connector (LV-Ground) whose female half (socket) is installed at the wall of 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 BOX 3 and controlled by BOX 4. In the mean time, forced disconnection is also used as a spare separation method.) Generally, WXTC disconnects at about 8min prior to launch. If the launch was terminated after the disconnection, WXTC could be reconnected within 30min. 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 30V, ≤100mA) is permitted to pass through the WXTC.
BOX1	BOX 1 is a box adapter for umbilical cable that is located inside the SC Cable Measurement Room on Floor 8.5 of the umbilical tower. (If needed, BOX 1 can provide more interfaces for the connection with SC ground equipment.)
BOX2	BOX 2 is another box adapter for umbilical cable that is located inside the SC Blockhouse on ground. Other SC ground support equipment (RPS, Console, etc.) are also located inside the Blockhouse.
BOX3	This is a relay box for the disconnection of the umbilical cable. BOX 3 is located inside the under-ground Power-Supply Room. Box 3 is powered by 2 DC regulated power supply sets. These two power supply sets are in "working-state" sparing to each other.
BOX4	BOX 4 is located inside Blockhouse. It is for the control of the pre-launch disconnection of SC (Payload) umbilical cables.

(2) Interface on Ground

Generally, there are four interfaces on ground, namely, two for SC Console (P1/J1&P2/J2), and the other two for SC power supply (P3/J3&P4/J4). SC side will define the detailed requirement of ground interfaces. Those connectors (P1,P2,P3,P4) to be connected with SC ground equipment should be provided by SC side to LV side for the manufacture of cables.

Location	Code	Specification	Quantity
LV side interfaces	P1 P2 P3 P4	To be defined by SC side	2 2 2 2

If LV side couldn't get the connectors from SC side, this ground interface cable will be provided in cores with pin marks.

SC side can also provide this ground cable. The length of this cable is about 5 meters. If so, LV side will provide the connectors (as Y11P-61) to connect with BOX 2.

(3) Type & Performance

The type and performance of the umbilical cables are listed in **Figure 5-8.**

✧ Onboard-LV Cable Net

Generally, ASTVR and ASTVRP wires are adopted for the onboard-LV cable net:
ASTVR, 0.5mm^2, fiber-sheath, PVC insulation;
ASTVRP, 0.5mm^2, fiber-sheath, PVC insulation, shielded.

For both cables, their working voltage is ≤500V and DC resistance is 38.0Ω/km (20°C). The single core or cluster is shielded and sheathed.

✧ Ground Cable Net

● Single-Core Shielded Cable

KYVRPP 80×0.5, Copper core, PV insulation, copper film plating on PV for shielding of each core, PVC sheath, woven wire net for shielding of cable; 80

cores/cable, 0.5mm^2/core; Working voltage: ≤60V; DC resistance (20°C) of each core: 38.0Ω/km.

- Ordinary Insulation Cable

KYVRP-1 108×0.75, copper core with PV insulation, PVC sheath, woven wire for shielding, flexible; 108 cores/cable, 0.75mm^2/core; No shielding for each core, woven tin-plated copper wire for shielding of cable; Working voltage: ≤110V; DC resistance (20°C) of each core: 28.0Ω/km.

- Twin-twist Shielded Cable

KSEYVP 6×2×0.75, 6 pairs of twin-twisted cores, 0.75mm^2/core. Each twisted pair is shielded and the whole cable has a woven wire net for shielding. Impedance: 100Ω.

Twin-twist shielded cable (KSEYVP) are generally used for SC data transmission and communication. Single-core shielded cable (KYVRPP) is often used for common control and signal indicating. KYVRP-1 cable is adopted for SC's power supply on ground and multi-cores are paralleled to meet the SC's single-loop resistance requirement.

Under normal condition, the umbilical cable (both on-board and ground) has a insulation resistance of ≥10MΩ (including between cores, core and shielding, core and LV shell)

5.3.3.3 Umbilical Cable Disconnect Control

LV side is responsible for the pre-launch disconnection of umbilical cable through BOX3 and BOX 4, see **Figure 5-12**.

Inside the underground Power Supply Room, there are two 36V/10A DC regulated power supply which will provide power for the cables. They are all in working condition sparing to each other.

Generally, according to the count-down launch procedure, only after LV side has received the confirmation that SC has turned to internal power and SC is normal, could the order of umbilical cable disconnection be sent out.

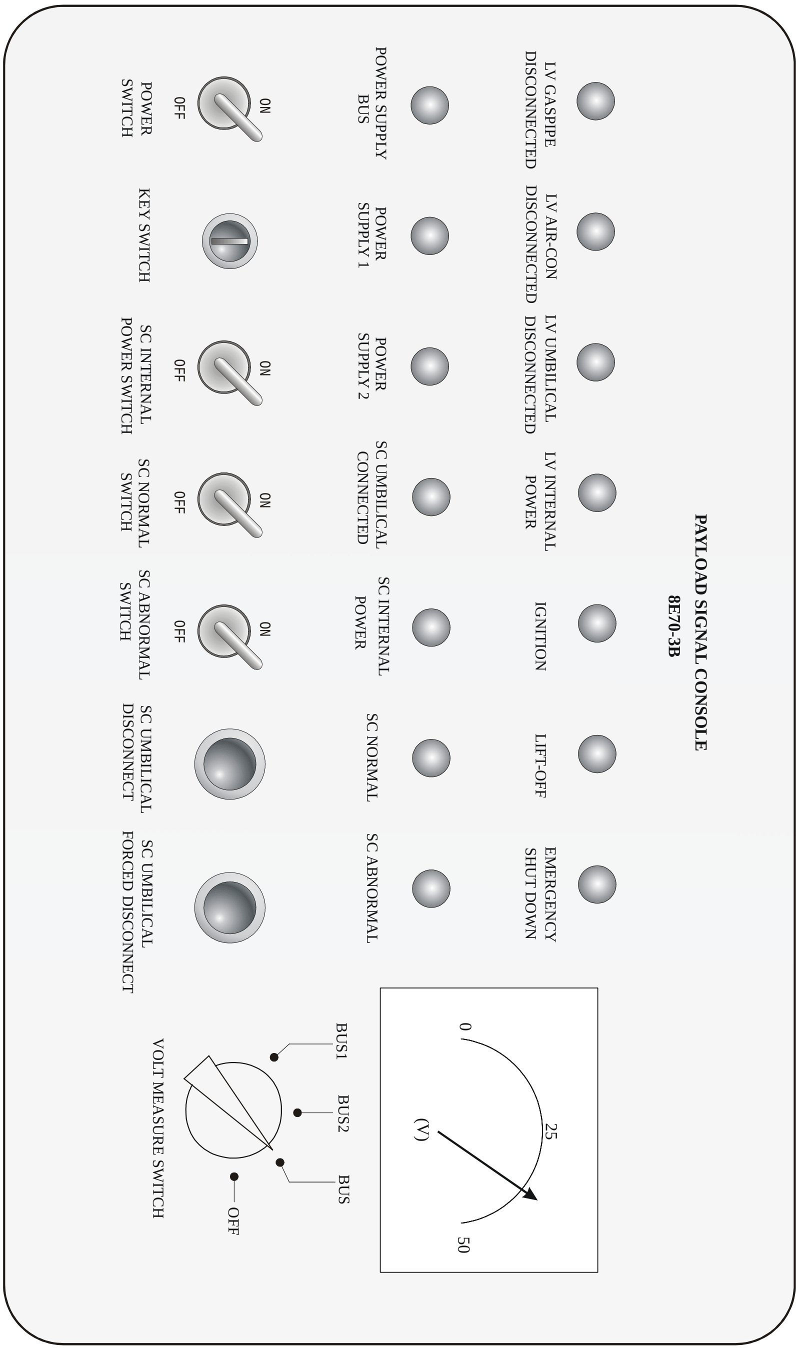


Figure 5-12 Illustration on the Control Panel of BOX4

5-31

5.3.4 Anti-lightning, Shielding and Grounding

In order to assure the safety of the operations of both LV and SC, some measures have been taken for anti-lightning, shielding and grounding.

(1) The cable has two shielding layers, the outer shielding is for anti-lightning while the inner shielding is for anti-interference.
(2) For the cables from WXTC to BOX 2, the outer shielding (anti-lightning) has a grounding point every 20m. These grounding measures can assure the lightning and other inductance to be discharged immediately. The grounding locations are either on the swing rods or the cable's supporting brackets.
(3) The inner shield has a single grounding. The inner shields of the on-board cables are connected to BOX 2 through WXTC. BOX 2 has a grounding pole.
(4) The inner and outer shields are insulated with each other inside the cables.

5.3.5 Continuity of SC "Earth-Potential"

The SC should have a reference point of earth-potential and this benchmark should be near to the SC/LV separation plane. Generally, the resistance between all other metal parts of SC (shell, structures, etc.) and this benchmark should be less than 10mΩ under a current of 10mA.

There is also a reference-point of earth-potential at the bottom of the adapter. The resistance between LV reference point at the adapter and SC reference should be less than 10mΩ with a current of 10mA. In order to keep the continuity of earth-potential and meet this requirement, the bottom of SC to be mated with adapter should not be treated chemically or treated through any other methodology affecting its electrical conductivity.

5.3.6 Miscellaneous

5.3.6.1 SC/LV Separation Control

(1) The characteristics of the explosive bolts on the clampband is as follows:

Ignition Method:	Two-end Ignition (Two Bridges on Each End)
Quantities:	2 (Redundancy Design)
Ignition Resistance:	0.9~1.2Ω for one Bridge
Ignition Current:	5~10A for one Bridge

(2) Ignition Signal

According to the flight procedures and time sequence, the onboard computer and programmer send out ignition signal to the explosive bolts to separate LV/SC reliably.

The ignition signal has following characteristics:

Battery voltage:	30±3V,
Signal duration (Impulse width):	≥200ms
Working current:	5~10A

5.3.6.2 Special Signal Service

If required, the LV time sequence system can provide some signals to SC through the onboard-LV cables and connectors. These signals can either be power-supply or dry-loop signals to be defined by SC side.

5.3.6.3 Special Statement

Any signal possibly dangerous to the flight can not be sent to the payload during the whole flight till SC/LV separation. Only LV/SC separation can be used as the initial reference for all SC operations. After LV/SC separation, SC side can control SC through microswitches and remote commands.

5.4 RF Links

5.4.1 RF Relay Path

The Launch Site can provide RF link from EGSE to SC either in BS or on the umbilical tower.

RF link path consists of points A (BS2), B (Relay Station), C (Umbilical Tower), and D (BS3). Refer to **Figure 5-13**.

At point C, there are two antennas, one of which points to SC and the other points to relay station (Point B). There are also two antennas at Point B. The two antennas have the function of amplifying signals. There are interfaces in BS2 to convey the RF signals from/to EGSE.

5.4.2 Characteristics of RF Link

(1) Frequency

C Band: Up-link: 5925~6425 MHz
Down-link: 3700~4200 MHz

Ku Band: TBD

(2) Signal Level

C Band: See following table
Ku Band: TBD

Frequency	SC Antenna		EGSE	
	EIRP	PFD	Input	Output
Telemetry	37dBm		-70dBm	
Command		-85dBW/m^2		30dBm

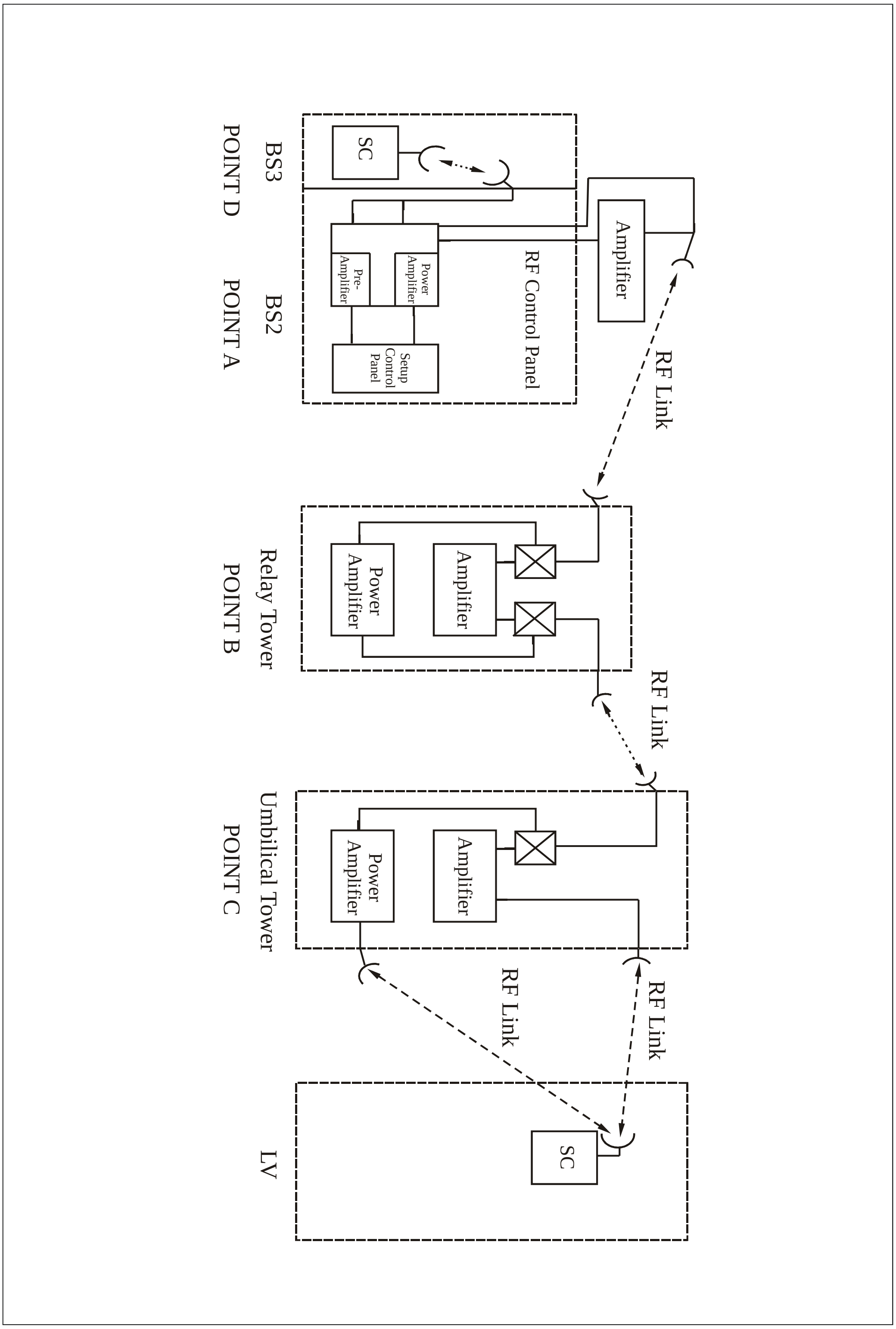


Figure 5-13 RF Links

CHAPTER 6

ENVIRONMENTAL CONDITIONS

6.1 Summary

This chapter introduces the natural environment of launch site, thermal environment during SC operation, thermal and mechanical environments (vibration, shock & noise) during LV flight and ground & on-board electromagnetic environment.

6.2 Pre-launch Environments

6.2.1 Natural Environment

The natural environmental data in XSLC such as temperature, ground wind, humidity and winds aloft are concluded by long-term statistic research as listed below.

(1) Temperature statistic result for each month at launch site.

Month	Highest (°C)	Lowest (°C)	Mean (°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

(2) The ground wind statistic result for each month at launch site

Month	Mean Speed (m/s)	Days (Speed >13m/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

(3) The relative humidity at launch site:
Maximum: 100% at rain season;
Minimum: 6% at dry season.

(4) The winds aloft used for LV design is an integrated vector profile, see **Figure 6-1**.

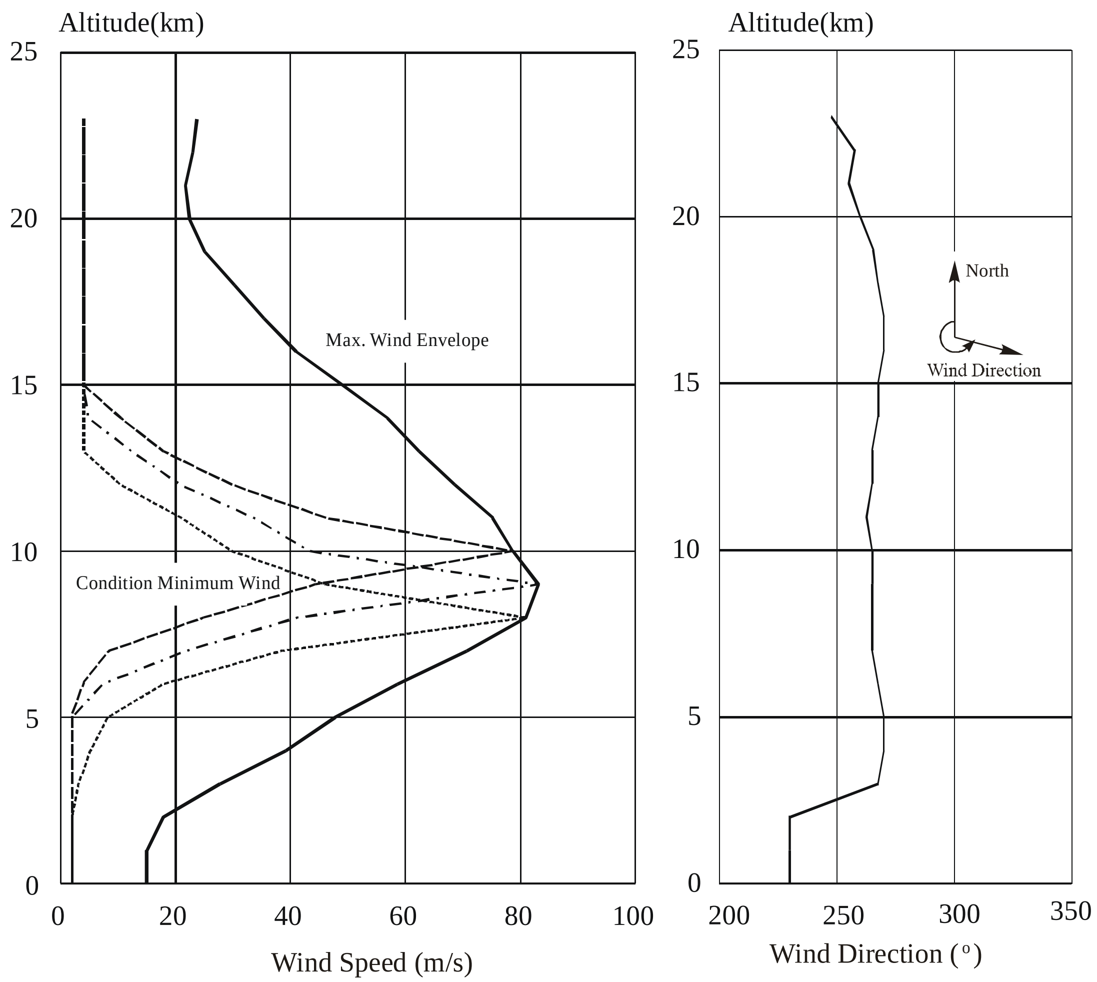


Figure 6-1 Wind Aloft Statistics Results in Xichang Area

6.2.2 SC Processing Environment

Before launch, SC will be checked, tested in SC Processing Buildings (BS2 and BS3) and then transported to the launch pad for launch. The environment impacting SC includes three phases: process in BS2 and BS3, transportation to launch pad and preparation on launch tower.

6.2.2.1 Environment of SC in BS2

The environmental parameters in BS2 and BS3 are as follows:

Temperature:	15°C~25°C
Relative humidity:	33%~55%
Cleanliness:	100,000 level

6.2.2.2 Environment of SC during Transportation to Launch Pad

(1) For Encapsulation-on-pad Method

It will take 30 minutes from BS3 to launch pad, during which the SC is put into a sealed container (SC Container) that can ensure the needed environment.

The SC Container is a sealed cylindrical container with an available inner space of 7450mm high and 3980mm in diameter. The thermal-insulation wall is made of Aluminum sandwich. See **Chapter 8**.

Before transportation, pure Nitrogen of 15°C~25°C will be filled into the SC Container to make pressurization protection. After the temperature of SC and container reaches 15°C~25°C, the container will be sealed and moved out of BS3. The temperature in the container is variable from 15°C to 25°C, the relative humidity is variable from 35% to 55%, the cleanliness is 100,000 level and the noise during the charging and venting process is lower than 90dB. During the transportation, because the inner pressure of container is higher than the outside air pressure, the cleanliness can be maintained at 100,000 level.

After the container is transported to the launch pad, it will be lifted to 8^{th} floor of the Service Tower, where an environmentally controlled area will be established. The detailed procedures are shown in **Chapter 8**. The environmental conditions in the clean area are listed below:

Temperature: 15°C~25°C;
Relative Humidity: 35%~55%;
Cleanliness: 100,000 level.

The container will stay in the clean area until the ambient environment meet the requirements, then the container will be opened and the SC will be moved out to mate to the Launch Vehicle.

(2) For Encapsulation-in-BS3 Method

The SC will be encapsulated directly into the fairing in BS3. The environment in fairing is the same as that in SC container. Before transportation, it is decided according to the specific conditions whether or not the air-conditioning system for the fairing will be introduced.

6.2.3 Air-conditioning inside Fairing

Air-conditioning system connecting to the fairing begins to work after the fairing is encapsulated on the launch pad. The fairing air-conditioning system is shown in **Figure 6-2**.

Air-conditioning parameters inside Fairing:

Temperature: 15°C~25°C
Relative Humidity: 33%~55%
Cleanliness: 100,000 level
Air Speed inside Fairing: ≤2m/s
Noise inside Fairing: ≤90dB
Max. Air Flow Rate: 3000~4000m^3/hour

The air-conditioning is shut off at L-45 minutes and would be recovered in 40 minutes if the launch aborted. The air-conditioning inlets are shown in **Chapter 4**.

For the fairing encapsulated in BS3, the air-conditioning begins to work after the fairing and SC mating to the Launch Vehicle.

