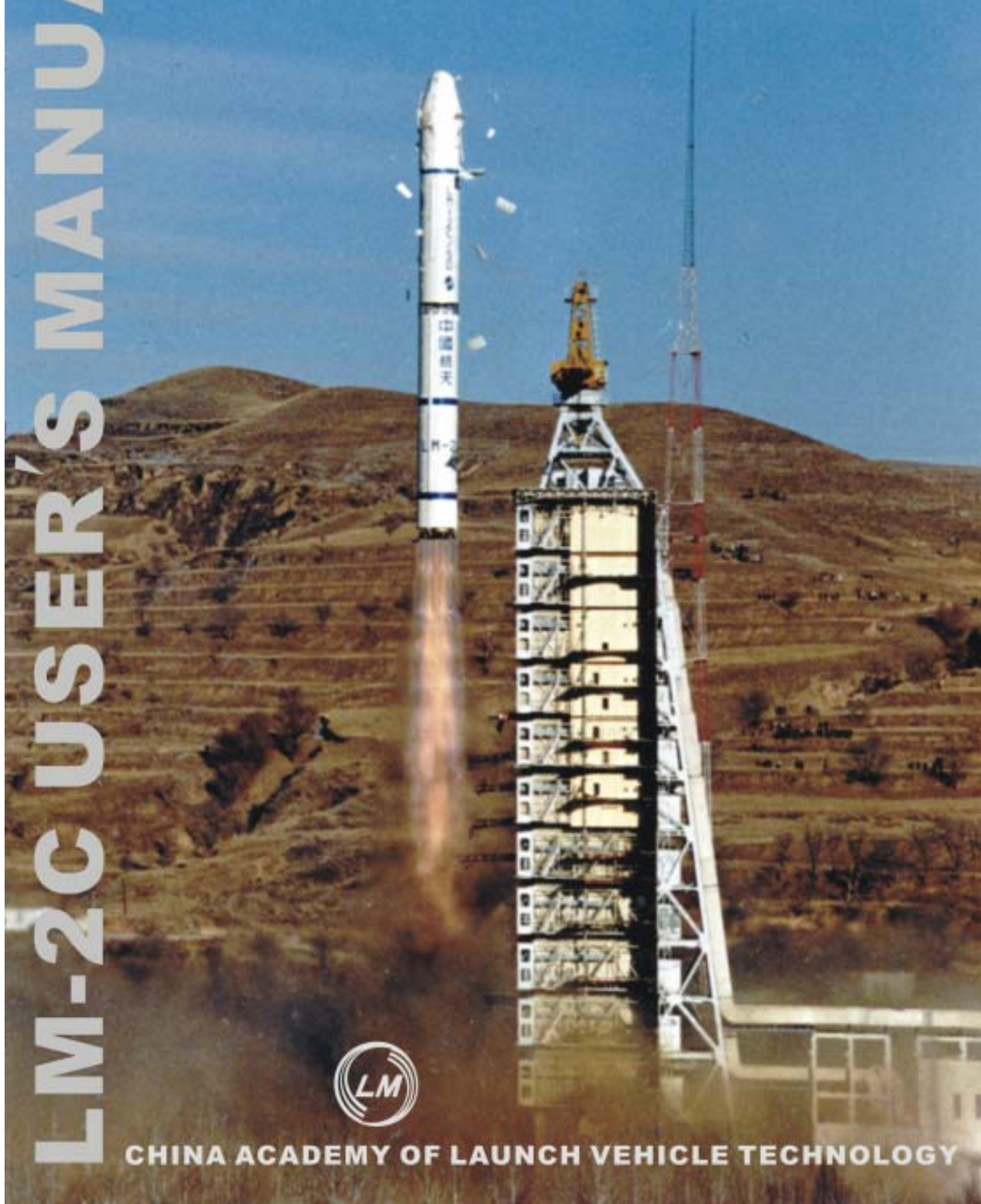


LM-2C USER'S MANUAL

LM-2C USER'S MANUAL



CHINA ACADEMY OF LAUNCH VEHICLE TECHNOLOGY

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ABBREVIATIONS

ADS	Automatic Destruction System
BL	Launch Vehicle Processing Building
BLS	LV&SC Processing Building
BM	Solid Rocket Motor Testing and Processing Buildings
BS2	SC Processing Hall
BS3	SC Fueling Hall
CALT	China Academy of Launch Vehicle Technology
CDS	Command Destruction System
CLA	Coupled Load Analysis
CLTC	China Satellite Launch and Tracking Control General
EDC	Effect Day of the Contract
CTS	A three-axis stabilized solid upper stage matching with LM-2C
GSE	Ground Support Equipment
GTO	Geo-synchronous Transfer Orbit
IFD	In-Flight-Disconnecter
JSLC	Jiuquan Satellite Launch Center
LCC	Launch Control Console
LEO	Low Earth Orbit
LH₂/LH	Liquid Hydrogen
LM	Long March
LOX	Liquid Oxygen
LV	Launch Vehicle
MCCC	Mission Command and Control Center
N₂O₄	Nitrogen Tetroxide
OMS	Orbital Maneuver 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 ($\Phi 2.25\text{m} \times 15\text{m}$). 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.

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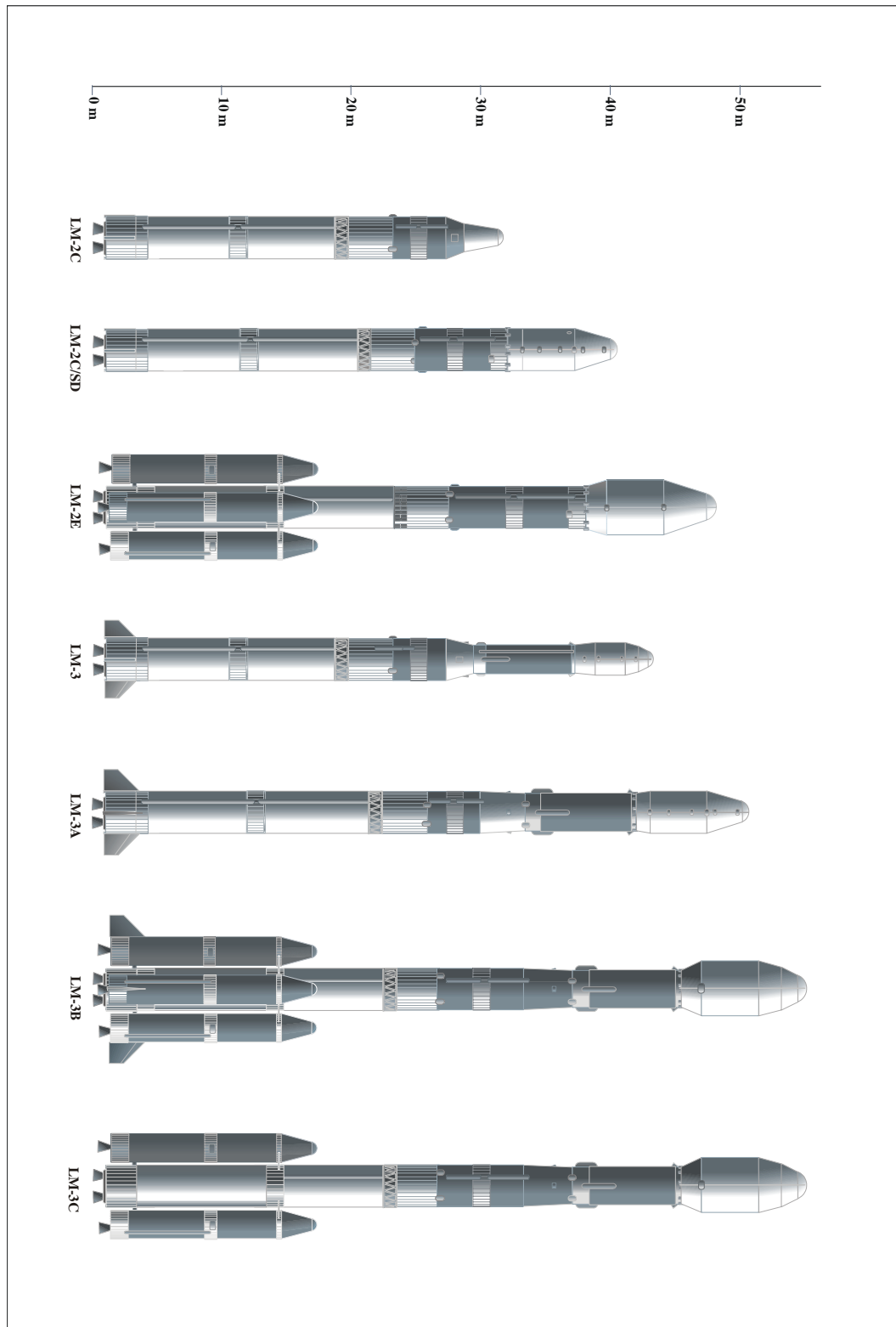


Figure 1-1 Long March Family

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.

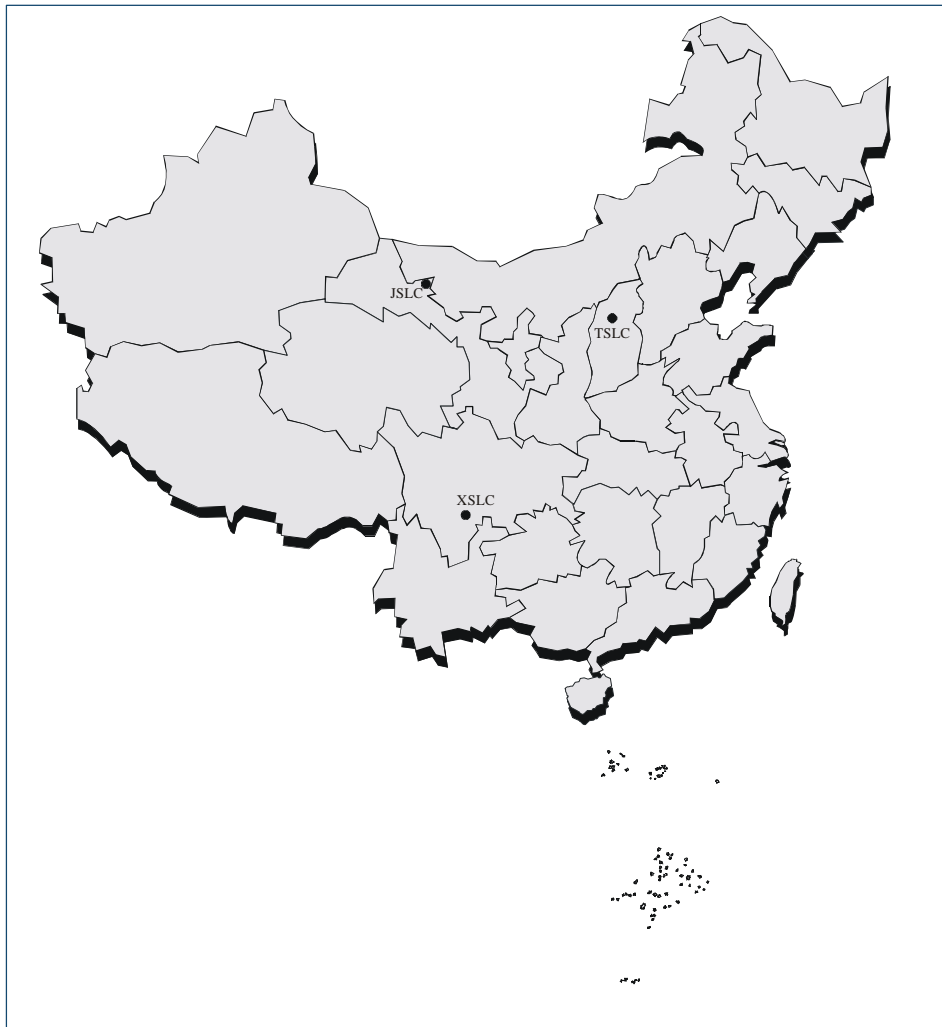


Figure 1-2 Locations of China's Three Launch Sites

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	JSJC	Success
2	LM-1 F-02	71.03.03	SJ-1	LEO	JSJC	Success
3	LM-2 F-01	74.11.05	FHW-1	LEO	JSJC	Failure
4	LM-2C F-01	75.11.26	FHW-1	LEO	JSJC	Success
5	LM-2C F-02	76.12.07	FHW-1	LEO	JSJC	Success
6	LM-2C F-03	78.01.26	FHW-1	LEO	JSJC	Success
7	LM-2C F-04	82.09.09	FHW-1	LEO	JSJC	Success
8	LM-2C F-05	83.08.19	FHW-1	LEO	JSJC	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	JSJC	Success
12	LM-2C F-07	85.10.21	FHW-1	LEO	JSJC	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	JSJC	Success
15	LM-2C F-09	87.08.05	FHW-1	LEO	JSJC	Success
16	LM-2C F-10	87.09.09	FHE-1A	LEO	JSJC	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	JSJC	Success
19	LM-4 F-01	88.09.07	FY-1	SSO	TSJC	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	TSJC	Success
25	LM-2C F-12	90.10.05	FHW-1A	LEO	JSJC	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	JSJC	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	JSJC	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	JSJC	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	JSJC	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 3

PERFORMANCE

The launch performance given in this chapter is based on the following assumptions:

- Taking into account the relevant range safety limitations and ground tracking requirements;
- Mass of the payload adapter and the separation system are included in LV mass;
- Standard fairing (3.35 m in diameter, 8.368 m in length) is adopted;
- At fairing jettisoning, the aerodynamic heating being less than 1135 W/m^2 ;
- The total impulse of CTS Solid Rocket Motor can be adjusted according to different mission requirements.
- Orbital altitude values given with respect to a mean radius of equator of 6378.140 km.

The two-stage LM-2C is mainly used for conducting LEO ($h < 500 \text{ km}$) missions and the LM-2C/CTS for circular LEO ($h \geq 500 \text{ km}$) and SSO missions. LM-2C takes JSLC as its main launch site, and it can also be launched from XSLC and TSLC. In this Chapter, the launch capabilities of LM-2C launching from JSLC and XSLC are introduced. The launch capabilities vary with different orbital altitudes and inclinations.

3.1 LM-2C Mission Descriptions

3.1.1 Flight Sequence

The typical flight sequence of LM-2C is shown in **Table 3-1** and **Figure 3-1**.

Table 3-1 LM-2C Flight Sequence

Events	Two-stage LM-2C Flight Time (s)	LM-2C/CTS Flight Time (s)
Liftoff	0.000	0.000
Pitch Over	10.000	10.000
Stage-1 Shutdown	120.270	120.270
Stage-1/Stage-2 Separation	121.770	121.770
Fairing Jettisoning	231.670	231.670

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Stage-2 Main Engine Shutdown	305.770	301.184
Stage-2 Vernier Engine Shutdown	566.234	613.333
Stage-2/CTS Separation	/	616.333
CTS Solid Rocket Motor Ignition	/	2888.347
Beginning of Terminal Velocity Adjustment	/	2928.347
SC/LV Separation	569.234	3013.347
CTS Deorbit	/	3213.347

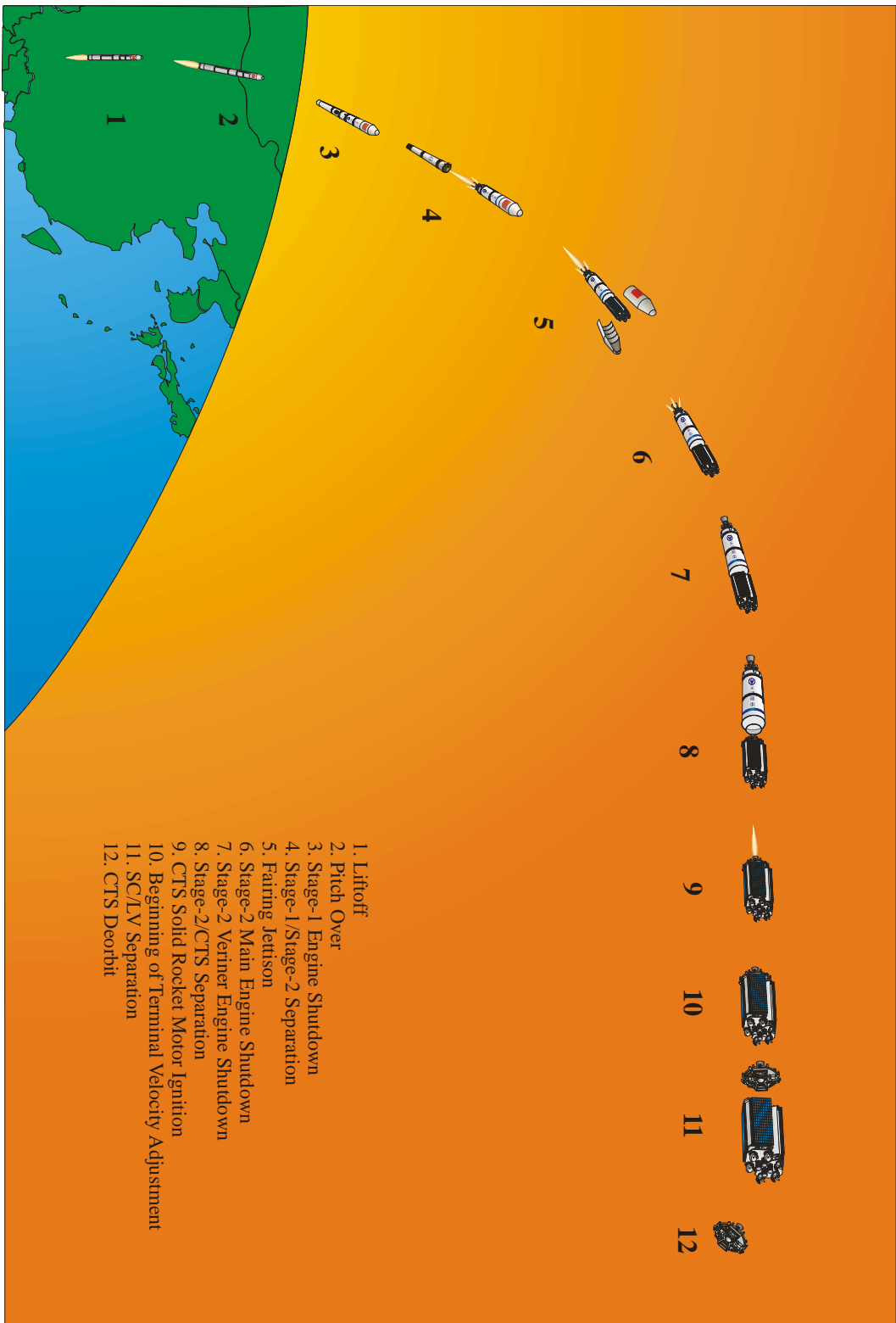


Figure 3-1 LM-2C/CTS Flight Sequence

3.1.2 LM-2C/CTS Characteristic Parameters

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

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	0.2	1.452	0	90	38.661	111.608
Stage-1 Shutdown	2035.853	47.052	61.755	22.765	38.106	111.633
Stage-1/Stage-2 Separation	2043.777	48.257	64.549	22.403	38.081	111.635
Fairing Jettisoning	3698.167	117.618	352.768	4.263	35.490	111.729
Stage-2 Main Engine Shutdown	6379.424	146.895	679.624	-2.540	32.551	111.813
Stage-2 Vernier Engine Shutdown	7917.684	181.142	2825.723	-25.629	13.252	112.076
Stage-2/CTS Separation	7918.657	181.104	2848.800	-25.829	13.045	112.077
CTS SRM Ignition	7402.700	637.804	18860.013	-173.727	-44.220	-80.123
Terminal Velocity Adjustment Ending	7512.356	639.455	18971.228	-177.295	-41.780	-80.001
SC/LV Separation	7520.725	637.611	18983.402	177.366	-36.557	-79.808

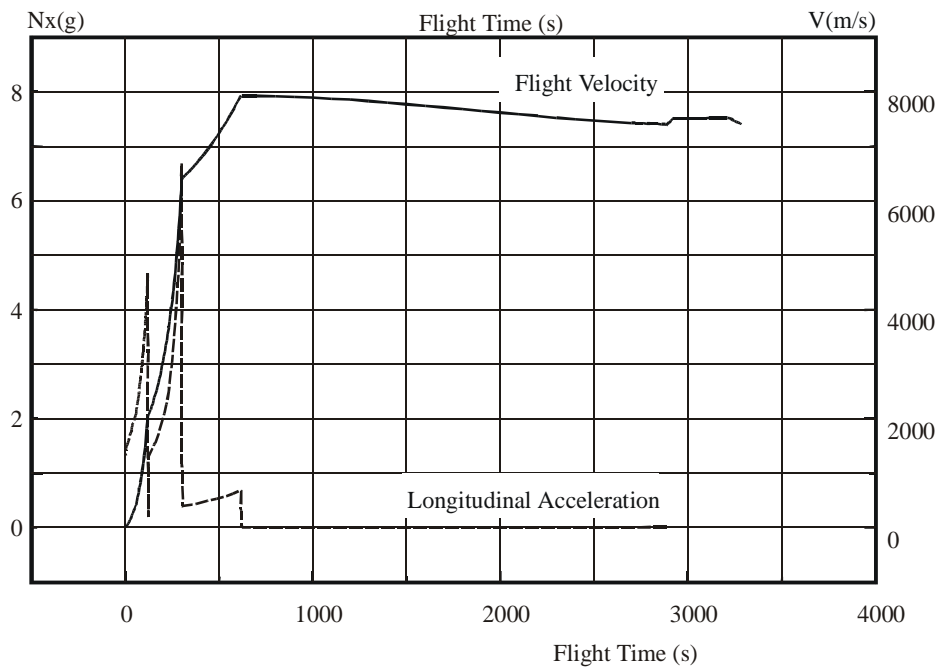


Figure 3-2a LM-2C/CTS Flight Acceleration and Flight Velocity vs. Flight Time

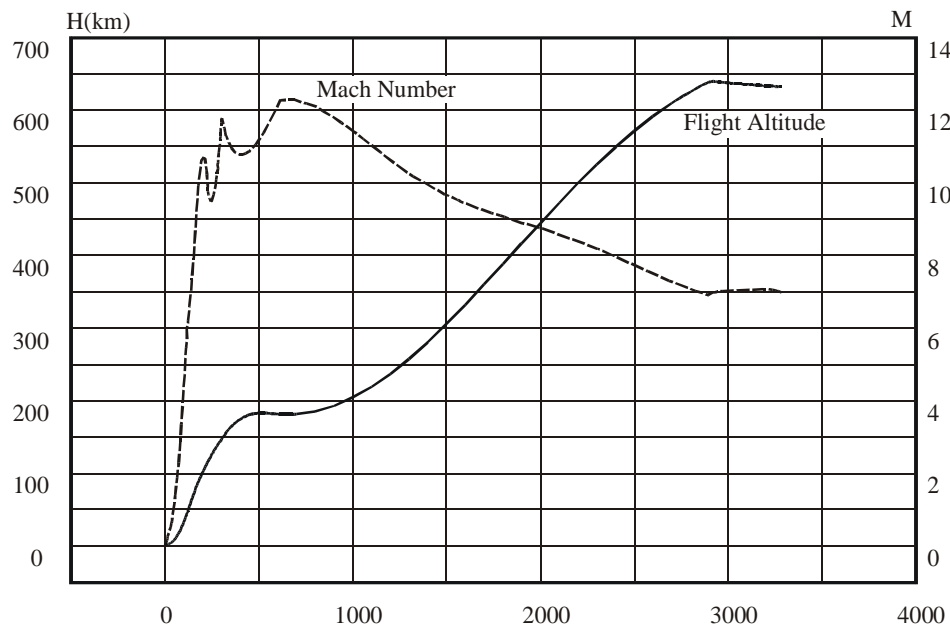


Figure 3-2b LM-2C/CTS Flight Altitude and Mach Numbers vs. Flight Time

3.2 Launch Capacities

3.2.1 Basic Information on Launch Sites

- **Jiuquan Satellite Launch Center (JSLC)**

Two-stage LM-2C and LM-2C/CTS conduct LEO and SSO missions from Jiuquan Satellite Launch Center (JSLC), which is located in Gansu Province, China. The geographic coordinates are listed as follows:

Latitude:	40.96°N
Longitude:	100 .29°E
Elevation:	1072m

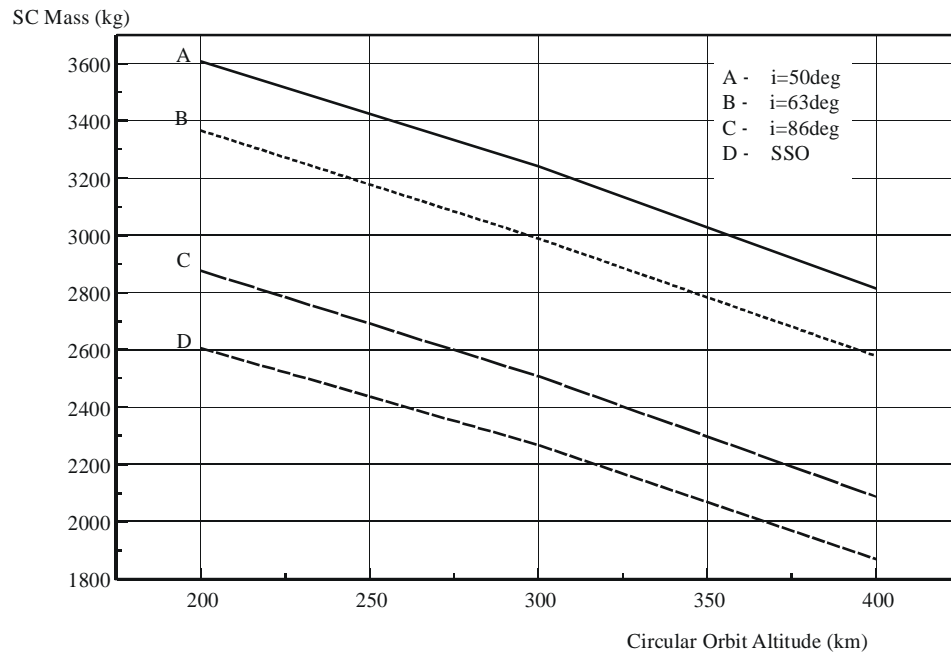
- **Xichang Satellite Launch Center (XSLC)**

Two-stage LM-2C and LM-2C/CTS conduct LEO missions from Xichang Satellite Launch Center (XSLC), which is located in Sichuan Province, China. The geographic coordinates are listed as follows:

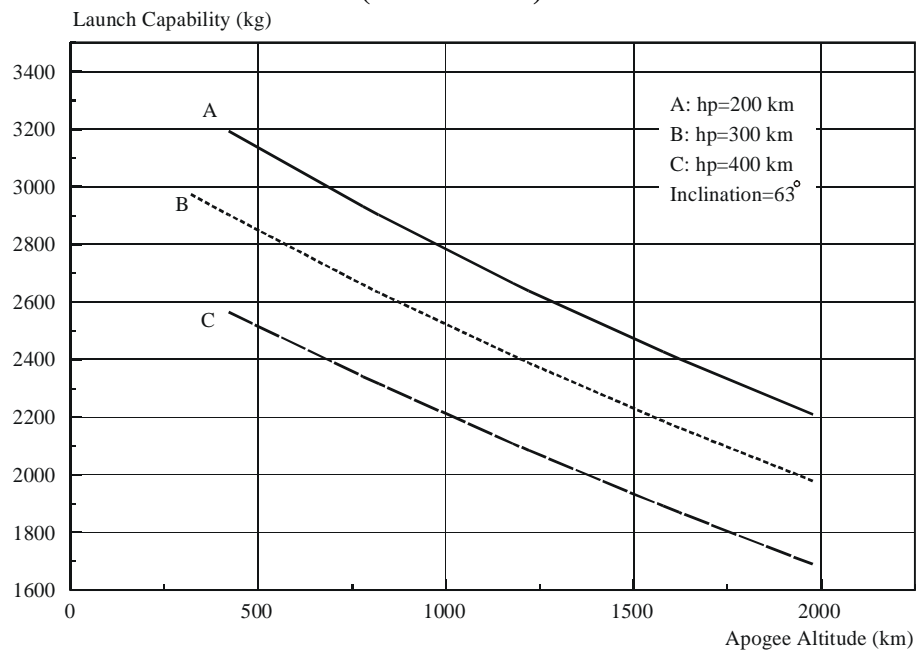
Latitude:	28.2°N
Longitude:	102.02°E
Elevation:	1826m

3.2.2 Two-stage LM-2C Mission Performance

The launch capacity of Two-stage LM-2C for typical LEO mission ($h=200\text{km}$, $i=63^\circ$) is 3366kg. The different LEO launch capabilities vs. different inclinations and apogee altitudes are shown in **Figure 3-3a,b,c&d**.



**Figure 3-3a Two-stage LM-2C's Capability for Circular Orbit Missions
(From JSLC)**



**Figure 3-3b Two-stage LM-2C's Capability for Elliptical Orbit Missions
(From JSLC)**

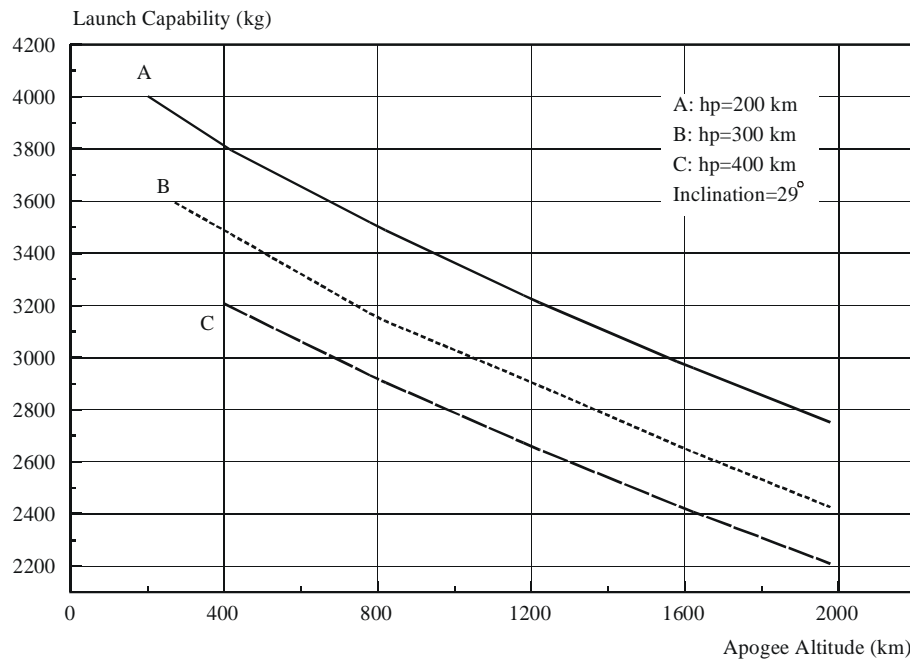


Figure 3-3c Two-stage LM-2C's Capability for Elliptical Orbit Missions (From XSLC)

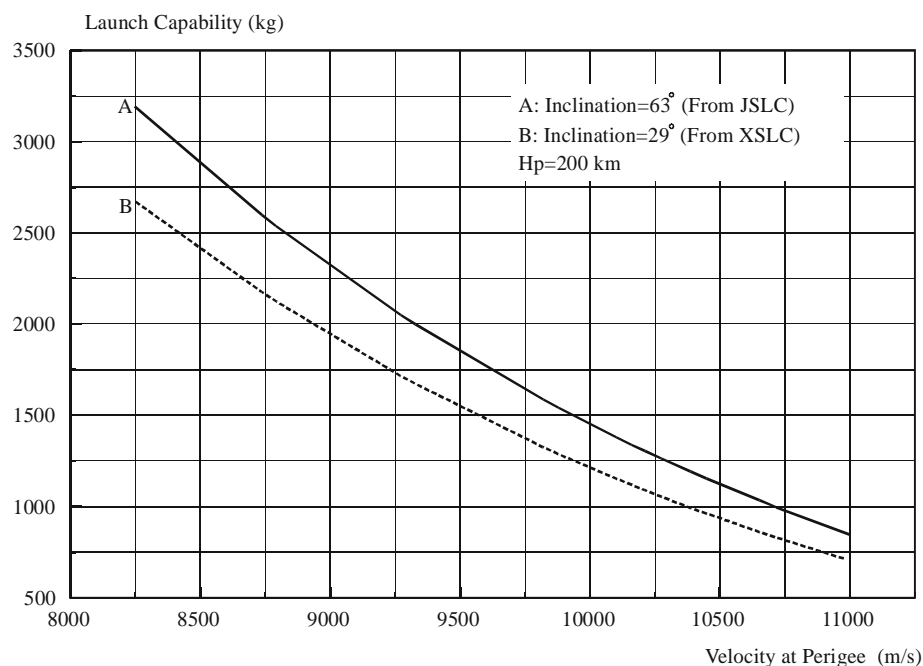


Figure 3-3d LM-2C's Capability for Large Elliptical Orbit Missions

Note: For this kind of mission, LM-2C works as follows: After Two-stage LM-2C reach the parking orbit (a LEO), it will release a solid upper stage and spin it up

according to required direction. Then the upper stage will go into the large elliptical transit orbit by ignition at the pre-determined time. The method is suitable for GTO or Earth escape missions. The solid upper stage for orbit maneuvering can be made according to user's specific requirements.

3.2.3 LM-2C/CTS Mission Performance

The launch capacity of LM-2C/CTS for typical LEO mission ($h=500$ km, $i=50^\circ$) is 3000 kg. The different LEO and SSO launch capabilities vs. different inclinations and apogee altitudes are shown in **Figure 3-4a&b**.

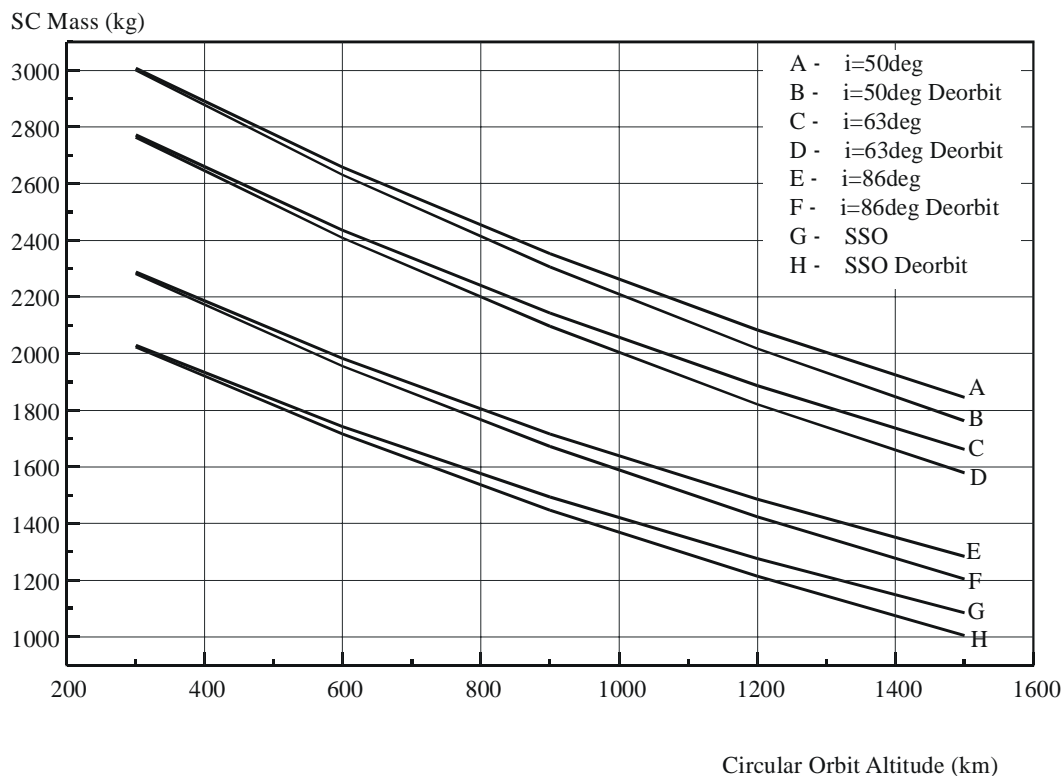
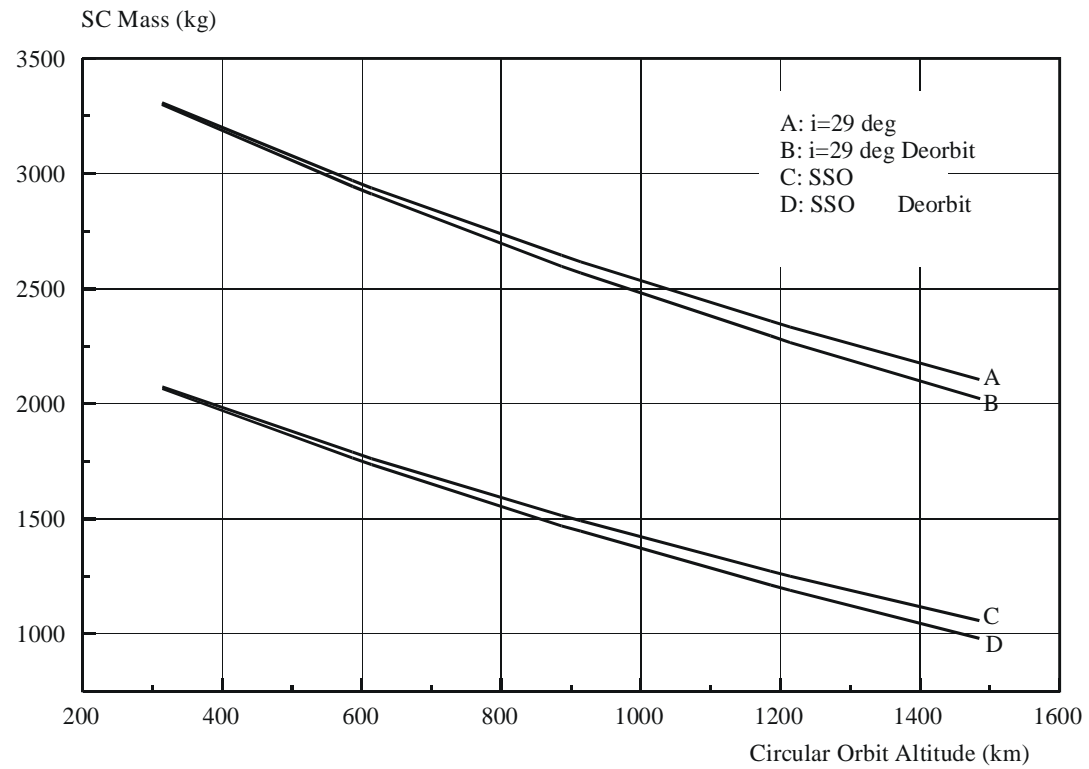


Figure 3-4a LM-2C/CTS's Capability for Circular Orbit Missions (From JSLC)

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**Figure 3-4b LM-2C/CTS's Capability for Circular Orbit Missions (From XSLC)**

3.3 Injection Accuracy

3.3.1 Two-stage LM-2C Injection Accuracy

The injection accuracy is different for the different missions. The injection accuracy for elliptical LEO (hp=200km, ha=400km) mission is shown in **Table 3-3** and **Table 3-4**.

**Table 3-3 Injection Accuracy for LEO Mission
(hp=200km, ha=400km)**

Symbol	Parameters	Deviation (1σ)
Δa	Semi-major Axis	1.1 km
Δe	Eccentricity	0.00022
Δi	Inclination	0.045 deg.
$\Delta \Omega$	Right Ascension of Ascending Node	0.055 deg.
$\Delta \omega$	Perigee Argument	1.67 deg.

**Table 3-4 Covariance Matrix of Injection for LEO Mission
(hp=200km, ha=400km)**

	a	e	i		
a	1.210	1.154E-4	-8.821E-3	2.202E-2	6.319E-1
e		4.840E-8	-3.086E-6	9.622E-6	1.564E-4
i			2.025E-3	-3.044E-4	7.823E-3
				3.025E-3	2.172E-2
					2.789

3.3.2 LM-2C/CTS Injection Accuracy

The injection accuracy for the circular orbit mission (h=630km) is shown in **Table 3-5**.

Table 3-5 Injection Accuracy for Circular Orbit Mission (h=630km)

Symbol	Parameters	Deviation (1σ)
Δh	Orbital Altitude	6 km
Δi	Inclination	0.05 deg.
$\Delta \Omega$	Right Ascension of Ascending Node	0.06 deg.

3.4 Separation Accuracy

3.4.1 Two-stage LM-2C Separation Accuracy

The separation accuracy of Two-stage LM-2C is shown in **Table 3-6**.

Table 3-6 Two-stage LM-2C Separation Accuracy (1σ)

Items	Separation Accuracy
Roll Angular Rates ω_x	$<0.5^\circ/\text{s}$
Yaw Angular Rates ω_y	$<1.1^\circ/\text{s}$
Pitch Angular Rates ω_z	$<1.1^\circ/\text{s}$
Pitch	$<3.2^\circ$
Yaw	$<3.2^\circ$
Roll	$<1.5^\circ$

3.4.2 LM-2C/CTS Separation Accuracy

The separation accuracy of LM-2C/CTS is shown in **Table 3-7**.

Table 3-7 LM-2C/CTS Separation Accuracy (1σ)

Items	Separation Accuracy
Roll Angular Rates ω_x	$<0.3^\circ/\text{s}$
Yaw Angular Rates ω_y	$<0.3^\circ/\text{s}$
Pitch Angular Rates ω_z	$<0.3^\circ/\text{s}$
Pitch	$<0.6^\circ$
Yaw	$<0.6^\circ$
Roll	$<0.6^\circ$

3.5 Launch Windows

LM-2C adopts automatic timing ignition, and it can be launched in zero-launch window.

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 by the atmosphere, which includes high-speed air-stream, aerodynamic loads, aerodynamic heating and acoustic noises, etc. The fairing provides the payload with acceptable environments.

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 Payload by the fairing.

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

See **Figure 4.1** for LM-2C Fairing Configuration.

A series of tests have been performed during LM-2C fairing development, including fairing wind-tunnel test, thermal test, acoustic test, separation test, model survey test and strength test, etc.

The typical LM-2C fairing is 3.35 m in diameter, and 8.368 m in length. The length of the fairing can be adjusted according to different mission requirements.

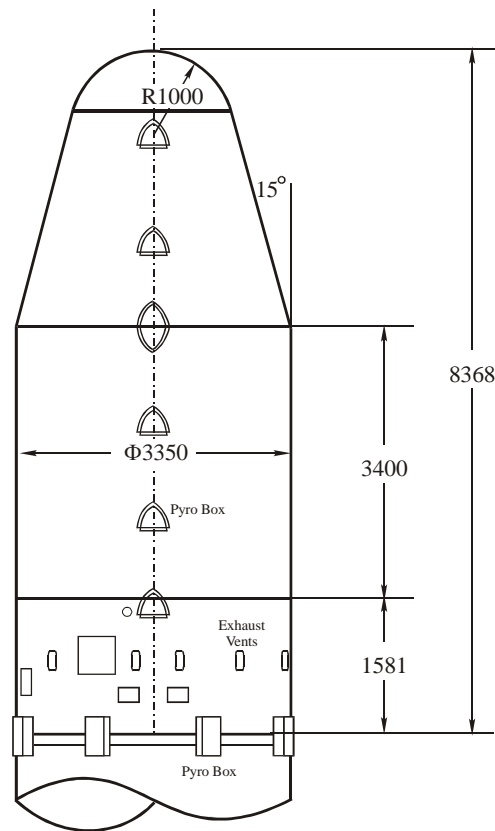


Figure 4-1 Fairing Configuration

4.1.2 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 fairing/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 ($\Phi 3000\text{mm}$) in the fairing cylindrical section. However, the extrusion issue shall be resolved by technical coordination between SC side and CALT.

The typical fairing static envelopes for Two-stage LM-2C are shown in **Figure 4-2a**, and **Figure 4-2b**. The typical fairing static envelope for LM-2C/CTS is shown in **Figure 4-2c**.

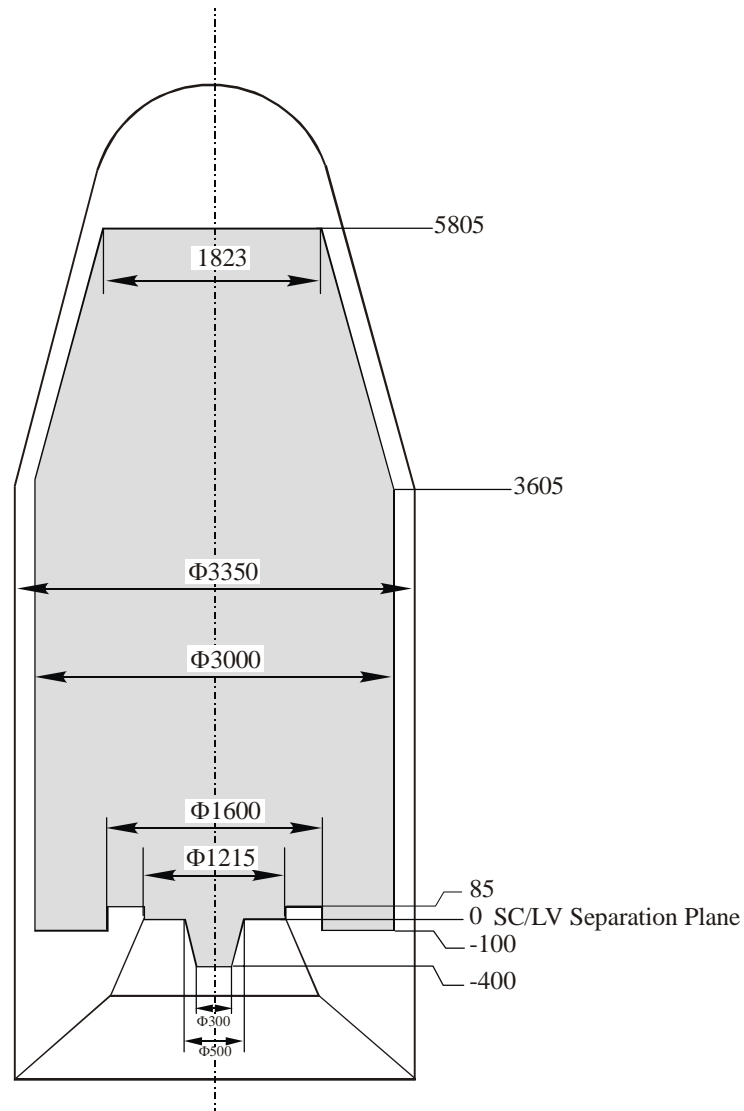


Figure 4-2a Two-stage LM-2C Fairing Static Envelope (1194A Interface)

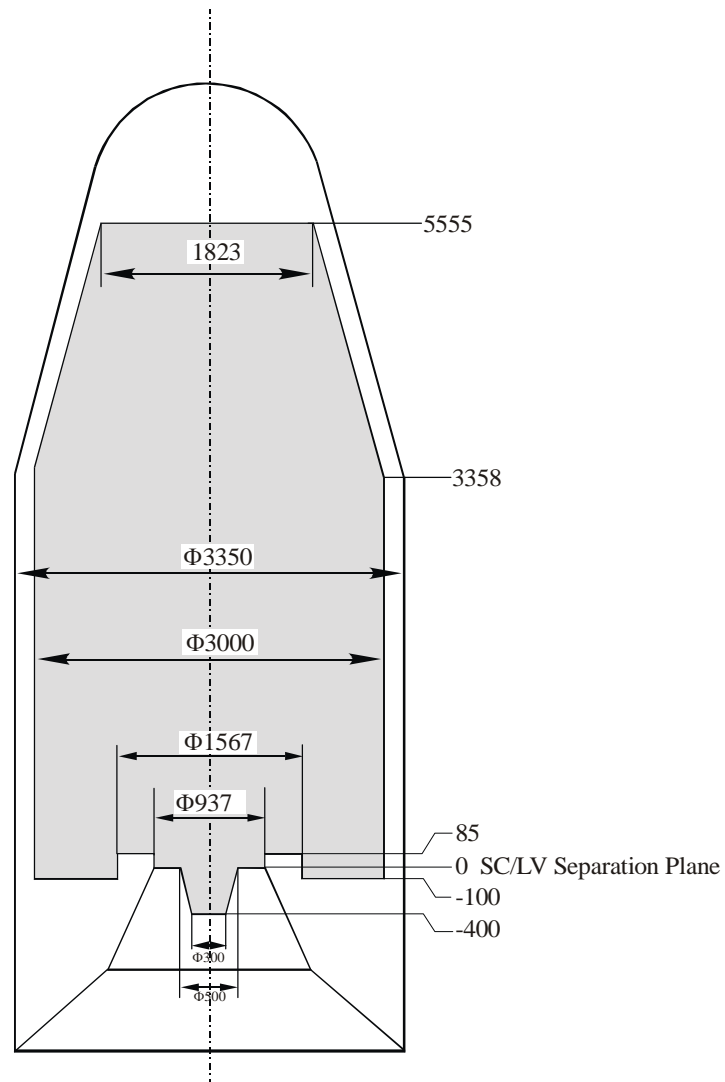


Figure 4-2b Two-stage LM-2C Fairing Static Envelope (937B Interface)

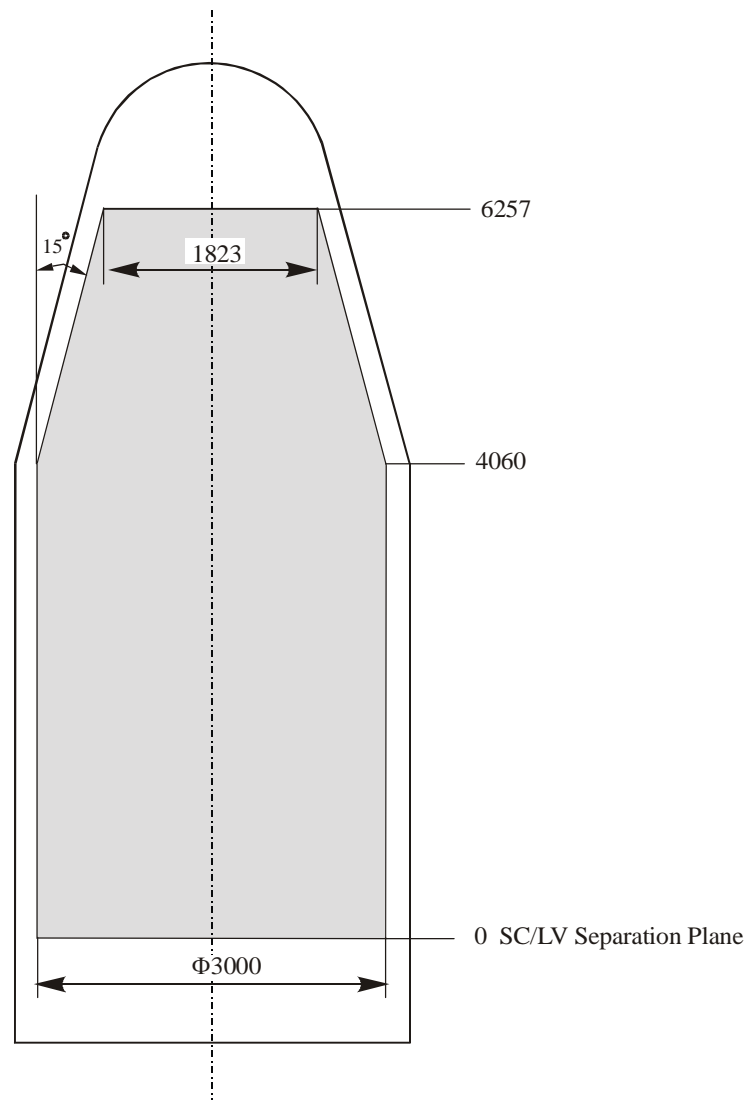


Figure 4-2c LM-2C/CTS Fairing Static Envelope (Explosive Bolt Interface)

4.2 Fairing Structure

The fairing consists of dome, forward cone section, and cylindrical section. The cylindrical section consists of two parts: honey-comb cylindrical section and chemical-milled cylindrical section. Refer to **Figure 4-3**.

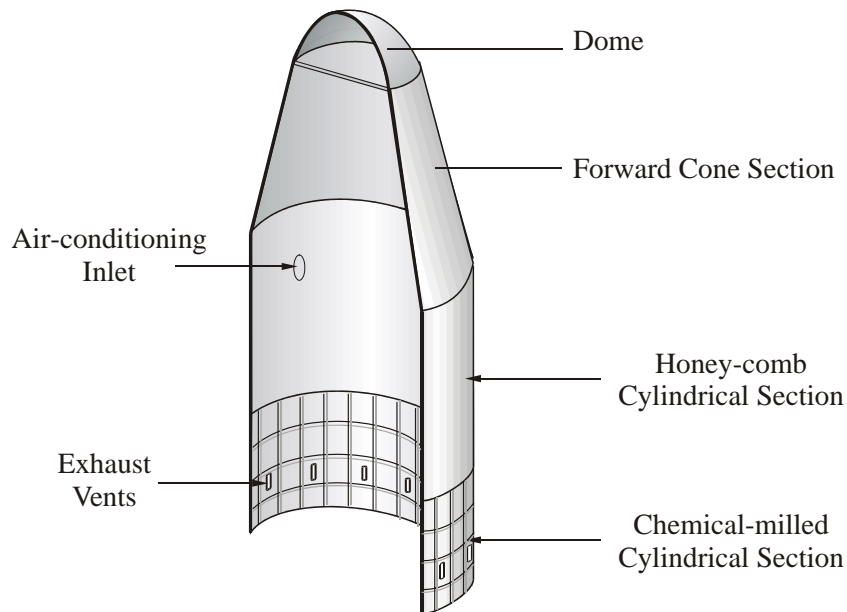


Figure 4-3 Fairing Structure

4.2.1 Dome

The dome is a semi-sphere body with radius of 1000 mm, height of 740 mm and base ring diameter of $\phi 1930\text{mm}$. It consists of dome shell, base ring, encapsulation ring and stiffeners. Refer to **Figure 4-4**.

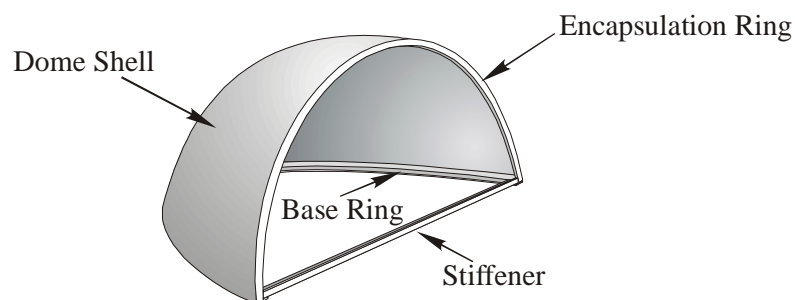


Figure 4-4 Structure of the Fairing Dome

The dome shell is made of 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 flight.

4.2.2 Forward Cone Section

The forward cone section is a 15°-cone with height of 2647 mm. The diameter of the top ring is $\phi 1930$ mm, and diameter of the base ring is $\phi 1930$ mm. The section is made of aluminum honeycomb sandwich structure.

4.2.3 Cylindrical Section

The cylindrical section is composed of two parts. The lower part is made of chemical-milled aluminum structure with height of 1581 mm, and the upper part is made of aluminum honeycomb sandwich structure with height of 3400 mm. Almost all the access doors are opened in the chemical-milled lower part. 12 exhaust vents with total area of 350 cm^2 on the lower part. The length of the cylindrical section can be adjusted according to different mission requirements. Refer to **Figure 4-1**.

4.3 Heating-proof Function of the Fairing

The outer surface of the fairing, especially the surface of the dome and forward cone 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 appropriate.

The fiberglass dome is of excellent heating-proof function. The outer surface of the forward cone section and cylindrical section is covered by special cork panel. The cork panel also functions to damp noise.

4.4 Fairing Jettisoning Mechanism

The fairing jettisoning mechanism consists of lateral unlocking mechanism and longitudinal unlocking mechanism and separation mechanism. See **Figure 4-5a,b&c**.

4.4.1 Lateral Unlocking Mechanism

The base ring of the fairing is connected with the LV second stage by 8 non-contamination explosive bolts. See **Figure 4-5a&b**.

4.4.2 Longitudinal Unlocking Mechanism

The longitudinal separation plane of the fairing is II-IV quadrant. The longitudinal unlocking mechanism consists of 12 non-contamination explosive bolts. See **Figure 4-5a**.

4.4.3 Fairing Separation Mechanism

The fairing separation mechanism is composed of two pairs of hinges and 12 springs. See **Figure 4-5b**. 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 4 kN. After fairing unlocking, each half of the fairing turns around the hinge. When the roll-over rate of the fairing half is larger than 15°/s, the fairing is jettisoned. Refer to **Figure 4-5c**.