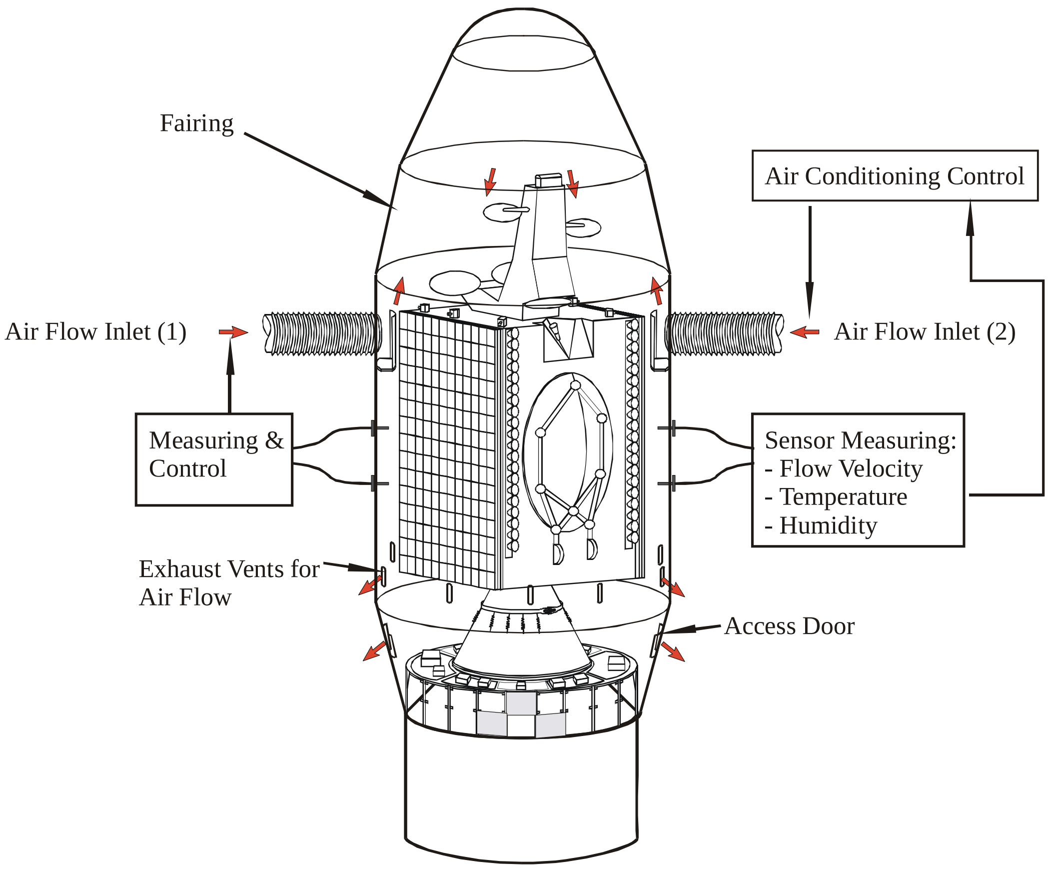


Figure 6-2 Fairing Air-conditioning on the Tower

6.2.4 Electromagnetic Environment

6.2.4.1 Radio Equipment onboard LM-3B and Ground Test Equipment

Characteristics of on-board radio equipment and ground test equipment are shown below:

	EQUIPMENT	FREQUENCY (MHz)	POWER (W)	Sensitivity	Polarization	Antenna position
LAUNCH VEHICLE	Telemetry Transmitter 3	2200~2300	10		linear	VEB
	Telemetry Transmitter 2	2200~2300	5		linear	Stage-2 Intertank
	Transponder 1	Rec.5840~5890 Tra.4200~4250	5	≤-120dBW	linear	Stage -2 Intertank
	Transponder 2	Rec.5860~5910 Tra.4210~4250	2	≤-120dBW	linear	Stage -2 Intertank
	Transponder 3	Rec. and Tra. 5580~5620	300(max) 0.8~1.0μs 800Hz P_{av}<300 mW	≤-90dBW	linear	Stage-3 Rear shell
	Beacon	2730~2770	2		linear	Stage-3 Rear shell
	Telemetry command Receiver	550~750		≤-128dBW	linear	Stage-2 Intertank
GROUND	Tester for Transponder 1	5840~5890	0.5			Tracking & safety system ground test room at launch center
	Tester for Transponder 2	5870~5910	0.5			
	Tester for Transponder 3	5570~5620	100W(peak)			
	Telemetry Command Transmitter	550~750	1W			

Onboard radio equipment mounted positions are shown in **Figure 6-3**.

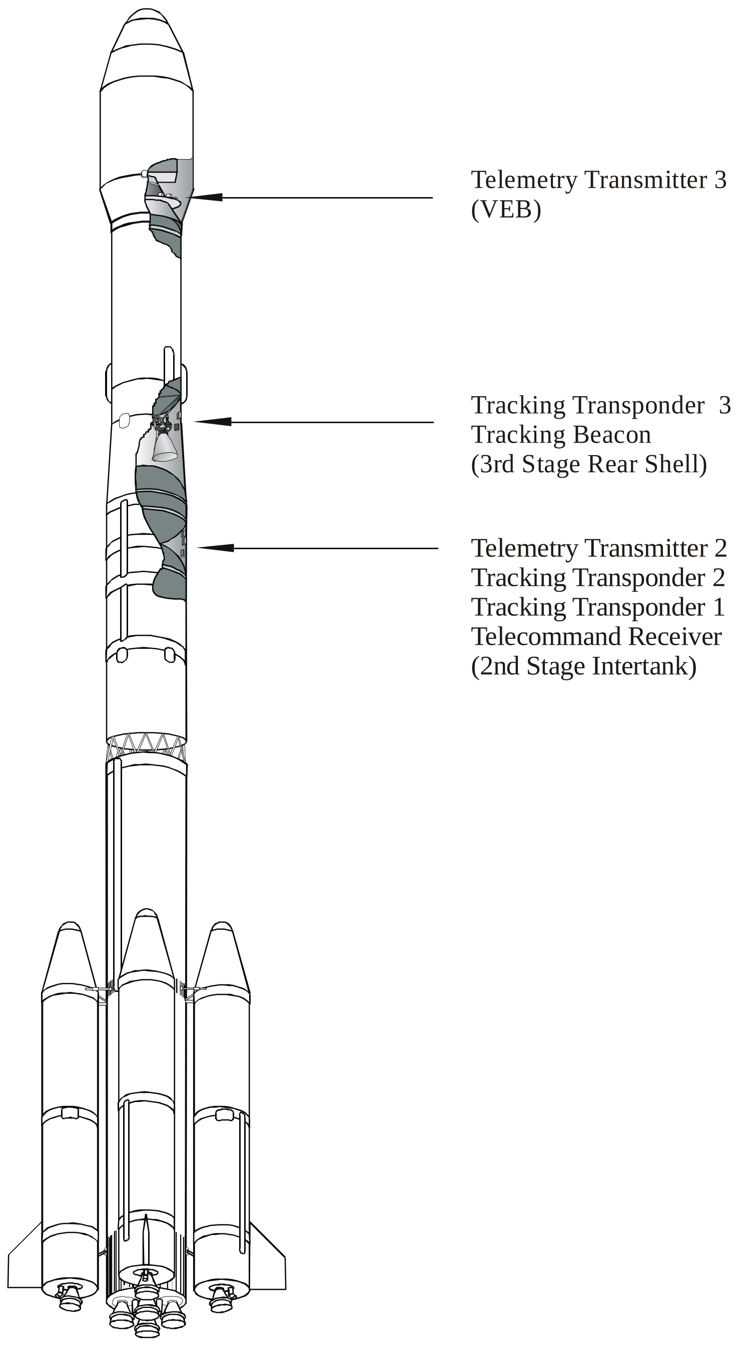


Figure 6-3 On-board Radio Equipment Mounted Positions

6.2.4.2 RF Equipment and Radiation Strength at XSLC

Working frequency:	5577~5617 MHz
Antenna diameter:	4.2m
Impulse power:	<1500 kW
Impulse width:	0.0008ms
Min. pulse duration:	1.25ms
Mean power:	<1.2kW

6.2.4.3 LV Electromagnetic Radiation and Susceptibility

The energy levels of launch vehicle electromagnetic radiation and susceptibility are measured at 1m above VEB. They are shown in **Figure 6-4** to **Figure 6-6**.

6.2.4.4 EMC Analysis among SC, LV and Launch Site

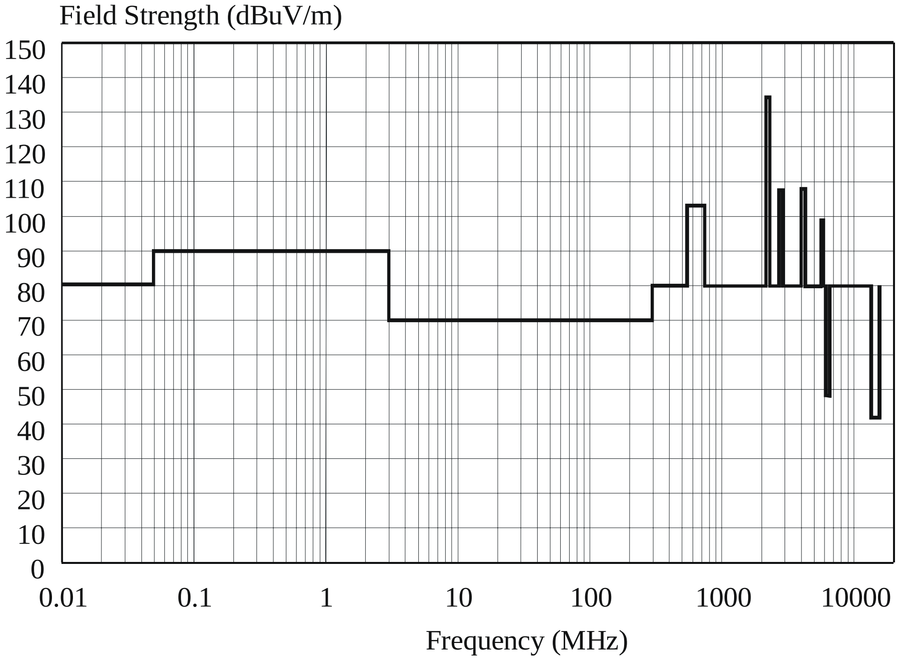
To conduct the EMC analysis among SC, LV and launch site, both SC and LV sides should provide related information to each other. The information provided by CALT are listed as **Figure 6-4** to **Figure 6-6,** while the information provided by SC side are as follows:

a. SC RF system configuration, characteristics, working time, antenna position and direction, etc.
b. Values and curves of the narrow-band electric field of intentional and parasitic radiation generated by SC RF system at SC/LV separation plane and values and curves of the electromagnetic susceptibility accepted by SC.

CALT will perform the preliminary EMC analysis based on the information provided by SC side, and both sides will determine whether it is necessary to request further information according to the analysis result.

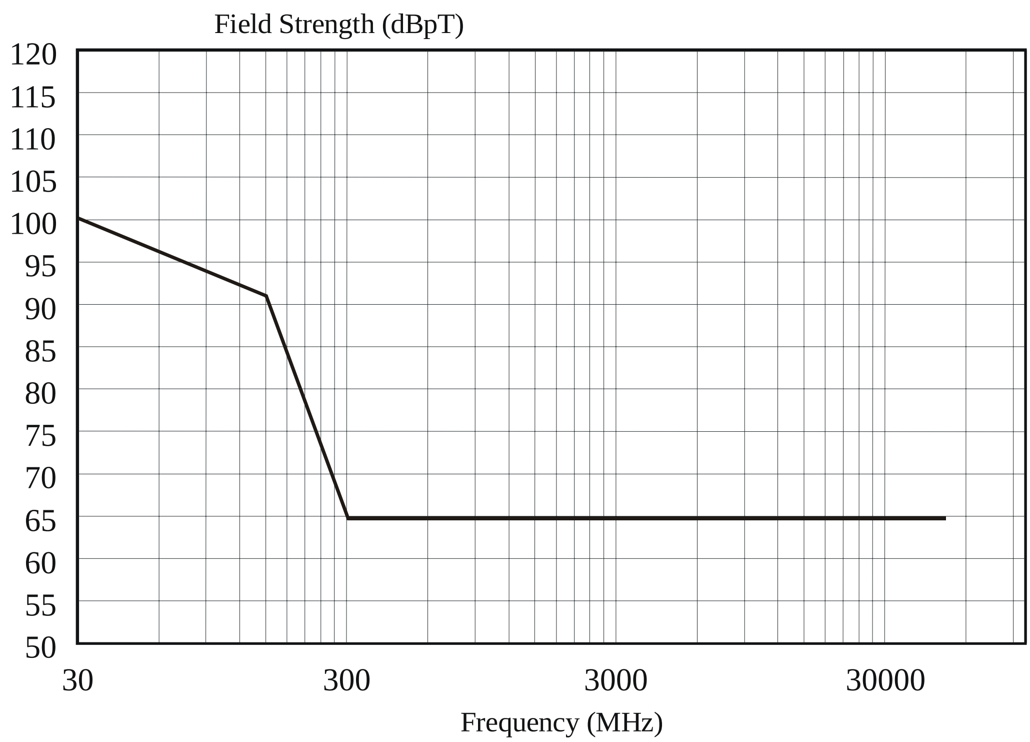
6.2.5 Contamination Control

The molecule deposition on SC surface is less than $2mg/m^2$/week.



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	134
2300-2730	80
2730-2770	107
2770-4200	80
4200-4250	107
4250-5580	80
5580-5620	99
5620-6000	80
6000-6500	48
6500-13500	80
13500-15000	42
15000-	80

Figure 6-4 Intentional Radiation from LV and Launch Site



Frequency (MHz)	Field Strength (dBpT)
30-150	100-91 (linear)
150-300	91-65 (linear)
300-50000	65

Figure 6-5 Magnetic Field Radiation from LV and Launch Site

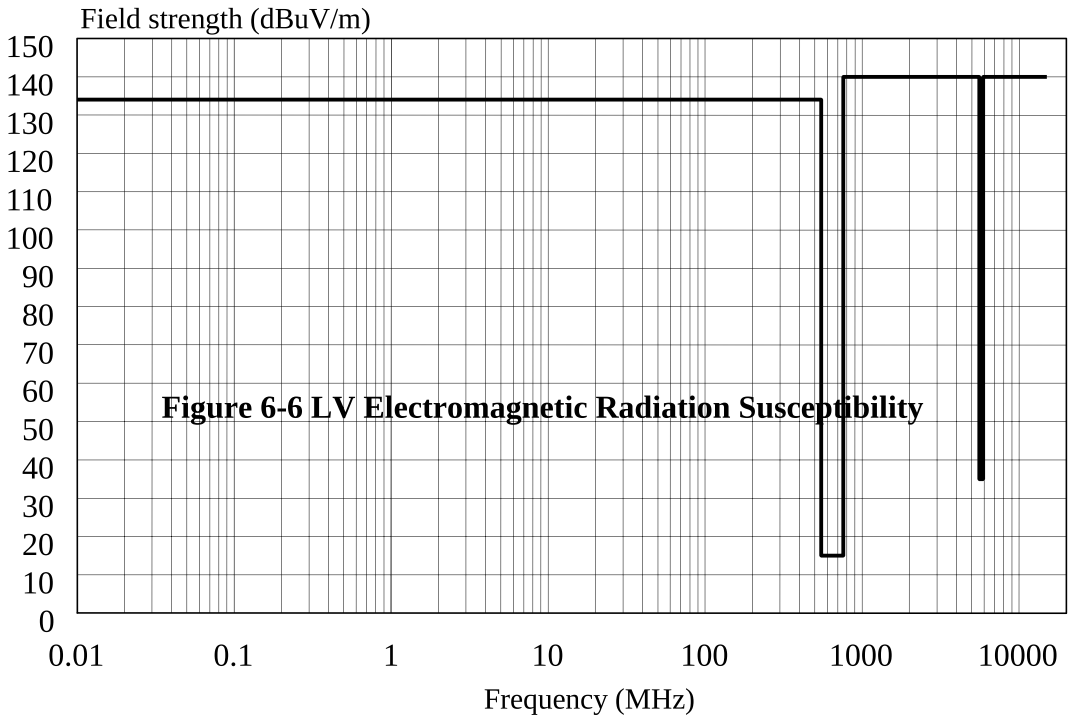


Figure 6-6 LV Electromagnetic Radiation Susceptibility

Frequency (MHz)	Field Strength (dBpT)
0.01-550	134
550-760	15
5580-5910	35

Figure 6-6 LV Electro-Magnetic Radiation Susceptibility

6.3 Flight Environment

6.3.1 Pressure Environment

When LM-3B launch vehicle flights in the atmosphere, the fairing air-depressurization is provided by 10 vents (total venting area 191cm^2) opened on the lower cylindrical section. The design range of fairing internal pressure is presented in **Figure 6-7**. The maximum depressurization rate inside fairing will not exceed 6.9kPa/sec.

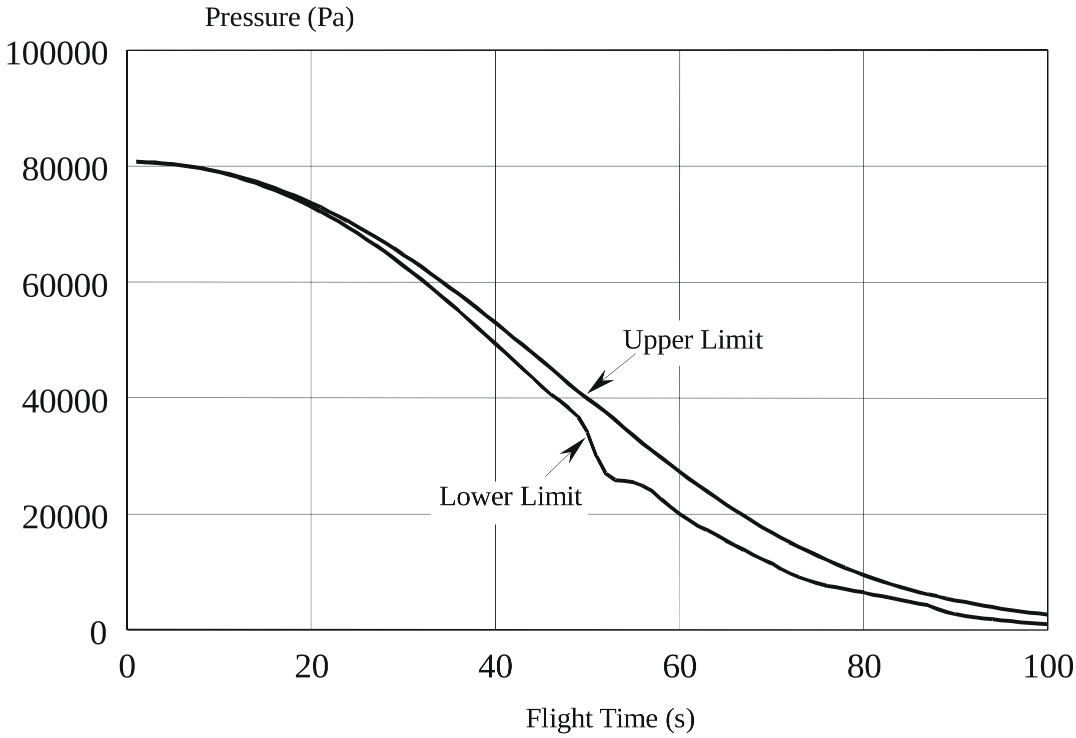


Figure 6-7 Design Range of Fairing Internal Pressure during LV Flight

6.3.2 Thermal environment

The radiation heat flux density and radiant rate from the inner surface of each section of the fairing is shown in **Figure 6-8**.

The free molecular heating flux at fairing jettisoning shall be lower than 1135W/m^2 (See **Figure 6-9**). After fairing jettisoning, the thermal effects caused by the sun radiation, Earth infrared radiation and albedo will also be considered. The specific affects will be determined through the SC/LV thermal environment analysis by CALT.

The LV retro-rockets will work 1.5 sec. and generate the heat flux of <300W/m^2 at SC/LV separation plane.

The heat flux due to third-stage engines working will not exceed 700 W/m^2 at SC/LV separation plane.

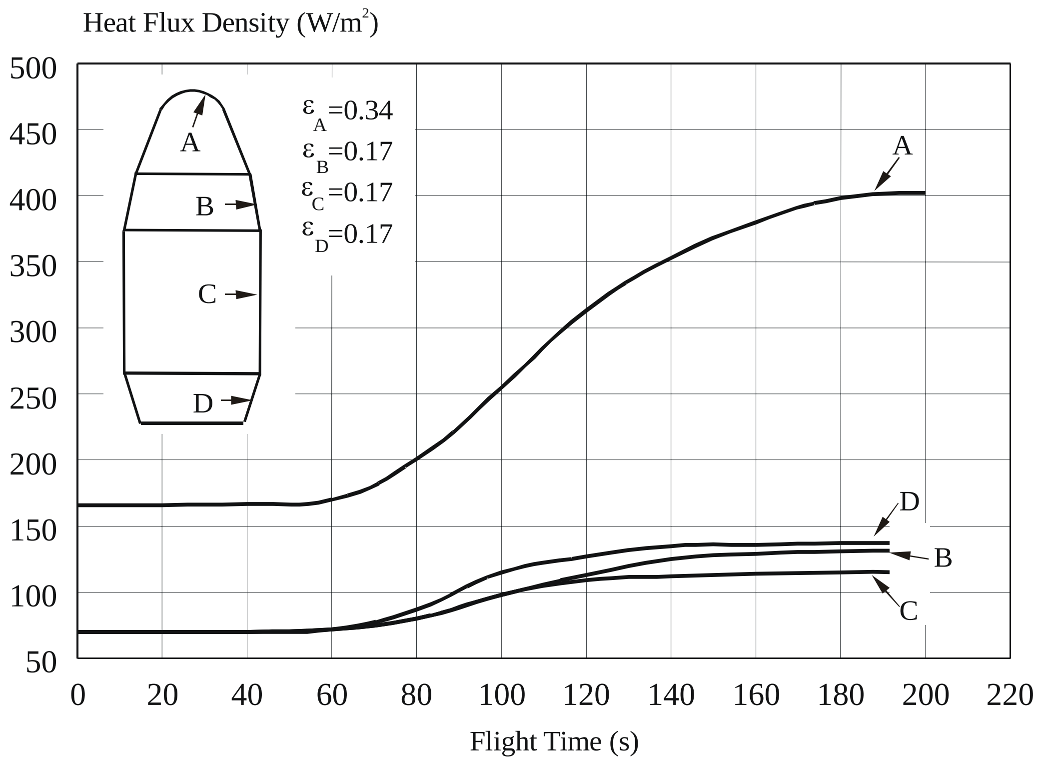


Figure 6-8 Radiation Heat Flux Density and Radiant Rate on the Inner Surface of Each Section of the Fairing

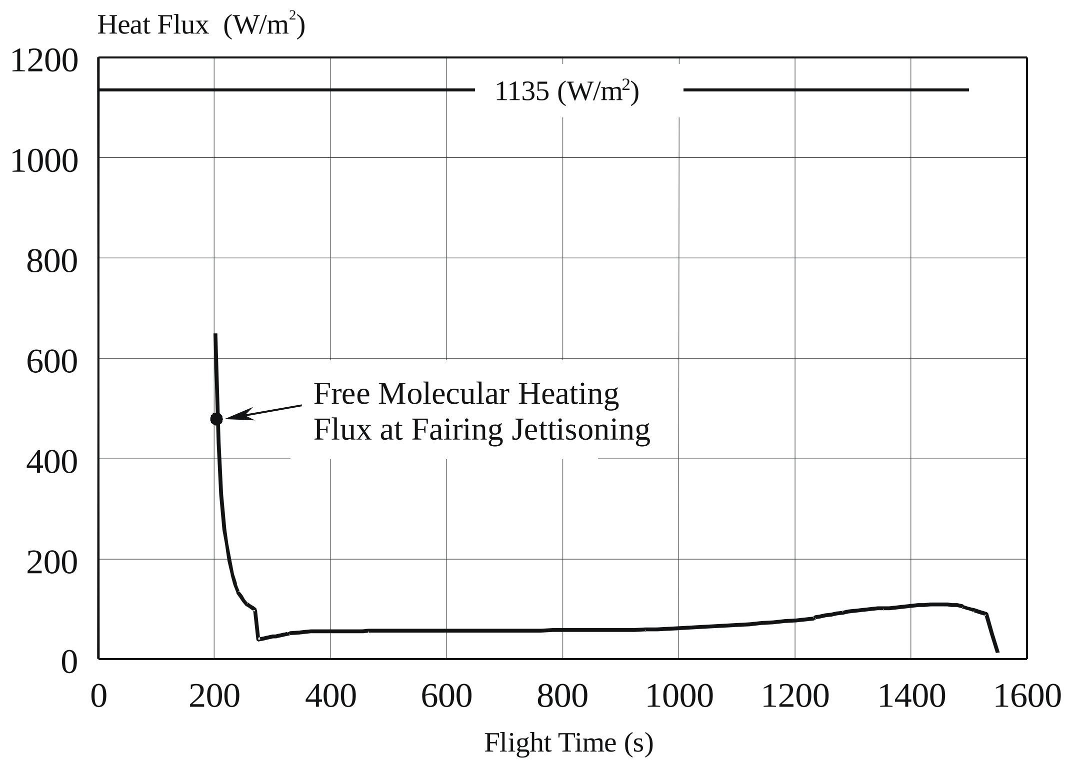


Figure 6-9 Typical Free Molecular Heating Flux

6.3.3 Static Acceleration

The launch vehicle longitudinal external forces generate the static longitudinal acceleration. They mainly include engine thrust and aerodynamic force.