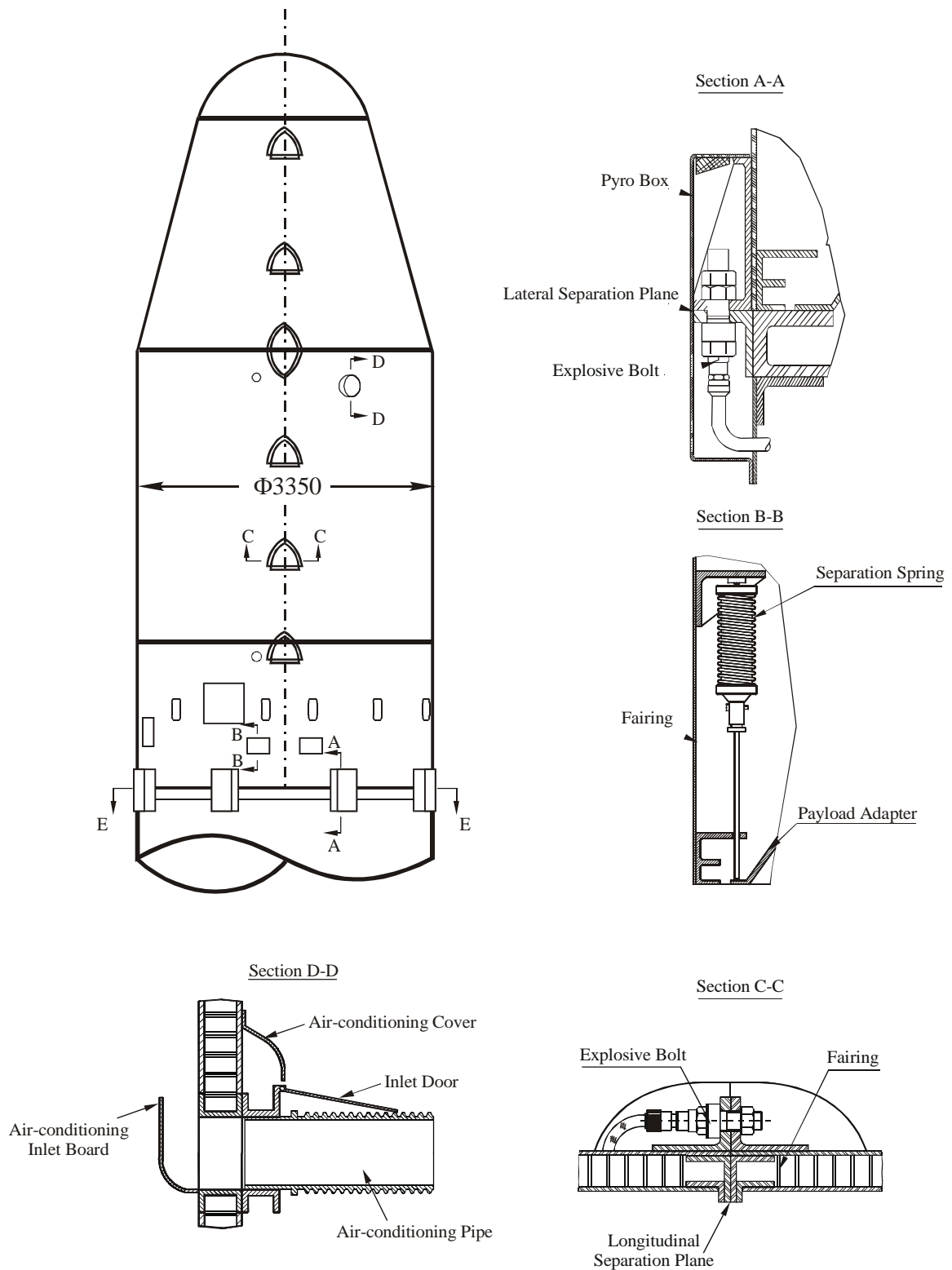
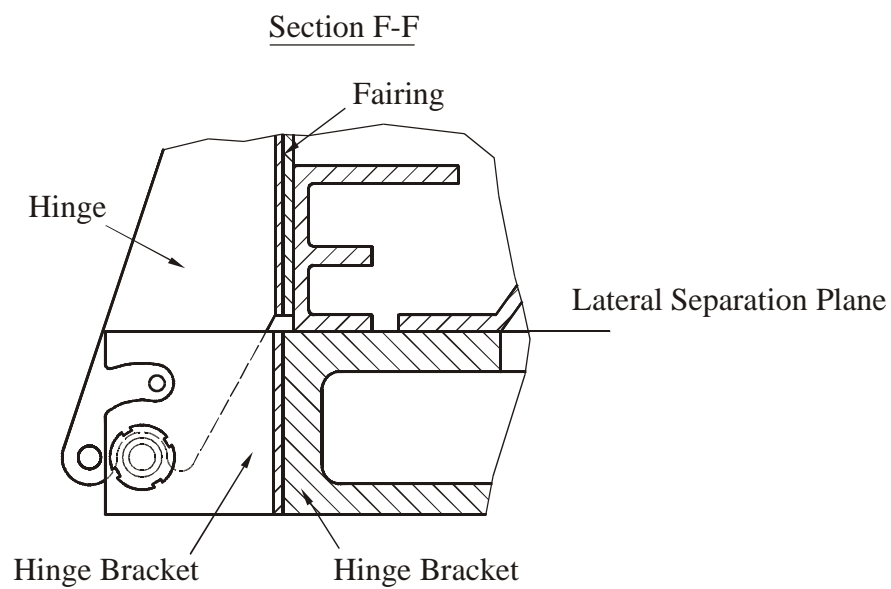
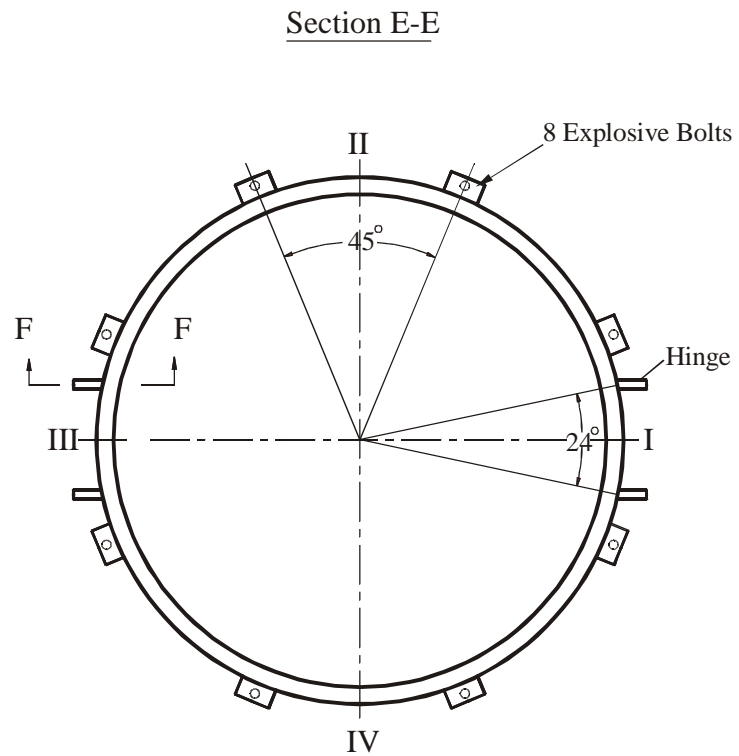


Figure 4-5a Fairing Jettisoning Mechanism (1)

**Figure 4-5b Fairing Jettisoning Mechanism (2)**

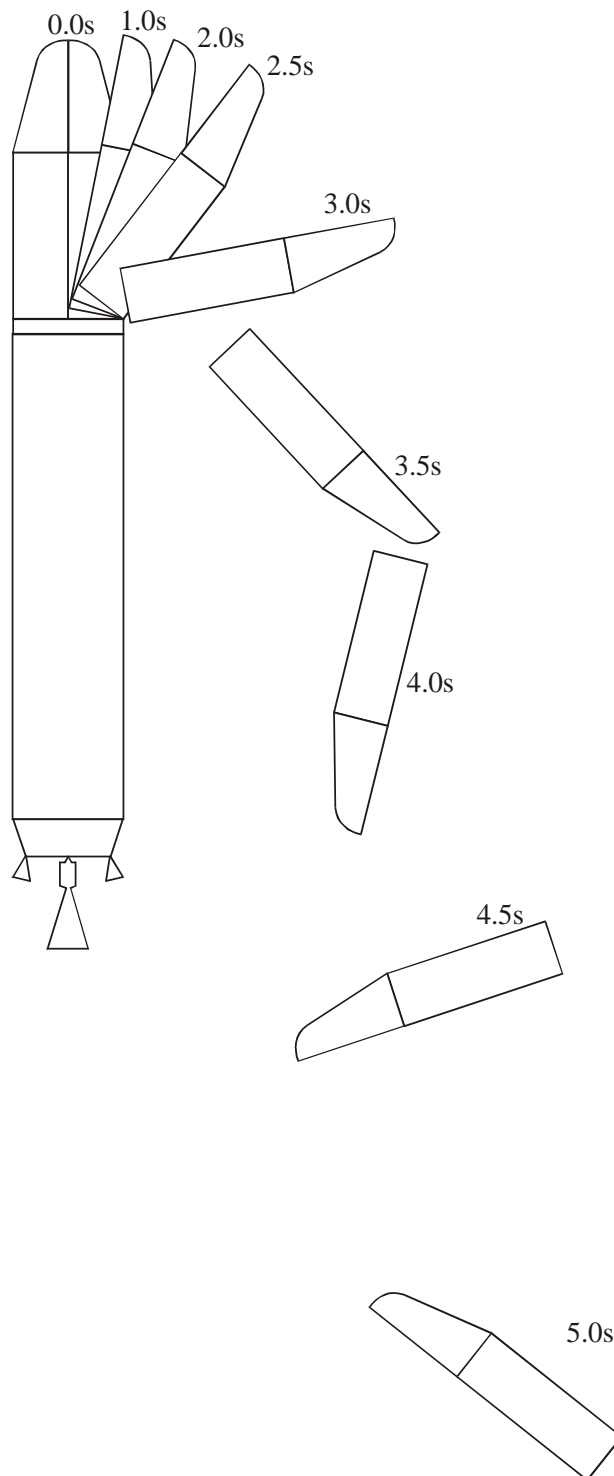


Figure 4-5c Fairing Separation Dynamic Process

4.5 RF Windows and Access Doors

The Radio Frequency (RF) transparent windows can be incorporated into the fairing forward cone section and cylindrical section to provide SC with RF transmission through the fairing, according to the user's need. The RF transparent windows are made of fiberglass, of which the RF transparency rate is larger than 85%.

Some area on the fairing can not be selected as the locations of access door or RF window, see **Figure 4-6**. The user can propose the requirements on access doors and RF windows to CALT. However, such requirements should be finalized 8 months prior to launch.

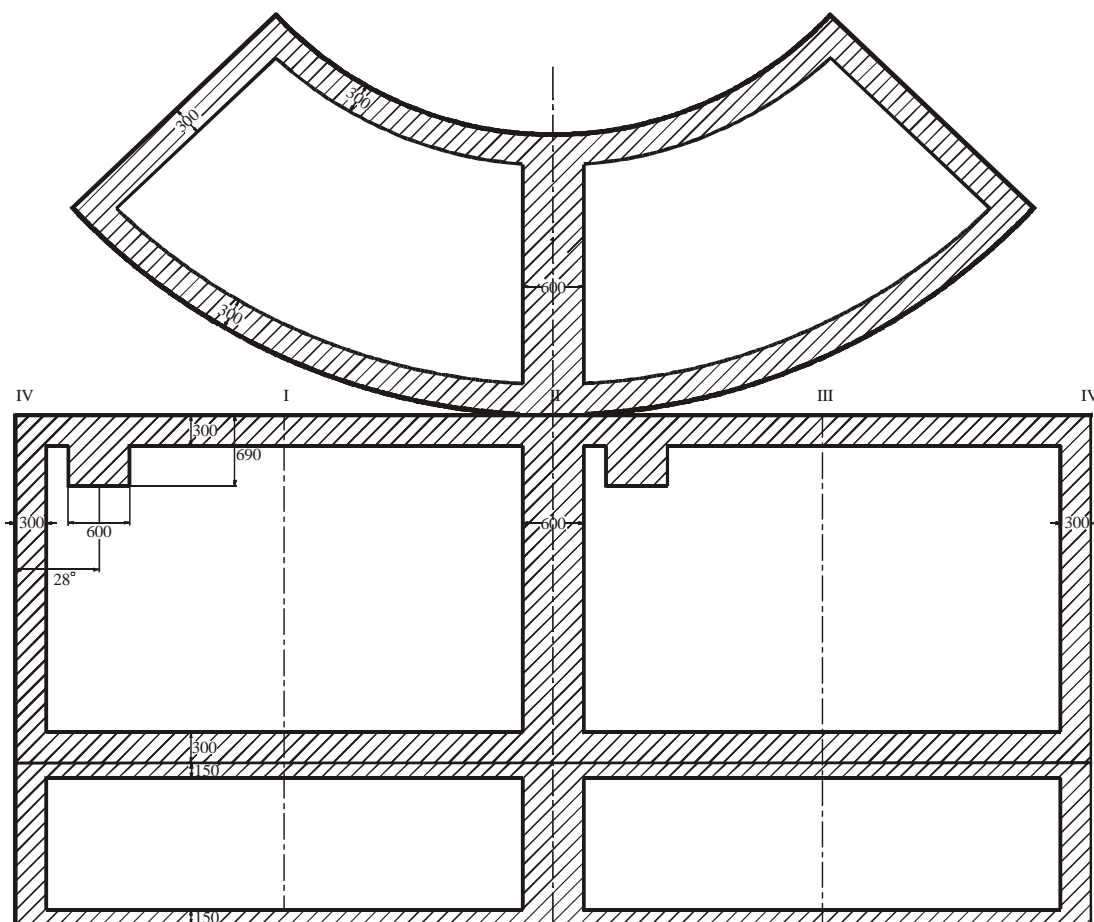


Figure 4-6 Prohibited Area for Access Doors

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

LM-2C provides two typical types of mechanical interface: Explosive Bolt Interface and Clampband Interface.

5.2.2 Explosive Bolt Interface

5.2.2.1 General Description

The SC is installed on the SC adapter by explosive bolts directly. The SC adapter is mounted to a dispenser on the CTS or the LV adapter of stage-2.

The typical layout of explosive bolt interface is shown in **Figure 5-1**.

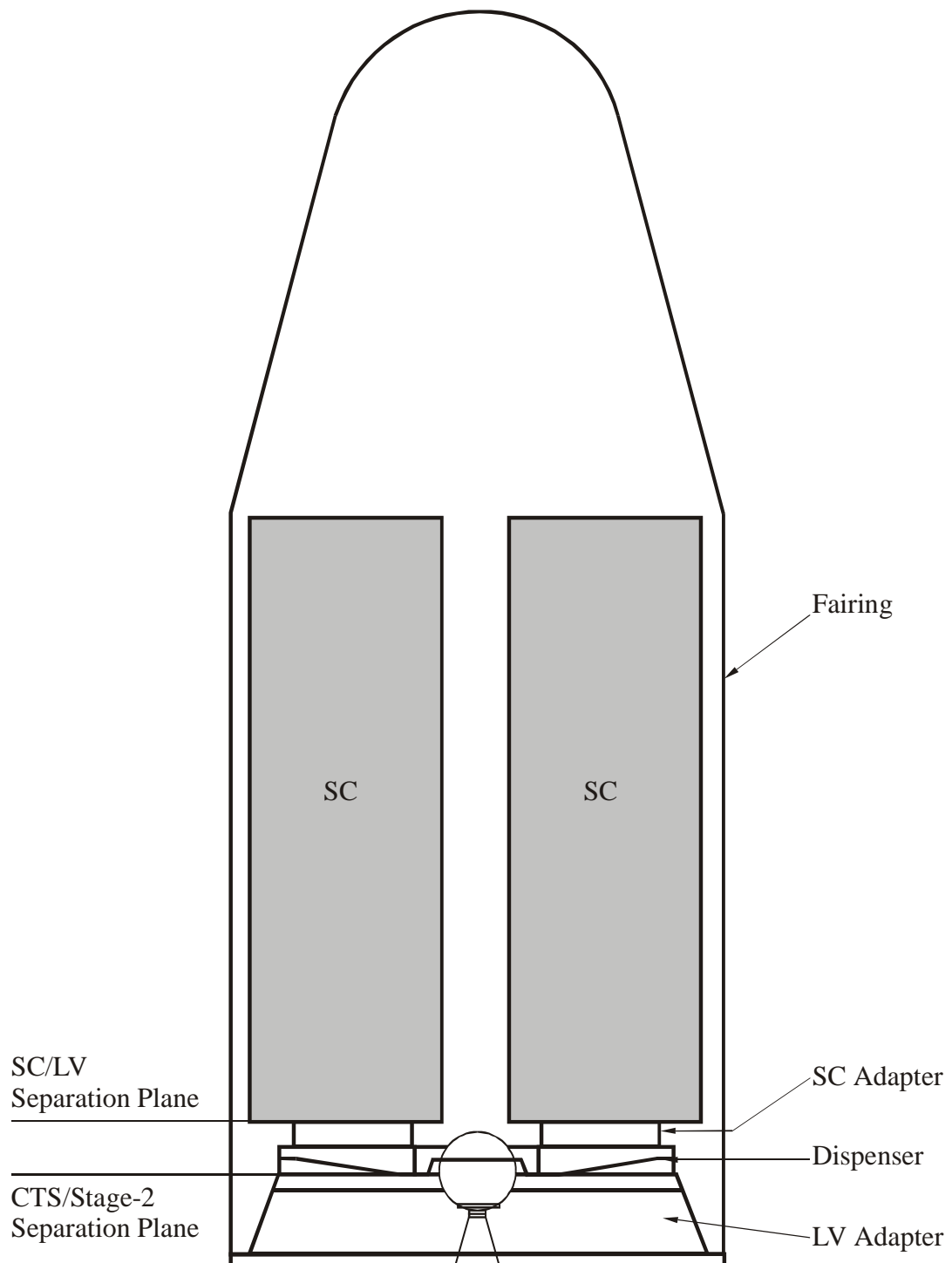


Figure 5-1 Typical Explosive Bolt Interface

5.2.2.2 SC Adapter

The configuration of SC adapter is varied to satisfy different mission requirement and SC structure. The typical SC adapter is as shown in **Figure 5-2**.

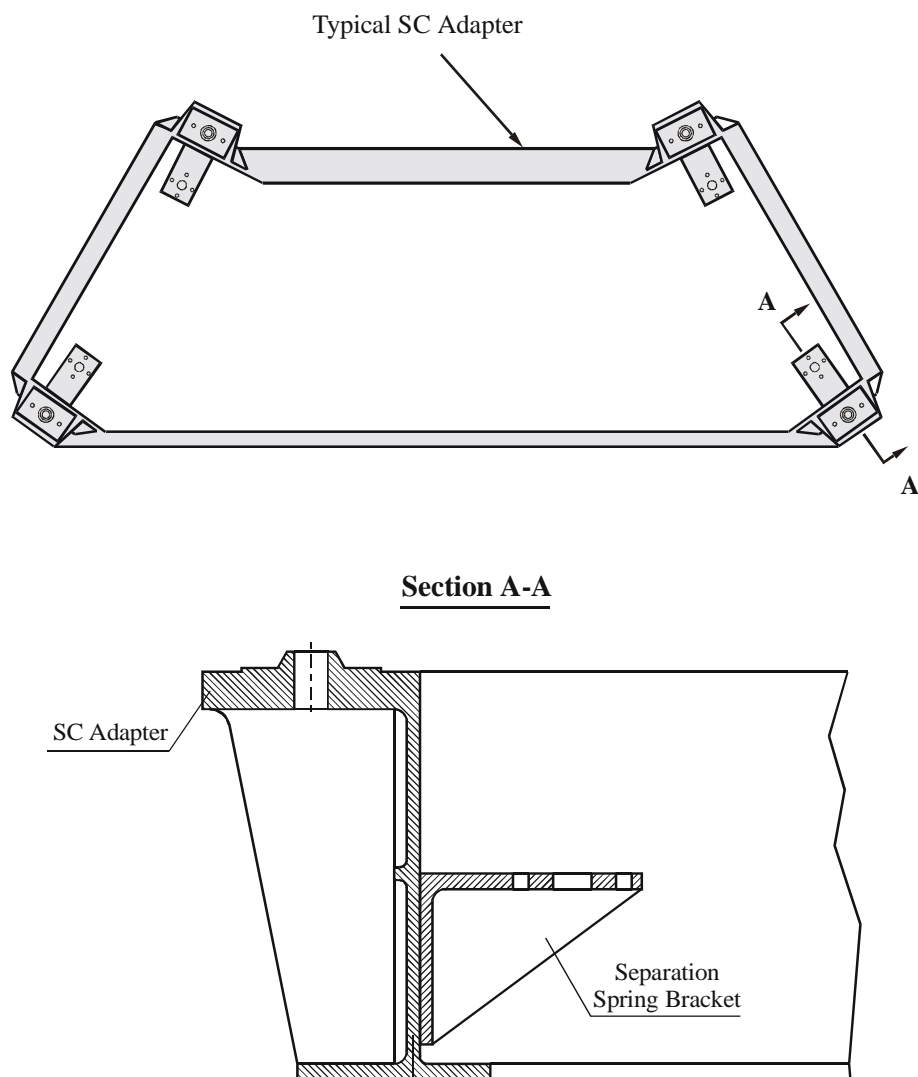


Figure 5-2 Typical SC Adapter

5.2.2.3 SC/LV Separation System for Explosive Bolt Interface

The separation mechanism is composed of separation system and explosive bolts. After the unlocking of explosive bolts, the SC and dispenser will be separated from LV by the pre-compressed springs. The forces and numbers of separation springs, the types and numbers of explosive bolts will be defined according to SC/LV separation requirement. The typical separation mechanism is shown in **Figure 5-3**.

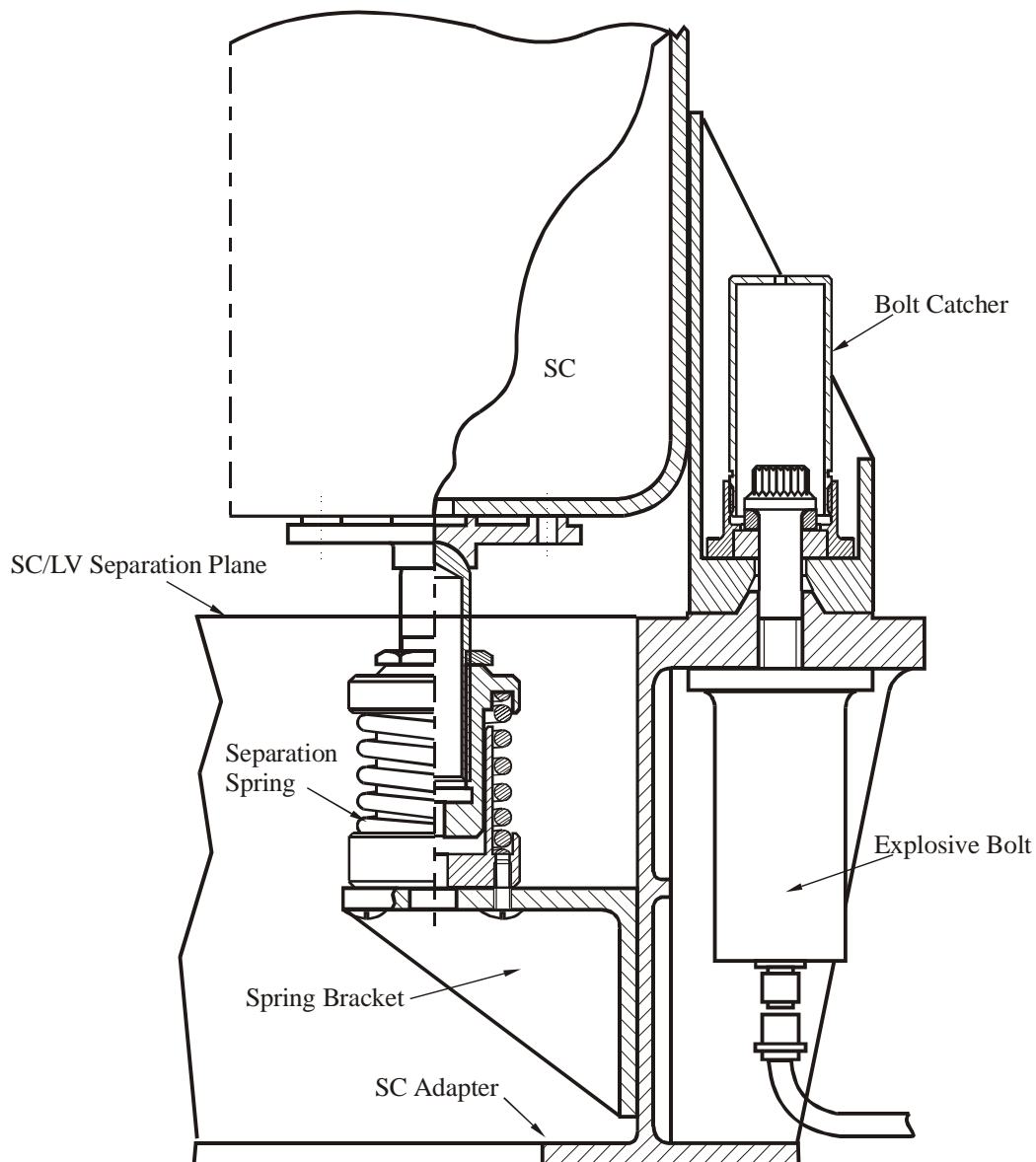


Figure 5-3 Typical Separation Mechanism for Explosive Bolt Interface

5.2.3 Clampband Interface

5.2.3.1 General Description

The clampband interface includes three parts: payload adapter, LV adapter, clampband separation system. The SC is mounted on the launch vehicle through payload adapter and LV adapter. The bottom ring of the payload adapter mates with LV adapter by 70 bolts, while the bottom ring of the LV adapter connects to the LV Stage-2. The top ring of the payload 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. See **Figure 5-4**.

LM-2C provides two types of clampband interfaces, which are 937B and 1194A. User should contact CALT if other interface is needed.

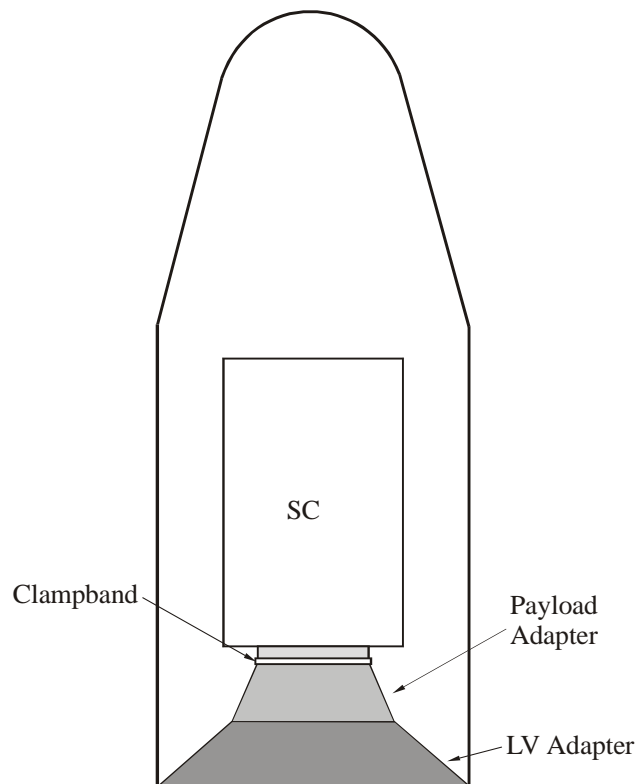


Figure 5-4 Typical Clampband Interface

5.2.3.2 Payload Adapter

- **937B Interface**

The 937B payload adapter is a 900mm-high truncated cone, whose top ring diameter is standard 945.26mm and bottom ring diameter is 1748mm. Refer to **Figure 5-5a&b**. 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.

- **1194A Interface**

The 1194A payload adapter is a 650mm-high truncated cone, whose top ring diameter is 1215mm and bottom ring diameter is 1748mm. Refer to **Figure 5-6a&b**. 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 the sandwich is made of aluminum honeycomb. The facesheets are made of carbon fiber composite. The total mass of the adapter is 53 kg, including the separation springs, cables and other accessories.

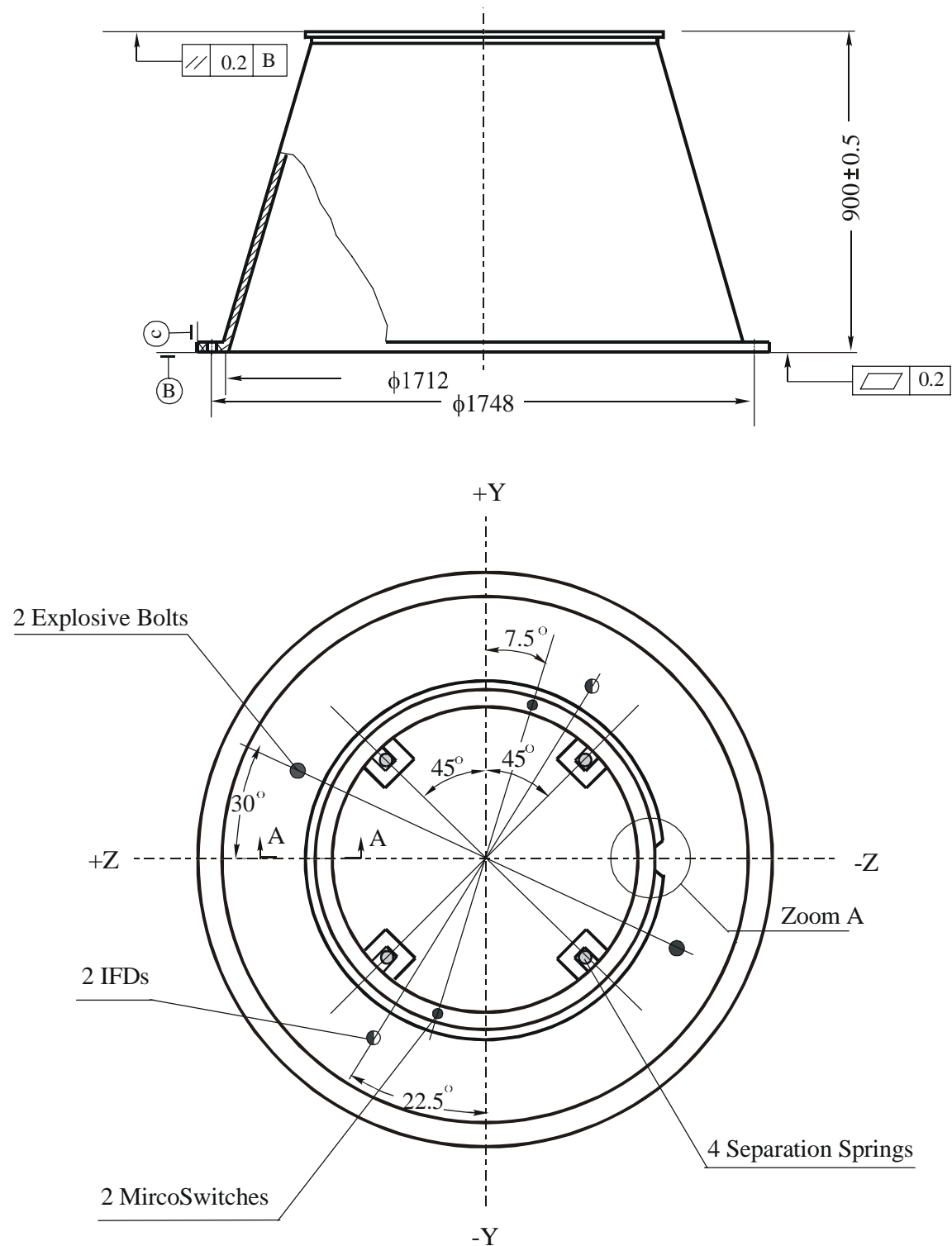


Figure 5-5a 937B Payload Adapter

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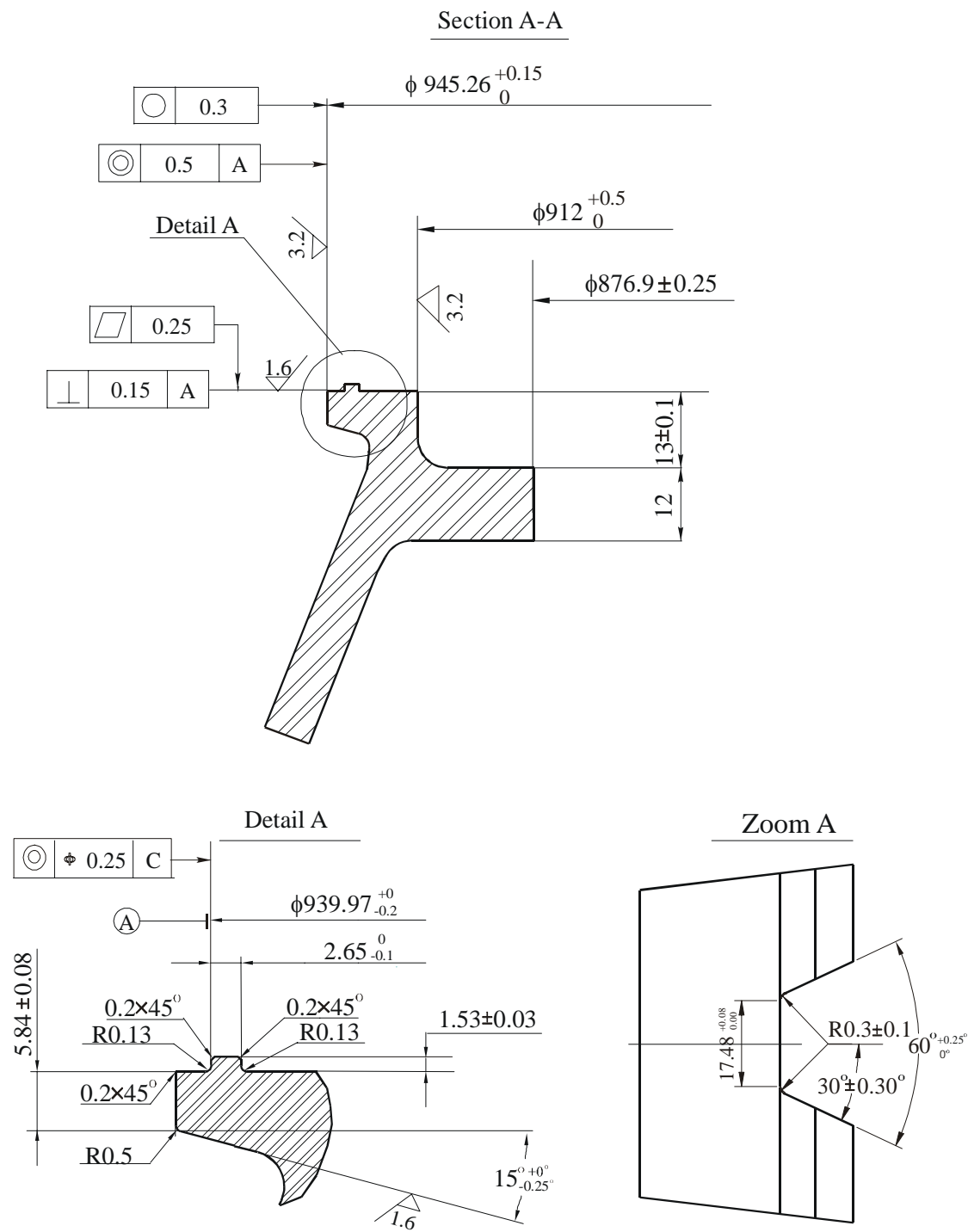


Figure 5-5b 937B Interface

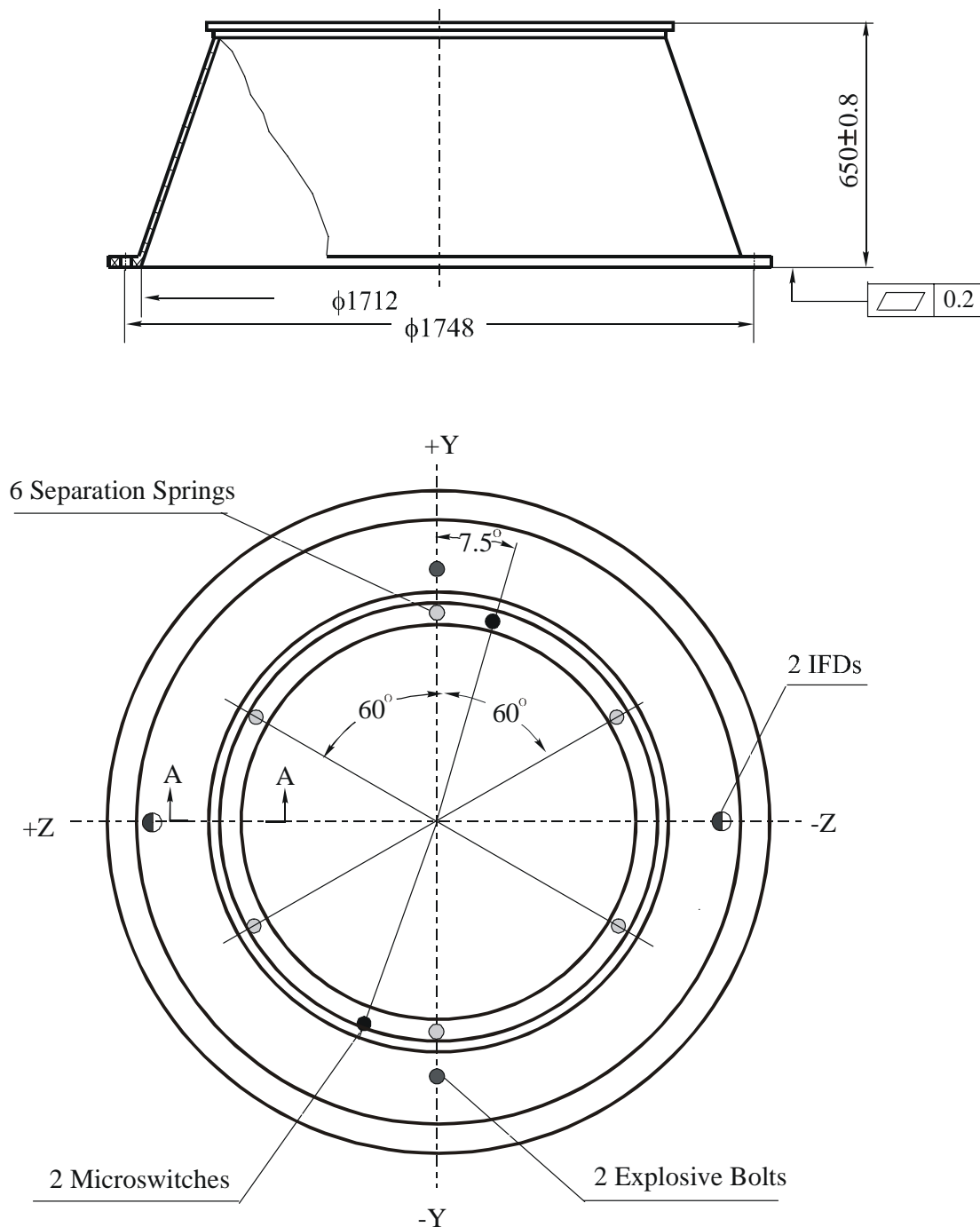
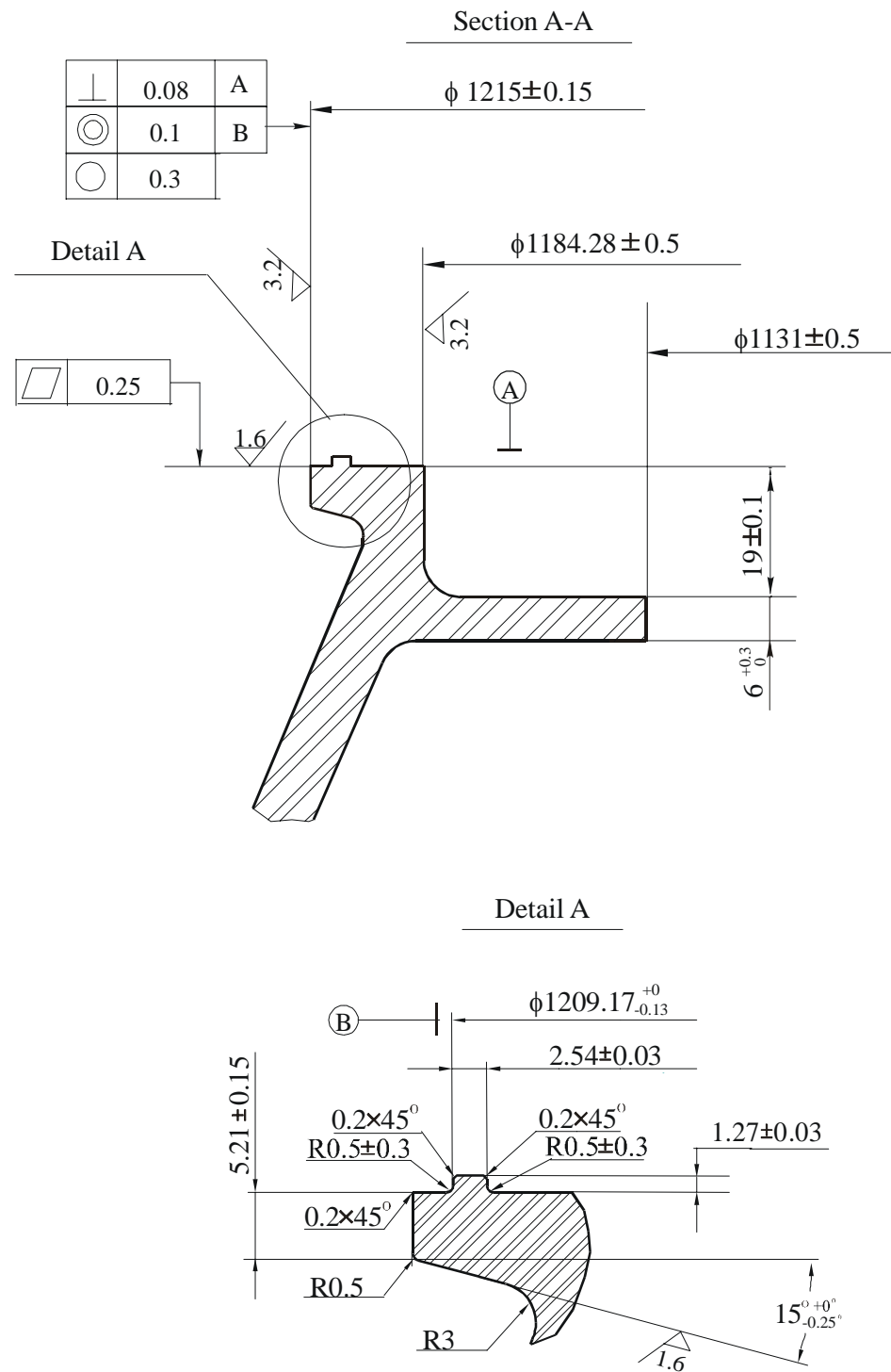


Figure 5-6a 1194A Payload Adapter



5.2.3.3 Clampband Separation System

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

Figure 5-7a,b,c,d&e shows the clampband separation system.

- **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 $24.2+1.0/-0\text{kN}$. 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. CALT is now designing the narrow clampband to benefit the performance of installation.

● Separation Spring System

The separation spring system 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.

5.2.4 Anti-collision Measures

5.2.4.1 Second Stage

The second stage will re-enter atmosphere in about 40 days no matter the LV with or without CTS. After the separation of second stage, some measures have been adopted to avoid the collision of second stage with CTS.

5.2.4.2 CTS

After the separation of Payload/CTS, the CTS will turn to the reverse direction and use the remained the propellant in RCS to reduce the altitude of CTS. The CTS will return to earth in about 80 days.

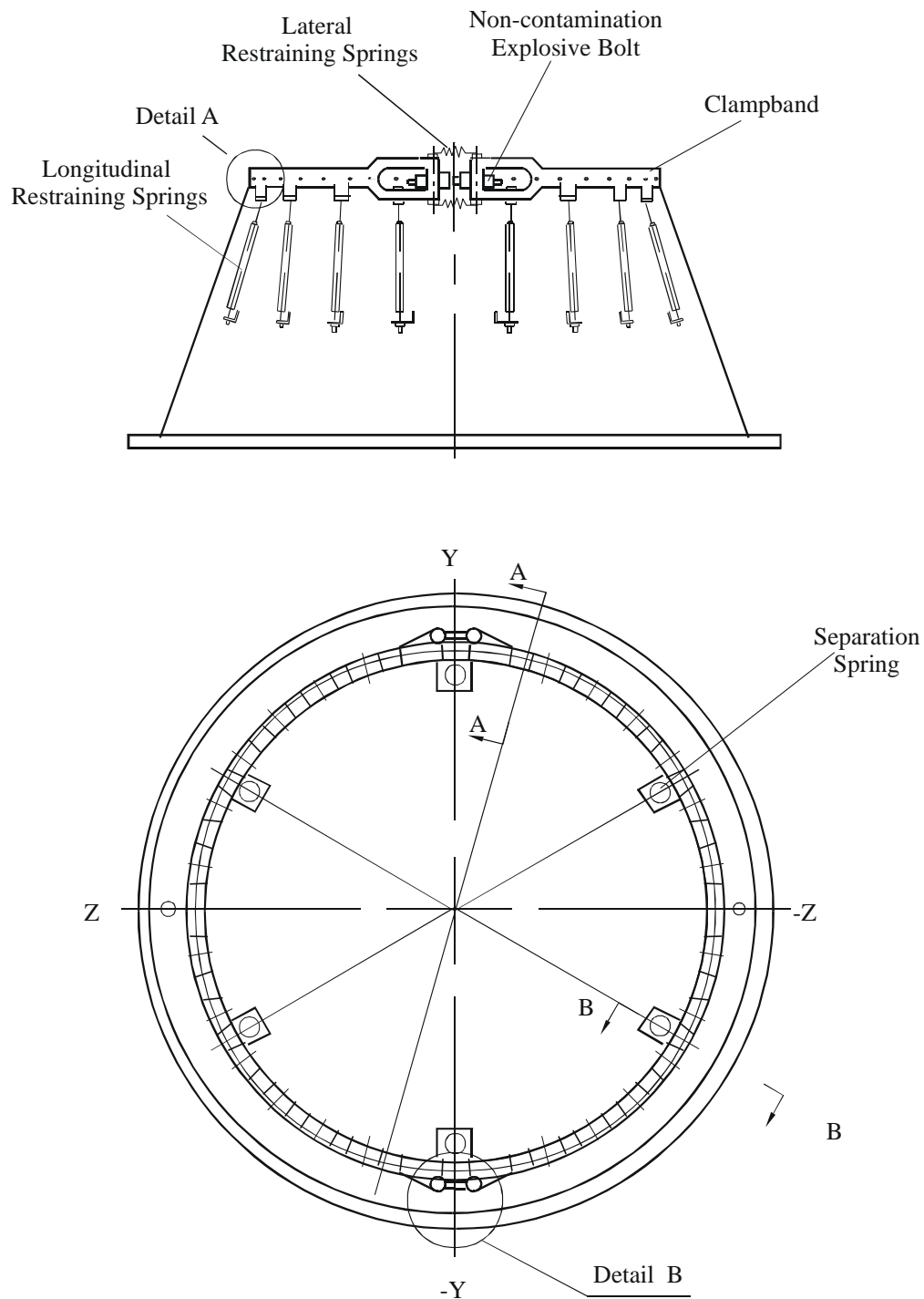
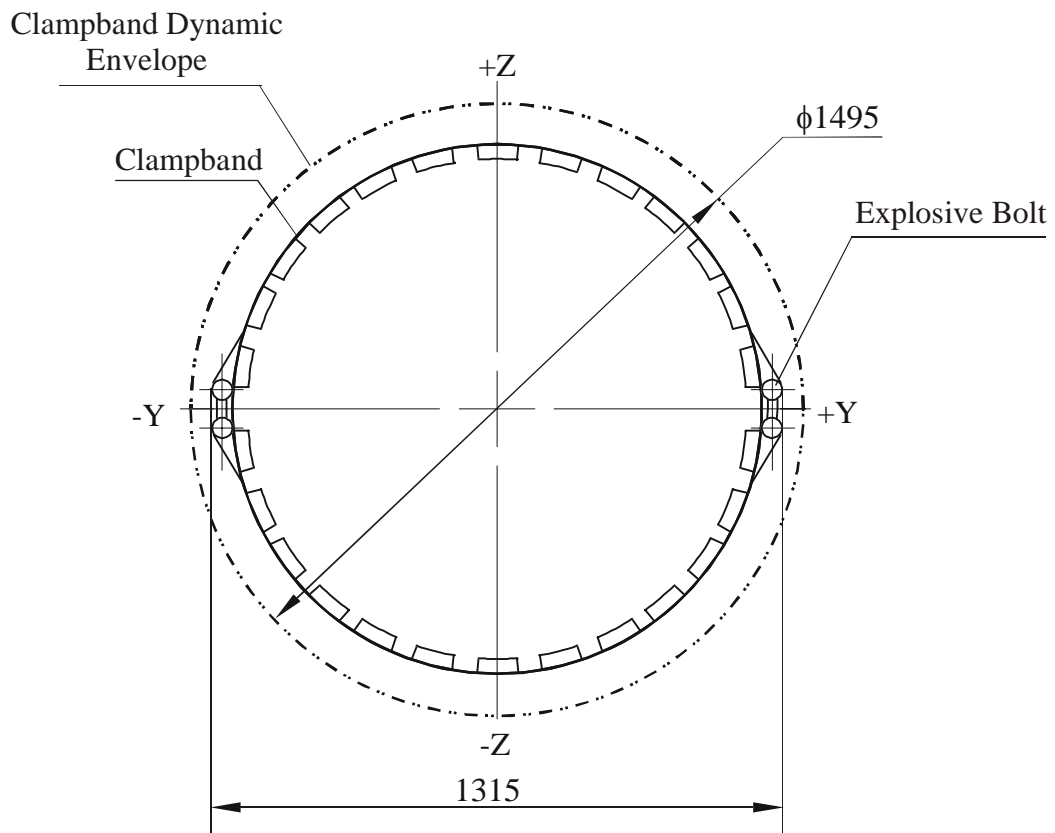
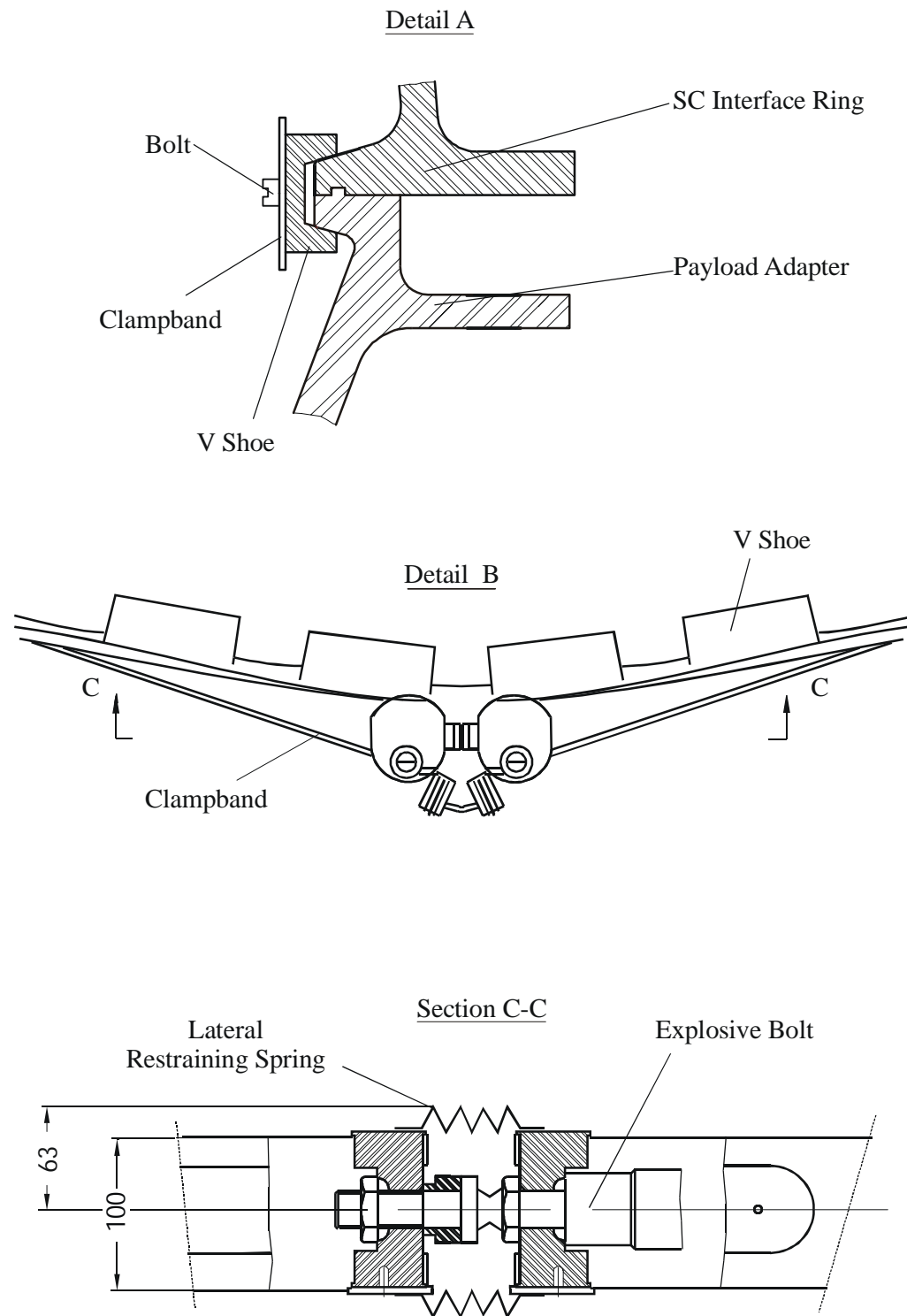
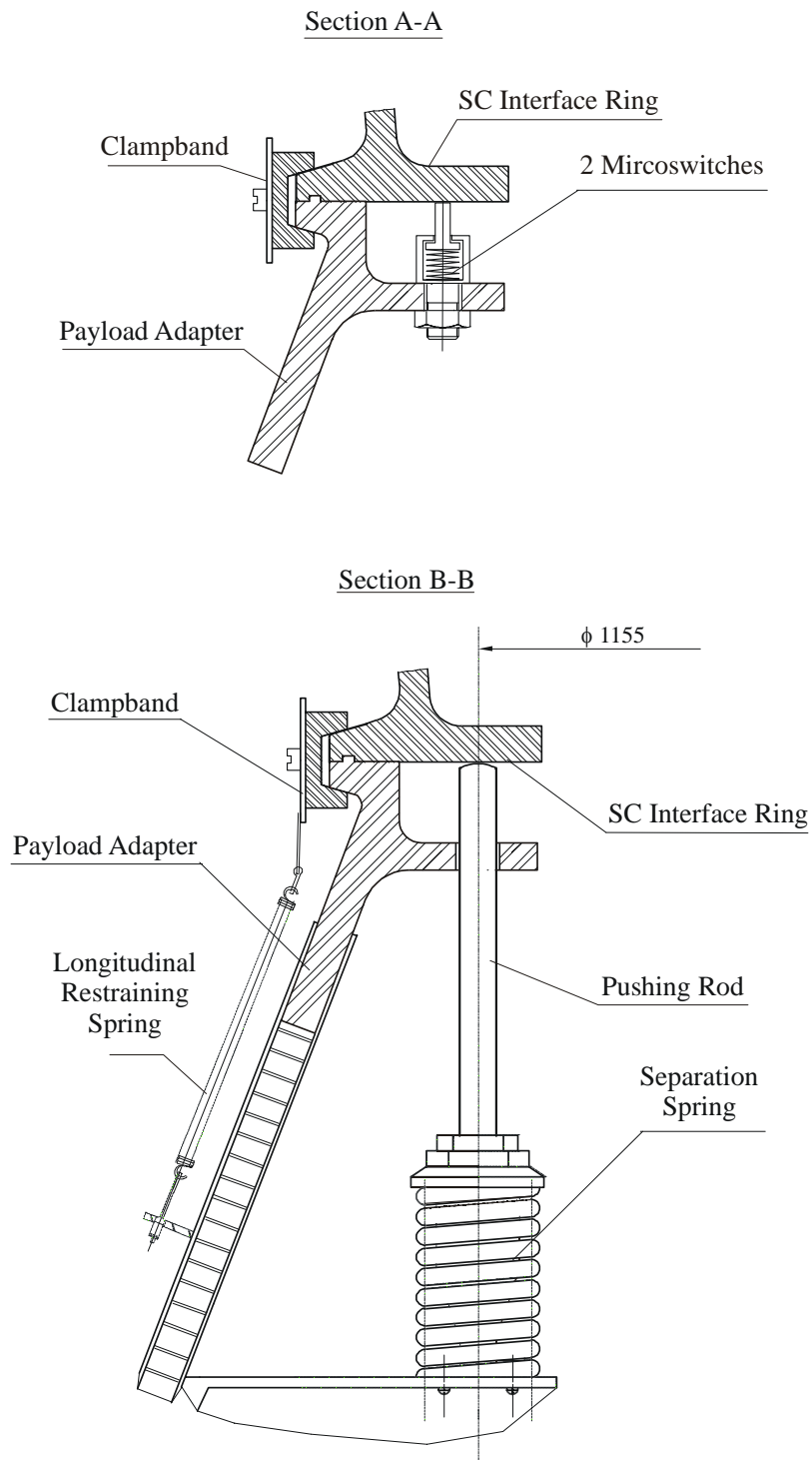


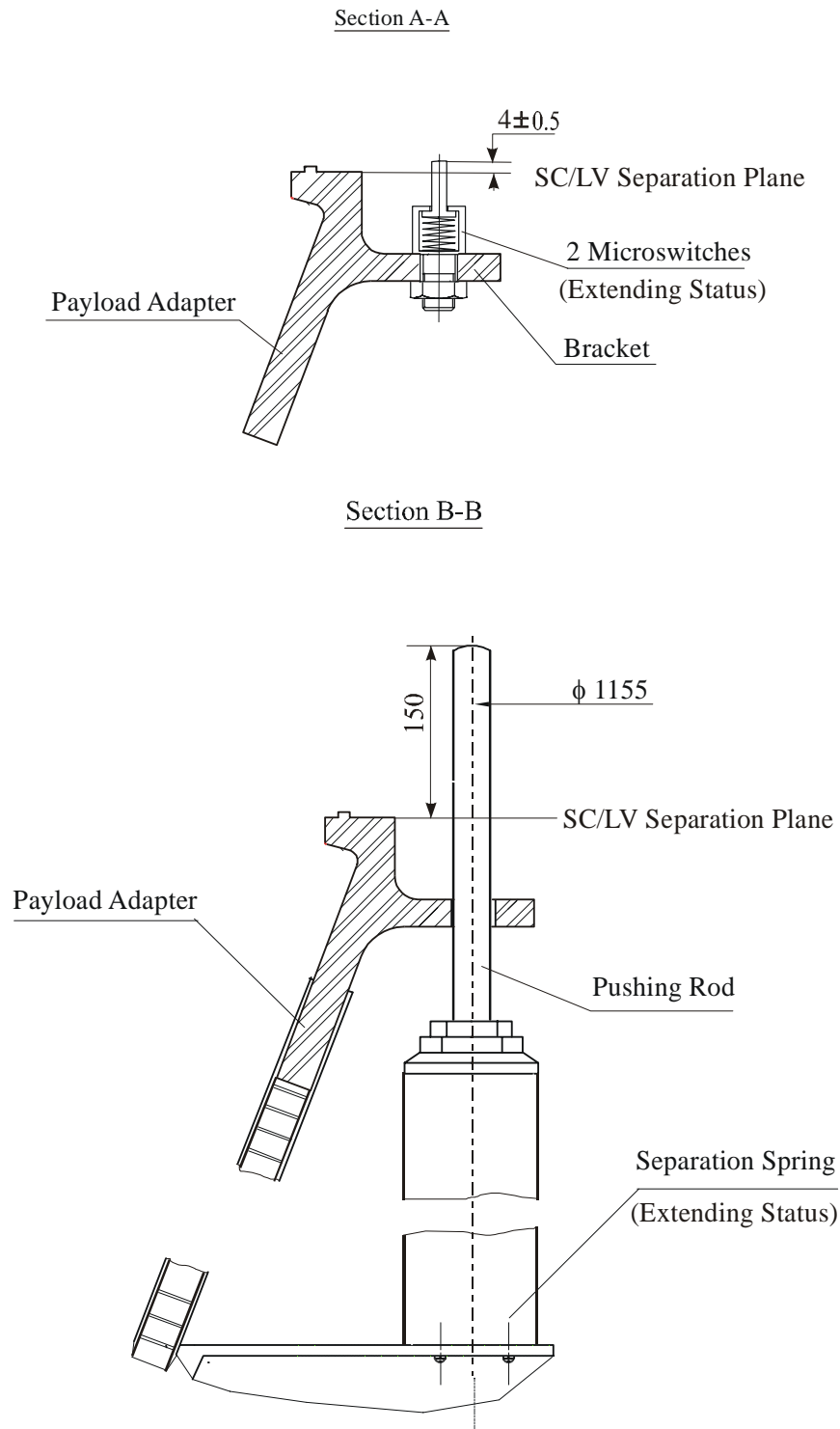
Figure 5-7a Clampband System



**Figure 5-7b Clampband Dynamic Envelope
(For 1194A interface only)**

**Figure 5-7c Clampband in Detail**

**Figure 5-7d SC/LV Separation Spring**

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

5.3 Electrical Interface

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 typical umbilical system consists of onboard-LV Parts and ground parts. Refer to **Figure 5-8, 5-9**. The practical networking will be designed for dedicated SC according to User's needs.