The typical maximum longitudinal acceleration during LV powered flights are shown in the following table. It can be seen that the maximum static acceleration occurred just prior to booster separation. The maximum static acceleration will be slightly variable to different missions.

Events	Value
Prior to booster separation	+5.3g
Prior to Stage I cut-off	+3.6g
During Stage II flight	+2.8g
During Stage III first flight	+1.2g
During Stage III second flight	+2.5g

Note: Here "+" means the direction of the acceleration coincides with LV +X axis.

6.3.4 Vibration Environment

A. Sinusoidal Vibration

The SC sinusoidal vibration mainly occurs in the processes of engine ignition and shut-off, transonic flight and stage separations. The sinusoidal vibration (zero-peak value) at SC/LV interface is shown below.

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

B. Random Vibration

The SC random vibration is mainly generated by noise and reaches the maximum at the lift-off and transonic flight periods.

The random vibration Power Spectral Density and the total Root-Mean-Square (RMS) value at SC/LV separation plane in three directions are given in the table below.

Frequency Range (Hz)	Power Spectral Density	Total RMS Value
20 - 200	6 dB/octave.	7.48 g
200 - 800	0.04 g^2/Hz	
800 - 2000	-3 dB/octave.	

6.3.5 Acoustic Noise

The flight noise mainly includes the engine noise and aerodynamic noise. The maximum acoustic noise suffered by SC occurs at the moment of lift-off and during the transonic flight phase. The values in the table below are the maximum noise levels in fairing.

Central Frequency of Octave Bandwidth (Hz)	Acoustic Pressure Level (dB)
31.5	120
63	126
125	132
250	136
500	135
1000	132
2000	127
4000	123
8000	116
Total Acoustic Pressure Level	141

0 dB referenced to 2×10^{-5} Pa.

6.3.6 Shock Environment

The maximum shock that SC suffered occurs at the SC/LV separation. The shock response spectrum at SC/LV separation plane is shown bellow.

Frequency Range (Hz)	Response Acceleration (Q=10)
100-1500	9.0 dB/octave.
1500-4000	4000 g

6.4 Load Conditions for SC Design

6.4.1 Frequency Requirement

To avoid the SC resonance with LM-3B launch vehicle, the primary frequency of SC structure should meet the following requirement (under the condition that SC/LV separation plane is considered as rigid body):

The frequency of the lateral main mode>10Hz

The frequency of the longitudinal main mode >30Hz

6.4.2 Loads Applied for SC Structure Design

The maximum lateral load occurs at the transonic phase or Maximum Dynamic Pressure phase. The maximum axial static load occurs prior to the boosters' separation. The maximum axial dynamic load occurs after the first and second stage separation. Therefore, the following limit loads corresponding to different conditions in flight are recommended for SC design consideration.

Flight Condition		Transonic phase and MDP	Prior to booster separation	After 1st/2nd stage separation
Longitudinal Acceleration(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 Acceleration(g)	Combined	1.5*	1.0	1.0

Notes:

❶ Here "*" means that 1.5g is effective only under the following conditions: The SC frequency meets the requirement in Paragraph 6.4.1, the mass of SC ≤ 5100kg, C.G location of the SC relative to the SC/LV separation plane≤1.6m.

For specific SC, the figure 1.5g may be larger. The User should consult with CALT to determine the accurate load conditions according to the specific SC conditions

❷ Usage of the above table:

SC design loads	=	Limit loads	×	Safety factor*

* The safety factor is determined by the SC designer.

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

❹ Lateral and longitudinal loads occur simultaneously.

❺ The plus sign "+" means compression in longitudinal.

6.4.3 Coupled Load Analysis

The SC manufacturer should provide the SC mathematical model to CALT for Coupled Loads Analysis (CLA) to CALT. CALT will predict the SC maximum dynamic response by coupled load analysis. The SC manufacturer should confirm that the SC could survive from the predicted environment and has adequate safe margin. (CALT requires that the safe factor is equal to or greater than 1.25.)

6.5 SC Qualification and Acceptance Test Specifications

6.5.1 Static Test (Qualification)

The main SC structure must pass static qualification tests without damage. The test level must be not lower than SC design load required in Paragraph 6.4.2.

6.5.2 Vibration Test

A. Sine Vibration Test

During tests, the SC must be rigidly mounted on the shaker. The table below specifies the vibration acceleration level (0 - peak) of SC qualification and acceptance tests at SC/LV interface. (See **Figure 6-10**)

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

Notes:

- Frequency tolerance is allowed to be ±2%
- Amplitude tolerance is allowed to be -0 ~ +10%
- Acceleration notching is permitted after consultation with CALT and concurred

by all parties. Anyway, the notched acceleration should not be lower than the coupled load's analysis results on the interface plane.

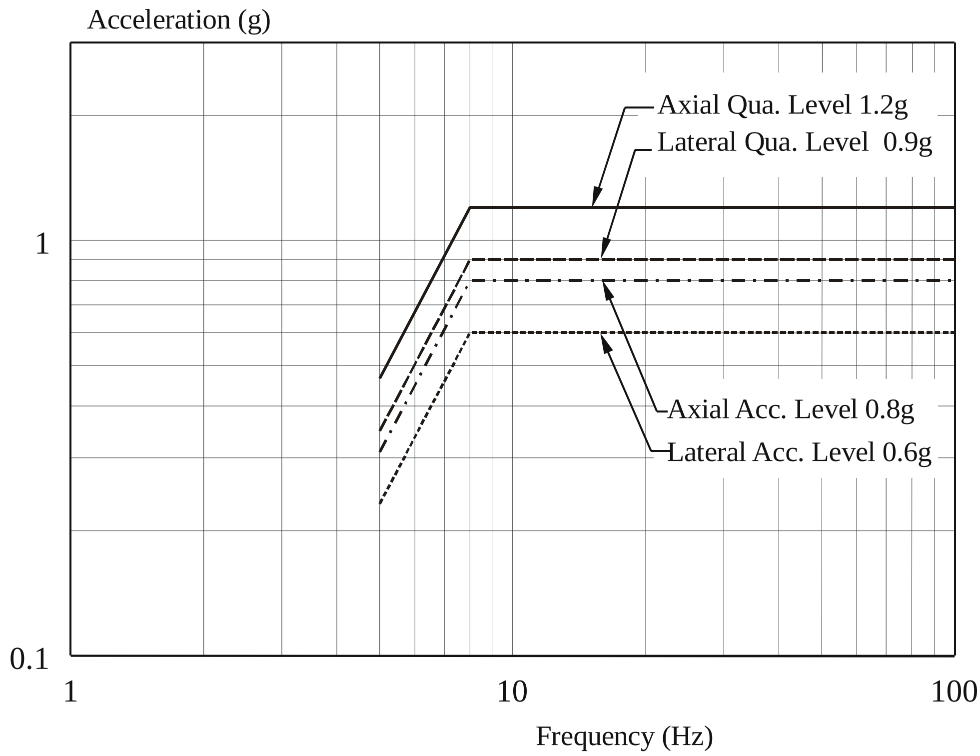


Figure 6-10 Sinusoidal Vibration Acceleration Level of SC Qualification and Acceptance Tests

B. Random Vibration Test

During tests, the SC structure must be rigidly mounted onto the shaker. The table below specifies the SC qualification and acceptance test levels at SC/LV interface in three directions (See **Figure 6-11**).

Frequency (Hz)	Acceptance		Qualification	
	Spectrum Density	Total rms (Grms)	Spectrum Density (g^2/Hz)	Total rms (Grms)
20 - 200	6 dB/octave.	7.48g	6 dB/octave.	11.22g
200 - 800	0.04 g^2/Hz		0.09 g^2/Hz	
800 - 2000	-3 dB/octave.		-3 dB/octave	
Duration	1min.		2min.	

Notes:

- Tolerances of ±3.0 dB for power spectral density and ±1.5 dB for total rms values are allowed.
- The random test can be replaced by acoustic test.

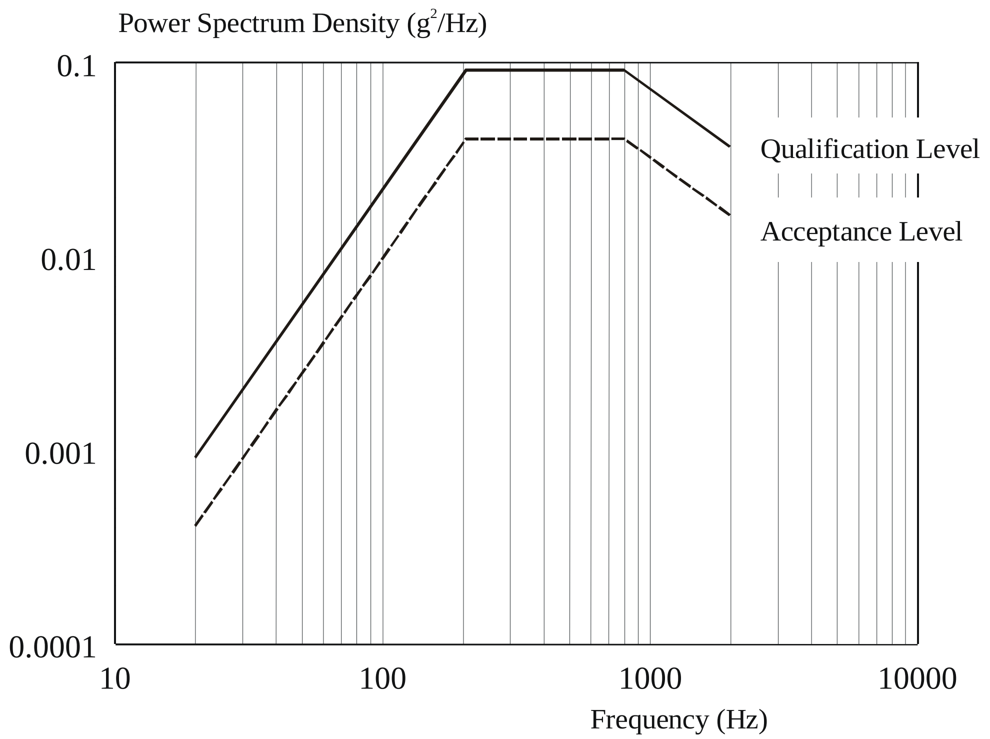


Figure 6-11 Random Vibration Acceleration Level of SC Qualification and Acceptance Tests

6.5.3 Acoustic Test

The acceptance and qualification test levels are given in the following table (also see **Figure 6-12**).

Central Octave Frequency (Hz)	Acceptance Sound Pressure Level (dB)	Qualification Sound Pressure Level (dB)	Tolerance (dB)
31.5	120	124	-2/+4
63	126	130	
125	132	136	
250	136	140	
500	135	139	
1000	132	136	
2000	127	131	
4000	123	127	-5/+4
8000	116	120	-5/+5
Total Sound Pressure Level	141	145	-1/+3

0 dB is equal to 2×10^{-5} Pa.

Test Duration:

- Acceptance test: 1.0 minute
- Qualification test: 2.0 minutes

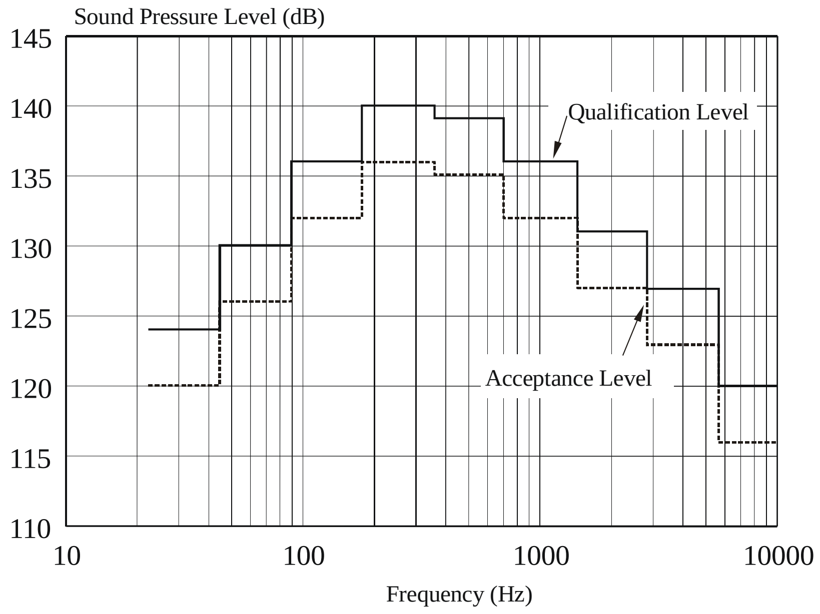
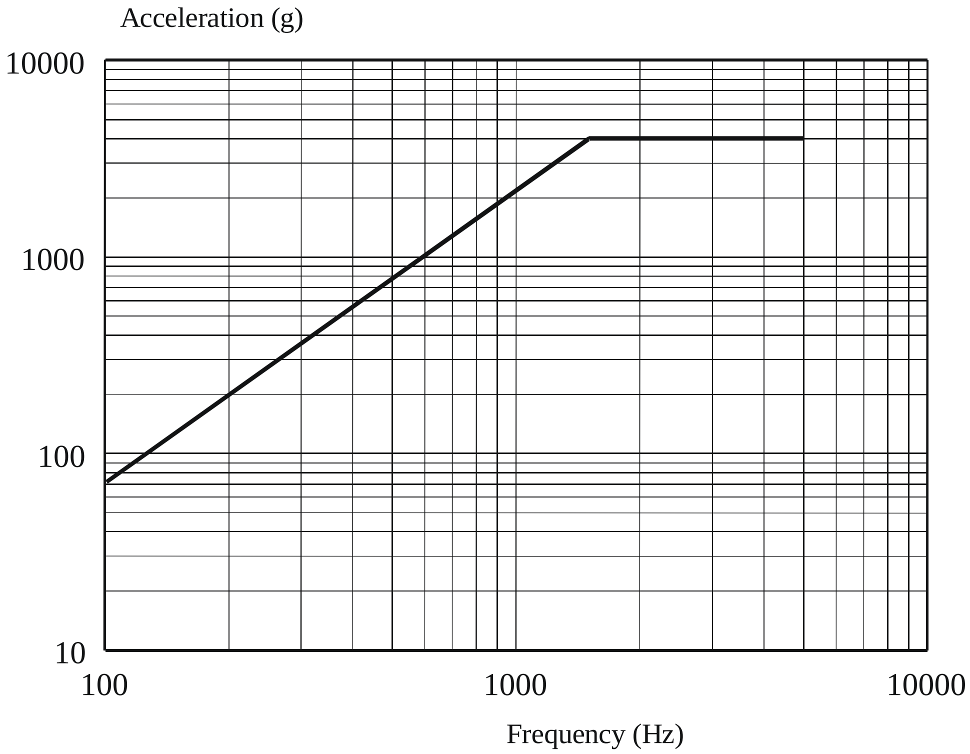


Figure 6-12 SC Acoustic Test

6.5.4 Shock Test

The shock test level is specified in Paragraph 6.3.6. Such test shall be performed once for acceptance, and twice for qualification. A ±6.0 dB tolerance in test specification is allowed. However, the test strength must be applied so that in the shock response spectral analysis over 1/6 octave on the test results, 30% of the response acceleration values at central frequencies shall be greater than or equal to the values of test level. (See **Figure 6-13**)

The shock test can also be performed through SC/LV separation test by using of flight SC, payload adapter, and separation system. Such test shall be performed once for acceptance, and twice for qualification.



Frequency Range (Hz)	Shock Response Spectrum (Q=10)
100~1500	9.0dB/octave
1500~4000	4000g

Figure 6-13 Shock Response Spectrum at SC/LV Separation Plane

6.5.5 Proto-flight Test

The Proto-flight test is suitable for the SC that is launched by LM-3B for the first time even though it has been launched by other launch vehicles.

The test level for the Proto-flight should be determined by satellite manufacturer and CALT and should be higher than the acceptance level but lower than the qualification level. If the same satellite has been tested in the conditions that are not lower than the qualification test level described in **Paragraph 6.5.2** to **Paragraph 6.5.4**, CALT will suggest the following test conditions:

a. Vibration and acoustic test should be performed according to the qualification level and acceptance test duration or scan rate specified in **Paragraph 6.5.2-6.5.3**.
b. Shock test should be performed once according to the level in **Paragraph 6.5.4**.

6.6 Environment Parameters Measurement

The inner environment of fairing is measured during each flight. The measuring parameters include temperature and pressure inside the fairing, noises inside and outside the fairing ands the vibration parameters at SC/LV interface.

CHAPTER 7

LAUNCH SITE

7.1 General Description

This chapter describes detailed information on the facilities and services provided by XSLC.

XSLC is subordinated to China Satellite Launch and Tracking Control General (CLTC). This launch site is mainly to conduct GTO missions.

XSLC is located in Xichang region, Sichuan Province, southwestern China. Its headquarter is located in Xichang City, 65 km away from the launch site. **Figure 7-1** shows the location of Xichang.

Xichang is of subtropical climate and the annual average temperature is 16ºC. The ground wind in the area is usually very gentle in all the four seasons.

Xichang Airport is located at the northern suburbs of Xichang City. The runway of Xichang Airport is capable of accommodating large aircraft such as Boeing 747 and A-124.

The Chengdu- Kunming Railway and the Sichuan-Yunnan Highway pass by XSLC. The distance between Chengdu and XSLC is 535km by railway. There are a dedicated railway branch and a highway branch leading to the Technical Center and the Launch Center of XSLC.

By using of cable network and satellite communication network, XSLC provides domestic and international telephone and facsimile services for the user.

XSLC consists of headquarter, Technical Center, Launch Center, Communication Center, Mission Center for Command and Control (MCCC), three tracking stations and other logistic support systems.

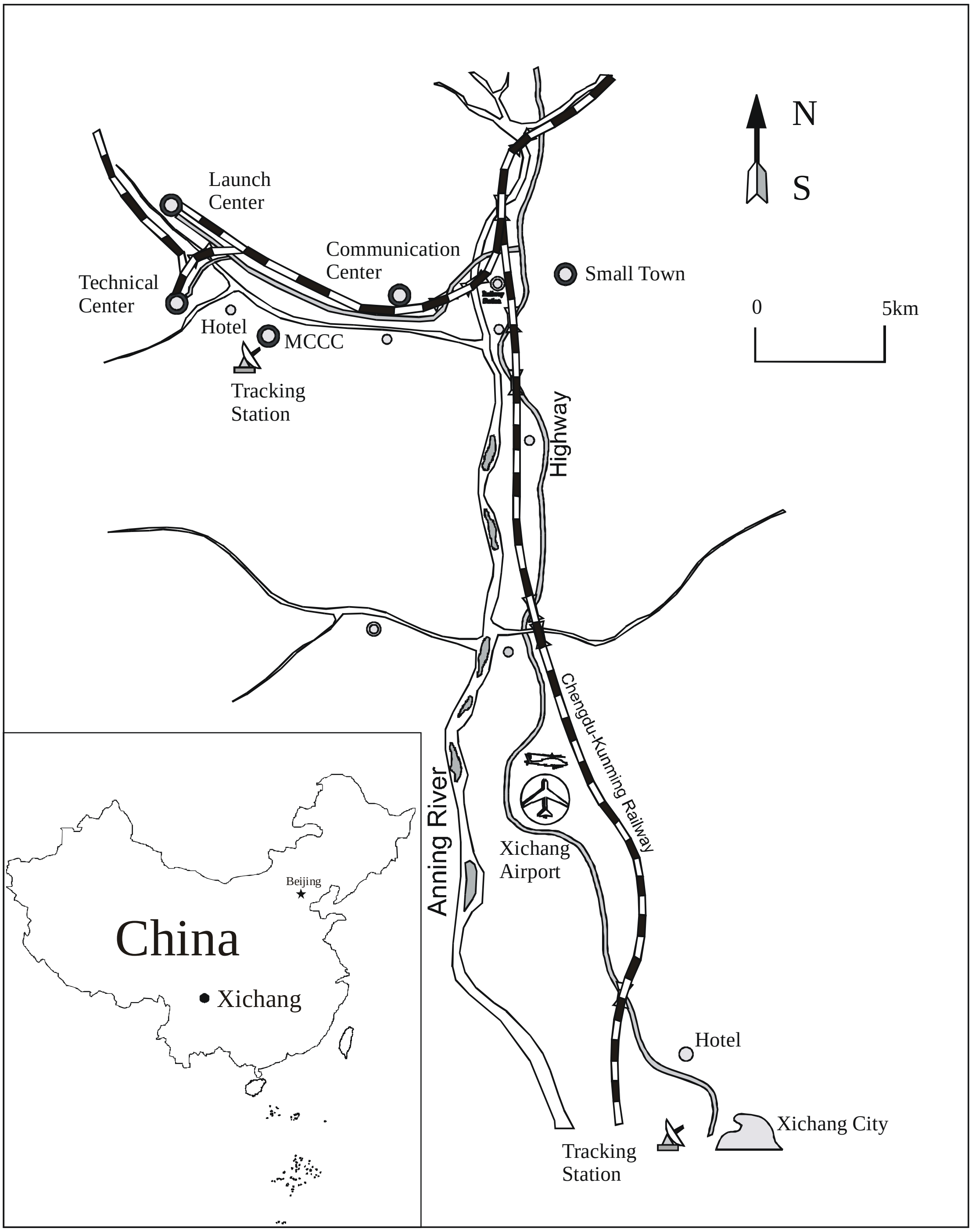


Figure 7-1 XSLC Map

7.2 Technical Center

Technical center includes LV Processing Building (BL), SC Processing Buildings (BS), Power Station, Truck-Barn, etc. The LV and the SC will be processed, tested, checked, assembled and stored in Technical Center. Refer to **Figure 7-2**.

7.2.1 LV Processing Building (BL)

The LV Processing Building (BL) comprises of Transit Building (BL1) and Testing Building (BL2).

7.2.1.1 BL1

BL1 is mainly used for the transiting and loading of the LV and other ground equipment. BL1 is 54 meters long, 30 meters wide, 13.9 meters high. The railway branch passes through BL1. BL1 is equipped with movable overhead crane. The crane has two hooks with capability of 50t and 10t respectively. The crane's maximum lifting height is 9.5meters.