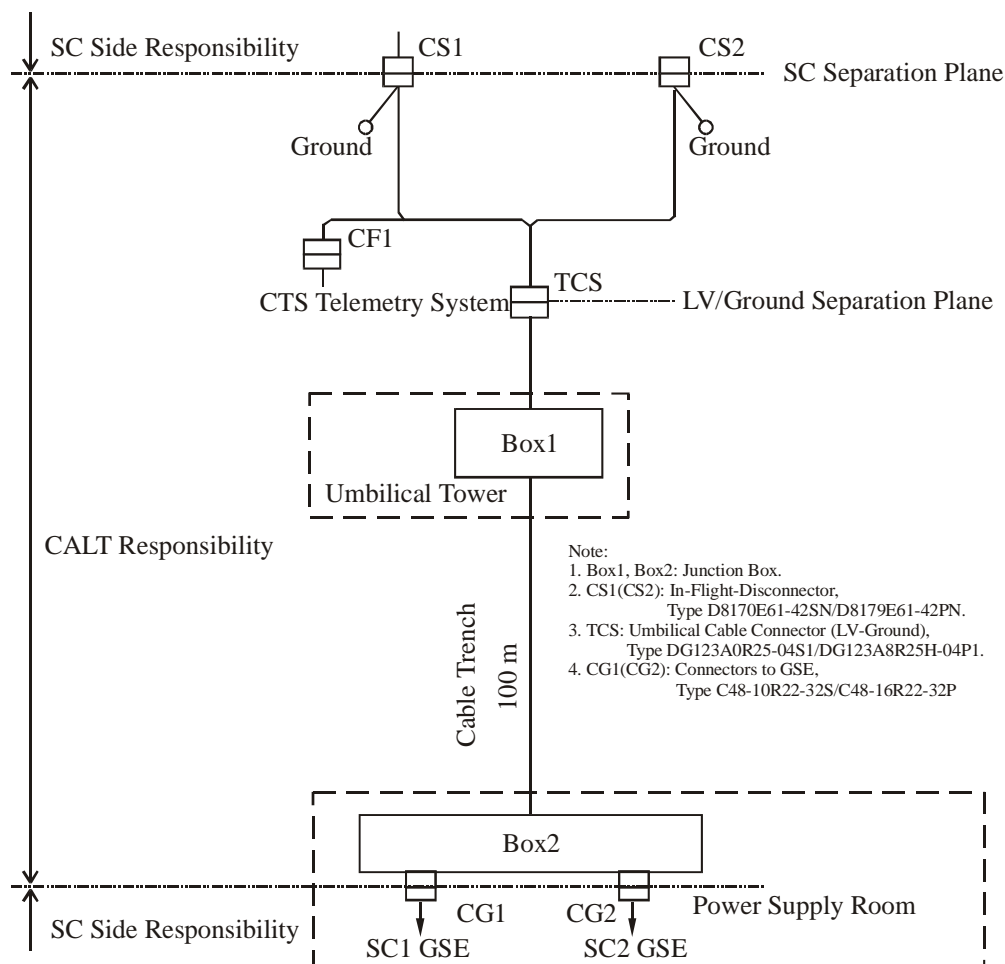
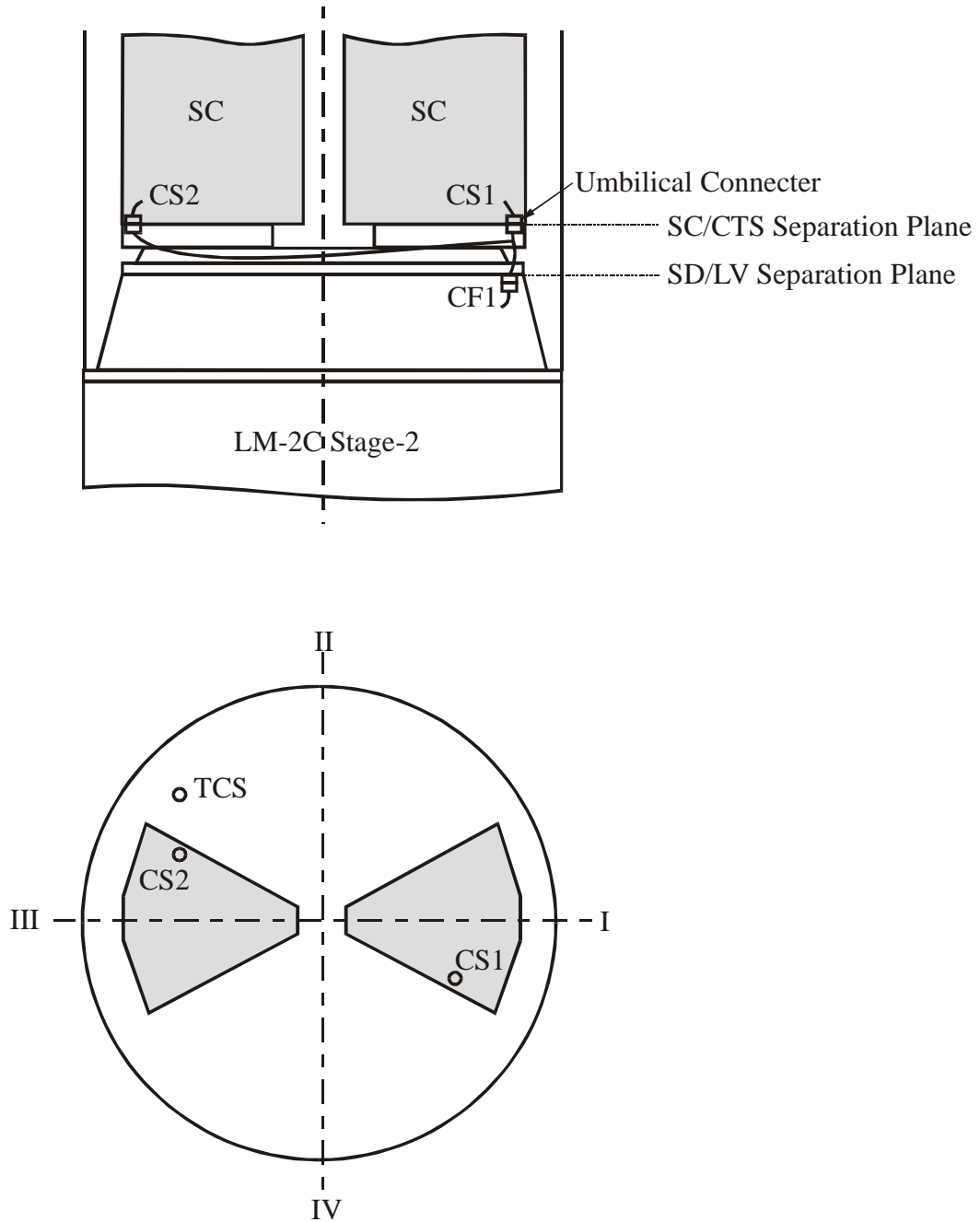


Figure 5-8 Ground Umbilical Cable

**Figure 5-9 On-board Umbilical Interface**

5.3.1 In-Flight-Disconnectors (IFDs)

5.3.1.1 Quantity

The quantity of IFDs will be determined according to specific mission requirements. The detailed location will be coordinated between SC and LV sides and finally defined in ICD.

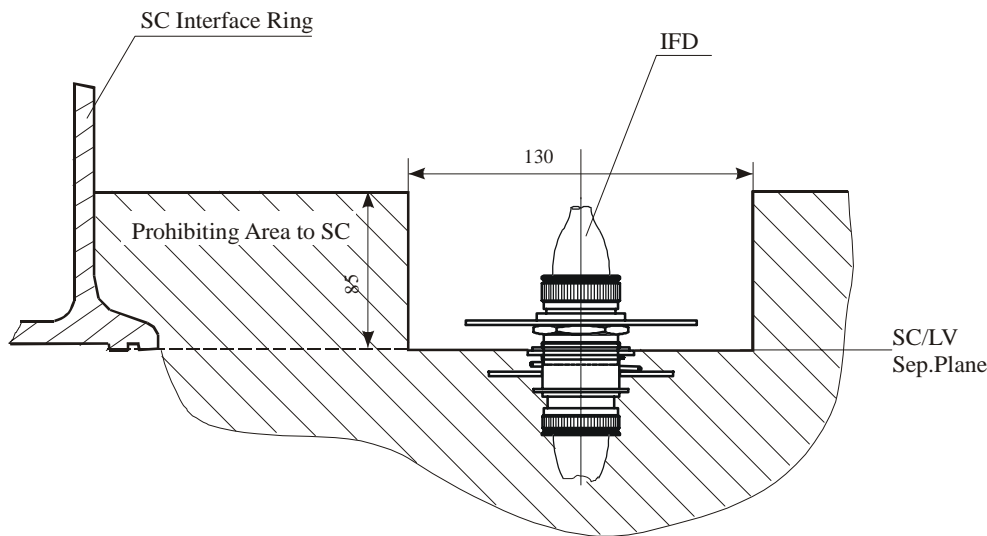


Figure 5-10 Typical IFD Location

5.3.1.2 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
D8179E61-42PN	D8170E61-42SN

User can also select other products of DEUTSCH or Chinese-made products.

5.3.1.3 IFD Supply

It is recommended that the user provide 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.

5.3.1.4 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.

5.3.2 Umbilical System

The umbilical system consists of onboard-LV parts and ground cable parts. The following describes the details on one satellite.

5.3.2.1 Onboard-LV Umbilical Cable

(1) Composition

The Onboard-LV cable net comprises the cables from the IFDs to TCS. These umbilical cables will fly with LV.

Whereas:

Code	Description
CS1(CS2)	IFD, Technological interfaces between SC adapter and LV
CF1	Interface between umbilical cable and LV TM system, through which the SC/LV separation signal is sent to LV TM system
TCS	Umbilical cable connector (LV-Ground)
Ground	Grounding points to overlap the shielding of wires and the shell of LV

(2) Generation of Separation Signal

There are break-wires on the plugs of IFD which can 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 break-wires on the sockets of IFDs which are mounted on

the SC side. The LV can acquire the separation signal through the break-wires circuitry break when SC/LV separates. This separation signal will be sent to LV's telemetry system through CF1 interface. Refer to **Figure 5-11** for the break-wire's circuitry. The break-wire's allowable current: $\leq 100\text{mA}$, allowable voltage: $\leq 30\text{V}$.

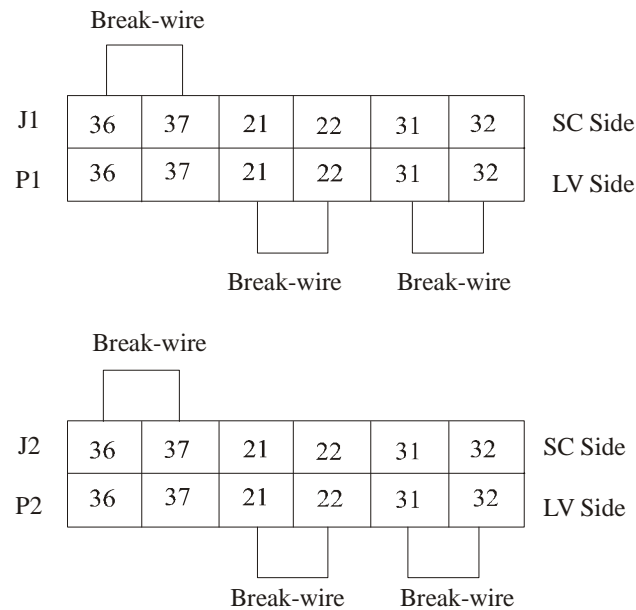


Figure 5-11 Break-wire for SC/LV Separation Signal

5.3.2.2 SC Ground Umbilical Cable Net

(1) Composition

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

Whereas:

Code	Description
TCS	TCS is the umbilical connector which connect the LV and ground cables. The disconnection of TCS is performed automatically or manually. If the launch was terminated after the disconnection, TCS could be reconnected within 60min.

BOX1	BOX 1 is a box adapter for umbilical cable that is located on 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 are also located inside the Blockhouse.

(2) Interface on Ground

SC side will define the detailed requirement of ground interfaces. The connectors to be connected with SC ground equipment should be provided by SC side to LV side for the manufacture of cables.

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

(3) Types of connectors to GSE (CG1,CG2)

The following connectors are recommended:

At the end of umbilical: C48-10R22-32S

At the end of GSE: C48-16R22-32P

5.3.2.3 Umbilical Cables and Performance

The types and characteristics of cables are as follows:

✧ Onboard-LV Cable Net

Generally, ASTVR and ASTVRP wires are adopted for the onboard-LV cable net:

ASTVR, 0.5mm², fiber-sheath, PVC insulation;

ASTVRP, 0.5mm², 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 will be shielded and sheathed.

✧ Ground Cable Net

- Single-Core Shielded Cable: KYVRP-52×0.5 mm², KYVRP-24×0.5 mm².
- Number of cores: 52, 24
- 80 cores/cable, 0.5mm²/core; Working voltage: ≤60V; DC resistance (20°C) of each core: 38.0Ω/km.

✧ Twin-twist Shielded Cable

- KSEYVP77-2×3×0.5, 6 pairs of twin-twisted cores, 0.5mm²/core.
- Each twisted pair is shielded and the whole cable has a woven wire net for shielding.
- Impedance: 75Ω.

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 $\geq 5\text{M}\Omega$ (including between cores, core and shielding, core and LV shell)

5.3.2.4 Umbilical Cable Disconnect Control

LV side is responsible for the pre-launch disconnection of umbilical cable , which can be pull out manually 80minutes before launch or disconnected automatically 15minutes prior ignition.

5.3.3 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.

- ✧ The cable has two shielding layers, the outer shielding is for anti-lightning while the inner shielding is for anti-interference.
- ✧ The inner shield of on-board cable is connected to BOX 2 through TCS. There is a special point connecting the shield to the GSE of SC in BOX 2 .
- ✧ The inner shield is insulated to ground.

5.3.4 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 $10\text{m}\Omega$ 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.

5.3.5 Miscellaneous

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.

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.

If the customer needs some telemetry data regarding the SC flight, those data could be transmitted through the LV telemetry system. Details of this issue can be coordinated between CALT and customer.

CHAPTER 6

ENVIRONMENT AND LOADS

6.1 Summary

This chapter introduces the natural environment of launch site, thermal environment during Payload operation, electromagnetic environment during launch preparation and LV flight, as well as thermal environments, mechanical environments (vibration, shock & noise) during LV flight.

6.2 Pre-launch Environments

6.2.1 Natural Environment

LM-2C can be launched in the three launch sites, JSLC, XSLC & TSLC. The natural environmental data in these three sites concluded by long-term statistic research. The environmental data in JSLC are emphasized as listed below.

- Temperature statistic result for each month at JSLC.

Month	Highest (°C)	Lowest (°C)	Mean (°C)
January	14.20	-32.40	-11.20
February	17.70	-33.10	-6.20
March	24.10	-21.90	1.90
April	31.60	-13.60	11.10
May	38.10	-5.60	19.10
June	40.90	5.00	24.60
July	42.80	9.70	26.50
August	40.60	7.70	24.60
September	36.40	-4.60	17.60
October	30.10	-14.50	8.30
November	22.10	-27.50	-1.70
December	16.00	-34.00	-9.60

- The relative humidity at launch site is 35~55%. The dry season is all over the year, the average annual rainfall is 44mm.

6.2.2 Payload Processing Environment

Payload will be checked, tested in Payload Processing Buildings (BS2 and BS3) and then transported to the launch pad for launch. The environment impacting Payload includes 3 phases: (1) Processing in BS2 and BS3; (2) Transportation from BS3 to launch pad; (3) preparation on launch tower.

6.2.2.1 Environment of Payload in Processing Building

The satellite will be tested and fueled in the BS2 and BS3 which are equipped with air conditioning system. The temperature, humidity and cleanness can be guaranteed in the whole process. Refer to chapter 7.

6.2.2.2 Environment of Payload during Transportation to Launch Tower

After finishing fairing encapsulation in BS3, the fairing/payload combination will be transported to launch pad. The environment for Payload during transportation can be assured by temperature-control measures (such as thermal blanket). The environmental parameters in fairing are as follows:

Temperature:	10°C~25°C
Relative humidity:	30%~60%
Cleanliness:	100,000 level

6.2.2.3 Air-conditioning inside Fairing at Launch Pad

The fairing air-conditioning system, shown in **Figure 6-1**, will be started after the payload was mated to the launch vehicle. The typical air-conditioning parameters inside the fairing are as follows:

Temperature:	15°C~22°C
Relative Humidity:	30%~45%
Cleanliness:	100,000 level
Air Flow Rate:	23~91kg/min

The air-conditioning is shut off at L-45 minutes and would be recovered in 40 minutes if the launch aborted.

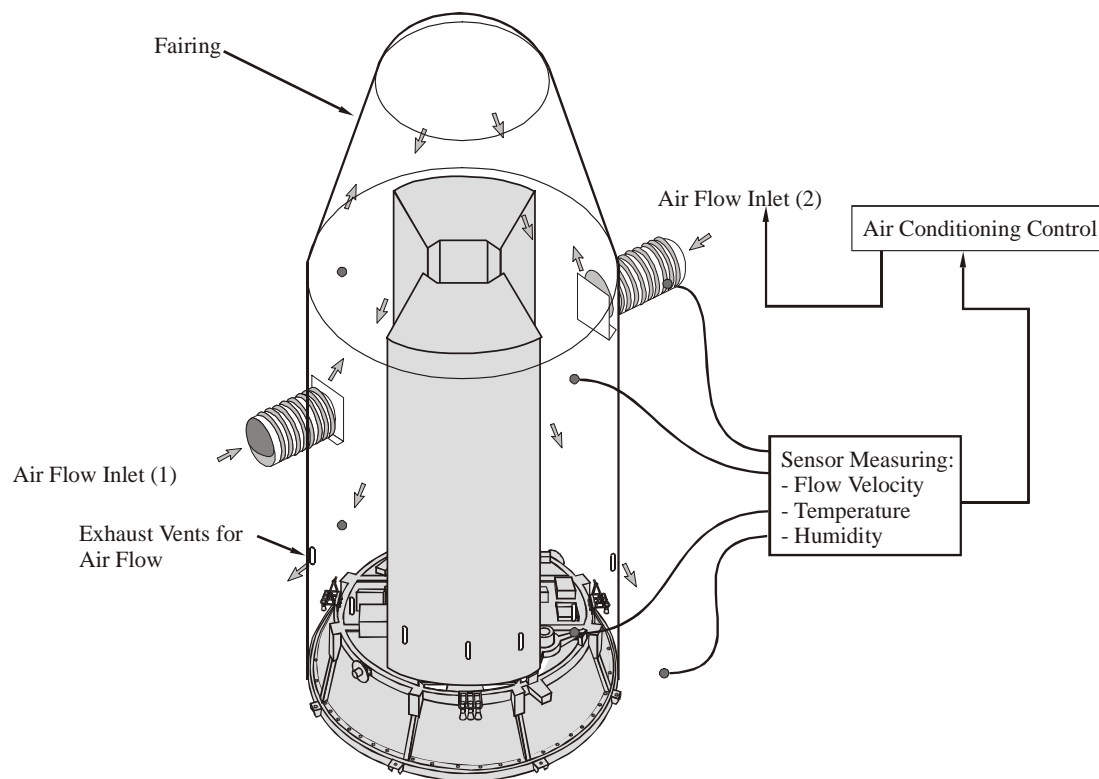


Figure 6-1 Fairing Air-conditioning on the Launch Tower

The SC battery cooling system can also be provided with the following typical parameters:

Temperature:	10°C~16°C
Relative Humidity:	30%~60%
Cleanliness:	100,000 level
Air Flow Rate:	>1.36kg/min
Relative pressure:	<35Kpa

6.2.3 Electromagnetic Environment

6.2.3.1 On-board Radio Equipment

Characteristics of on-board radio equipment are shown below:

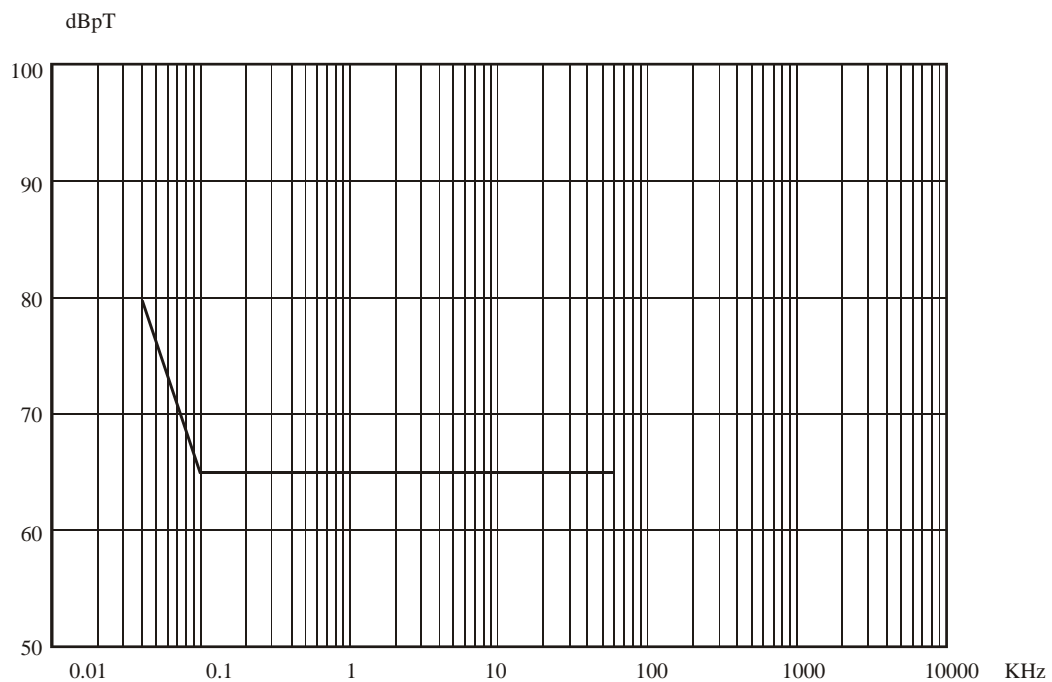
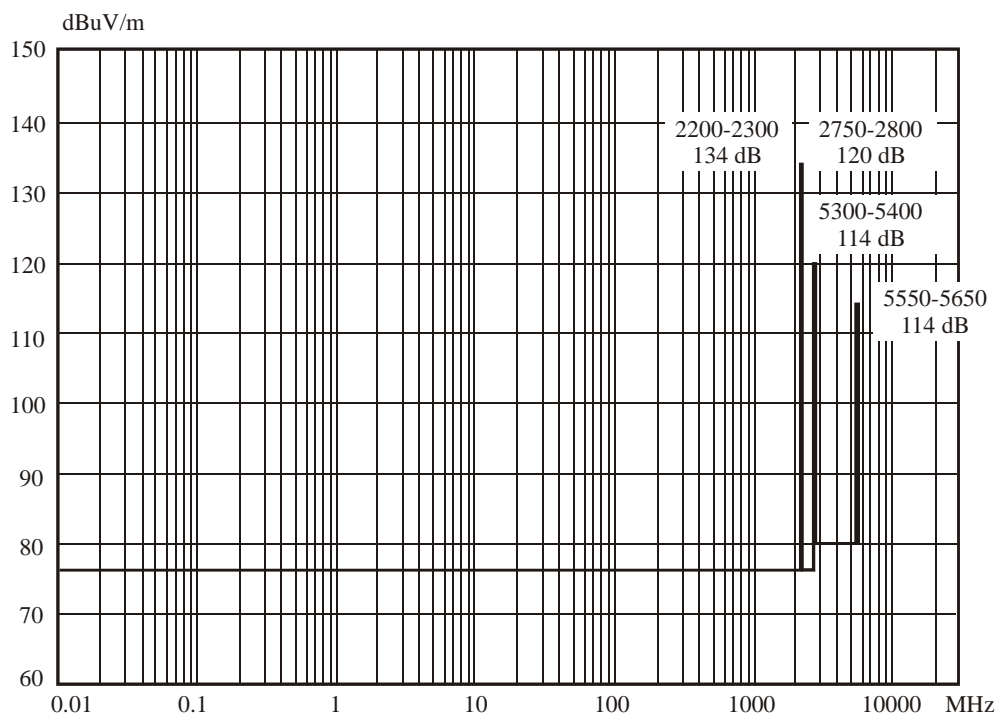
EQUIPMENT	FREQUENCY (MHz)	POWER (W)	susceptibility (dBW)	Polarization	Antenna position
Telemetry Transmitter 1	2200~2300	10		linear	Stage-2 Inter-tank section
Telemetry Transmitter 2	2200~2300	3x2		linear	SD
Beacon	5300~5400(down) 5650~5850(up)	1.5	-110		Stage -2 Inter-tank section
Transponder	Rec.5550~56500. 8us,800bit	0.8μs, 800bit	-91	linear	Stage -2 Inter-tank section
Beacon	2750~2800	1		linear	Stage-2 Inter-tank section
Telemetry command Receiver	600~700		-129	linear	Stage-2 Inter-tank section

6.2.3.2 Electromagnetic Radiation Reduction

The payload is shielded by the launch tower and fairing. The electromagnetic strength is reduced 12dB at 0.1~10GHz comparing to the outside environment.

6.2.3.3 LV Electromagnetic Radiation and Susceptibility

The energy levels of launch vehicle electromagnetic radiation and susceptibility are measured at SC/LV separation plane. They are shown in **Figure 6-2** to **Figure 6-5**.

**Figure 6-2 Narrow Band Magnetic Emission from LM-2C****Figure 6-3 Narrow Band Electric Field Radiation from LM-2C**

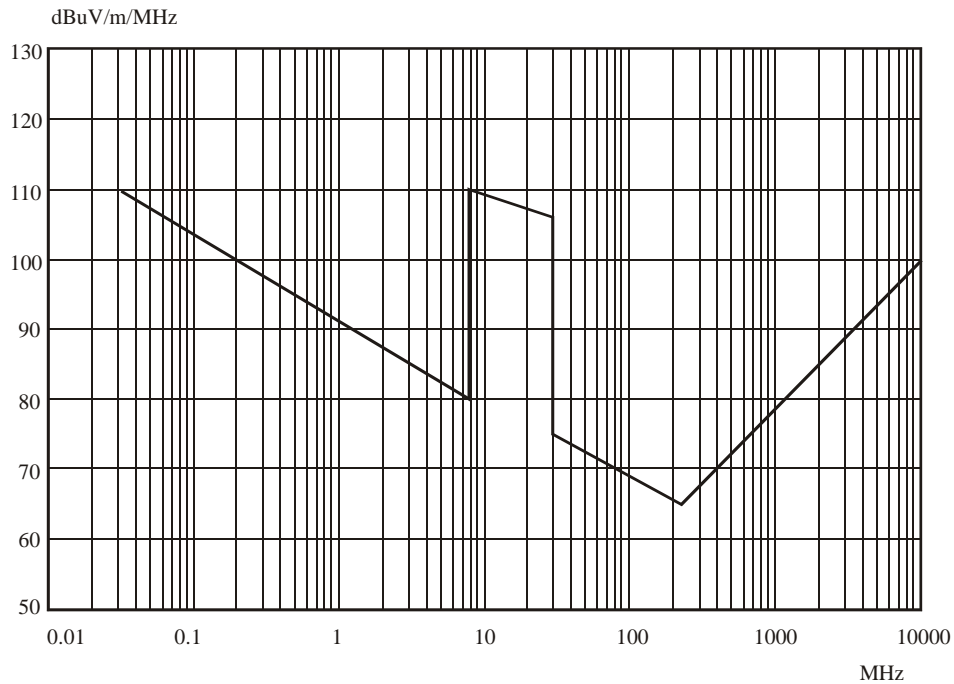


Figure 6-4 Broad Band Electric Field Radiation from LM-2C

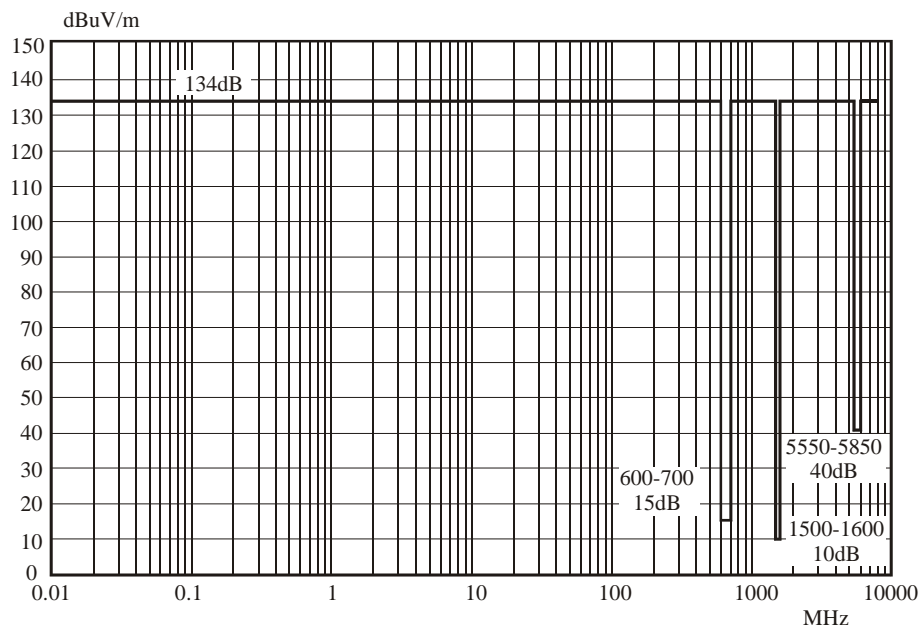


Figure 6-5 Permissive Electric Field Radiation from LM-2C

6.2.3.4 EMC Analysis among Payload, LV and Launch Site

To conduct the EMC analysis among Payload, LV and launch site, both Payload and LV sides should provide related information to each other. The information provided by CALT are indicated in the **Figure 6-2 to 6-5** in this chapter, while the information provided by SC side are as follows:

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

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.

6.2.3.5 Usage of SC RF Equipment

SC side and CALT will coordinate the RF working time phase during launch campaign and LV flight.

6.2.4 Contamination Control

The molecule deposition on Payload surface is less than $2\text{mg}/\text{m}^2/\text{week}$. The total mass loss is less than 1%. The volatile of condensable material is less than 0.1%.

6.3 Flight Environment

The mechanical environment for Payload is at Payload/LV interface. The pressure environment and thermal environment is just for typical fairing.

6.3.1 Pressure Environment

When the launch vehicle flies in the atmosphere, the fairing air-depressurization is provided by 12 vents (total venting area 350cm^2) opened on the lower cylindrical section. The typical design range of fairing internal pressure is presented in **Figure 6-6**. The maximum depressurization rate inside fairing will not exceed 6.0 kPa/sec .

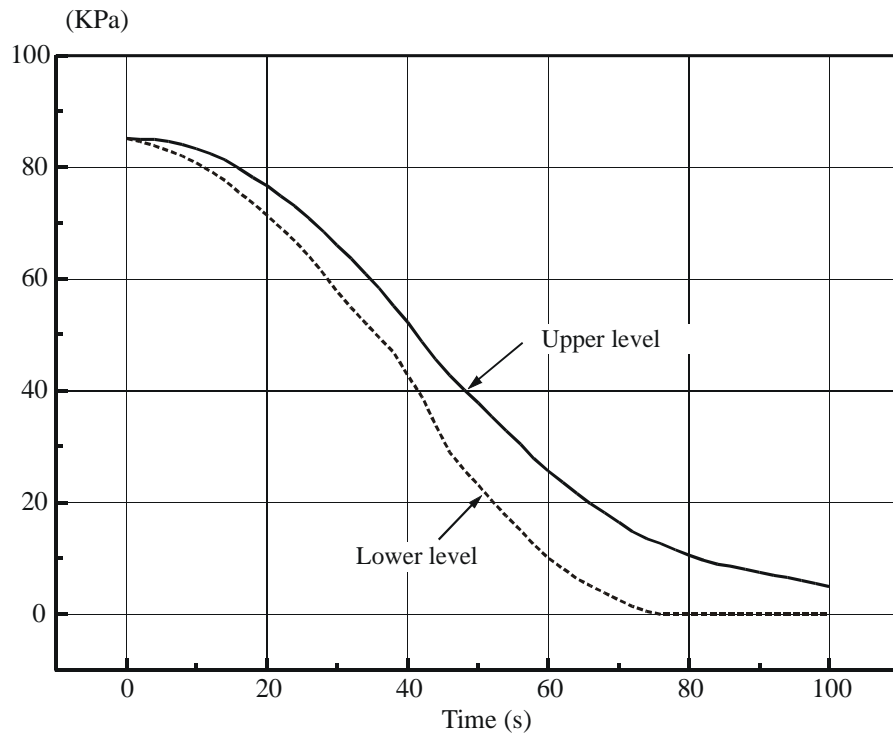


Figure 6-6 Fairing Internal Pressure vs. Flight Time
(Maximum Pressure depressurization rate Vs. time is 6.0kPa/sec .)

6.3.2 Thermal environment

The radiation heat flux density and radiant rate from the inner surface of the fairing is shown in **Figure 6-7**.

The free molecular heating flux at fairing jettisoning shall be lower than 1135W/m^2 . 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 Payload/LV thermal coupling analysis by CALT.

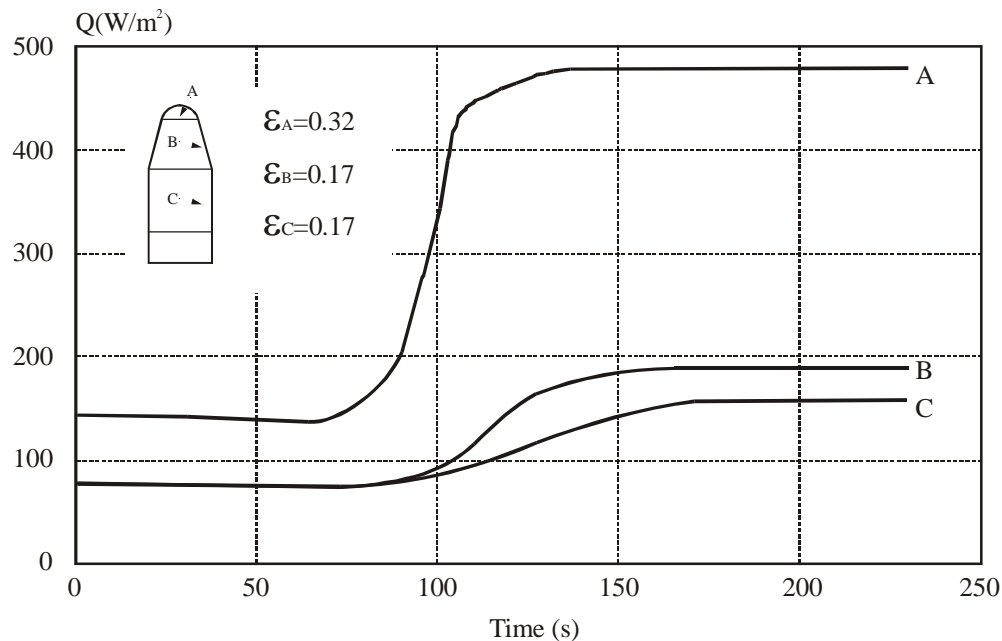


Figure 6-7 Radiation Heat Flux Density and Radiant Rate on the Inner Surface of Each Section of the Fairing

6.3.3 Static Acceleration

6.3.3.1 Longitudinal Static Acceleration

The longitudinal static acceleration is caused by the LV engine thrust and aerodynamic foresees. The acceleration is usually given in longitudinal static over load. The maximum overload is 4.6g for first stage flight and 6.7g for second stage flight, which could be varied slightly to different payloads.

6.3.3.2 Lateral Static Acceleration

The lateral static acceleration is caused by the LV maneuver and aerodynamic foresees. The maximum overload will not exceed 0.4g during the whole flight, which also could be varied slightly to different payloads.

6.3.4 Dynamic Environment

The LV suffers engine thrust, aerodynamic forces (including buffeting during transonic phase, wind aloft, etc.), various separation forces (such as stage-1/stage-2 separation, fairing jettisoning, SC/LV separation, etc.) during powered flight phase. It is also affected by disturbances caused by engine jet and transonic acoustic noise. According to the acting forces and LV responses, the dynamic environment can be divided into sinusoidal vibration, random vibration, shock and acoustic.

6.3.4.1 Sinusoidal Vibration

The 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 Payload/LV interface is shown below.

Direction	Frequency Range (Hz)	Amplitude or Acceleration	
		Two-stage LM-2C	LM-2C/CTS
Longitudinal	5 – 10	2 mm	2.5mm
	10 – 100	0.8g	1.0 g
Lateral	5 – 10	1.5mm	1.75mm
	10-100	0.6g	0.7g

6.3.4.2 Random Vibration

The Payload 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) values at Payload/LV separation plane in three directions are given in the table below.

Frequency Range (Hz)	Power Spectral Density	Total RMS Value
20 - 150	+3dB/octave.	6.94 g
150 - 800	$0.04 \text{ g}^2/\text{Hz}$	
800 - 2000	-6 dB/octave.	

6.3.4.3 Acoustic Noise

The flight noise mainly includes the engine noise and aerodynamic noise. The maximum acoustic noise Payload suffers 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	118
63	131
125	134.5
250	135
500	133.5
1000	127
2000	122
4000	118
8000	114
Total Acoustic Pressure Level	140

0 dB referenced to 2×10^{-5} Pa.

6.3.4.4 Shock Environment

The maximum shock Payload suffers occurs at the Payload/LV separation. Different separation mechanism and preload forces will affect the separation shock significantly. The typical shock response spectrum at Payload/LV separation plane is shown bellow.

Frequency Range (Hz)	Response Acceleration (Q=10)
100-1500	+9.0 dB/octave.
1500-6000	4000 g

6.4 Load Conditions for Payload Design

6.4.1 Frequency Requirement

To avoid the Payload resonance with launch vehicle, the primary frequency of Payload structure should meet the following requirement (under the condition that the Payload is rigidly mounted on the LV separation plane.):

The frequency of the lateral main mode > 12Hz

The frequency of the longitudinal main mode > 35Hz

Whereas:

For Two-stage LM-2C, payload here means the SC.

For LM-2C/CTS, payload here means the SC plus CTS.

6.4.2 Loads Applied for Payload Structure Design

During LV flight, the Payload suffers four cases: the transonic phase or Maximum Dynamic Pressure phase, the first stage engines shut down, the first and second stage separation, and the second stage main engines shut down. Therefore, the following limit loads at SC/LV separation plane corresponding to different conditions in flight are recommended for Payload design consideration.

Flight Condition	Longitudinal Acceleration(g)			Lateral Acceleration(g)
	Static	Dynamic	Combined	
Transonic and MDP	+2.2	± 0.4	+2.6	1.0
Stage-1 shut down	+4.6	± 1.0	+5.6	0.6
Stage-1/2 separation	+0.8	± 3.0	+3.8/-2.2	0.8
Stage-2 shut down	+6.7	± 0.5	+7.2	0.4

Notes:

✧ Usage of the above table:

$$\boxed{\text{Payload design loads}} = \boxed{\text{Limit loads}} \times \boxed{\text{Safety factor *}}$$

* The safety factor is determined by the Payload designer. (CALT suggests ≥ 1.25).

- ✧ The direction of the longitudinal loads is the same as the LV longitudinal axis.
- ✧ The lateral load means the load acting in any direction perpendicular to the longitudinal axis.
- ✧ Lateral and longitudinal loads occur simultaneously.
- ✧ “+” means compress in axial direction.
- ✧ The loads are acting on the separation plane.

6.4.3 Coupled Load Analysis

The Payload manufacturer should provide the Payload mathematical model to CALT for Coupled Loads Analysis (CLA). CALT will predict the Payload maximum dynamic response by coupled load analysis. The detailed data exchange requirements and special technical specifications will be coordinated by SC side and LV side. The Payload manufacturer should confirm that the Payload could survive from the predicted environment and has adequate safety margin.

6.5 Payload Qualification and Acceptance Test Specifications

6.5.1 Static Test (Qualification)

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

6.5.2 Dynamic Environment Test

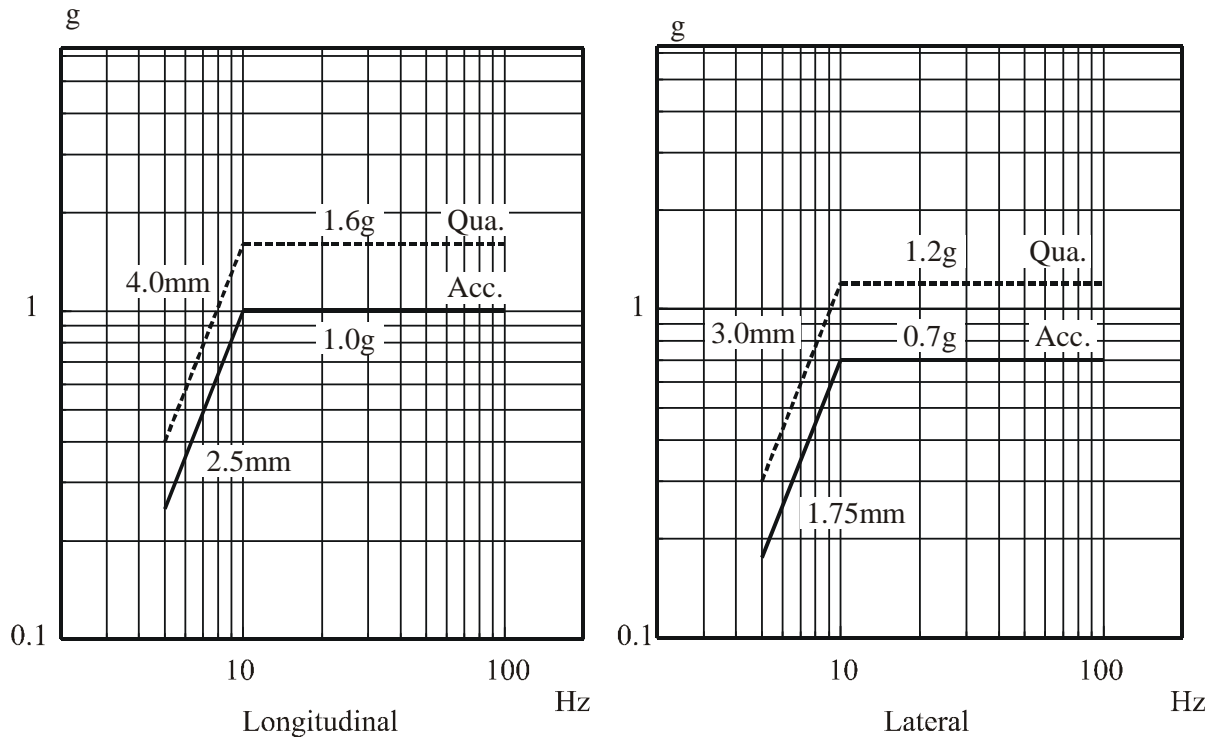
6.5.2.1 Sine Vibration Test

During tests, the Payload must be rigidly mounted on the shaker. The tables below specifies the vibration acceleration level (zero - peak) of Payload qualification and acceptance tests at Payload/LV interface. (See **Figure 6-8a&b**).

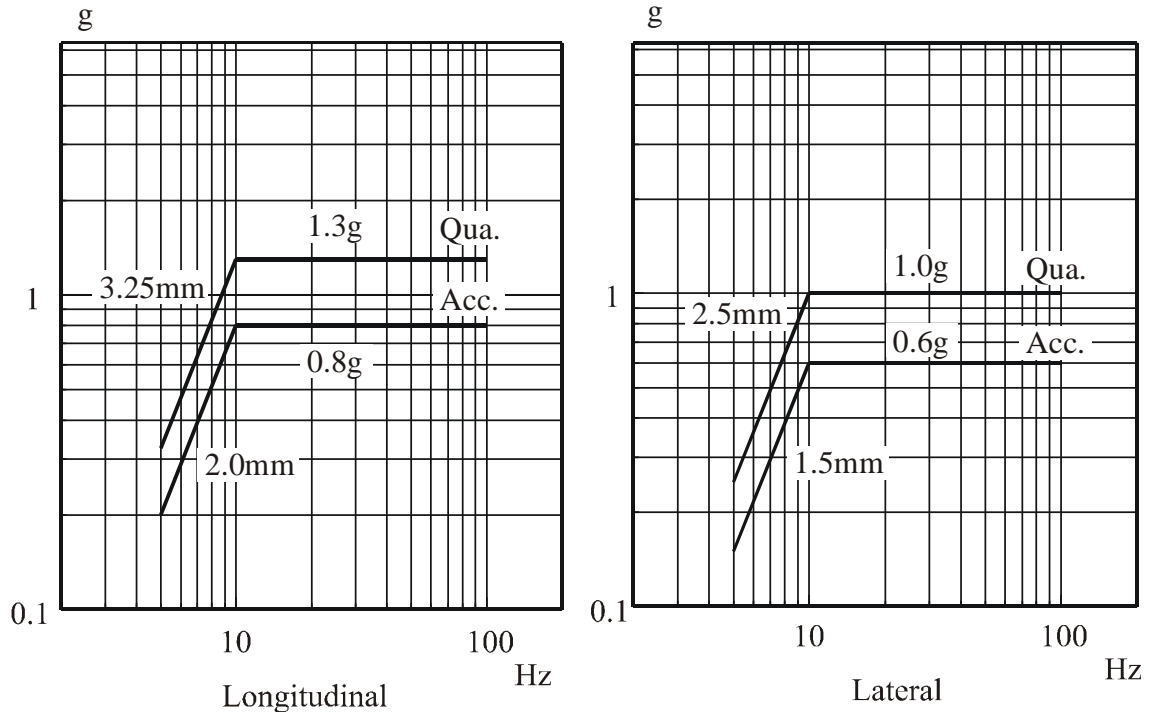
		Frequency (Hz)	Test Load	
			Acceptance	Qualification
For LM-2C/CTS	Longitudinal	5-10	2.5 mm	4.0 mm
		10-100	1.0 g	1.6 g
	Lateral	5-10	1.75 mm	3.0 mm
		10-100	0.7 g	1.2 g
	Scan rate		4 Oct/min	2 Oct/min
For Two-stage LM-2C	Longitudinal	5-10	2.0 mm	3.25 mm
		10-100	0.8 g	1.3 g
	Lateral	5-10	1.5 mm	2.5 mm
		10-100	0.6 g	1.0 g
	Scan rate		4 Oct/min	2 Oct/min

Notes:

- Frequency tolerance is allowed to be $\pm 2\%$
- Amplitude tolerance is allowed to be $\pm 10\%$
- Acceleration notching is permitted after consultation with CALT and concurred by all parties. Anyway, the coupled load analysis results should be considered , and the safety margin should be enough (CALT requires that safety factor ≥ 1.25).



**Figure 6-8a Sinusoidal Vibration Test in Longitudinal & lateral directions
(For LM-2C/CTS)**



**Figure 6-8b Sinusoidal Vibration Test in Longitudinal & lateral directions
(For Two-stage LM-2C)**

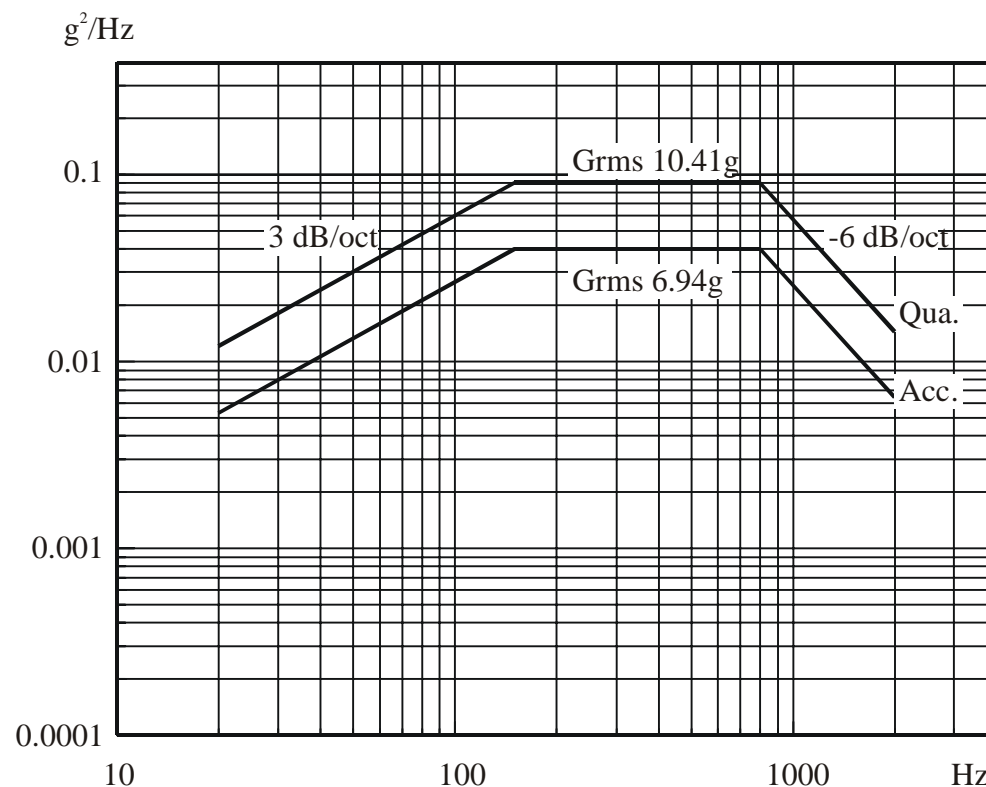
6.5.2.2 Random Vibration Test

During tests, the Payload structure must be rigidly mounted onto the shaker. The table below specifies the Payload qualification and acceptance test levels at Payload/LV interface. (See **Figure 6-9**).

Frequency (Hz)	Acceptance		Qualification	
	Spectrum Density	Total rms (Grms)	Spectrum Density	Total rms (Grms)
20 - 150	+3 dB/oct	6.94 g	+3 dB/oct	10.41 g
150 - 800	0.04 g ² /Hz		0.09 g ² /Hz	
800 - 2000	-6 dB/octave.		-6 dB/octave	
Duration	1 min.		2 min.	

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 6-9 Random Vibration Power Spectrum Density Test Conditions
(For Two-stage LM-2C and LM-2C/CTS in All Directions)**

6.5.2.3 Acoustic Test

The acceptance and qualification test levels are given in the following table (also see **Figure 6-10**).

Central Octave Frequency (Hz)	Acceptance Sound Pressure Level (dB)	Qualification Sound Pressure Level (dB)	Tolerance (dB)
31.5	122	126	-2/+4
63	128	132	-1/+3
125	134	138	
250	139	143	
500	135	139	
1000	130	134	
2000	125	129	-6/+4
4000	120	124	
8000	116	120	-1/+3
Total Sound Pressure Level	142	146	

0 dB is equal to 2×10^{-5} Pa.

Test Duration:

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

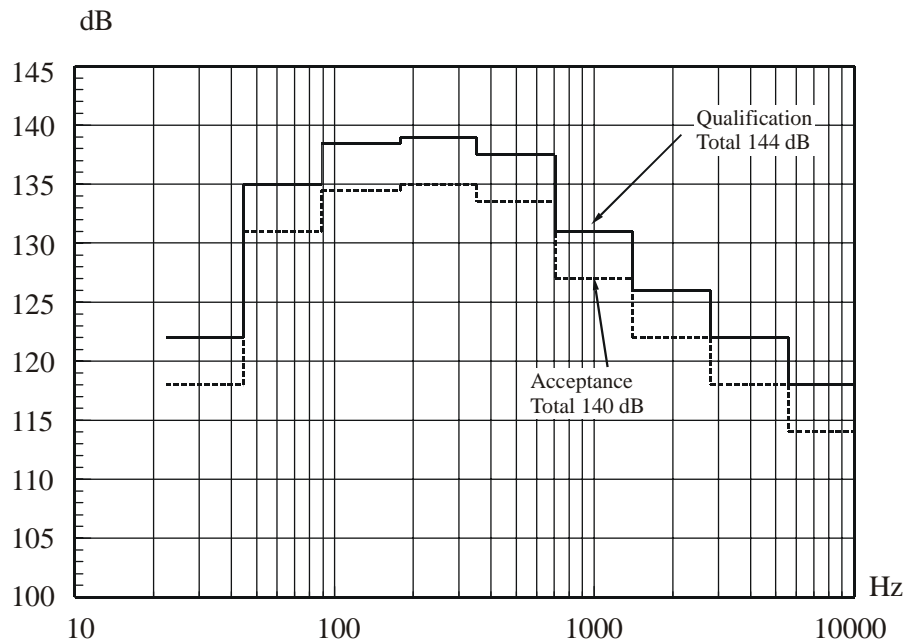
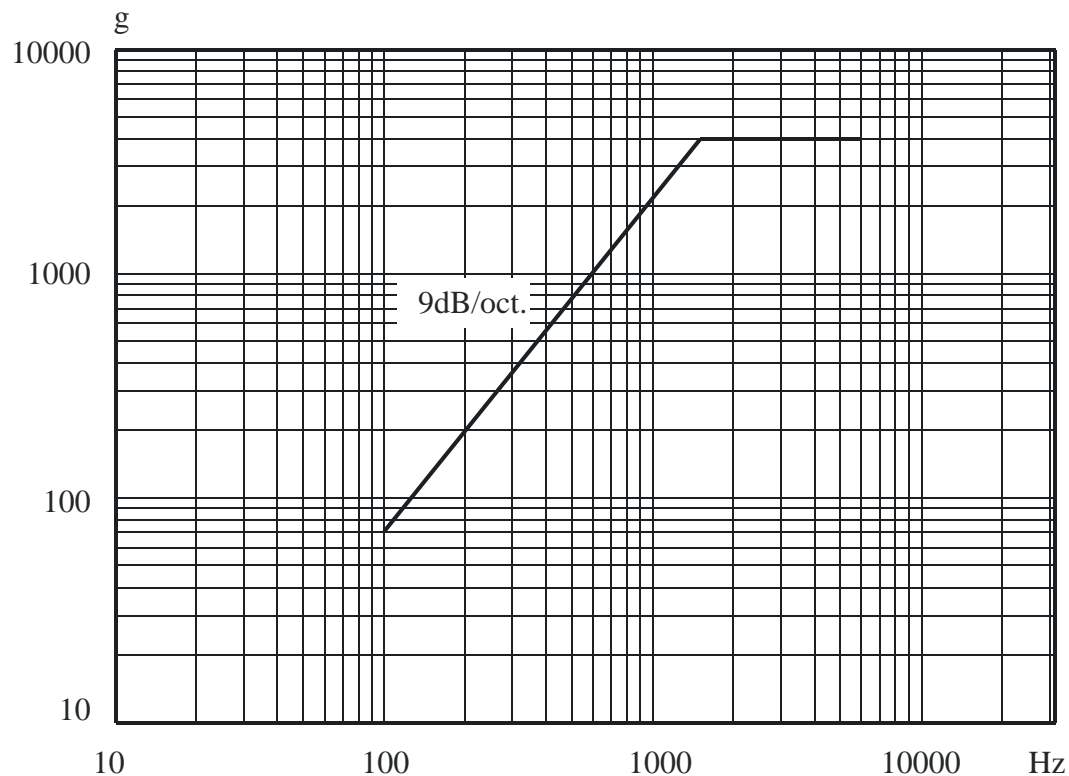


Figure 6-10 Payload Acoustic Test

6.5.2.4 Shock Test

The shock test level is specified in **Paragraph 6.3.4.4**. Such test shall be performed once for acceptance, and twice for qualification. A $\pm 6.0\text{dB}$ 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 6-11**)

The shock test can also be performed through Payload/LV separation test by using of flight Payload, 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	9.0 dB/oct.
1500~6000	4000g

Figure 6-11 Shock Response Spectrum at Payload/LV Separation Plane

CHAPTER 7

LAUNCH SITE

This chapter describes general information on the facilities and services provided by Jiuquan Satellite Launch Center (JSLC).

JSLC is subordinated to China Satellite Launch and Tracking Control General (CLTC). JSLC is mainly used for conducting LEO and SSO missions. JSLC is located in Jiuquan region, Gansu Province, Northwestern China. **Figure 7-0** shows the location of Jiuquan, as well as the layout of JSLC.

Jiuquan is of typical inland climate. The annual average temperature is 8.7°C. There is little rainfall and thunder in this region.

Dingxin Airport is 75 km southwest to JSLC. The runway of Dingxin Airport is capable of accommodating large aircraft. The Gansu-Xinjiang Railway and the Gansu-Xinjiang Highway pass by JSLC. There are a dedicated railway branch and a highway branch leading to the Technical Centers and the Launch Centers of JSLC.

By using of cable network and communications network, JSLC provides domestic and international telephone and facsimile services for the user.

JSLC consists of headquarter, South Launch Site, North Launch Site, Communication Center, Mission Center for Command and Control (MCCC), Tracking System and other logistic support systems. The North Launch Site is composed of North Technical Center and North Launch Center, which is dedicated for launching Two-stage LM-2C, LM-2C/CTS and LM-2D. The South Launch Site is composed of South Technical Center and South Launch Center, which is mainly used for launching Two-stage LM-2E and LM-2E/ETS, as well as LM-2C.

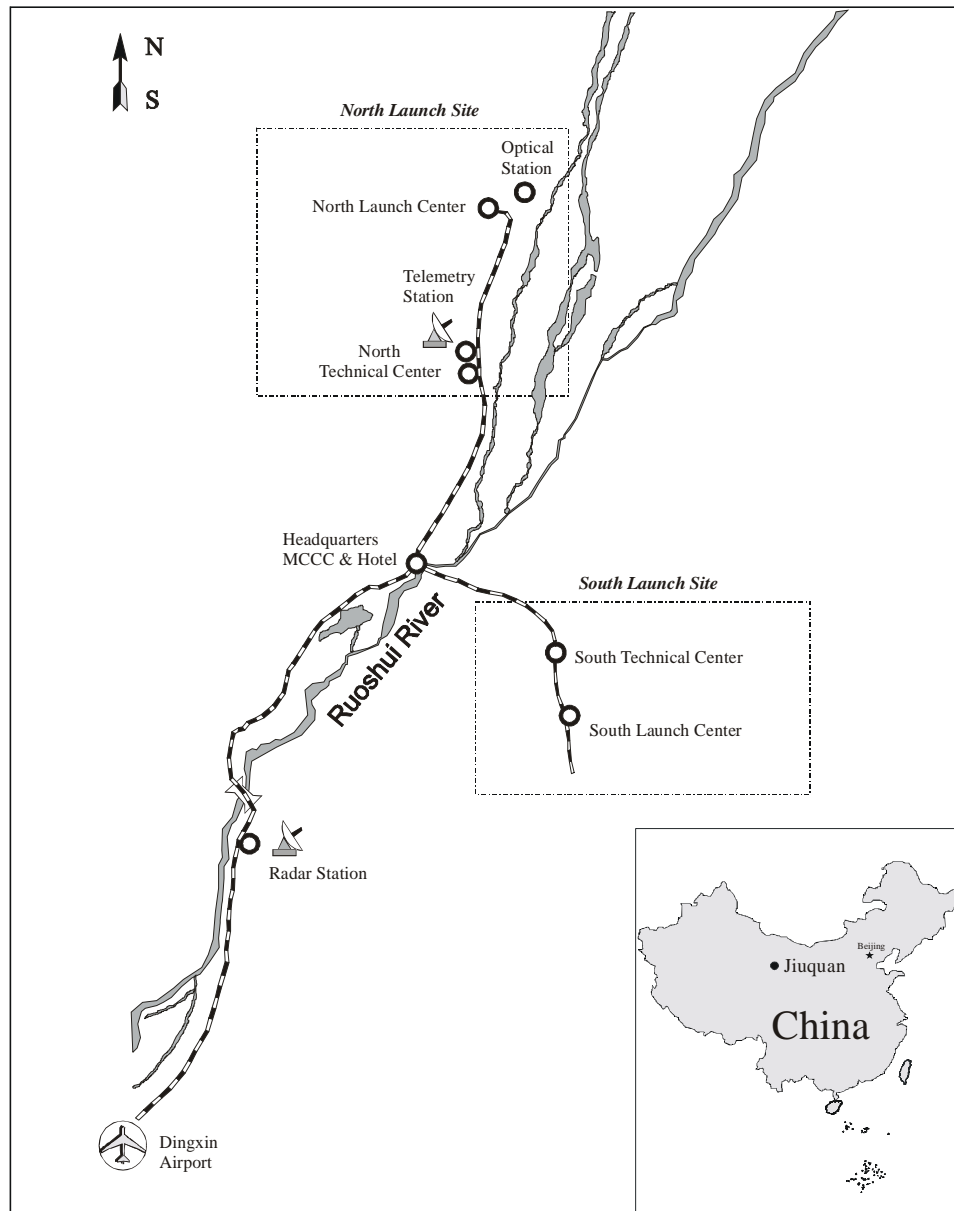


Figure 7-0 JSLC Map

Part A: North Launch Site

A7.1 North Technical Center

The North Technical Center includes LV&SC Processing Building (BLS), Solid Rocket Motor (SRM) Checkout and Processing Building (BM) etc. The LV and the SC will be processed, tested, checked, assembled and stored in North Technical Center. Refer to **Figure A7-1**.