7.2.1.2 BL2

BL2 is mainly used for the testing operation, necessary assembly and storage of the launch vehicle. This building is 90m long, 27m wide and 15.58m high, with the capability of processing one launch vehicle and storing another vehicle at the same time. A two-hook overhead movable crane is equipped in BL2. The lifting capabilities of the two hooks are 15t and 5t respectively. The lifting height is 12 meters. There are testing rooms and offices beside the hall.

7.2.2 SC Processing Buildings (BS)

The SC Processing Buildings includes Test and Fueling Building (BS2 and BS3), Solid Rocket Motor (SRM) Testing and Processing Buildings (BM), X-ray Building (BMX), Propellant Storage Rooms (BM1 and BM2). BS2 is non-hazardous operation building, and BS3 is hazardous operation building (BS3). All of the SC's pre-transportation testing, assembly, fuelling and SC/Adapter operations will be performed in BS2 and BS3. Refer to **Figure 7-3**, **Table 7-1** and **Table 7-2**.

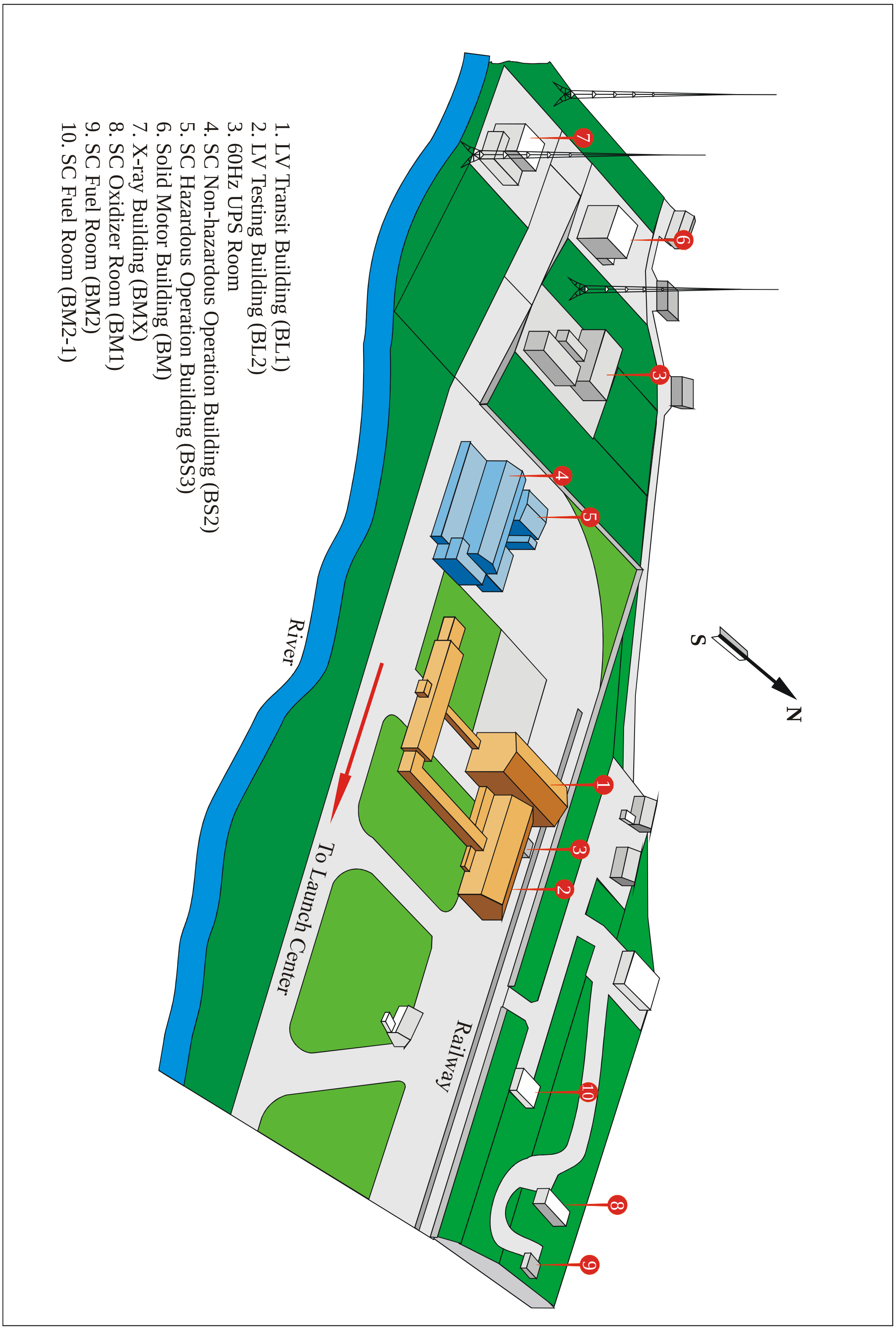


Figure 7-2 Technical Center

7-4

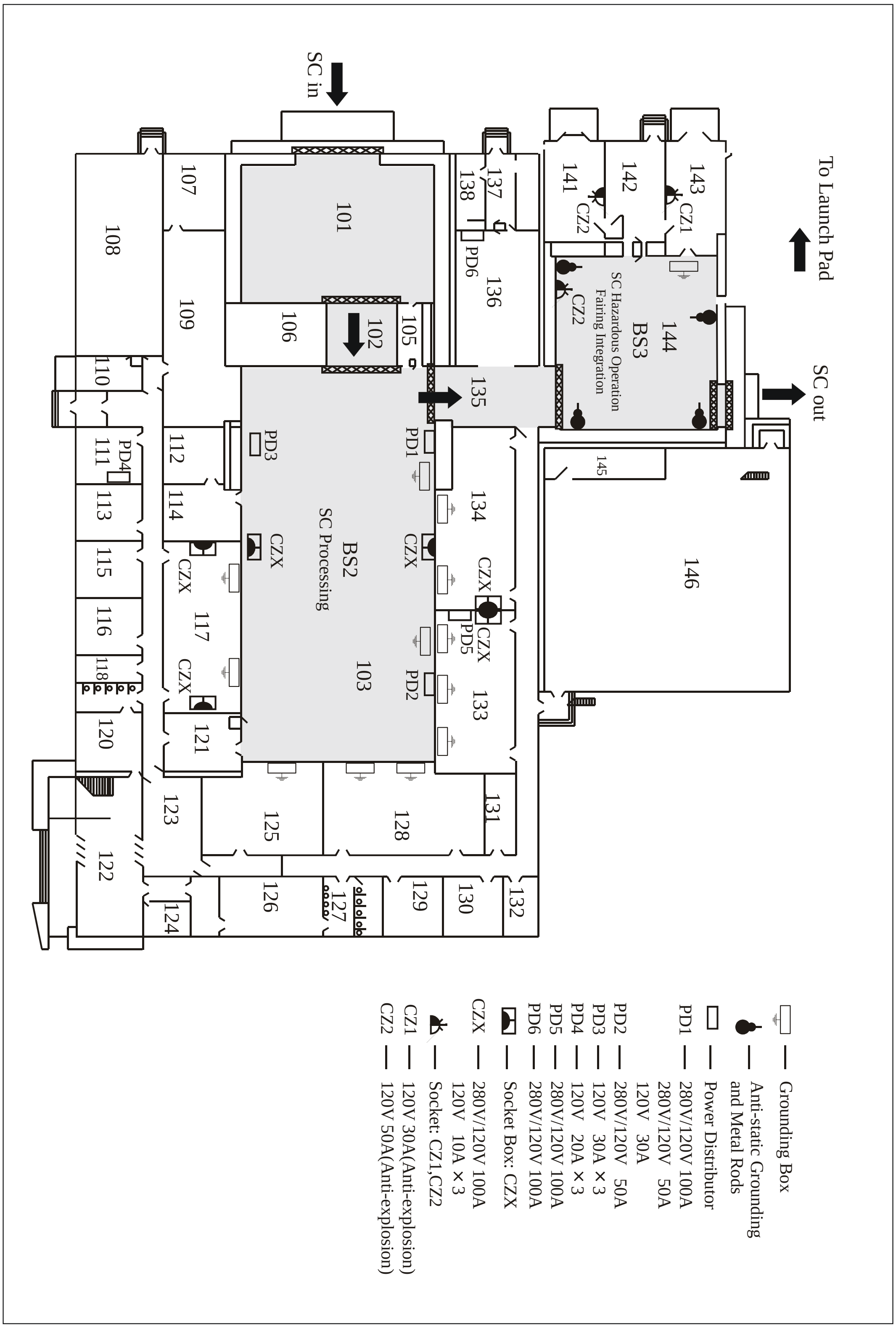


Figure 7-3 Layout of First Floor of BS Building

7-5

7.2.2.1 Non-Hazardous Operation Building (BS2)

- **General**

The Non-Hazardous Operation Room Building (BS2) consists of the following parts:

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

Refer to **Figure 7-3** and **Table 7-1**.

- **Transit Hall (101)**

Lifting Capability of the crane equipped in Transit Hall:

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

- **Satellite Testing Room (High-bay 103)**

It is used for the satellite's measurement, solar-array operations, antenna assembly, etc. SC weighing and dry-dynamic-balance operation is also performed in high-bay 103.

Lifting capacity:

Main hook: 16t
Subsidiary hook: 3.2t
Lifting height: 15m

Electronic scale weighing range: 50-2721.4kg
Maximum capacity of Dynamic balance instrument: 7700kg

A supporter for fixing the antenna is mounted on the inner wall. A ladder and a platform can be used for the installation of the antenna. There are large glass windows for watching the whole testing procedure from outside. Hydra-set is also available for the SC lifting and assembly. For the dynamic balance test, adapting sets should be prepared by SC side.

Table 7-1 Room Area and Environment in BS2

Room	Usage	Measurement		Door	Environment		
		L×W×H (m× m×m)	Area (m^2)	W×H (m×m)	T (°C)	Humidity (%)	Cleanness (Class)
101	Transit Hall	12×18×18	216	5.4×13	18~28	50±10	100,000
102	Air-Lock	6×5.64×13	33.8	5.4×12.5	18~28	50±10	100,000
103	SC-Level Test Area	42×18×18	756	5.4×12.5	15~25	35~55	100,000
107	Unit-Level Test Room)	6×6.9	41.4	1.5×2.1	22±2	30~36	100,000
109	Unit-Level Test Room)	18×6.9	124.2	1.5×2.1	22±2	30~36	100,000
111	Office	6×6×3	36	1.5×2.1	20~25	30~36	
112	Storage Room	6.9×6×3	41.4	1.5×2.1	20~25	35~55	100,000
113	Office	6×6×3	36	1.5×2.1	20~25	30~60	
114	Storage Room	6.9×6×3	41.4	1.5×2.1	20~25	35~55	100,000
115	Office	6×6×3	36	1.5×2.1	20~25	30~60	
116	Office	6×6×3	36	1.5×2.1	20~25	30~60	
117A	Test Room	18×6.9×3.0	124.2	1.5×2.1	20~25	30~60	
125	Office	10.5×6.9×3	72.5	1.5×2.1	20~25	30~60	
128D	Office	15.9×6.9×3	110	1.5×2.1	20~25	30~60	
129	Security Equipment	6×6×3.0	36	1.5×2.1	20~25	30~60	
130	Communication Terminal Room	6×6×3.0	36	1.5×2.1	20~25	30~60	
131	Battery Refrigerator	6.9×3.9×3.0	27	1.5×2.1	5~15	≤60	
132	Wire-Distribution Room	6×4.25×3.0	25.5	1.5×2.1	20~25	30~60	
133C	Measurement Equipment	18×6.9×3.0	124.2	1.5×2.1	20~25	30~60	
134B	Measurement Equipment	18×6.9×3.0	124.2	1.5×2.1	20~25	30~60	
135	Passage	6.9×6×13	41.4	5.0×12.5	20~25	≤55	100,000
136	Leakage-Test	12×9.3×7	111.6	3.8×6	20~25	≤55	100,000
137	Leakage Control	6×3.62	21.7	1.5×2.1	18~28	≤70	
138	Passage to BS3	6×3.9	23.4	1.5×2.1	18~28	≤70	

7.2.2.2 Hazardous Operation Building (BS3)

The hazardous operation building (BS3) is a clean building for satellite's hazardous assembly, mono-propellant or bi-propellant fueling, the integration of the satellite and the SRM, spinning balance and weighing.

- **General**

The hazardous operation building (BS3) mainly consists of the following parts:

- ✧ SC fueling and assembly hall (144);
- ✧ Oxidizer fueling-equipment room (141);
- ✧ Propellant fueling-equipment room (143);
- ✧ Fueling operation room (142).

Refer to **Figure 7-3** and **Table 7-2.**

- **SC Fueling and Assembly Hall (144)**

It is used for the fueling of hydrazine or bi-propellant, the integration of satellite and SRM, wet-satellite dynamic balance, leakage-check and SC/LV combined operations.

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

Lifting capacity:

Main hook:	16t
Subsidiary hook:	3.2t
Lifting height:	15m

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 has the capacity of anti-pressure. Hydra-set is available for satellite assembly and lifting.

A Germany-made weighing scale (EGS300) is equipped. Its maximum weighing range is 2721.4kg(6000lb) with accuracy of 0.05kg (0.1lb). The measurement of the weighing platform is 2m×1.5m(79in×59in). Another weighing equipment up to 10t will be provided.

Inside hall 144, there are eye washing device, gas-alarm and shower for emergency.

- **Measurement Equipment Room (133, 134)**

Room 133 is for system-level test and room 134 is for storage of supporting test equipment. RF system is provided so that SC side can use the equipment in BS2 to monitor the spacecraft wherever it is in BS 3 or at the launch complex (#1 or #2). uplink and downlink RF channel are provided.

Table 7-2 Room Area and Environment in BS3

Room	Usage	Measurement		Door W×H (m×m)	Environment		
		L×W×H (m× m×m)	Area (m^2)		T (°C)	Humidity (%)	Cleanness (Class)
133C	Measurement Equipment	18×6.9×3.0	124.2	1.5×2.1	20~25	30~60	
134B	Measurement Equipment	18×6.9×3.0	124.2	1.5×2.1	20~25	30~60	
135	Passage	6.9×6×13	41.4	5.0×12.5	20~25	≤55	100,000
136	Leakage-Test	12×9.3×7	111.6	3.8×6	20~25	≤55	100,000
137	Leakage Control	6×3.62	21.7	1.5×2.1	18~28	≤70	
138	Passage to BS2	6×3.9	23.4	1.5×2.1	18~28	≤70	
141	Oxidizer Fueling Equipment Storage Room	8.1×6×3.5	48.6	2.8×2.7	18~28	≤60	
142	Fueling Control Room	8.1×6×3.5	48.6	1.5×2.1	18~28	≤60	
143	Propellant Fueling Equipment Storage 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	15~25	35~55	100,000

7.2.2.3 SRM Checkout and Processing Building (BM)

- **General**

The SRM Checkout and Processing Building (BM) is used for the storage of the SRM and pyrotechnics, SRM assembly, pyrotechnics checkout, X-ray checkout of SRM, etc.

BM consists of following parts:

- ✧ Checkout and Processing Hall;
- ✧ SRM Storage Room;
- ✧ Pyrotechnics Storage;
- ✧ Checkout Room;
- ✧ Offices;
- ✧ Locker Room;
- ✧ Room of air-conditioning unit.

Refer to **Figure 7-4**. The area and environment are listed in **Table 7-3**.

Table 7-3 Room Area and Environment in BM

Room	Usage	Measurement		Door	Environment		
		L×W×H (m× m×m)	Area (m^2)	W×H(m)	T (°C)	Humidity (%)	Cleanness (Class)
101	Reception	5.1×3×3.5	15.3	1.0×2.7			
102	Rest room	3.3×3×3.5	9.9	1.0×2.7			
103	Office	6.0×5.1×3.5	30.6	1.5×2.7			
104	Spare Room	5.1×3×3.5	15.3	1.0×2.7			
105	Spare Room	5.1×3×3.5	15.3	1.0×2.1			
106	Pyro Storage	5.1×3×3.5	15.3	1.0×2.1	21±5	<55	
107	Pyro Storage	5.1×3×3.5	15.3	1.0×2.1	21±5	<55	
108	Air-conditioning	10.6×6×3.5	93.8	1.5×3.0			
109	SRM Checkout and X-rays Processing	12×9×9.5	108	3.6×4.2	21±5	<55	
110	SRM Storage	6×3.9×3.5	23.4	2.0×2.6	21±5	<55	

- **SRM Checkout and X-rays Processing Room (109)**

This hall is equipped with explosion-proof movable crane. Its lifting capacity is 5t and lifting height is 7m.

A railway (1435mm in width) is laid in the hall. It leads to the SRM X-ray hall (BMX) and the cold soak chamber.

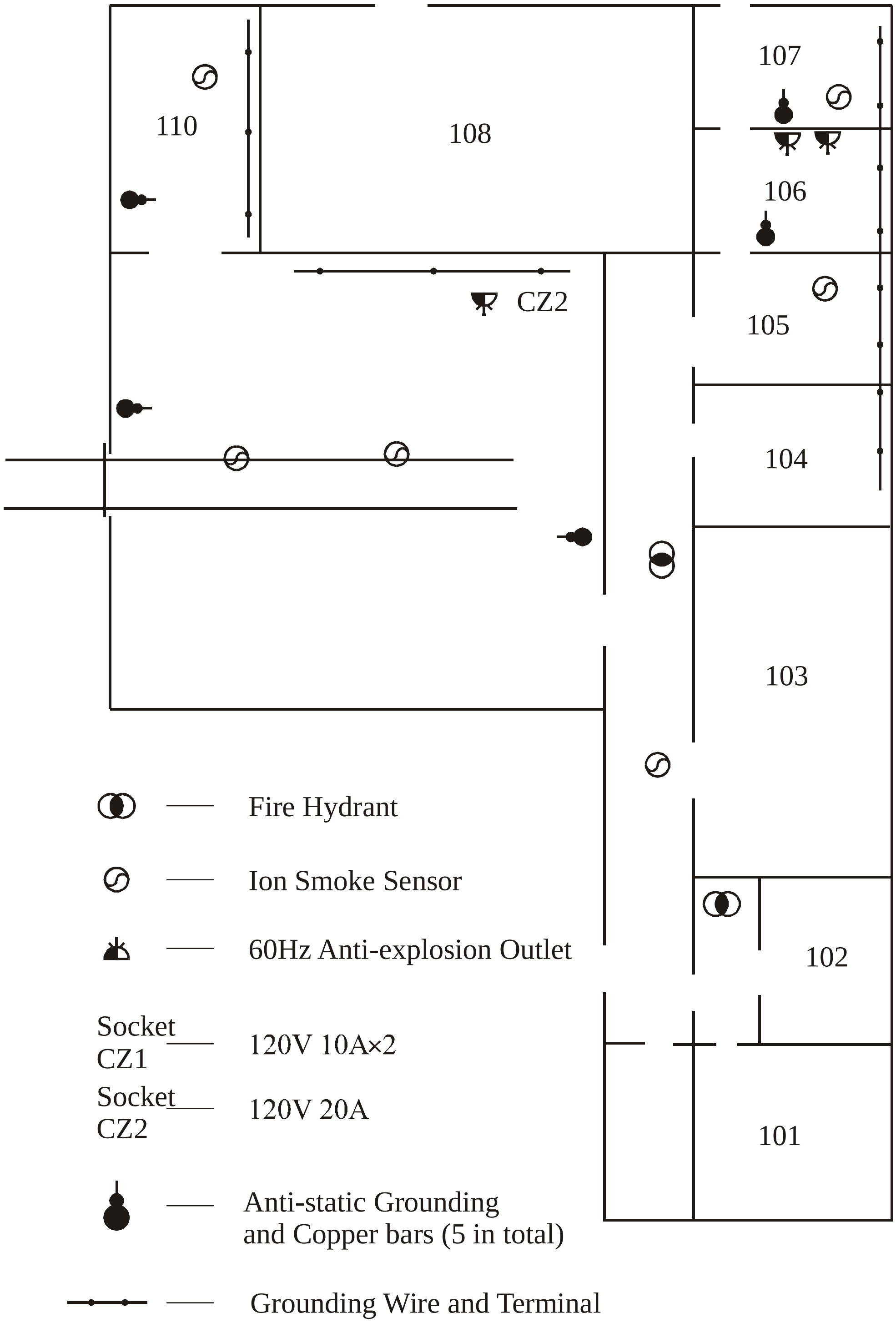


Figure 7-4 Layout of BM

7.2.2.4 SRM X-ray Building (BMX)

- **General**

The BMX is used for X-ray and cold-soak of solid motors. BMX consists of the following parts: cold soak chamber, X-ray operation hall, control room, detecting equipment room, modular cabinet room, film Processing, processing and evaluation rooms, chemical and instrument room, offices, locker room and room of air-conditioning unit. Refer to **Figure 7-5**. The area and environment are listed in **Table 7-4**.

Table 7-4 Room Area and Environment in BM

Room	Usage	Measurement		Door	Environment		
		L×W×H (m)	Area (m^2)	W×H (m)	T (°C)	Humidity (%)	Clearance (Class)
101	X-ray Detection	12.5×10×15	125	3.2×4.5	20~26	35~55	
102	Cold-soak	3.2×3×4	9.6	3.2×3.5	0~15	35~55	
103	X-ray Control	5×3.6×3.7	18	1.0×2.1	20~26	35~60	
104	Detection	5×3.3×3.7	16．5	1.0×2.0	20~26	35~60	
105	Modular Cabinet	5×3.3×3.7	16.5	1.5×2.4	20~26	35~60	
106	Film Process	6×5.1×3.7	30.6	1.2×2.1	18~22	<70	
107	Film Processing	3.6×3.1×3.7	11.1	1.0×2.1			
108	Chemical /instrument	5.1×3.3×3.7	16.8	1.0×2.4			
109	Film evaluation	5.1×3.3×3.7	16.8	1.0×2.4			

- **X-ray Detection Room (101)**

This hall is used for x-ray operations of SRM. Linatron 3000A linear accelerator was equipped. The nominal electron beams energy are 6, 9 and 11 million electronic volts (mev). The continuous duty-rated output at full power and nominal energy is 3000 rads/min at one meter on the central axis. 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 meters thick.

The doors between the hall and the control room and the large protection door are equipped with safety lock 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 various protections. All these mean to assure the safety of the operators.

The hall is equipped with an explosion-proof movable overhead crane with lifting height of 8m and a telescopic arm that supports the head of the X-ray machine.
A railway (1435mm in width) is laid in the hall and leads to the cold-soak chamber and the SRM checkout and Processing hall (BM).