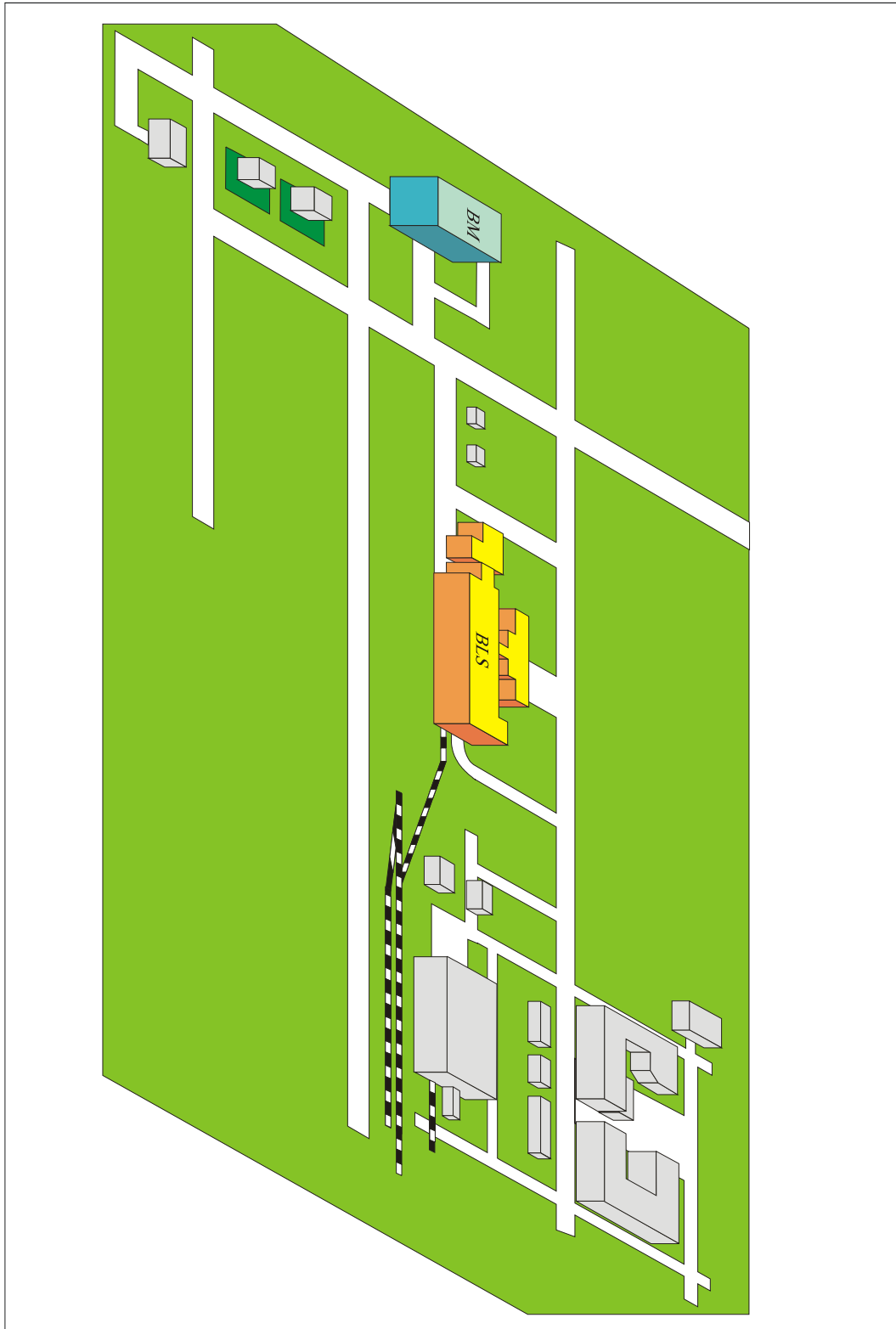


Figure A7-1 JSLC North Technical Center

A7.1.1 LV&SC Processing Building (BLS)

BL1 is mainly used for transiting the LV, the SC and relevant ground equipment, as well as LV processing, SC processing & fueling, etc. It mainly includes processing hall (BL & BS2), SC fueling hall (BS3), unit testing rooms, and power-supply, gas-supply, air-conditioning and firing alarm & protection systems, etc. The BLS is 140 meters long with total area of 4587 m². See **Figure A7-2** for BLS layout.

● Processing Hall (BL&BS2)

The processing hall is 90 meters long, 8 meters wide. The processing hall is the common place for LV and SC testing, the east side is the LV processing hall (BL), and the west is the SC processing hall (BS2). The processing hall is equipped with following facilities:

- ✧ A crane with maximum lifting capability of 16t/3.2t/10m;
- ✧ 380V/220V/50Hz and 110V/60Hz power supply;
- ✧ Air-conditioning system:
 - The corresponding environment parameters are:
 - ✓ Temperature: 20±5°C;
 - ✓ Relative humidity: 35%~55%;
 - ✓ Cleanness (class): 100,000.
- ✧ Grounding System;
- ✧ Fire alarm & protection system.

● SC Fueling Hall (BS3)

The SC fueling hall (BS3) is 24 meters long, 8 meters wide. It is equipped with following facilities:

- ✧ An explosion-proof crane with maximum lifting capability of 16t/8m;
- ✧ 380V/220V/50Hz and 110V/60Hz power supply;
- ✧ Air-conditioning system:
 - The corresponding environment parameters are:
 - ✓ Temperature: 20±5°C;
 - ✓ Relative humidity: 35%~55%;
 - ✓ Cleanness (class): 100,000.
- ✧ Grounding System;
- ✧ Fire alarm & protection system;

- ✧ SC propellant leak detection room;
- ✧ SC fueling equipment;
- ✧ Shower Room;
- ✧ Rinsing Device;
- ✧ Gas-leaking Alarm;

- Unit-testing Rooms

There are 25 unit-testing rooms along the processing hall. They are mainly used for performing LV and SC unit-testing and also used for storage of the test equipment.

- Clean SC Test Room

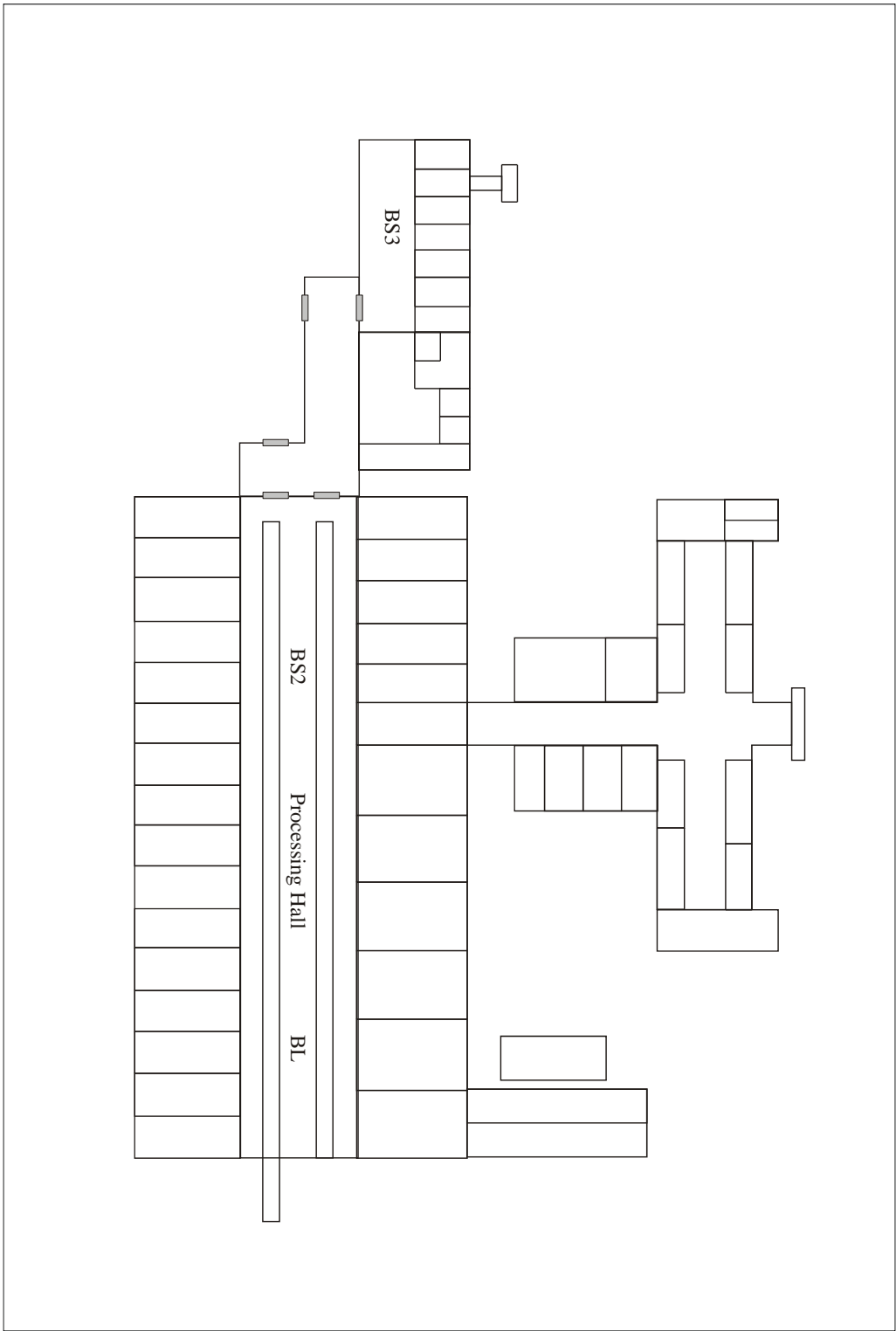
A clean room is provided only to the user for SC testing. The temperature inside the room is $20\pm 5^{\circ}\text{C}$, relative humidity 35%~55%, and cleanness 100,000 class.

- Other Support Systems

BLS also provides following support systems:

- ✧ 380V/220V/50Hz and 110V/60Hz power supply;
- ✧ Air-conditioning system;
- ✧ Communication system;
- ✧ Fire alarm & protection system;
- ✧ Grounding system;
- ✧ Watch room, offices, conference room and infirmary;

Figure A7-2 Layout of BLS



A7.1.2 Solid Rocket Motor (SRM) Checkout and Processing Building (BM)

BM is mainly used for SRM assembly, testing and short-time storage. The BM includes SRM processing hall, SRM storage room, testing rooms, and air-conditioning, power-supply, fire protection & alarm, telecommunication systems. See **Figure A7-3** for BM layout.

● SRM Processing Hall

The SRM processing hall is 24 meters long, 12 meters wide. It is equipped with following facilities:

- ✧ An explosion-proof double-speed crane with maximum lifting capability of 16t/3.2t/10m;
- ✧ 380V/220V/50Hz and 110V/60Hz power supply;
- ✧ Air-conditioning system:
 - The corresponding environment parameters are:
 - ✓ Temperature: $20\pm 5^{\circ}\text{C}$;
 - ✓ Relative humidity: 35%~55%;
 - ✓ Cleanness (class): 100,000.
- ✧ Grounding System;
- ✧ Fire alarm & protection system.

● SRM Storage Room

The total area of the SRM storage room is 36 m^2 , the temperature is $20\pm 5^{\circ}\text{C}$, and the relative humidity is 35%~55%.

● Testing Rooms

There are 3 testing rooms inside the BM.

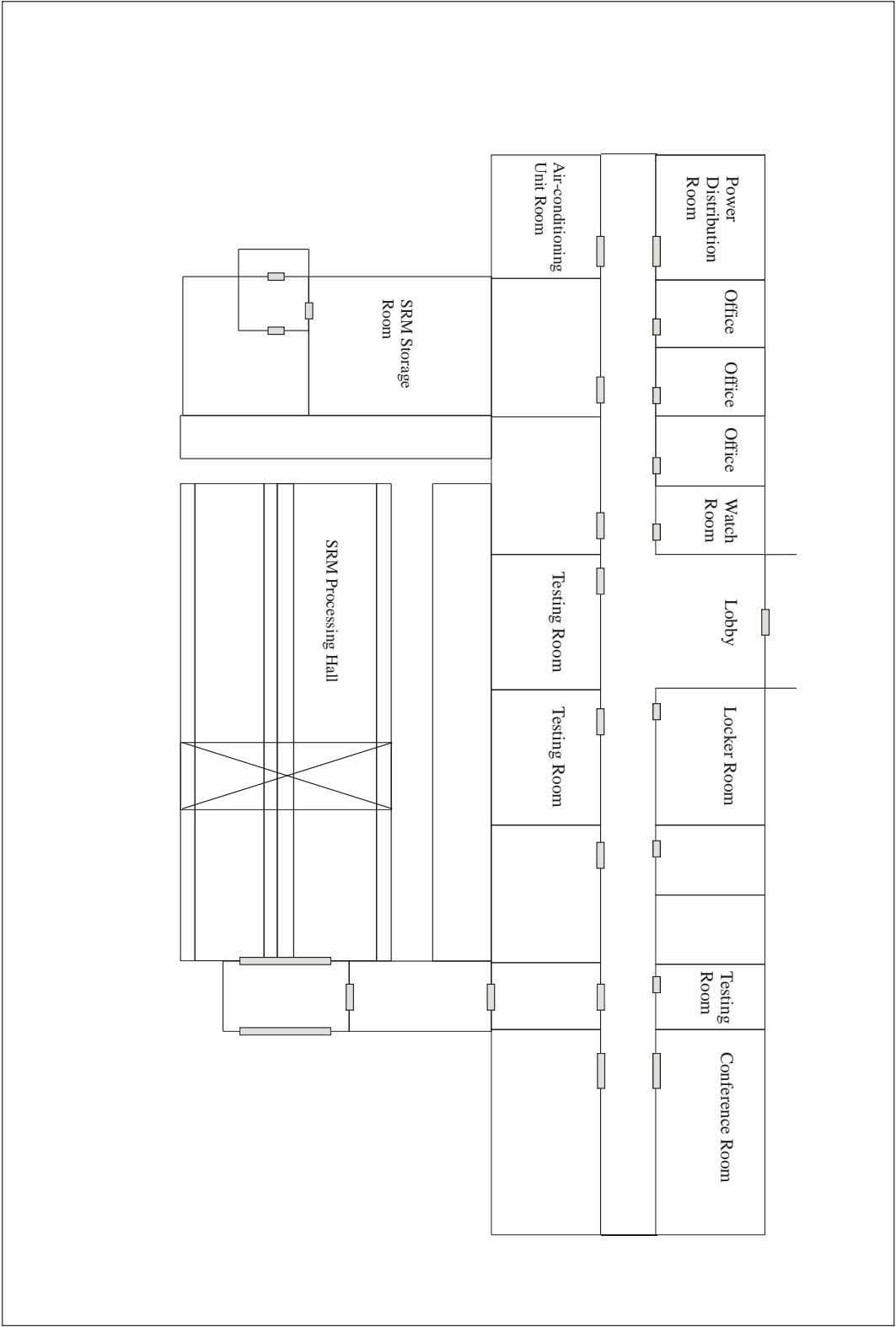


Figure A7-3 Layout of BM

A7.2 North Launch Center

A7.2.1 General

Coordinates of the Launch Tower for LM-2C:

Longitude: 100°17.4'E,

Latitude: 40°57.4'N

Elevation: 1073m

Facilities in the north launch center are umbilical tower, moveable service tower, launch pad, launch control center (LCC), fuelling system, power-supply system, gas-supply system, fire protection and alarm system, communication system, etc. Refer to **Figure A7-4**.



Figure A7-4 JSLC North Launch Center

A7.2.2 Moveable Service Tower

The moveable service tower provides operating platform and environment dedicated for LV erection, LV and SC integration. It is composed of tower body, gantry crane, elevator, operating platform, SC working room, etc. Refer to **Figure A7-5**.

The tower body is an 11-floor fixed steel structure with height of 55.23 m, length of 30.52 m, and width of 20.9 m. The lifting capability of the gantry crane is 15 ton (main hook)/5 ton (subsidiary hook), and the lifting height is 44.5m. There are two elevators with load capability of 500 kg at two sides of the tower body. There are totally 6 floors of operating platform on the tower body. The SC working room is located at height of 29 m to 42 m inside the tower body, and the cleanliness of the room is 100,000 class.

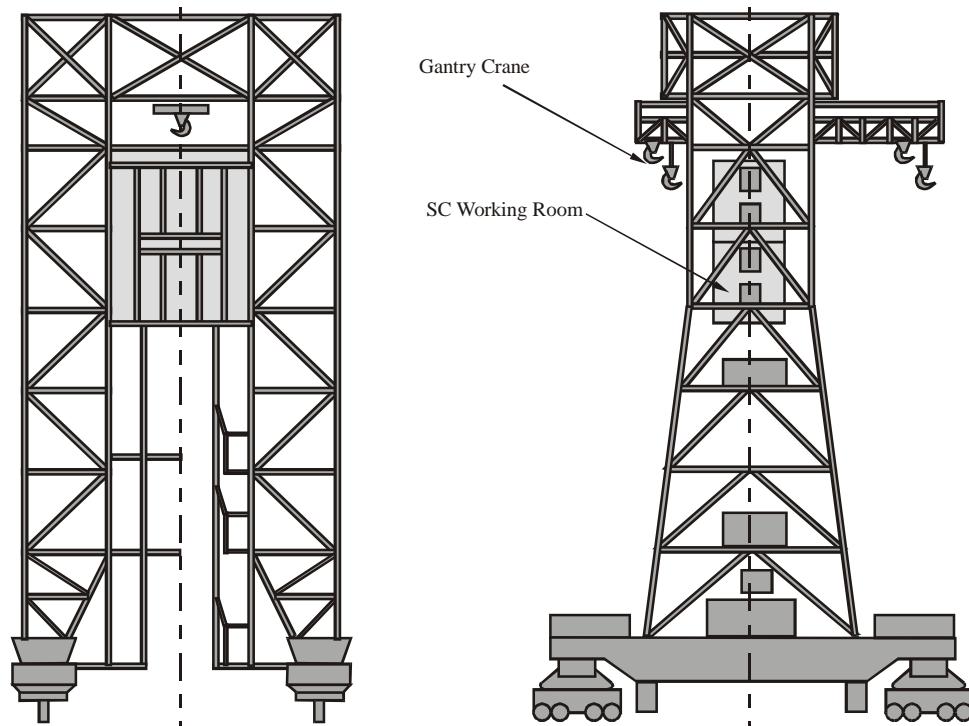


Figure A7-5 Moveable Service Tower

A7.2.3 Umbilical Tower

The umbilical tower provides operating platform and environment dedicated for LV fueling, LV and SC checkouts. It is mainly composed of tower body, operating platform, umbilical silo, swinging arm for umbilical, fueling system, gas-supply system, fire protection & alarm system, and elevator etc.

The umbilical tower is 45 m in height, 7.8 m in length and 7.8 m in width. It is equipped with an elevator with load capability of 1000 kg, 5 floors of rotating platforms and 2 floors of roll-over platforms. See **Figure A7-6**.

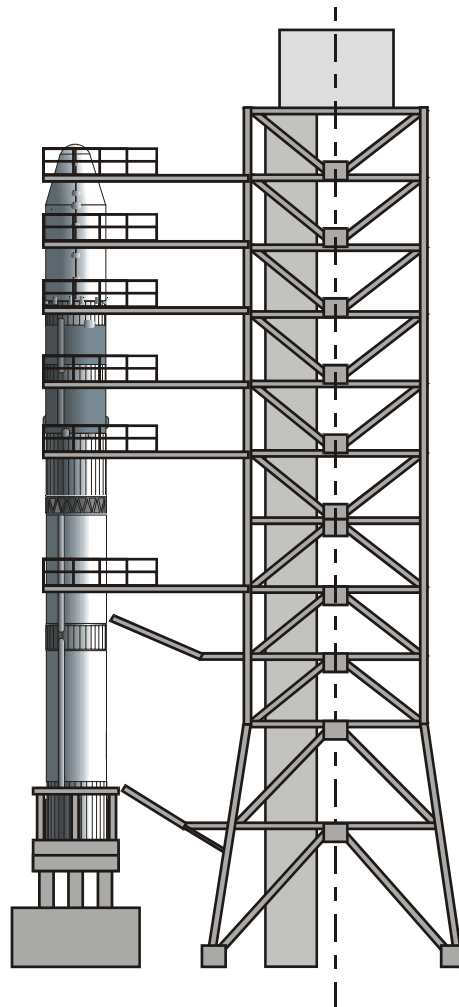


Figure A7-6 Umbilical Tower

A7.2.4 Launch Control Console (LCC)

Launch Control Console (LCC) is an underground rounded fortress. The LCC mainly consists of control room, SC testing rooms, LV testing rooms, power-supply system, air-conditioning system, and communication system. Refer to **Figure A7-7**. LCC is of following main functions:

- ✧ Commanding and coordinating LV system and SC system to conduct comprehensive checkouts and launch;
- ✧ Remote control on LV pre-launch process, fire-protecting system of the launch tower;
- ✧ Common and testing communications between North Technical Center and North Launch Center;
- ✧ Launch Monitoring and Controlling;
- ✧ Medical Assistance and Weather Forecast.

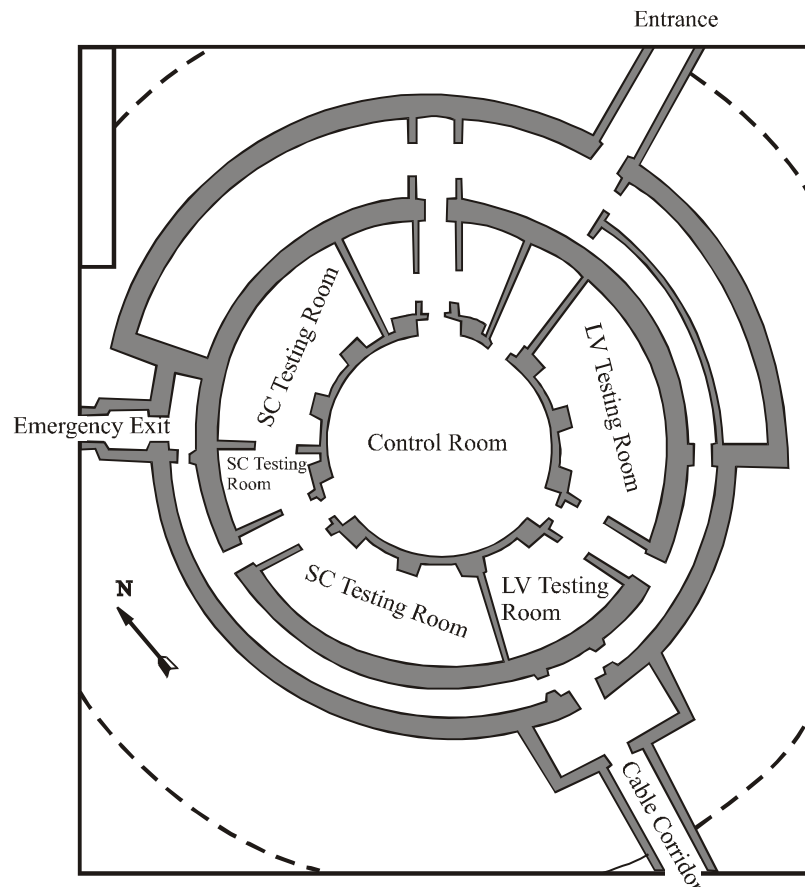


Figure A7-7 Launch Control Center

A7.2.5 Mission Command & Control Center (MCCC)

MCCC includes command and control hall, computer room, internal communication room and offices, etc. **Figure A7-8** shows the layout of MCCC.

MCCC is of following main functions:

- ✧ 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 SC Control Center (XSCC);
- ✧ Provide display information to the SC working-team console;
- ✧ Perform post-mission data processing.

The Configuration of MCCC is as follows:

- ✧ 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 telecommand system.
- ✧ Communication system.
- ✧ Timing and data transmission system.
- ✧ Film developing and printing equipment.

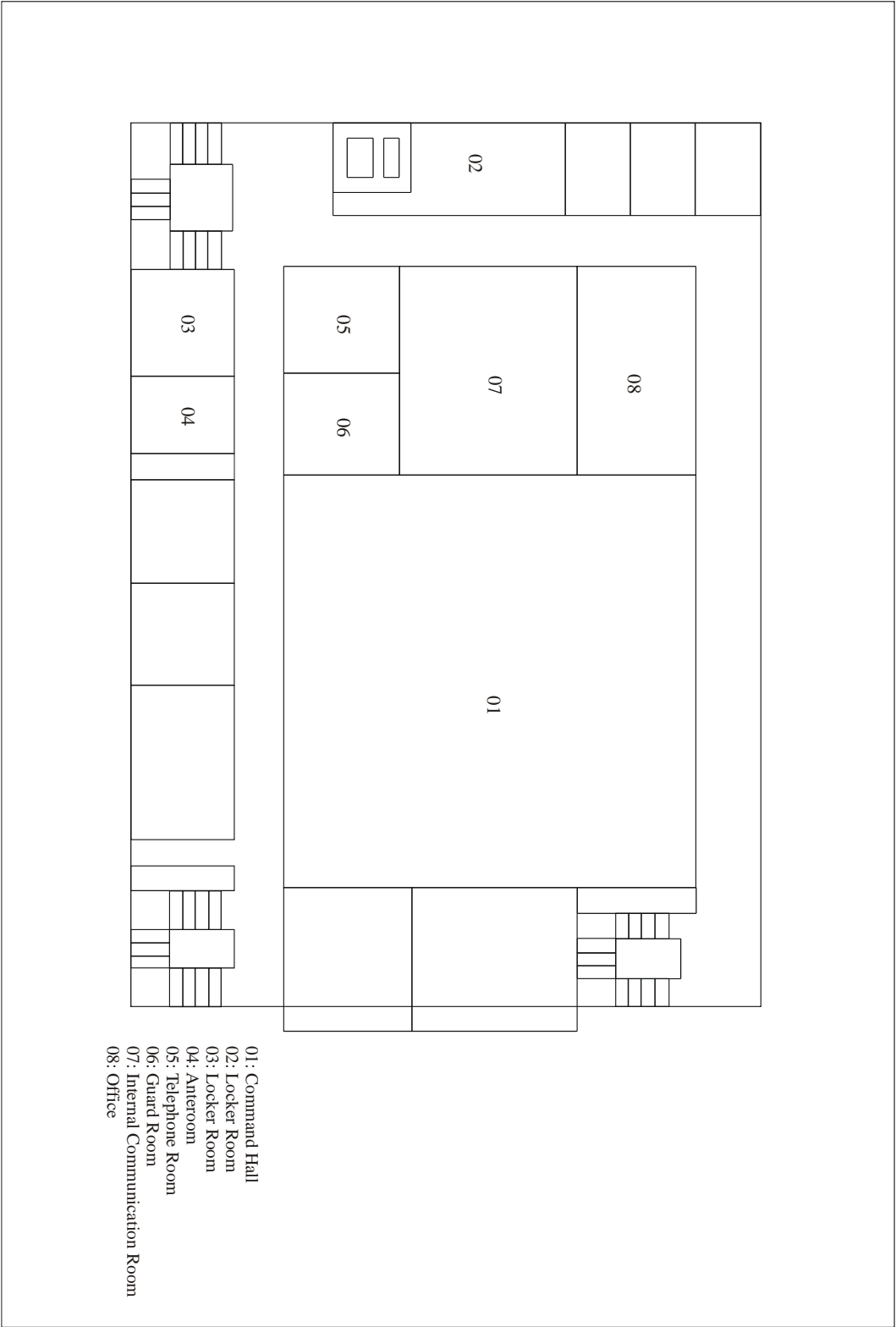


Figure A7-9 MCCC Layout

7-15

A7.3 Tracking, Telemetry and Control System (TT&C)

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

The TT&C system of JSLC mainly consists of:

- ✧ MCCC;
- ✧ Radar Stations;
- ✧ Optical Tracking Stations;
- ✧ Mobile Tracking Stations.

The TT&C system of XSCC mainly includes:

- ✧ Weinan Tracking Station;
- ✧ Nanning Tracking Station;
- ✧ Mobile Tracking Stations.

Main Functions of TT&C are described as follows:

- ✧ 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 SC;
- ✧ Making flight range safety decision;
- ✧ Computing the SC/LV separation status and injection parameters.

Part B: South Launch Site

B7.1 South Technical Center

South Technical Center includes LV Vertical Processing Building (BLS), LV Horizontal Transit Building (BL1), SC Non-hazardous Operation Building (BS2), SC Hazardous Operation Building (BS3), Solid Rocket Motor (SRM) Checkout and Processing Building (BM) and Pyrotechnic Storage and Processing Building (BP1, BP2). The LV and the SC will be processed, tested, checked, assembled and stored in South Technical Center. Refer to **Figure B7-1**.

B7.1.1 LV Horizontal Transit Building (BL1)

BL1 is mainly used for transiting the LV and relevant ground equipment. It mainly includes LV horizontal processing hall, transit room and unit testing rooms.

LV horizontal processing hall is 78 meters long, 24 meters wide. It is mainly used for LV horizontal processing. There are three steel tracks and a moveable overhead crane inside the hall.

The transit room, which is 42 meters long, 30 meters wide, is equipped with a moveable overhead crane with the maximum height of 12 meters. The gate of the transit room is 8 meters wide, 8 meters high.

B7.1.2 LV Vertical Processing Building (BLS)

BLS is mainly used for LV integration, LV & SC integration, LV vertical checkouts, LV & SC combined checkouts. BLS includes two high-bays and two vertical-processing halls.

Each vertical-processing hall is 26.8 meters wide, 28 meters long, 81.6 meters high, and it is equipped with following facilities:

- ✧ 13-floor moveable platform;
- ✧ A crane with maximum lifting capability of 50t/30t/17m;
- ✧ 380V/220V/50Hz and 110V/60Hz power supply;
- ✧ Air-conditioning system;

The corresponding environment parameters inside BLS are:

- ✓ Temperature: $20\pm 5^{\circ}\text{C}$;
- ✓ Relative humidity: 35%~55%;
- ✓ Cleanness (class): 100,000.
- ✧ Grounding System;
- ✧ Fire alarm & protection system.

See **Figure B7-2**.