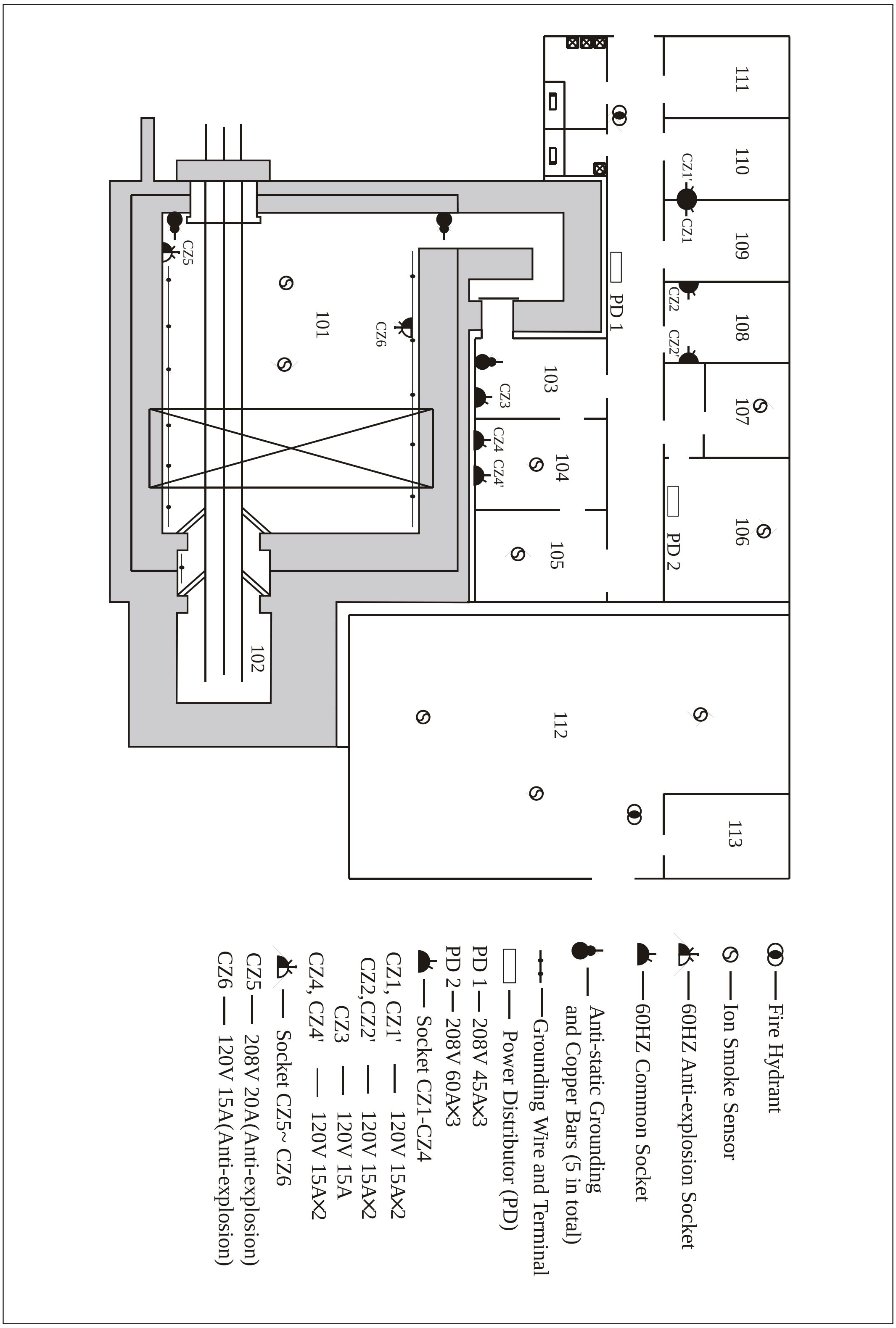


Figure 7-5 Layout of BMX

7-15

7.2.2.5 Hazardous Substances Storehouse

Hazardous substance storehouses are used for the storage inflammable and explosive articles. BM1 and BM2 are for the storage of satellite propellants. There are also other houses for the test and storage of LV pyrotechnics.

7.2.2.6 Power Supply, Grounding, Lightning Protection, Fire-Detection and Alarm

- **Power Supply System**

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

- ✧ 60Hz UPS
  - Voltage: 208/110V±1%
  - Frequency: 60±0.5Hz
  - Power: 64kVA

- ✧ 50Hz UPS
  - Voltage: 380/220V±1%
  - Frequency: 50±0.5Hz
  - Power: 130kVA

Four kinds of power distributors are available in the all SC processing halls and rooms. Each of them has Chinese/English description indicating its frequency, voltage, rated current, etc.

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

- **Lightning Protection and Grounding**

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

Grounding copper bar is installed to eliminate static at the entrance of fueling and assembly hall, in the oxidizer fueling equipment room and the propellant fueling equipment room.

The SRM checkout room (109), SRM storage room (110), pyrotechnics storage and checkout rooms (106, 107) are also equipped with grounding copper bar at the entrance to eliminate static. In BMX and terminals room, there are also grounding copper bar to eliminate static. The SRM checkout and Processing building is equipped with a grounding system for lightning protection. There are two separate lightning rods outside SRM.

- **Fire Detection and Alarm System**

The SRM checkout room (109), SRM storage room (110), pyrotechnics storage and checkout rooms (106, 107), 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 audio warning to alarm the safety personnel to take necessary measures.

X-ray operation hall, control room, equipment room, modular cabinet room, film Processing and processing room, air conditioning room are all equipped with smoke sensors. The control room is equipped with fire alarm system. In case of a fire, the alarm system will give a warning to alarm the safety personnel to take necessary measures.

7.3 Launch Center

7.3.1 General

Coordinates of Launch Pad #2 for LM-3B:

Longitude: 102.02°E,
Latitude: 28.250°N
Elevation: 1826m

The launch site is 2.2 km (shortcut) away from the Technical Center. Facilities in the launch area mainly consist of Launch Complex #1 and Launch Complex #2. Refer to **Figure 7-6**.

Launch Complex #1 is designated for LM-3 and LM-2C launch vehicles.

Launch Complex #2 is about 300 meters away from Launch Complex #1.

Launch Complex #2 is designated for launches of LM-2E, LM-3A, LM-3B and LM-3C. It is also a backup launch complex for LM-3.

Two types of power supply are available in the launch center:

- 380V/220V, 50Hz power supplied by the transformer station;
- 120V/60Hz power supplied by the generators.

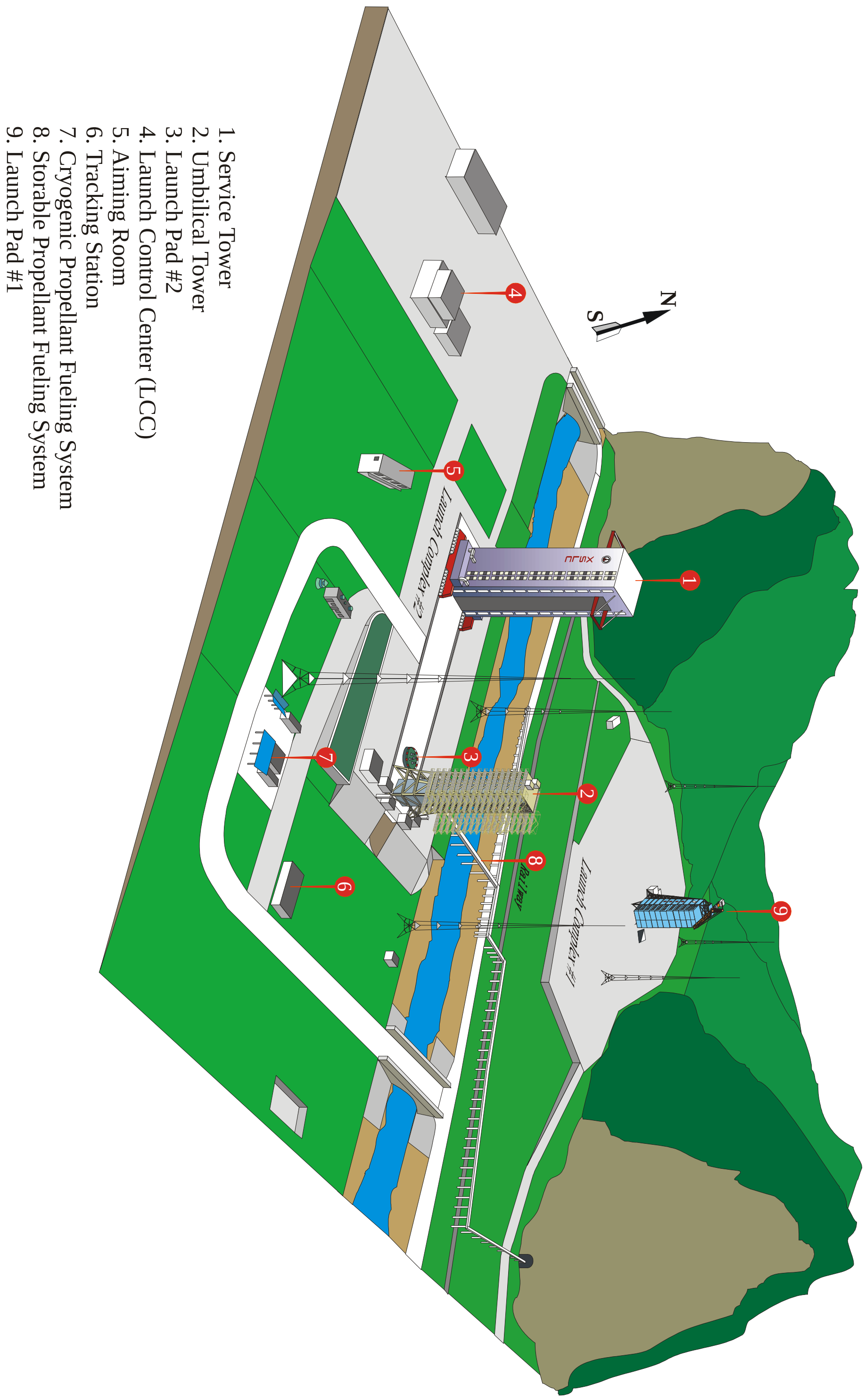


Figure 7-6 Launch Center

7.3.2 Launch Complex #2

This launch complex includes launch pad, service tower, umbilical tower, launch control center (LCC), fueling system, gas supply system, power supply system, lightning-proof tower, etc. Refer to **Figure 7-7**.

7.3.2.1 Service Tower

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

This tower is 90.60 meters high. Two cranes are equipped on the top of the tower. The effective lifting height is 85 meters. The lifting capability is 20t (main hook) and 10t (sub hook). There are two elevators (Capability 2t) for the lifting of the personnel and stuff. The tower has platforms for the checkouts and test operations of the launch vehicle and the satellite.

The upper part of the tower is an environment-controlled clean area. The cleanliness level is Class 100,000 and the temperature within the satellite operation area can be controlled in the range of 15 ~ 25 °C. SC/LV mating, SC test, fairing encapsulation and other activities will be performed in this area. A telescopic/rotate overhead crane is equipped for these operations. This crane can rotate in a range of 180° and its capability is 8t.

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

Besides the hydrant system, Service Tower is also equipped with plenty of powder and 1211 fire extinguisher.

7.3.2.2 Umbilical Tower

Umbilical Tower is to support electrical connections, gas pipelines, liquid pipelines, as well as their connectors for both SC and LV. Umbilical Tower has swinging-arm system, platforms and cryogenic fueling pipelines. Through the cryogenic fueling pipelines, LV side will perform the cryogenic propellant fueling. Umbilical Tower also has air-conditioning system for SC/Fairing, RF system, communication system, rotating platforms, fire-extinguish system, etc.

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

In Umbilical Tower, Room 722 is exclusively prepared for SC side. Its area is $8m^2$. Inside 722, 60Hz/50Hz UPS (Single phase 110V/220V/15A) is provided. The grounding resistance is lower than 1Ω.

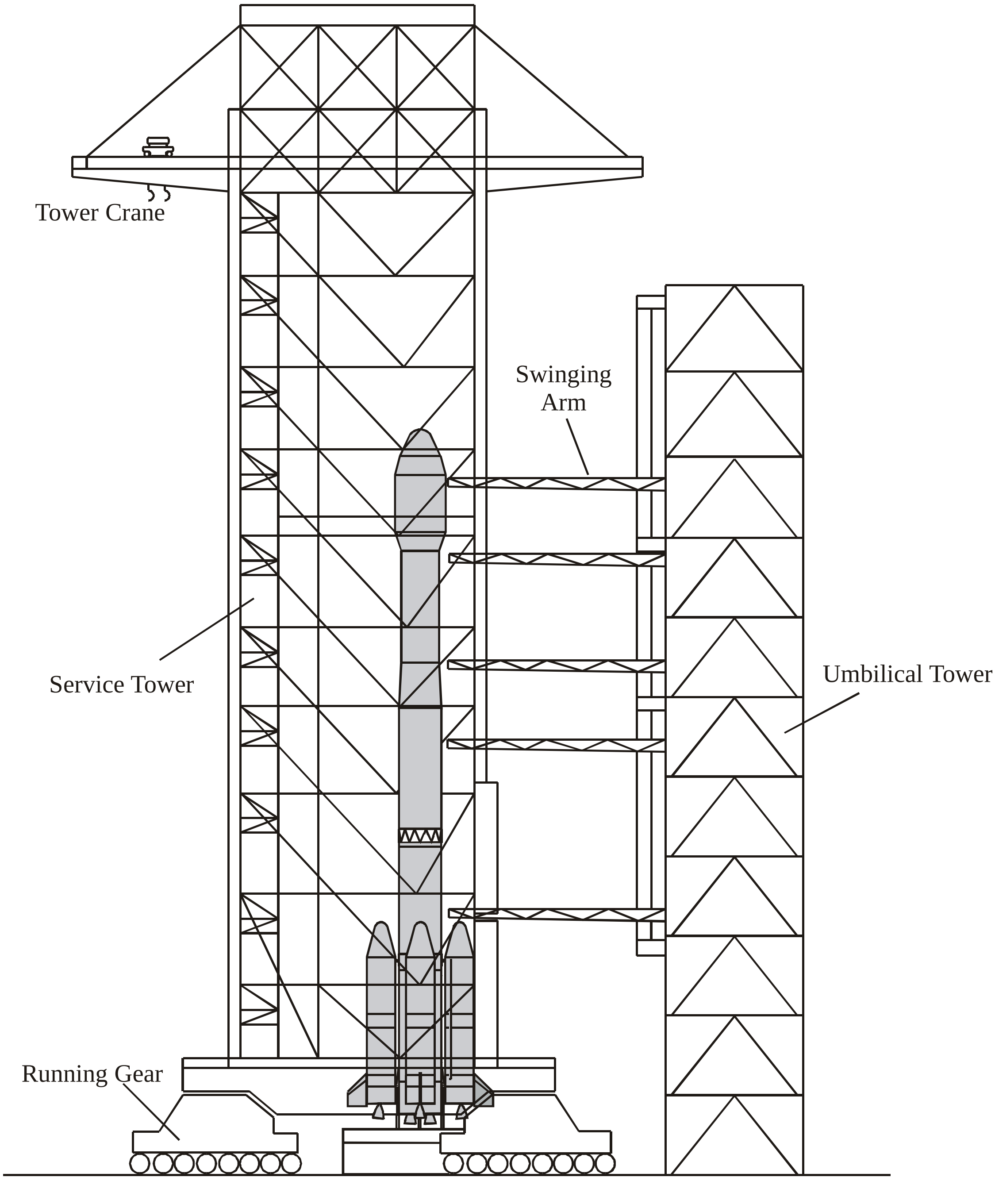


Figure 7-7 Launch Complex #2

7.3.2.3 Launch Control Center (LCC)

- **General**

Launch Control Center (LCC) is a blockhouse structure with ability of explosion-proof. The on-tower operations (such as pre-launch tests, fueling, launch operations) of LV are controlled in LCC. The SC launch control can also be conducted in LCC. Its construction area is $1000m^2$. The layout of LCC is shown as **Figure 7-8**.

The LCC includes the launch vehicle test rooms, satellite test rooms, fueling control room, launch control room, display room for mission director, air-conditioning system, evacuating passage, etc. The whole LCC is air-conditioned.

- **Satellite Test Room (104,105)**

There are two rooms for the tests of the satellite, see **Figure 7-8**. The area of each room is 48.6 m^2. The inside temperature is 20±5°C and the relative humidity is 75%.

The grounding resistance is less than 1Ω. 380V/220V, 50Hz and 120V/208V, 60Hz power distribution panels are equipped in each room.

The satellite is connected with the control equipment inside test room through umbilical cables. Refer to **Chapter 5**. The detailed cable interface will be defined in ICD.

- **Telecommunication**

Telephone and cable TV monitoring system are avaiable in the satellite test room, payload operation platform on tower, BS2 and MCCC.

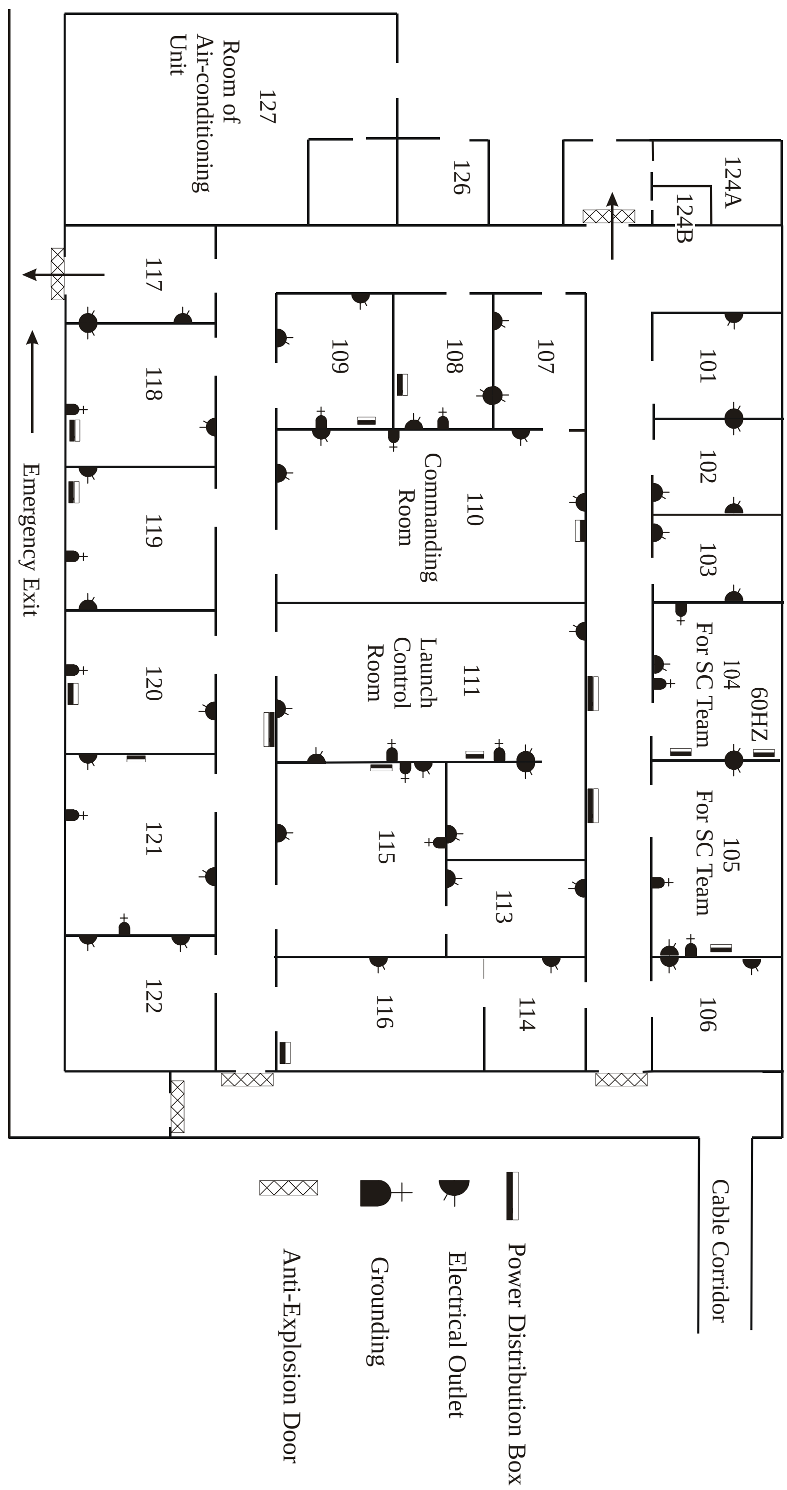


Figure 7-8 Layout of LCC

7-24

7.4 Mission Command & Control Center (MCCC)

7.4.1 General

MCCC is located 7km southeast from the launch area. The whole building includes two parts: one is the command and control hall and the other is computer room. The command and control hall consists of two areas: the command area and the range safety control area. Around the hall are operation rooms and offices. There is a visitor room on the second floor and the visitors can watch the launch on television screen. There is cable TV sets for visitors. **Figure 7-9** shows the layout of MCCC.

7.4.2 Functions of MCCC

- ✧ Command all the operations of the tracking stations and monitor the performance and status of the tracking equipment.
- ✧ Perform the range safety control after the lift-off of the launch vehicle.
- ✧ Gather the TT&C information from the stations and process these data in real-time.
- ✧ Provide acquisition and tracking data to the tracking stations and Xi'an Satellite Control Center (XSCC).
- ✧ Provide display information to the satellite working-team console.
- ✧ Perform post-mission data processing.

7.4.3 Configuration of MCCC

- ✧ Real-time computer system.
- ✧ Command and control system.
- ✧ Monitor and display for safety control, including computers, D/A and A/D converters, TV display, X-Y recorders, multi-pen recorders and tele-command system.
- ✧ Communication system.
- ✧ Timing and data transmission system.
- ✧ Film developing and printing equipment.

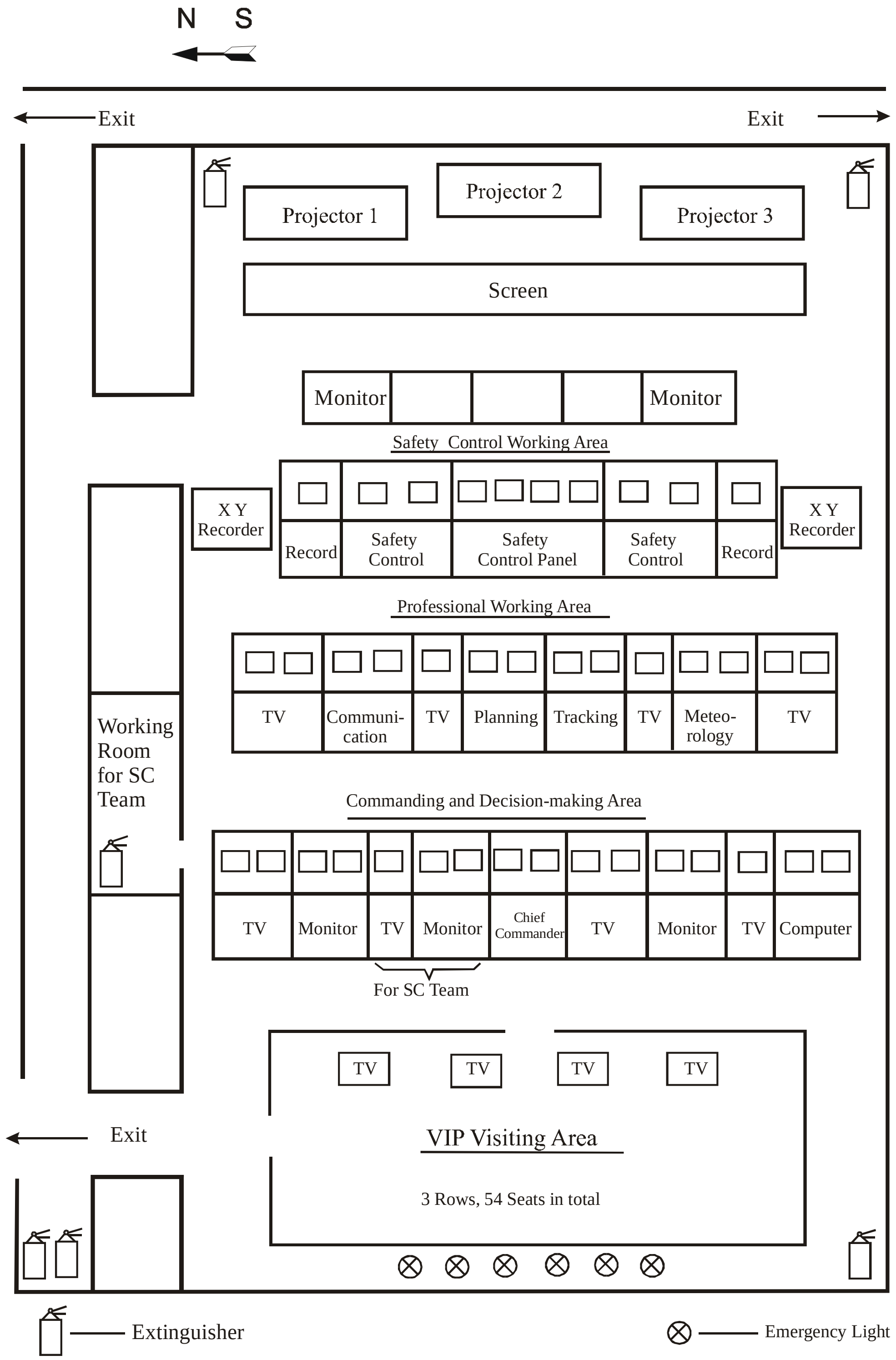


Figure 7-9 Layout of MCCC

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

7.5.1 General

The TT&C system of XSLC and TT&C system of Xi'an Satellite Control Center (XSCC) form a TT&C net for the mission.

The TT&C system of XSLC mainly consists of:
- ✧ Xichang Tracking Station;
- ✧ Yibin Tracking Station;
- ✧ Guiyang Tracking Station.

The TT&C system of XSCC mainly includes:
- ✧ Weinan tracking station;
- ✧ Xiamen tracking station;
- ✧ Instrumentation Ships.

Refer to **Figure 7-10**.

Xichang Tracking Station includes optical, radar, telemetry and telecommand equipment. It is responsible for measuring and processing of the launch vehicle flight data and also the range safety control. Data received and recorded by the TT&C system are used for the post-mission processing and analysis.

7.5.2 Main Functions of TT&C

- ✧ Recording the initial LV flight data in real time;
- ✧ Measuring the trajectory of the launch vehicle;
- ✧ Receiving, recording, transmitting and processing the telemetry data of the launch vehicle and the satellite;
- ✧ Making flight range safety decision;
- ✧ Computing the SC/LV separation status and injection parameters.

7.5.3 Tracking Sequence of TT&C System

After LV liftoff, it is tracked immediately by the optical, telemetry equipment and radars around the launch site. The received data will be sent to MCCC. These data will be initially processed, and sent to the related stations. The station computers receive these data and do coordinate conversion and use the data as acquisition data to guide the TT&C system to acquire and track the target.

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

In case of a failure during the first stage 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 by tracking ships and sent to XSCC. The results are sent to Xichang MCCC for processing and monitoring.

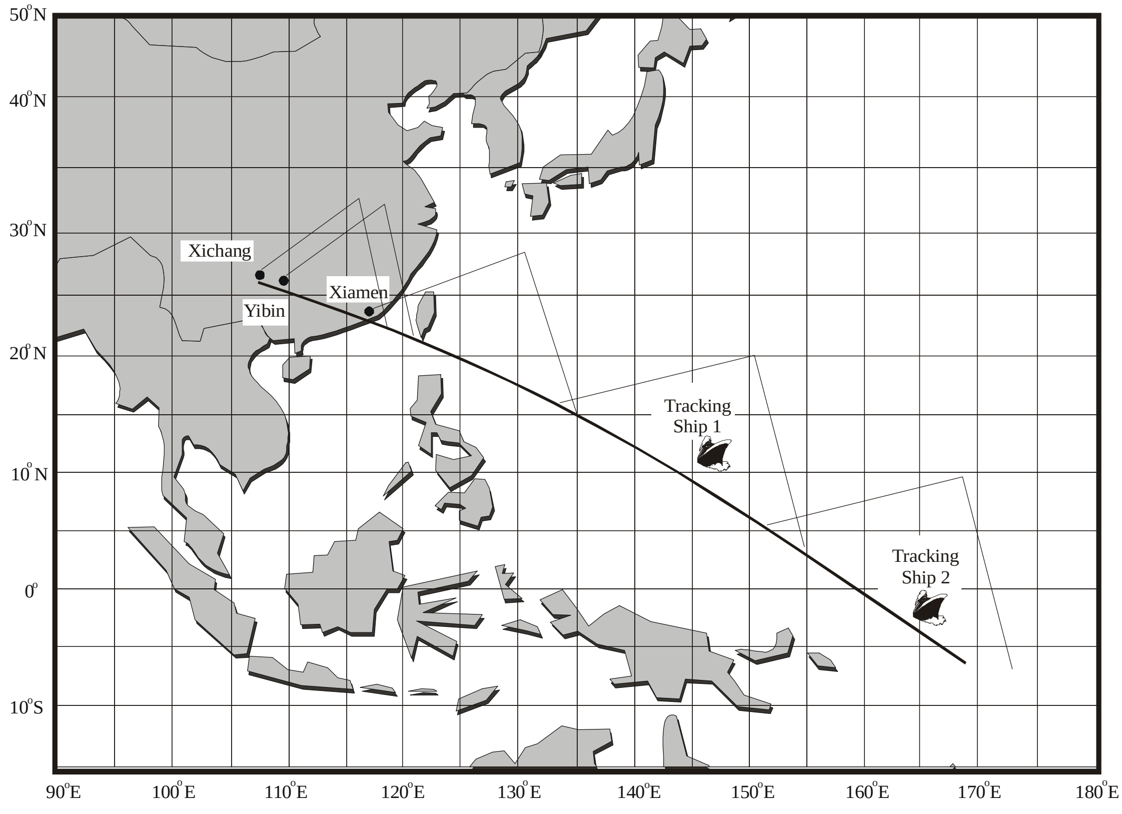


Figure 7-10 Tracking Stations

CHAPTER 8

LAUNCH SITE OPERATION

8.1 Briefing to Launch Site Operation

Launch Site Operation mainly includes:

- LV Checkouts and Processing;
- SC Checkouts and Processing;
- SC and LV Combined Operations.

The typical working flow and requirements of the launch site operation are introduced in this chapter. For different launch missions, the launch site operation will be different, especially for combined operations related to joint efforts from SC and LV sides. Therefore, the combined operations could be performed only if the operation procedures are coordinated and approved by all sides.

SC/LV Combined Operations are conducted in technical center and launch center. LM-3B provides two SC/LV integration methods, i.e. Encapsulation-on-pad and Encapsulation-in-BS3. Details about the two methods are described in paragraph 8.3.

8.2 LV Checkouts and Processing

LM-3B launch vehicle is transported from CALT facility (Beijing, China) to XSLC (Sichuan Province, China), and undergoes various checkouts and processing in Technical Center and Launch Center of XSLC. The typical LV working flow in the launch site is shown in **Table 8-1**.

Table 8-1 LV Working Flow in the Launch Site

	No.	Item	Working Period	Accumulative Period
TECHNICAL	1	To Unload LV from the Train and Transfer LV to LV Test Building (BL1).	1 day	1 day
	2	Unit Tests of Electrical System	7 days	8 days
	3	Tests to Separate Subsystems	3 days	11 days
	4	Matching Test Among Subsystems	4 days	15 days
	5	Four Overall Checkouts	4 days	19 days
	6	Review on Checkout Results	1 day	20 days
	7	LV Status Recovery before Transfer	2 days	22 days
	8	To Transfer LV to Launch Center	1 days	23 days
LAUNCH CENTER	9	LV Vertical Integration on the Launch Tower	2 days	25 days
	10	Tests to Separate Subsystems	3 days	28 days
	11	Matching Test Among Subsystems	3 days	31 days
	12	The first and second overall checkouts	2 days	33 days
	13	To Transfer SC and Fairing to Launch Center Separately, SC/LV Integration, Fairing Encapsulation	1.5 days	34.5 days
	14	SC Testing	1.5 days	36 days
	15	The Third Overall Checkout (SC Involved)	1 day	37 days
	16	The Fourth Overall Checkout	1 day	38 days
	17	Review on Checkout Results	1 day	39 days
	18	Functional Check before Fueling, Gas Replacement of Tanks	2 days	41 days
	19	N_2O_4/UDMH Fueling	1 days	42 days
	20	LOX/LH2 Fueling	0.5 day	42.5 days
	21	Launch	0.5 days	43 days
Total			43 days	43 days

After SC is transferred to Launch Center, some of SC and LV operations can be performed in parallel under conditions of no interference.

The working flow for Encapsulation-in-BS3 method is similar to the typical one, except for the following part: The SC and Fairing are integrated in BS3, and the encapsulated fairing is transported to the Launch Pad to mate with LV.

8.3 SC/LV Combined Operations

8.3.1 Summary

The SC/LV combined operations are conducted in Technical Center and in Launch Center. LM-3B provides two operation methods, i.e. Encapsulation-on-pad and Encapsulation-in-BS3.

The typical working procedure of Encapsulation-on-pad method is as follows:
1. The payload adapter and fueled SC are mated in BS3 of the technical center;
2. The SC/adapter stack is put into the clean SC container, which is then shipped to launch center;
3. The SC container and fairing are hoisted to the 8^{th} floor of the service tower in the launch center. A clean area (big closure) is established here on the tower following the arrivals of SC container and fairing.
4. The SC/LV integration is performed on the 8^{th} floor of the Service Tower.
5. The fairing is finally encapsulated inside the clean area. Air-conditioning to the fairing starts following encapsulation.

The typical working procedure of Encapsulation-in-BS3 method is as follows:
1. The payload adapter and fueled SC are mated in BS3 of the technical center;
2. The fairing encapsulates the SC/Adapter stack in BS3;
3. The fairing, encapsulating the SC/Adapter stack, is lifted to a special transfer vehicle, which transfers the fairing to launch center;
4. The encapsulated fairing is mated with LV on the 8^{th} floor of the service tower in the launch center.

8.3.2 SC/LV Combined Operation for Encapsulation-on-pad Method

8.3.2.1 SC Container

SC Container is a dedicated container used for transferring SC from Technical Center to Launch Center. The available space of SC container is 3980mm in diameter, 7450mm high and 92.6 m^3 in volume. The SC container is composed of a base pad and five cylindrical sections, which can be assembled together. Two guide poles are equipped outside the SC container. The core of wall is made of aluminum, and the outer surface and inner surface of the wall are covered by thermal-proof materials. See **Figure 8-1**. This SC Container is only used for Encapsulation-on-pad method. LM-3B also provides small SC Container for selection.

The characteristics of the SC container are listed as follows:

- SC/Adapter stack is fastened inside the SC container;
- Dry N_2 is filled to the SC container, the SC is protected by positive pressure;
- The temperature inside the SC container is 24±6°C during transportation from BS3 to Service Tower;
- SC container is of thermal-proof function.
- Temperature, humidity, noise and accelerations, etc. inside the SC container can be measured and recorded during transportation process.

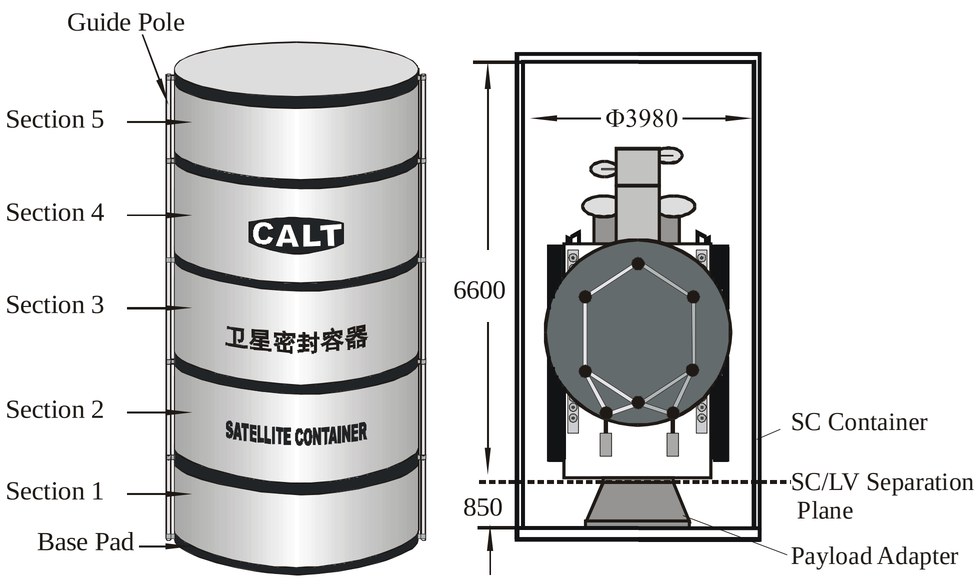


Figure 8-1 SC Container Configuration

8.3.2.2 SC/LV Integration in Technical Center (Encapsulation-on-pad Method)

The payload adapter and SC are mated in BS3 after SC is fueled and weighed. SC team carries out all the SC operations. CALT is responsible for mating SC with the payload adapter, and installing SC/LV separation devices. The following describes the working procedure:

1. CALT to bolt payload adapter on the technological stand and to install SC/LV locked separation springs;
2. SC team to lift up the SC, CALT to mate SC with payload adapter;
3. CALT to install clampband system and to engage SC/LV In-Flight Disconnectors (IFD); CALT and SC team to test and verify IFD; CALT to unlock the separation springs.
4. CALT to unbolt the payload adapter from the technological stand; After SC team and CALT's approval, SC team to lift up and move the SC/Adapter stack to the base pad of the SC container; CLTC to bolt the adapter with the base pad, and SC team to verify SC's status;
5. CLTC to integrate SC container;
6. CALT to seal the SC container and to fill dry N_2 into the SC container; The 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 for Encapsulation-on-pad method is shown in **Figure 8-2**.

8.3.2.3 SC Transfer (Encapsulation-on-pad Method)

CLTC is responsible for using special vehicle to transfer SC container to the Launch Center. Following working procedures are then performed:

7. CLTC to lift the SC container, which already contained SC/Adapter stack, onto the special vehicle and to fasten the SC container with ropes.
8. CLTC to drive the special vehicle from BS3 to Service Tower in Launch Center;
9. CLTC to release the SC container from the transfer vehicle; CLTC to lift the SC container up to the 8^{th} floor of the Service Tower;

See **Figure 8-3** and **Figure 8-4**.

8.3.2.4 SC/LV Integration in Launch Center (Encapsulation-on-pad Method)

The SC/LV integration in Launch Center includes:
- To mate Payload adapter with LV third stage;
- To encapsulate the fairing.

CALT is responsible for LV third stage/Adapter integration and fairing encapsulation in the clean big closure, and SC team is responsible for SC lifting. Following working procedures are performed.

10. CLTC to close all the doors of the 8th floor and upper floors to form the clean area; CLTC to open the SC container when the environmental conditions, including temperature, humidity and cleanness, reach the SC requirements.
11. CLTC unstacks the SC container;
12. SC team to install the slings on the SC; CLTC to unbolt the payload adapter from the base pad of the SC container;
13. SC team to hoist and move the SC/Adapter stack to the above of the LV third stage by using of the crane of 8th floor; CALT to mate the payload adapter with LV third stage;
14. SC team to remove the SC slings; SC team to do SC pre-flight checkouts; CALT to encapsulate the two halves of the fairing after SC and LV sides confirm that SC and LV is ready for fairing encapsulation;
15. CALT to remove the fairing fixture and complete the integration. CALT and CLTC to connect SC ground umbilical connectors and fairing air-conditioning system; CLTC to open the big closure and lift the SC container down to the ground.

SC team can only perform simple operations and checkouts to the SC through access door of the fairing after encapsulation.

See **Figure 8-5**.

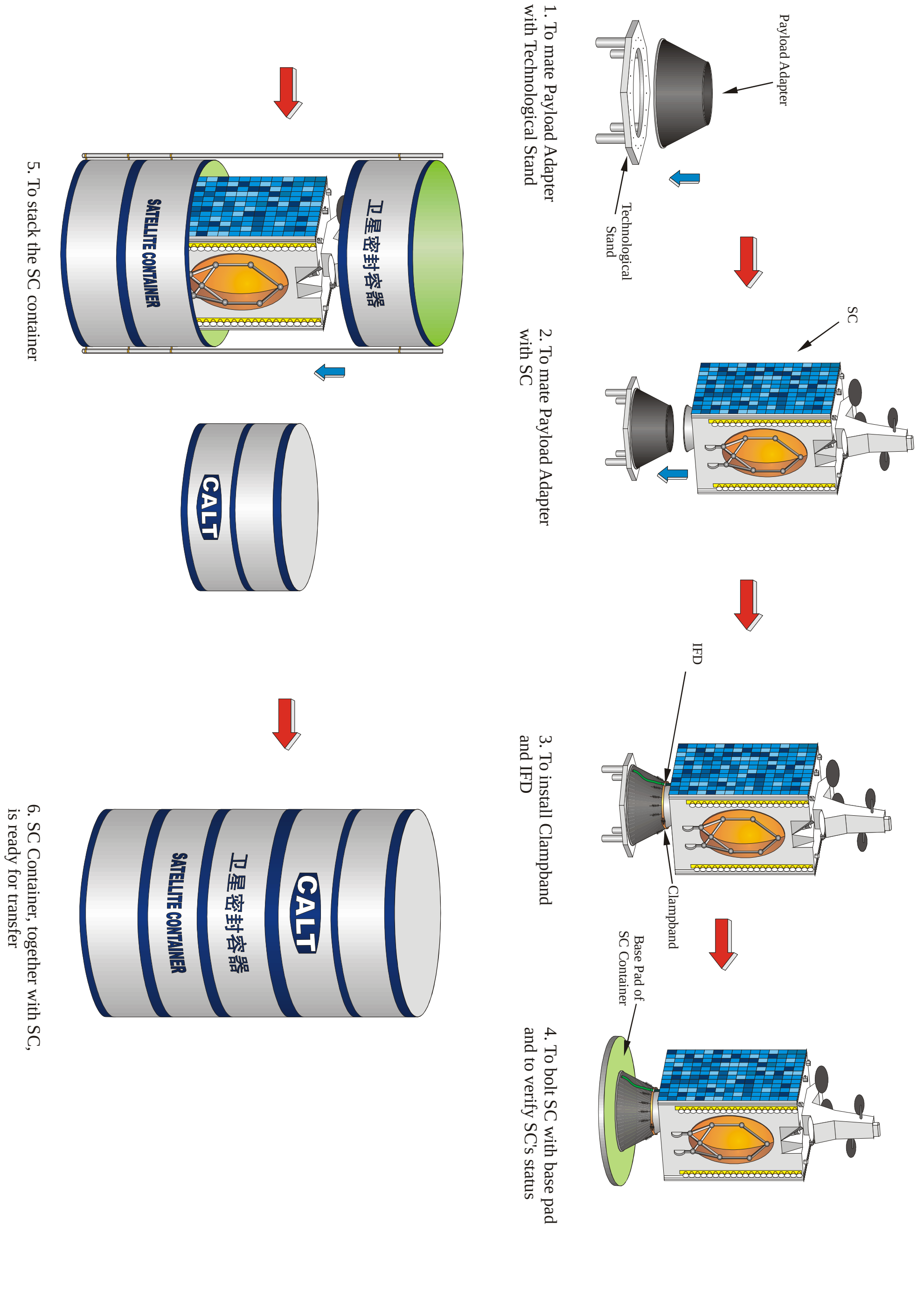
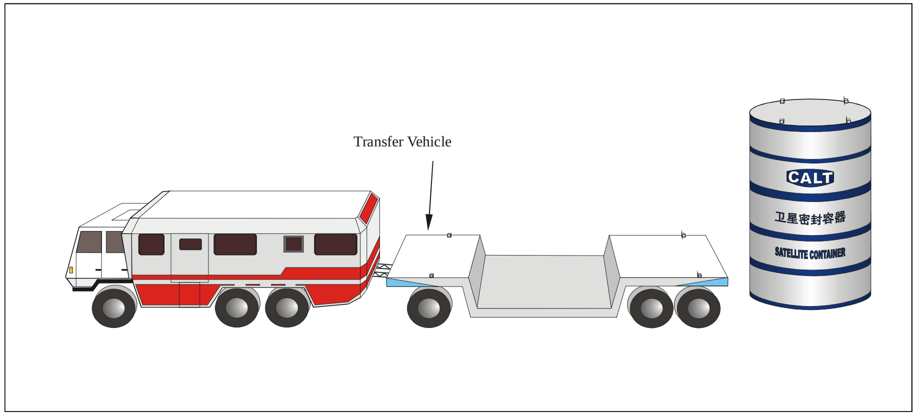
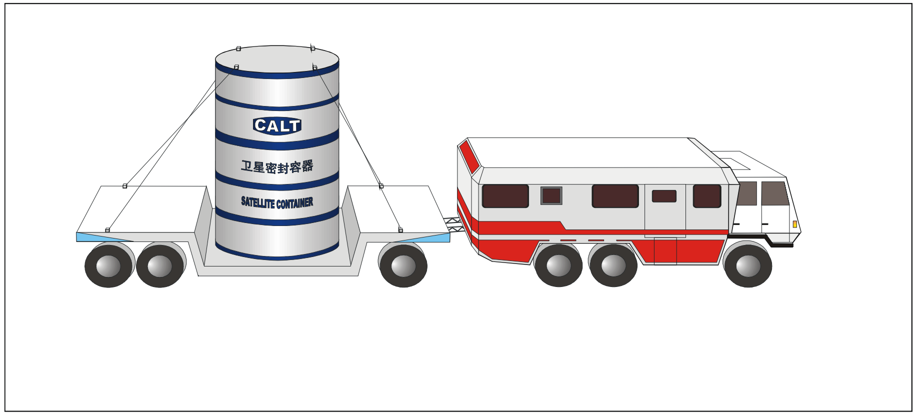


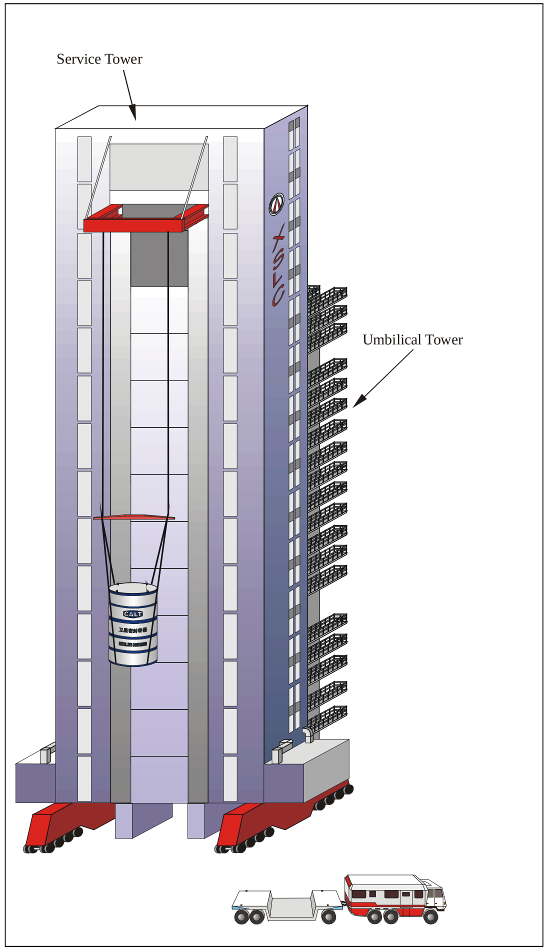
Figure 8-2 SC/LV Integration in Technical Center (Encapsulation-on-pad Method)



7. SC Container is to be hoisted on the Transfer Vehicle.



8. The Transfer Vehicle transfer SC Container to Launch Center.



9. To lift the SC container up to the 8th floor of the Service Tower

Figure 8-3 SC Transfer (Encapsulation-on-pad)

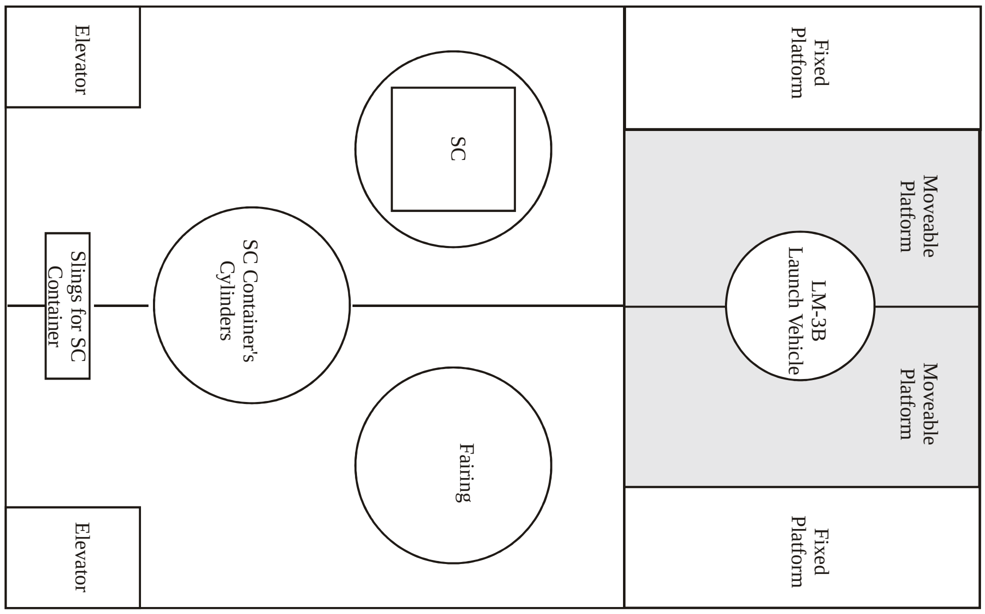


Figure 8-4 Layout of the Clean Area on the 8th Floor of the Service Tower

8-9

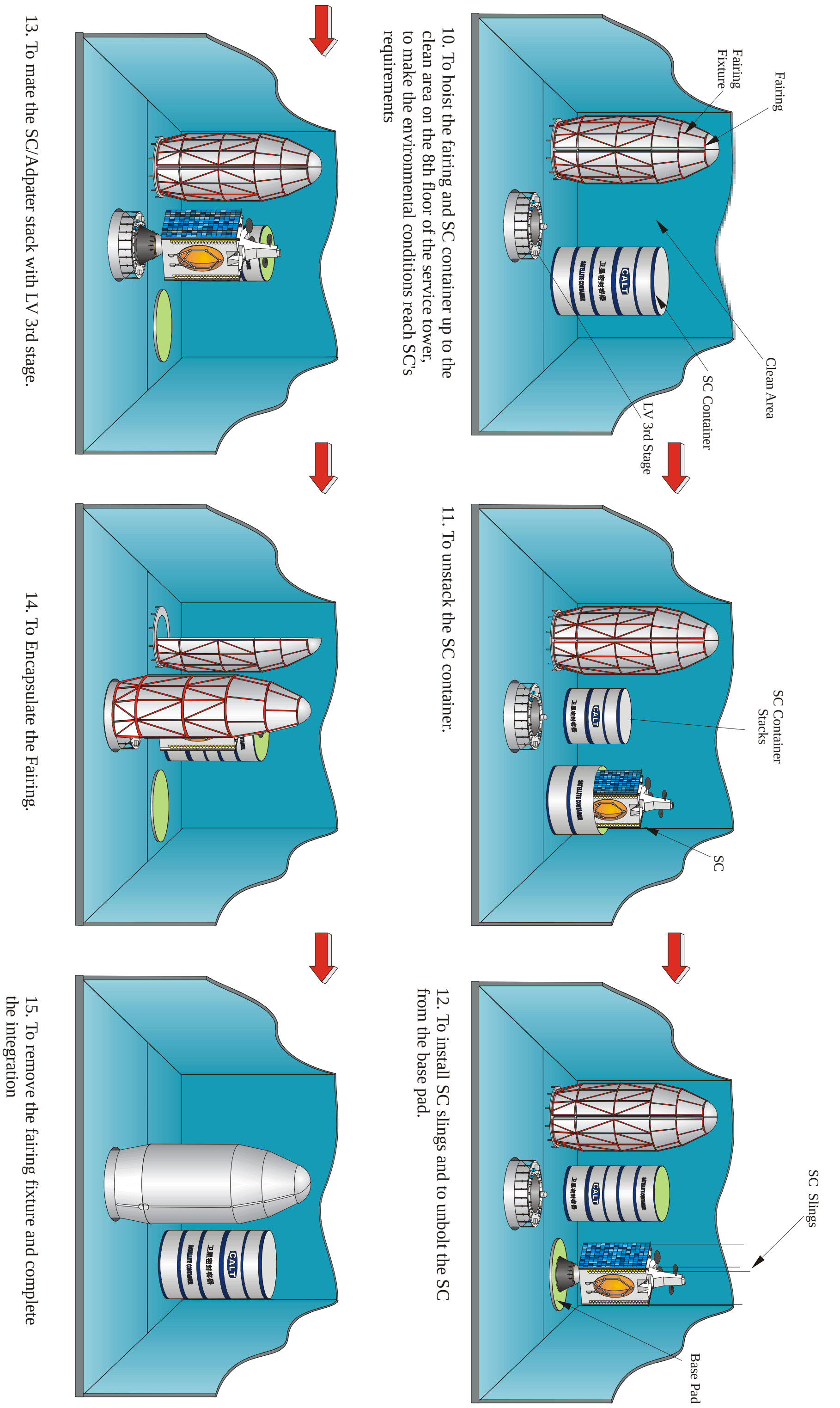


Figure 8-5 SC/LV Integration in Launch Center (Encapsulation-on-pad Method)

8.3.3 SC/LV Combined Operations for Encapsulation-in-BS3 Method

8.3.3.1 SC/LV Integration in Technical Center (Encapsulation-in-BS3 Method)

SC/LV integration in BS3 of Technical Center includes:

- To mate payload adapter with SC;
- To encapsulate the fairing with SC/payload adapter stack.

The payload adapter and SC are mated in BS3 after SC is fueled and weighed. SC team carries out all the SC operations. CALT is responsible for mating SC with payload adapter and installing SC/LV separation devices. Following describes the working procedure:

1. CALT to bolt payload adapter on the technological stand, and to install SC/LV locked separation springs;
2. SC team to lift up the SC to mate it with payload adapter; CALT to install clampband system and to engage SC/LV In-flight Disconnectors (IFD); CALT and SC team to test and verify IFD; CALT to unlock the separation springs.
3. CALT to unbolt the payload adapter from the technological stand; After SC team and CALT's approval, SC team to lift up the SC/adapter stack, and CALT to mate it with LV transition adapter; SC team to remove the SC slings;
4. CALT to encapsulate the fairing, which is supported by the fairing fixture.
5. CALT to remove the fairing fixture and to install the hoisting basket.

See **Figure 8-6** and **Figure 8-7**.

8.3.3.2 SC Transfer (Encapsulation-in-BS3 Method)

CLTC is responsible for transferring the encapsulated fairing from BS3 to Launch Center.

Following working procedures are performed:

6. CLTC to lift the encapsulated fairing onto the special vehicle and to fasten the fairing with ropes; CLTC to connect the air-conditioning to the fairing if necessary; CLTC to drive the vehicle from BS3 to Launch Service Tower;
7. CLTC to release the encapsulated fairing from the transfer vehicle; CLTC to install slings to the encapsulated fairing under the Launch Service Tower; CLTC

to lift the fairing onto the 8th floor of the tower;

See **Figure 8-7**.

8.3.3.3 SC/LV Integration in Launch Center (Encapsulation-in-BS3 Method)

The encapsulated fairing will be mated with the LV third stage on the service tower.

Following working procedures are performed:

8. CALT to hoist the encapsulated fairing to the above of the LV third stage;
9. CALT to joint the bottom of the fairing with LV third stage; CLTC to remove the hoisting basket outside the fairing; CLTC to connect the SC umbilical connectors and SC air-conditioning.

See **Figure 8-8**.

8.3.4 SC Preparation and Checkouts

- CALT and CLTC are responsible for checking and verifying the umbilical cables and RF links. If necessary, SC team could witness the operation.

- LV accessibility and RF silence time restriction must be considered, when SC team performs operation to SC.

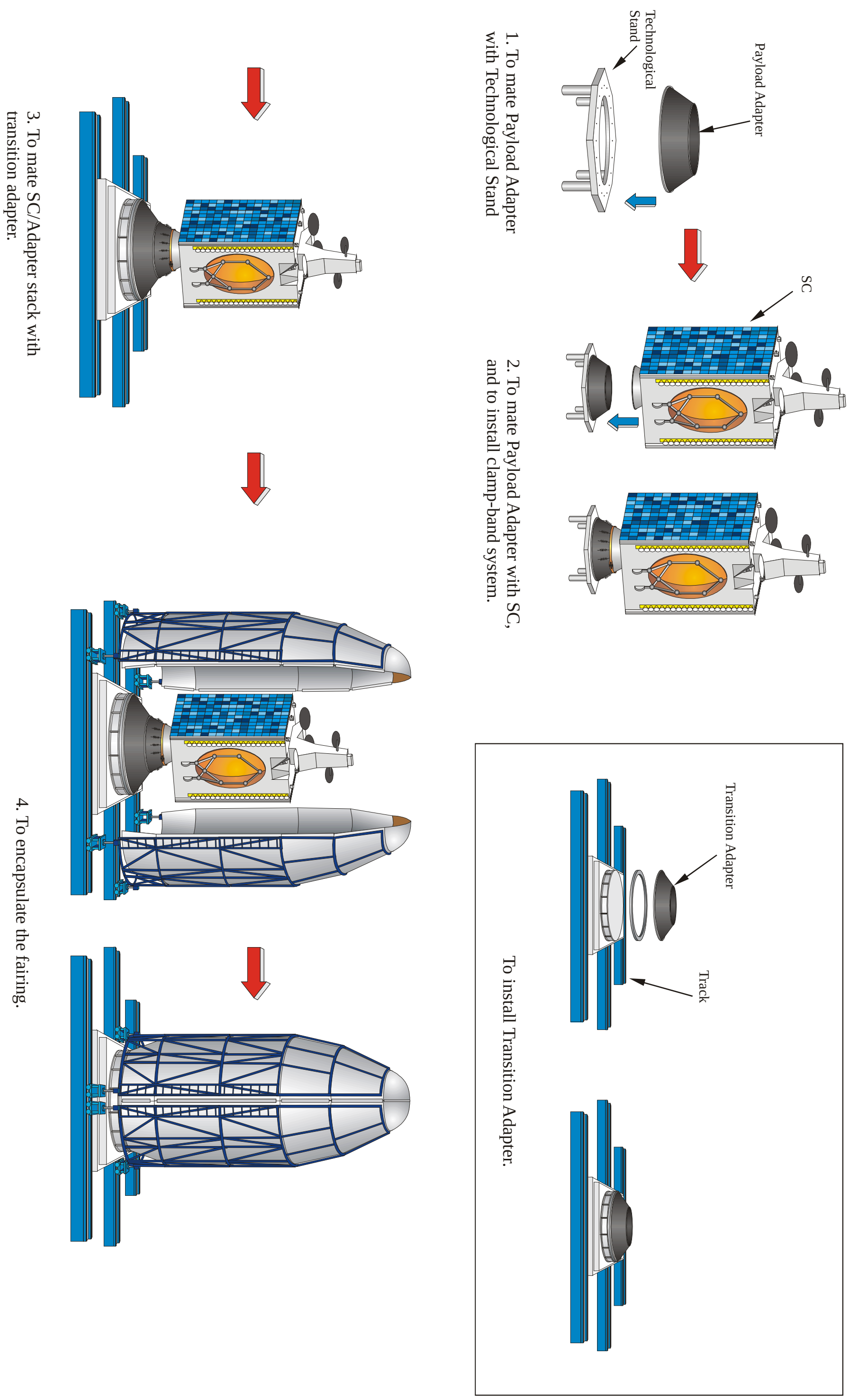


Figure 8-6 SC/LV Integration in Technical Center (Encapsulation-in-BS3)

8-13

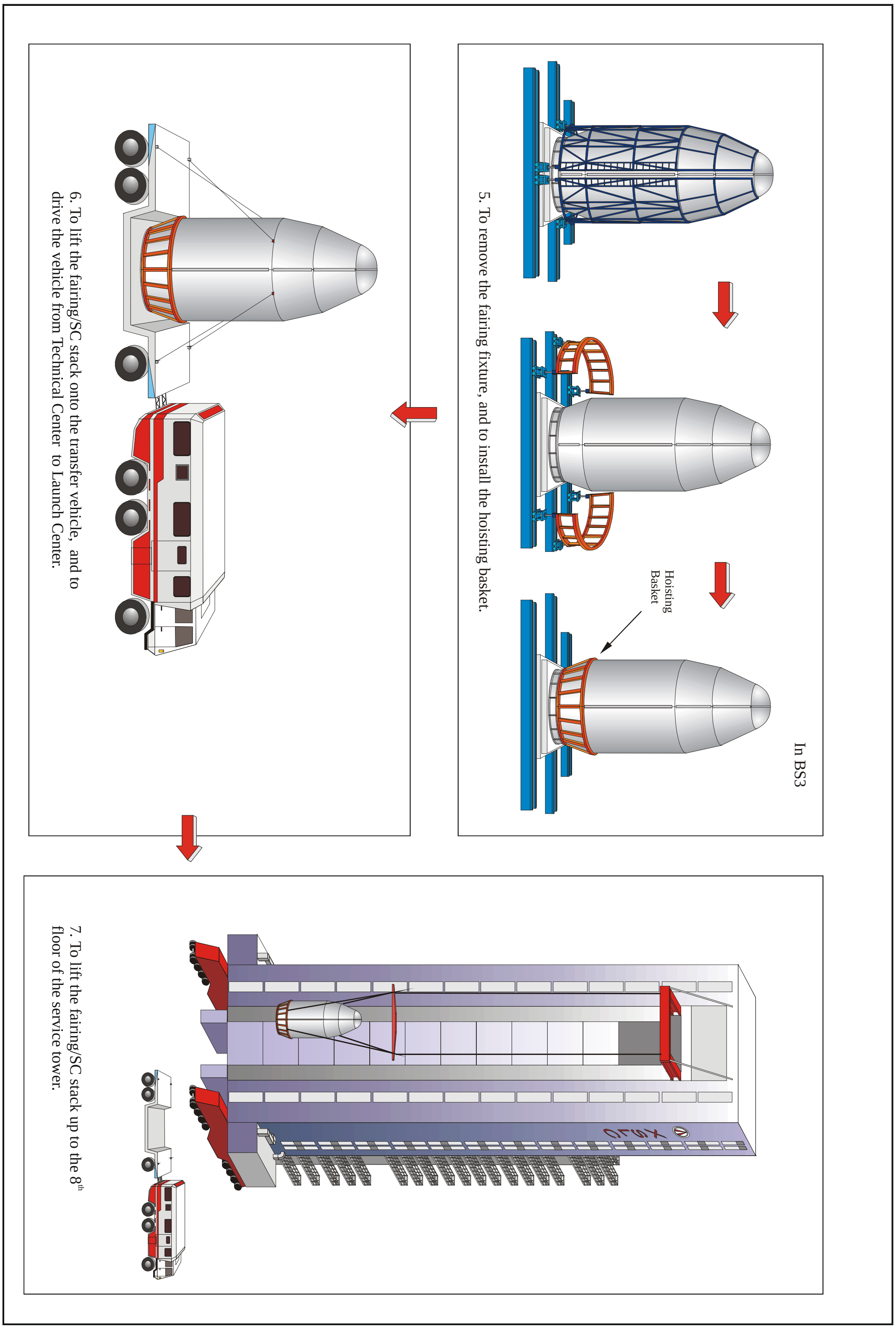


Figure 8-7 SC Transfer (Encapsulation-in-BS3)

8-14

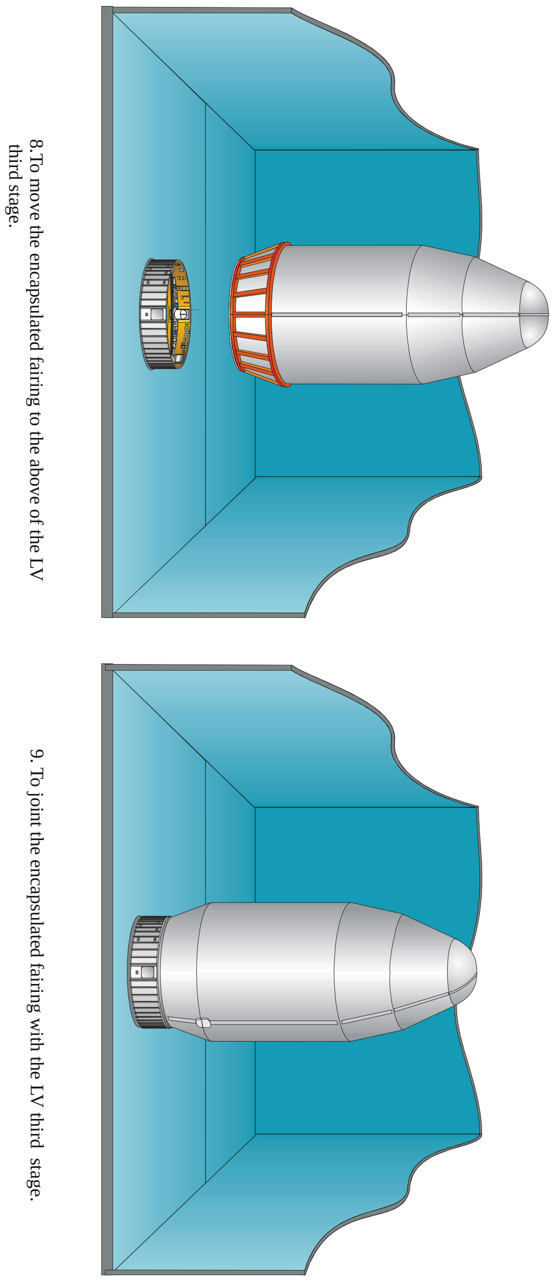


Figure 8-8 SC/LV Integration in Launch Center (Encapsulation-in-BS3)

8-15

8.4 Launch Limitation

8.4.1 Weather Limitation

- The average ground wind velocity in the launch area is lower than 10m/s
- The winds aloft limitation: $q\times\alpha\leq 2500N/m^2\cdot rad$ ($q\times\alpha$ reflects the aerodynamic loads acting on the LV, whereas, q is the dynamic head, and α is LV angle of attack.)
- The horizontal visibility in the launch area is farther than 20km.
- No thunder and lightning in the range of 40km around the launch area, the atmosphere electrical field strength is weaker than 10kV/m.

8.4.2 "GO" Criteria for Launch

- The SC's status is normal, and ready for launch.
- The launch vehicle is normal, and ready for launch.
- All the ground support equipment is ready;
- All the people withdraw to the safe area.

8.5 Pre-launch Countdown Procedure

The typical pre-launch countdown procedure in the launch day is listed below:

No.	Time	Event
1	-7 hours	LV third stage LOX/LH_2 Fueling
2	-2 hours	LV Control System Power-on & Functional Checkout
3	-60 minutes	LV Telemetry System Power-on & Functional Checkout
4	-45 minutes	Fairing air-conditioning Stopping & Air-conditioning Pipe Disconnecting
5	-40 minutes	Accurately aiming; Loading and Checking Flight Program; Gas pipes for the first and second stages drop-off;
6	-20 minutes	LV third stage Engines Pre-cooling;
7	-13 minutes	LV third stage propellants topping;
8	-15~-12 minutes	SC umbilical disconnection;

9	-3 minutes	Telemetry and Tracking Systems Power Switch-over; LV third stage Propellant Fueling Pipe Disconnection;
10	-2 minutes	Gas Pipe for third stage Disconnection;
11	-90 seconds	Control System Power Switch-over;
12	-60 seconds	Control System, Telemetry System and Tracking System Umbilical Disconnection;
13	-30 seconds	TT&C Systems Starting;
14	-7 seconds	Camera on;
15	0 seconds	Ignition.

8.6 Post-launch Activities

The orbital parameters of the injected orbit will be provided to Customer in half-hours.

The LV flight report will be provided to the Customer in a month after launch.

CHAPTER 9

SAFETY CONTROL

This chapter describes the range safety control procedure and the criteria to minimize the life and property lose in case of a flight anomaly following lift-off.

9.1 Safety Responsibility and Requirements

XSLC designates a range safety commander, whose responsibilities are:

- To work out "Launch Vehicle Safety Control Criteria" along with the LV designer according to the concept of the safety system;
- To know the distribution of population and major infrastructures in the down range area;
- To guarantee that the measuring equipment provide sufficient flight information for safety control, i.e. clearly show the flight anomaly or flying inside predetermined safe range; and
- To terminate the flight according to the "Launch Vehicle Safety Control Criteria" if the launch vehicle behaves so unrecoverably abnormal that the launch mission can never completed and a ground damage is possible.

9.2 Safety Control Plan and Procedure

9.2.1 Safety Control Plan

Even though a flight anomaly occurs, the launch vehicle will not be destroyed by the ground command during the first 15 seconds following lift-off. The launch vehicle will go 400 meters from the launch pad during the 15 seconds to protect the launch facilities.

The destruction to the launch vehicle can be conducted from 15 seconds of flight to the second stage shut-down.

9.2.2 Safety Control Procedure

The destruction of the launch vehicle will be performed by the Command Destruction System (CDS) and Automatic Destruction System (ADS) together.

(1) Command Destruction System

The ground tracking and telemetry system will acquire the flight information independently. If the flight anomaly meets the destruction criteria, the safety commander will select the impact area and send the destruction command. Otherwise the ground control computer will automatically send the command and remotely destroy the launch vehicle.

(2) Automatic Destruction System

The launch vehicle system makes the decision according to flight attitude. If the attitude angle of Launch Vehicle exceeds safety limits, the control system will send a destruction signal to on-board explosive devices. After a delay of 15 sec., the Launch Vehicle will be exploded. The range safety commander can use the delayed 15 seconds to select the impact location and send the destruction command. If the range safety commander could not find a suitable area within 15 seconds, the launch vehicle will be exploded by ADS.

The objective of choosing impact location is to make the launch vehicle debris drops to the area of less population and without important infrastructures.

The flowchart of the control system is shown in **Figure 9-1.**

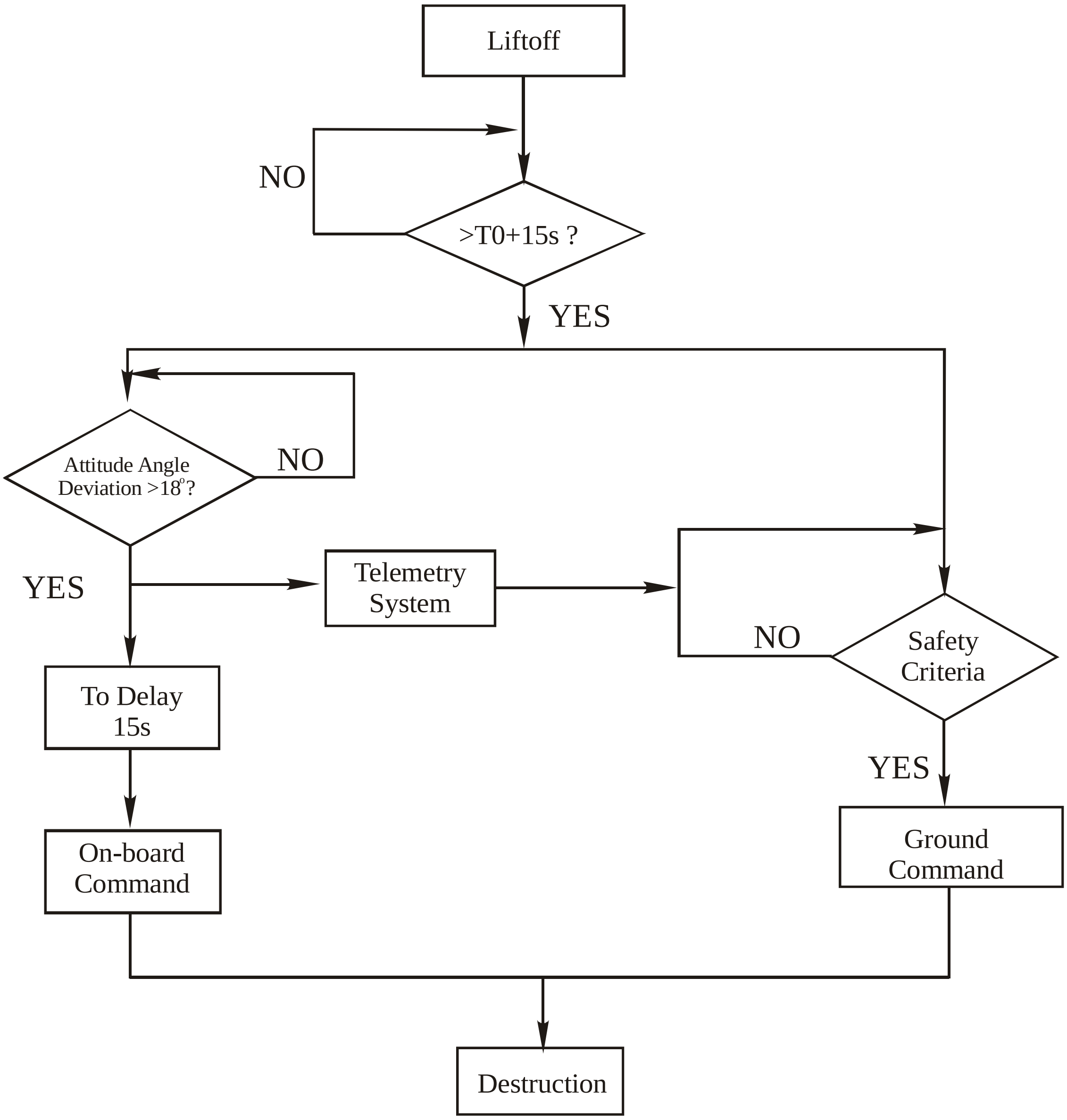


Figure 9-1 Flowchart of Control System

9.3 Composition of Safety Control System

The range safety control system includes on-board segment and ground segment. The on-board safety segment works along with the onboard tracking system, i.e. Tracking and Safety System. The on-board safety control system consists of ADS, CDS, explosion system, tracking system and telemetry system.

The ground safety control system consists of ground remote control station, tracking station, telemetry station and communication system.

The flight data that the safety control system needs include: flight velocity, coordinates, working status of LV subsystems, safety command receiving status, working status of onboard safety control system, as well as safety command to destroy the LV from ground.

9.4 Safety Criteria

The range safety criteria are the regulation used to destroy the launch vehicle. It is determined according to the launch trajectory, protected region, tracking equipment, objective of flight, etc. See **Figure 9-2**.

9.4.1 Approval Procedure of Range Safety Criteria

The range safety criteria vary with different launches, so the criteria should be modified before each launch. Normally the criteria is drafted by XSLC, reviewed by CALT and CLTC and excised by the safety commander.

9.4.2 Common Criteria

- If all the tracking and telemetry data disappear for 5 seconds, the launch vehicle will be destroyed immediately.
- If the launch vehicle flies toward the reverse direction, the safety commander will select a suitable time to destroy the launch vehicle considering the impact area.
- If the launch vehicle flies vertically to the sky other than pitches over to the predetermined trajectory, it will be destroyed at a suitable altitude.
- If the launch vehicle shows obvious abnormal, such as roll over, fire on some parts, it will be destroyed at a suitable time.
- If the engines of launch vehicle suddenly shut down, the launch vehicle will be destroyed immediately
- If the launch vehicle exceeds the predefined destruction limits (including attitude being unstable seriously), it will be destroyed at a suitable altitude

considering the impact area.

9.4.3 Special Criteria

- If the launch vehicle is horizontally closer than 400m away from the launch pad, the launch vehicle will not be destroyed to protect the launch site.
- If the launch vehicle leaves the normal trajectory and flies to the Technical Center during 15~30 seconds and Z≥400m, the launch vehicle will be destroyed immediately to protect the Technical Center, here Z is the distance between launch vehicle and the normal launch plane.
- If launch vehicle is flying out of the safety limit for 30~60seconds, it will be destroyed immediately to protect MCCC.

9.5 Emergency Measures

Before the launch takes place, people will be evacuated from some related facilities and area according to the predetermined plan.

XSLC has the following emergency measures:

- ✧ Emergency commander
- ✧ First aid team
- ✧ Fire fight team
- ✧ Ambulance
- ✧ Backup vehicles
- ✧ Helicopter

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

All the safety equipment can be checked by the User before using. Any comments or suggestions can be discussed in the launch mission or launch site review.

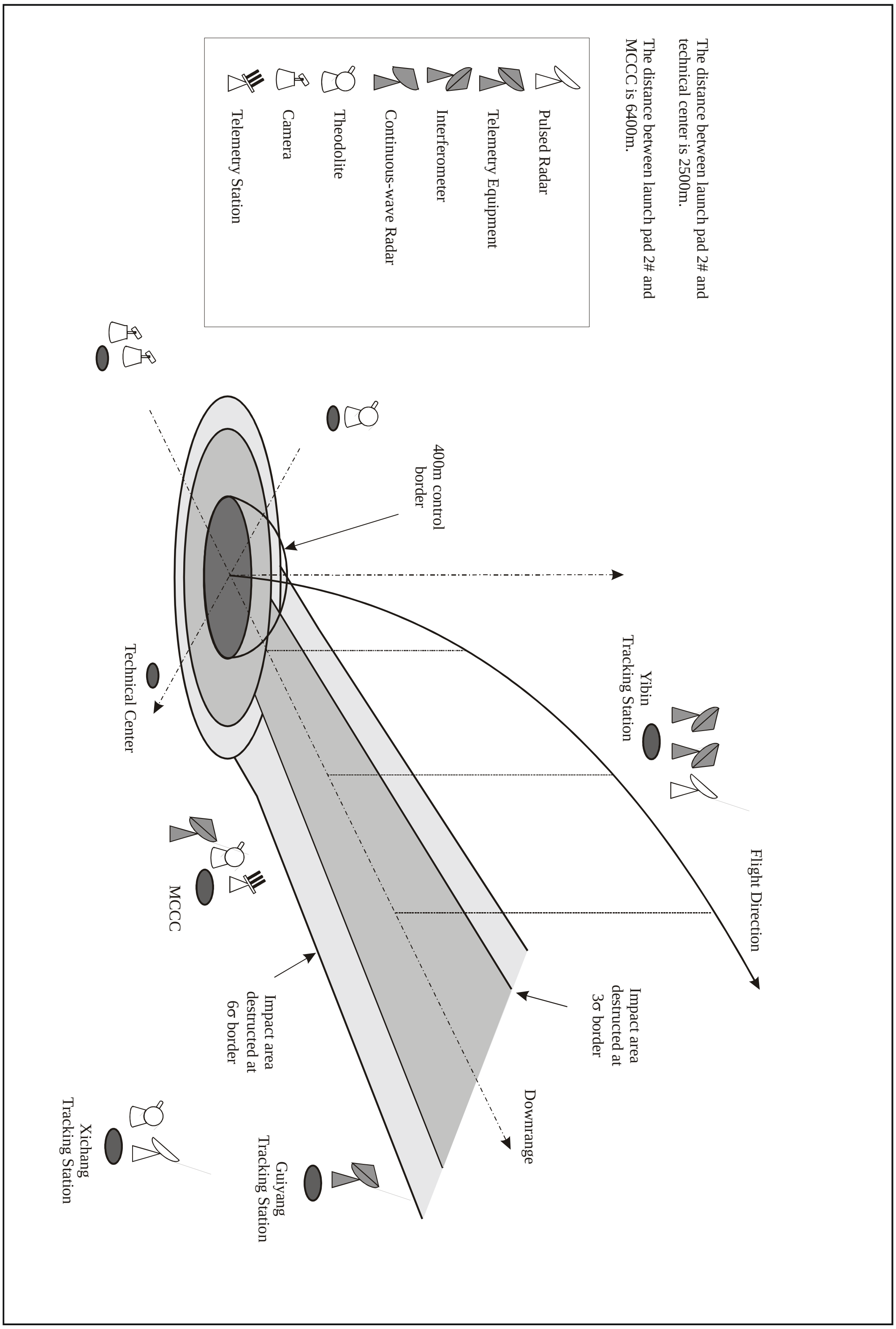


Figure 9-2 Ground Safety Control System

9-6

CHAPTER 10

DOCUMENTS AND MEETINGS

10.1 General

To ensure the SC/LV compatibility and the mission success, SC and LV sides should exchange documents and hold some meetings in 24 months from Effect Day of the Contract (EDC) to the launch.

Following the signature of the Contract, the launch vehicle side will nominate a Program Manager and a Technical Coordinator. The customer will be required to nominate a Mission Director responsible for coordinating the technical issues of the program.

10.2 Documents and Submission Schedule

Exchanged documents, Providers and Due Date are listed in **Table 10-1**. Each party is obliged to acquire the necessary permission from the Management Board of its company or its Government.

Table 10-1 Documents and Submission Schedule

No.	Documents	Provider	Due Date
1	**Launch Vehicle's Introductory Documents** ✧ *Launch March User's Manual* ✧ *XSLC User's Manual* ✧ *Long March Safety Requirement Documents* ✧ *Format of Spacecraft Dynamic Model and Thermal Model*	LV Side	1 month after EDC
2	**LM-3B Application** The customer will prepare the application covering following information: ✧ *General Mission Requirements* ✧ *Launch Safety and Security Requirements* ✧ *Special Requirement to Launch Vehicle*	Customer	2 months after EDC

No.	Documents	Provider	Due Date
	and Launch Center The application is used for very beginning of the program. Some technical data could be defined during implementation of the contract.		
3	**Spacecraft Dynamic Math Model (Preliminary and Final)** The customer shall provide hard copies and floppy diskettes according to *Format of Spacecraft Dynamic Model and Thermal Model*. CALT will perform dynamic Coupled Load Analysis with the model. The customer shall specify the output requirement in the printing. The math model would be submitted once or twice according to progress of the program.	Customer	2 month after No.1
4	**Dynamic Coupled Load Analysis (Preliminary and Final)** CALT will integrate SC model, launch vehicle model and flight characteristics together to calculate loads on SC/LV interface at some critical moments. The customer may get the dynamic parameters inside spacecraft using analysis result. Analysis would be carried out once or twice depending on the progress of the program.	CALT	3 months after No.3.
5	**Spacecraft Thermal Model** The customer shall provide printed documents and floppy diskettes of spacecraft thermal model according to *Format of Spacecraft Dynamic Model and Thermal Model*. CALT will use the model for thermal environment analysis. The analysis output requirement should be specified in printing.	Customer	2 month after No.1
6	**Thermal Analysis** This analysis determines the spacecraft thermal environment from the arrival of the spacecraft to its separation from the launch vehicle.	CALT	3 months after No.5
7	**Spacecraft Interface Requirement and Spacecraft Configuration Drawings (preliminary and final)** ✧ *Launch Orbit, mass properties, launch constrains and separation conditions.*	Customer	3 months after EDC.

No.	Documents	Provider	Due Date
	✧ *Detailed spacecraft mechanical interfaces, electrical interfaces and RF characteristics* ✧ *Combined operation requirement and constrains.* 3 months after EDC, customer should provide the spacecraft configuration drawings to the launch vehicle side. For minimal or potential extrusion out of fairing envelope, it is encouraged to settle the issue with CALT one year before launch.		
8	**Mission Analyses (Preliminary and Final)** LV side should provide the customer with preliminary and final mission analysis report according to customer's requirements. Both sides shall jointly review these reports for SC/LV compatibility. <u>Trajectory Analysis</u> To optimize the launch mission by determining launch sequence, flight trajectory and performance margin. <u>Flight Mechanics Analyses</u> To determine the separation energy and post-separation kinematics conditions (including separation analysis and collision avoidance analysis). <u>Interface Compatibility Analyses</u> To review the SC/LV compatibility (mechanical interface, electrical interface and RF link/working plan).	CALT	3 month after No.7
9	**Spacecraft Environmental Test Document** The document should detail the test items, test results and some related analysis conclusions. The survivability and the margins of the spacecraft should also be included. The document will be jointly reviewed.	Customer	15 days after the test
10	**Safety Control Documents** To ensure the safety of the spacecraft, launch vehicle and launch site, the customer shall submit documents describing all hazardous systems and operations, together with corresponding safety analysis, according to *Long March Safety Requirement Documents.* Both sides will jointly review this document.	Customer	2 months after EDC to 6 months before launch

No.	Documents	Provider	Due Date
11	**Spacecraft Operation Plan** This Plan shall describe the spacecraft operations in the launch site, the launch team composition and responsibilities. The requirements to the facilities in launch site should also be detailed. Both sides will jointly review this document. Part of the document will be incorporated into ICD and most part will be written into SC/LV Combined Operation Procedure.	Both Sides	8 months before launch
12	**SC/LV Combined Operations Procedure** The document contains all jointly participated activities following the spacecraft arrival, such as facility preparations, pre-launch tests, SC/LV integration and real launch. The launch vehicle side will work out the *Combined Operation Procedure* based on *Spacecraft Operation Plan*. Both sides will jointly review this procedure.	Both Sides	4 month before launch
13	**Final Mass Property Report** The spacecraft's mass property is finally measured and calculated after all tests and operations are completed. The data should be provided one day before SC/LV integration	Customer	1 day before mating of SC/LV
14	**Go/No go Criteria** This document specifies the GO/NO-GO orders issued by the relevant commanders of the mission team. The operation steps have been specified inside *SC/LV Combined Operation Procedure*.	Both Sides	15 days before launch
15	**Injection Data Report** The initial injection data of the spacecraft will be provided 40 minutes after SC/LV separation. This document will either be handed to the customer's representative at XSLC or sent via telex or facsimile to a destination selected by the customer. Both sides will sign on this document.	LV Side	40 minutes after orbit injection

No.	Documents	Provider	Due Date
16	**Orbital Tracking Report** The customer is required to provide spacecraft orbital data obtained prior to any spacecraft maneuver. This data is used to re-check the launch vehicle performance.	Customer	20 days after launch
17	**Launch Mission Evaluation Report** Using the data obtained from launch vehicle telemetry, the launch vehicle side will provide assessment to the launch vehicle's performance. This will include a comparison of flight data with preflight predictions. The report will be submitted 45 days after a successful launch or 15 days after a failure.	CALT	45 day after launch

10.3 Reviews and Meetings

During the implementation of the contract, some reviews and technical coordination meetings will be held. The specific time and locations are dependent on the program process. Generally the meetings are held in spacecraft side or launch vehicle side alternatively. The topics of the meetings are listed in **Table 10-2**, which could be adjusted and repeated, as agreed upon by the parties.

Table 10-2 Reviews and Meetings

No.	Meetings
1	**Kick-off Meeting** In this meeting, both parties will introduce the management and plan of the program. The major characteristics, interface configuration and separation design are also described. The design discussed in that meeting is not final, which will be perfected during the follow-up coordination. Kick-off Meeting will cover, but not be limited to, the following issues: ✧ *Program management, interfaces and schedule* ✧ *Spacecraft program, launch requirements and interface requirements* ✧ *Launch vehicle performance and existing interfaces* ✧ *Outlines of ICD for this program* ✧ *Launch site operations and safety*

No.	Meetings
2	**Interface Control Document Review (ICDR)** The purpose of the ICD Review is to ensure that all the interfaces meet the spacecraft's requirements. The ICD will be reviewed twice, preliminary and final. Some intermediate reviews will be held if necessary. Action Items will be generated in the reviews to finalize the ICD for the specific program.
3	**Mission Analyses Reviews (MAR)** The preliminary MAR follows the preliminary mission analyses to draft ICD and work out the requirements for spacecraft environment test. The final MAR will review the final mission analyses and spacecraft environment test result and finalize the mission parameters. ICD will be updated according to the output of that meeting.
4	**Spacecraft Safety Reviews** Generally, there are three safety reviews after the three submissions of *Safety Control Documents.* The submittals and questions/answers will be reviewed in the meeting.
5	**XSLC Facility Acceptance Review** This review is held at XSLC six months before launch. The spacecraft project team will be invited to this review. The purpose of this review is to verify that the launch site facilities satisfy the Launch Requirements Documents.
6	**Combined Operation Procedure Review** This review will be held at XSLC following the submission of *Combined Operation Procedures*, drafted by the customer. The *Combined Operation Procedure* will be finalized by incorporating the comments put forward in the review.
7	**Launch Vehicle Pre-shipment Review (PSR)** This review is held in CALT facility four months before launch. The purpose of that meeting is to confirm that the launch vehicle meet the specific requirements in the process of design manufacture and testing. The delivery date to XSLC will be discussed in that meeting. CALT has a detailed report to the customer introducing the technical configuration and quality assurance of the launch vehicle. The review is focused on various interfaces
8	**Flight Readiness Review (FRR)** This review is held at XSLC after the launch rehearsal. The review will cover the status of spacecraft, launch vehicle, launch facilities and TT&C network. The launch campaign will enter the fueling preparation after this review.

No.	Meetings
9	**Launch Site Operation Meetings** The daily meeting will be held in the launch site at the mutually agreed time. The routine topics are reporting the status of spacecraft, launch vehicle and launch site, applying supports from launch site and coordinating the activities of all sides. The weekly planning meeting will be arranged if necessary.

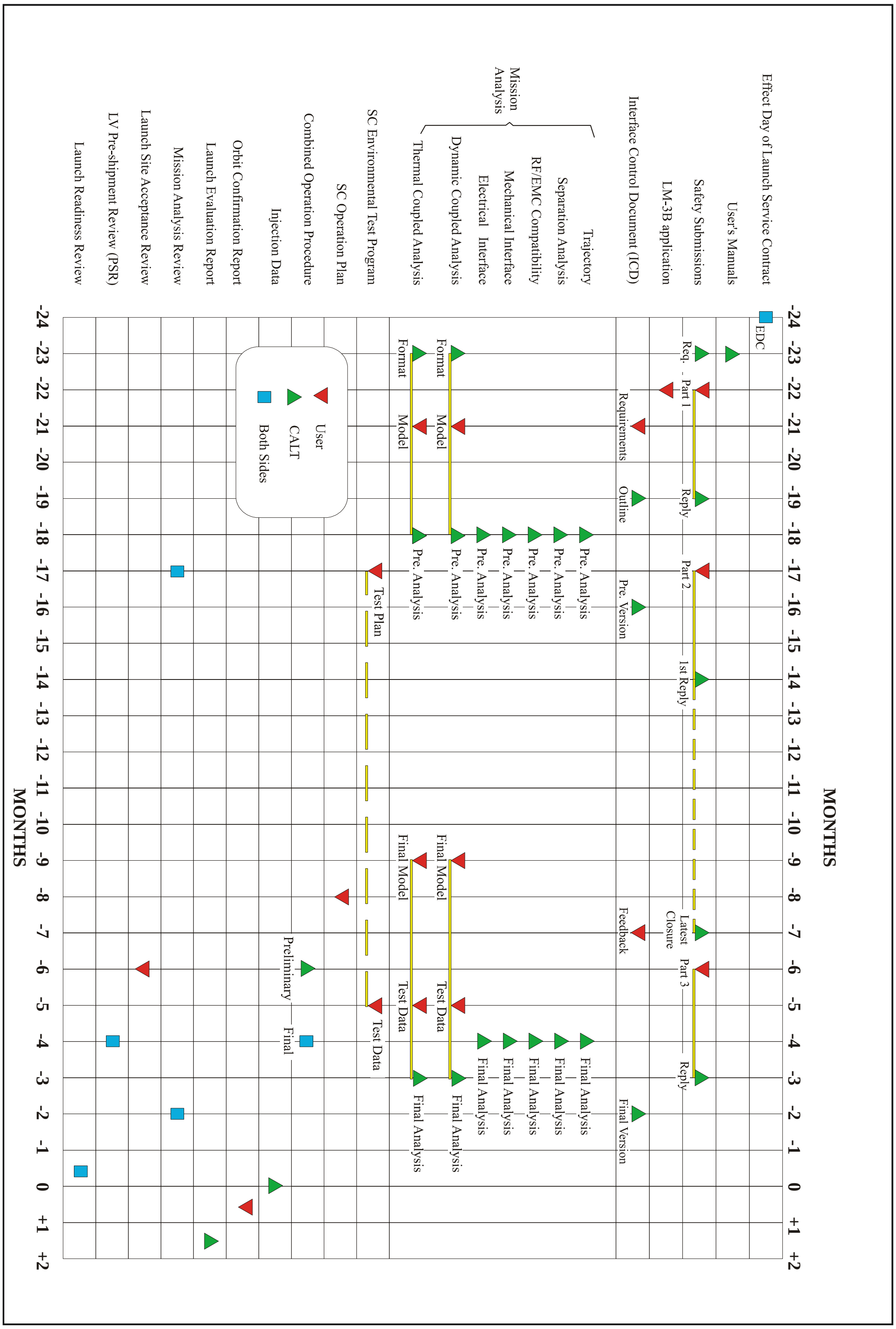


Figure 10-1 Time-schedule of Documentation and Reviews

10-8