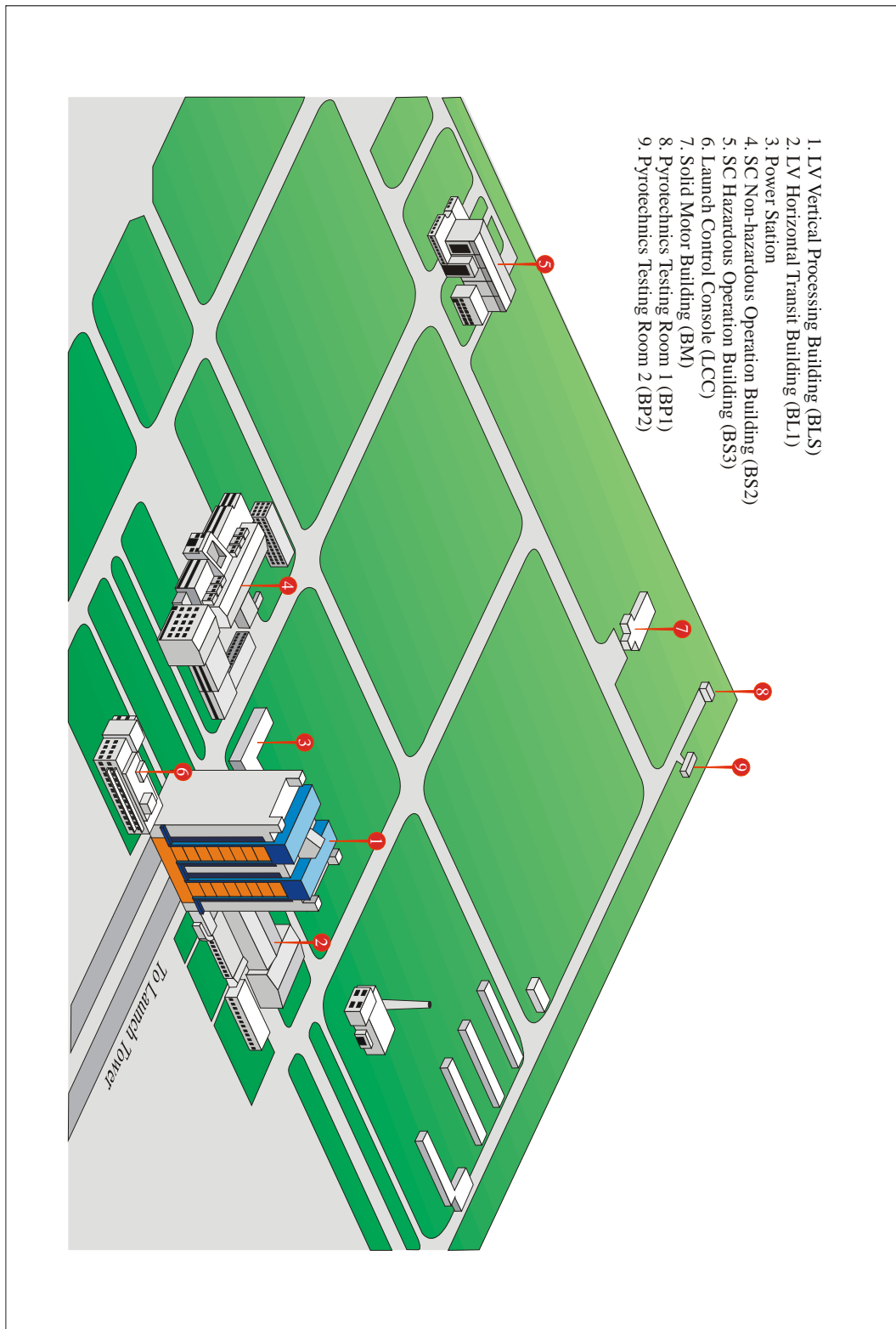
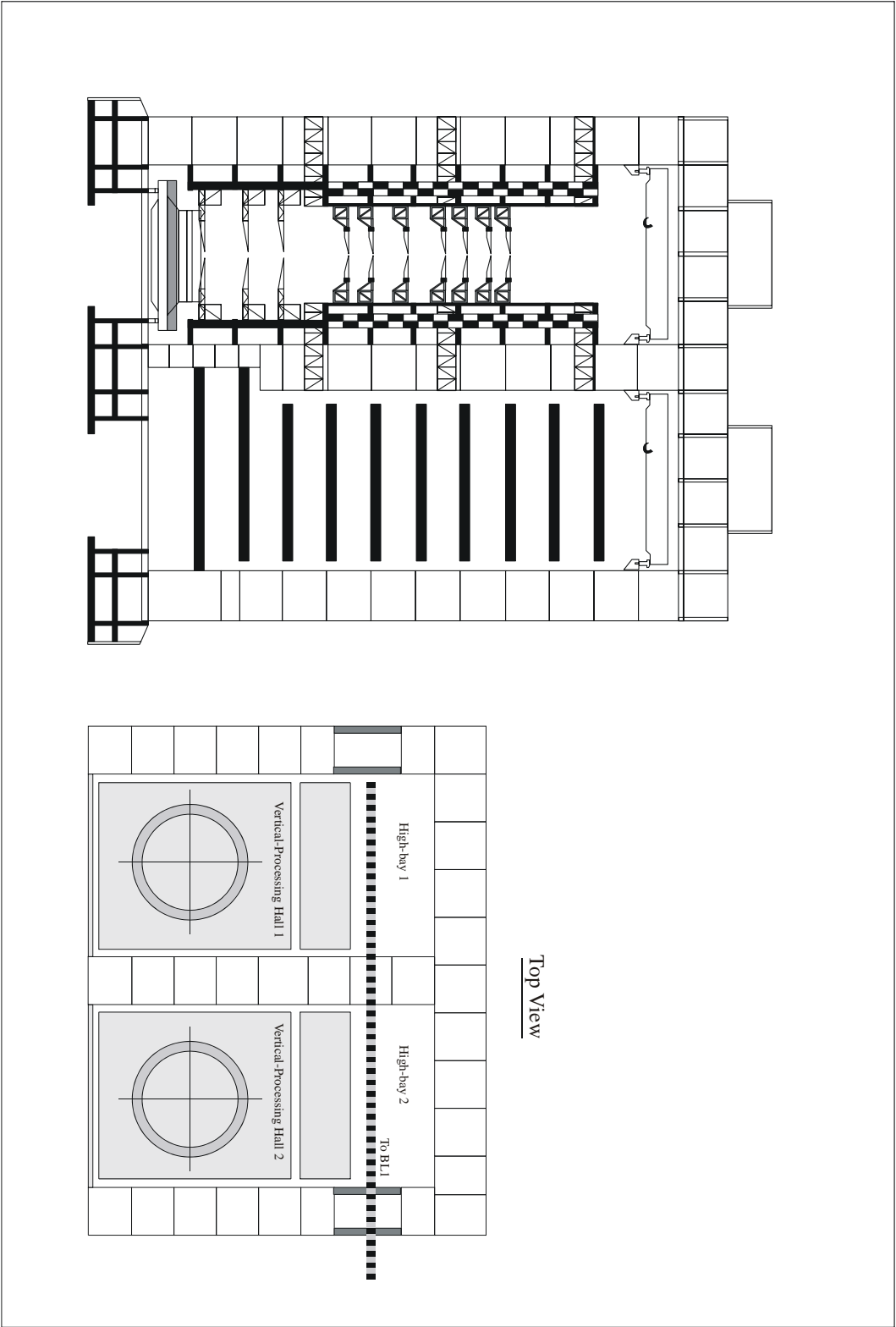


Figure B7-1 South Technical Center

Figure B7-2 LV Vertical Processing Building (BLS)



B7.1.3 SC Non-hazardous Operation Building (BS2)

The SC Non-hazardous Operation Building (BS2) is a clean area for SC testing and integration. BS2 consists of the following parts:

- ✧ BS2 Transit Hall: (Crane Lifting Capability: 32t/10t/17m);
- ✧ SC Testing Hall: (Crane Lifting Capability: 32t/10t/17m);
- ✧ Air-drench Rooms;
- ✧ System Test Equipment (STE) Rooms;
- ✧ Unit-level Test Rooms;
- ✧ Control Room;
- ✧ Equipment Storage Rooms;
- ✧ RF Room;
- ✧ Offices etc.

Refer to **Figure B7-3** and **Table B7-1**.

Table B7-1 Room Area and Environment in BS2

Room	Usage	Dimension		Environment		
		L×W (m× m)	Area (m ²)	T (°C)	Humidity (%)	Cleanness (Class)
01	BS2 Transit Hall	30×24	720			
02	SC Testing Room	72×24	1728	23±5	35~55	100,000
03	Locker Room for Men	12×6.5	78			
04	Locker Room for Women	9×6.5	58.5			
05	Air-drench Room	12×6.5	78			
06	Air-drench Room	6×6.5	39			
07	System Test Equipment Room	18×6.5	117	15~25	35~55	100,000
08	Unit-level Test Room	12×6.5	78	15~25	35~55	100,000
09	Unit-level Test Room	18×6.5	117	15~25	35~55	100,000
10	Unit-level Test Room	12×6.5	78	15~25	35~55	100,000
11	Control Room	18×6.5	117	20~25	35~55	100,000
12	Equipment Storage Room	6×6.5	39	20~25	35~55	100,000
14	RF Room	18×6.5	117	20~25	35~55	100,000
15	Equipment Storage Room	6×6.5	39	20~25	35~55	100,000

In addition, BS2 is equipped with gas-supply, grounding, air-conditioning, fire alarm & protection and cable TV systems. It also provides 380V/220V/50Hz and 110V/60Hz power-supplies.

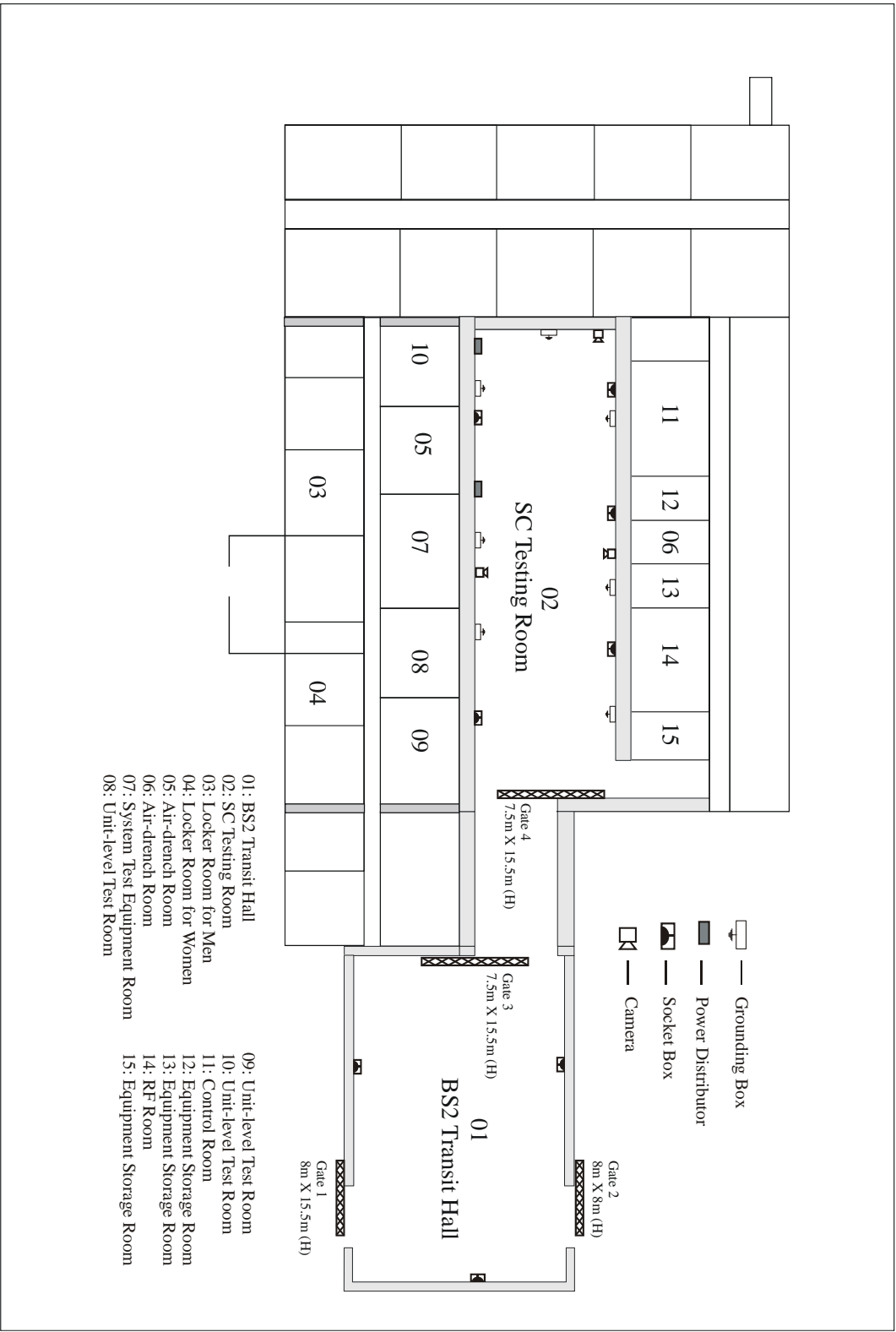


Figure B7-3 Layout of First Floor of BS2

B7.1.4 SC Hazardous Operation Building (BS3)

The SC hazardous operation building (BS3) is a clean area for SC's hazardous assembly, mono-propellant or bi-propellant fueling, the integration of the SC and the Fairing, spinning balance and weighing. BS3 mainly consists of the following parts:

- ✧ BS3 transit hall: (Crane Lifting Capability: 16t/3.2t/17m);
- ✧ SC fueling hall: (Crane Lifting Capability: 16t/3.2t/17m);
- ✧ SC assembly hall: (Crane Lifting Capability: 16t/3.2t/18m);

Refer to **Figure B7-4** and **Table B7-2**.

Table B7-2 Room Area and Environment in BS3

Room	Usage	Dimension		Environment		
		L×W (m× m)	Area (m ²)	T (°C)	Humidity (%)	Cleanness (Class)
01	BS3 Transit Hall	24×15	360			
02	SC Fueling Hall	12×18	216	15~25	35~55	100,000
03	Testing Room	7.5×6	45	15~25	35~55	100,000
04	Testing Room	6×6	36	15~25	35~55	100,000
05	Locker Room	6×6	36			
06	Testing Room	6×6	36	15~25	35~55	100,000
07	SC Assembly Hall	36×18	648	15~25	35~55	100,000
08	Fuel-filling Room	6×6	36	15~25	35~55	100,000
09	Fuel-filling Room	7.3×6	43.8	15~25	35~55	100,000
10	Office	4.3×6	25.8			
11	Air-drench Room	3×6	18			
12	Oxidizer-filling room	6×6	36	20~25	35~55	100,000
13	Room of Air-conditioning Unit					
14	Power Distribution Room					

In addition, BS3 is equipped with electronic weighing, gas-supply, air-conditioning, grounding, fire alarm & protection and cable TV systems. It also provides 380V/220V/50Hz and 110V/60Hz power-supplies.

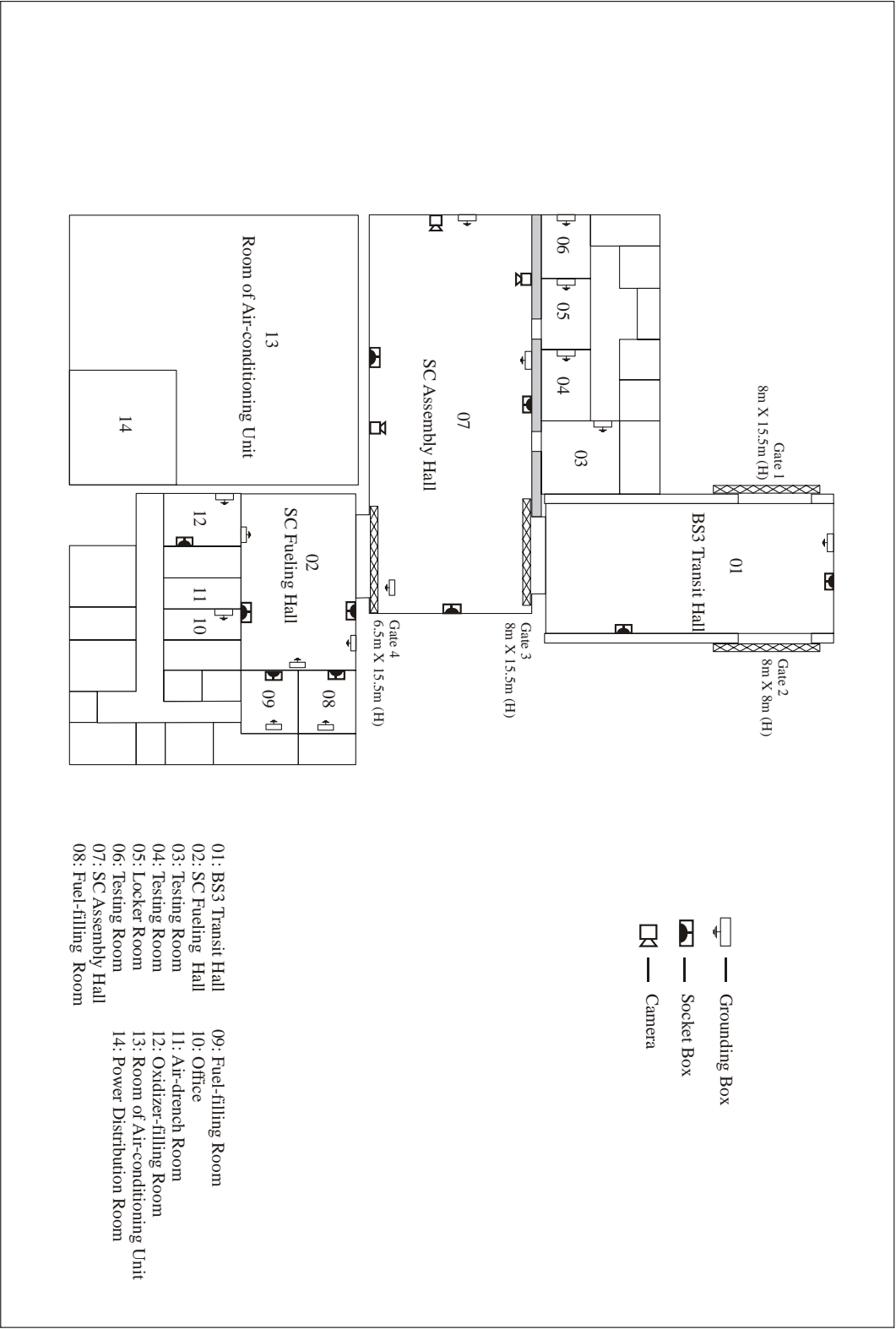


Figure B7-4 Layout of First Floor of BS3

B7.1.5 SRM Checkout and Processing Building (BM)

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

BM mainly consists of following parts:

- ✧ SRM Processing Hall;
- ✧ SRM Storage Room;

Refer to **Figure B7-5**. The area and environment are listed in **Table B7-3**.

Table B7-3 Room Area and Environment in BM

Room	Usage	Measurement		Environment		
		L×W (m×m)	Area (m ²)	T (°C)	Humidity (%)	Cleanness (Class)
01	SRM Processing Hall	24×15	360	18~28	35~55	100,000
02	SRM Storage Room	6×6	36	18~28	35~55	100,000
03	Locker Room	3.3×5	16.5			
04	Power Distribution Room	3.3×5	16.5			
05	Meeting Room	3.3×5.1	16.83			
06	Testing Room	3.3×5.1	16.83	18~28	40~60	100,000
07	Data-processing Room	6.6×5.1	33.66			
08	Testing Room			18~28	40~60	100,000

A series of anti-thunder, anti-static measures have been adopted in BM. BM is equipped with air-conditioning and fire alarm & protection systems. It also provides 380V/220V/50Hz and 110V/60Hz power-supply.

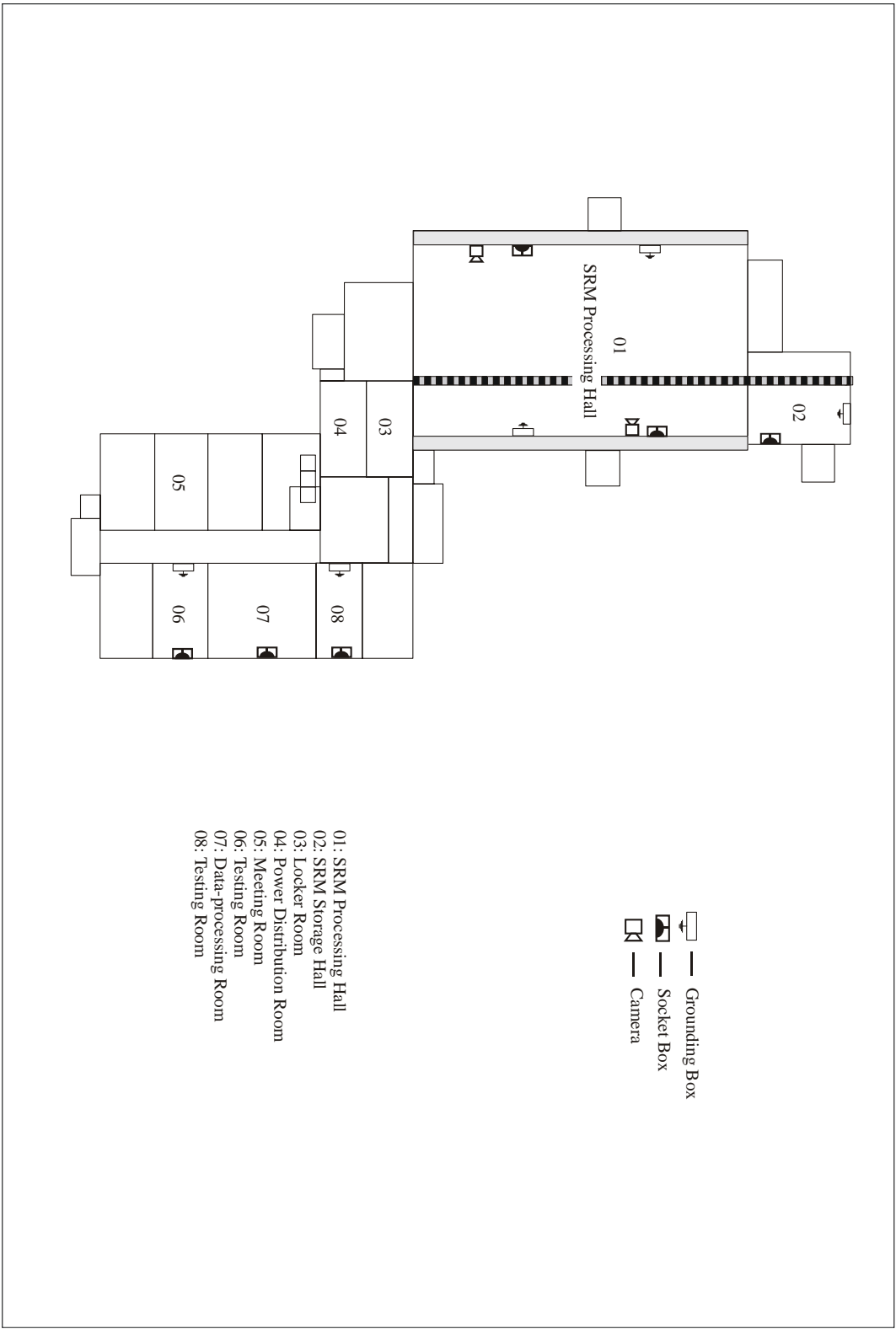


Figure B7-5 BM Layout

B7.1.6 Launch Control Console (LCC)

Launch Control Console (LCC) is located beside BLS. LCC is electrically connected with Launch Tower and BS2 via cables and radio frequency. LCC is of following main functions:

- ✧ Commanding and coordinating LV system and SC system to conduct comprehensive checkouts and launch;
- ✧ Remote control on LV pre-launch process, fire-protecting system of the launch tower;
- ✧ Common and testing communications between South Technical Center and South Launch Center;
- ✧ Launch Monitoring and Controlling;
- ✧ Medical Assistance and Weather Forecast.

The LCC mainly consists of following parts:

- ✧ LV Control Room;
- ✧ SC Control Room;
- ✧ Checkout & Launch Command Room;
- ✧ Communication Center;

Refer to **Figure B7-6** and **Table B7-4**.

Table B7-4 Room Area and Environment in LCC

Room	Usage	Dimension		Environment		
		L×W (m×m)	Area (m ²)	T (°C)	Humidity (%)	Cleanness (Class)
01	SC Control Room	13.2×19	237.6	18~26	40~70	
02	Checkout & Launch Command Room	13.2×19	237.6	18~26	40~70	
03	LV Control Room		118.8	18~26	40~70	
04	Locker Room					
05	Meeting Room	8×6	48			
06	Anteroom	3.3×5.1	16.83			
07	Testing Room	6×5	30	18~26	40~70	
08	Testing Room	8×6	48	18~26	40~70	
09	Testing Room	4×6	24	18~26	40~70	

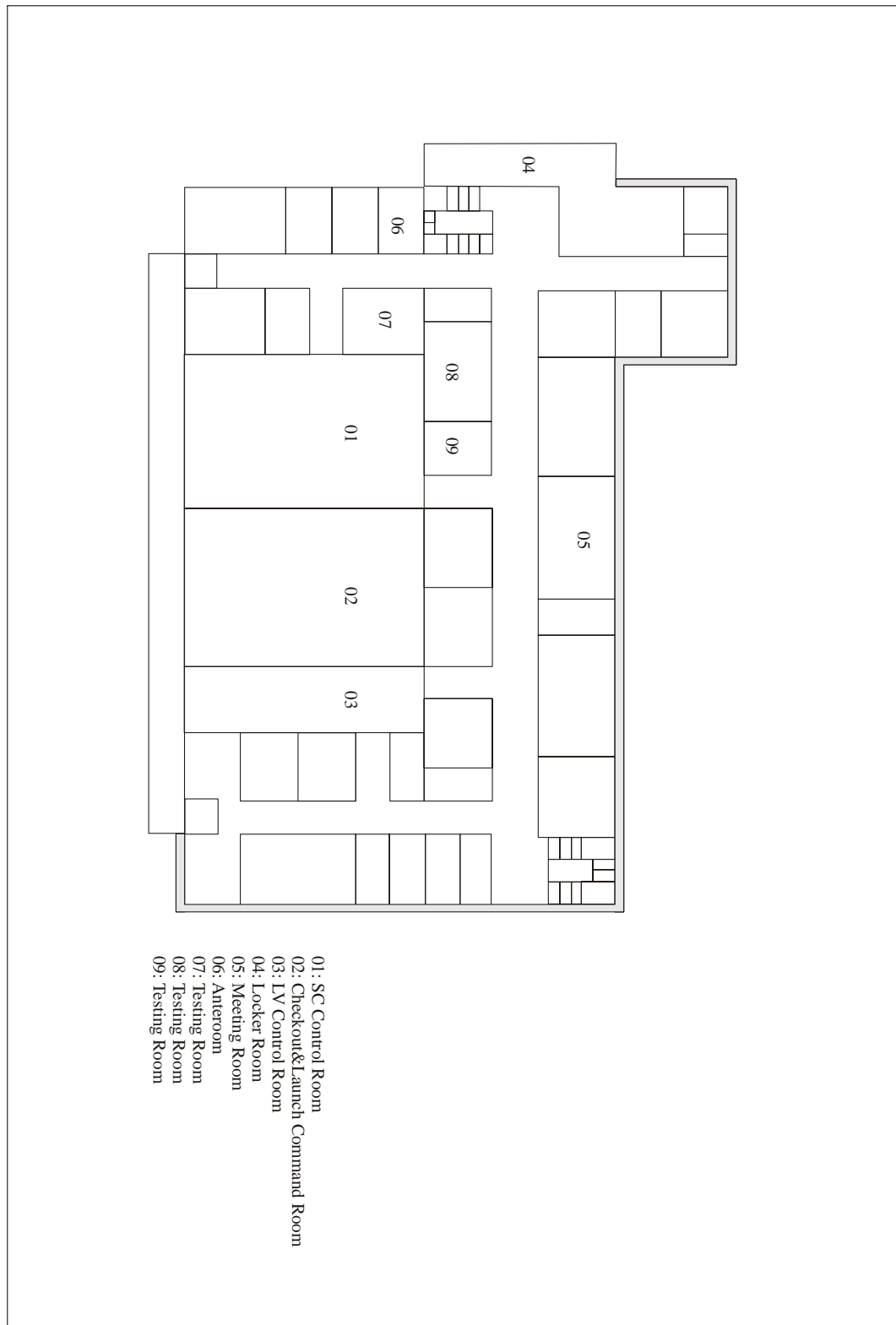


Figure B7-6 Layout of the Second Floor of LCC

B7.1.7 Pyrotechnics Storage & Testing Rooms (BP1 & BP2)

BP1 and BP2 are used for the storage & testing of LV and SC pyrotechnics. BP1 and BP2 are equipped with power-supply, anti-lightning & grounding and fire-extinguish systems.

B7.1.8 Power Supply, Grounding, Lightning Protection, Fire Alarm & Protection Systems in the South Technical Center

- **Power Supply System**

Two sets of 380V/220, 50Hz power supplies are provided in the south technical center, which spare each other. The power supply for illumination is separate to that. In addition, all of the sockets inside BS2 and BS3 are explosion-proof.

- **Lightning Protection and Grounding**

In technical areas, there are three kinds of grounding, namely technological grounding, protection grounding and lightning grounding. Some advanced lightning protection and grounding measures are adopted in all the main buildings and a common grounding base is established for each building. All grounding resistance is lower than 1Ω. Grounding copper bar is installed to eliminate static in the processing areas.

- **Fire Alarm & Protection System**

All the main buildings are equipped with fire alarm & protection system. The fire alarm system includes ultraviolet flame sensors, infrared smoke sensors, photoelectric smoke sensors, manual alarm device and controller, etc. The fire protection system includes fire hydrant, powder fire-extinguisher etc.

B7.2 South Launch Center

B7.2.1 General

Coordinates of the Launch Tower:

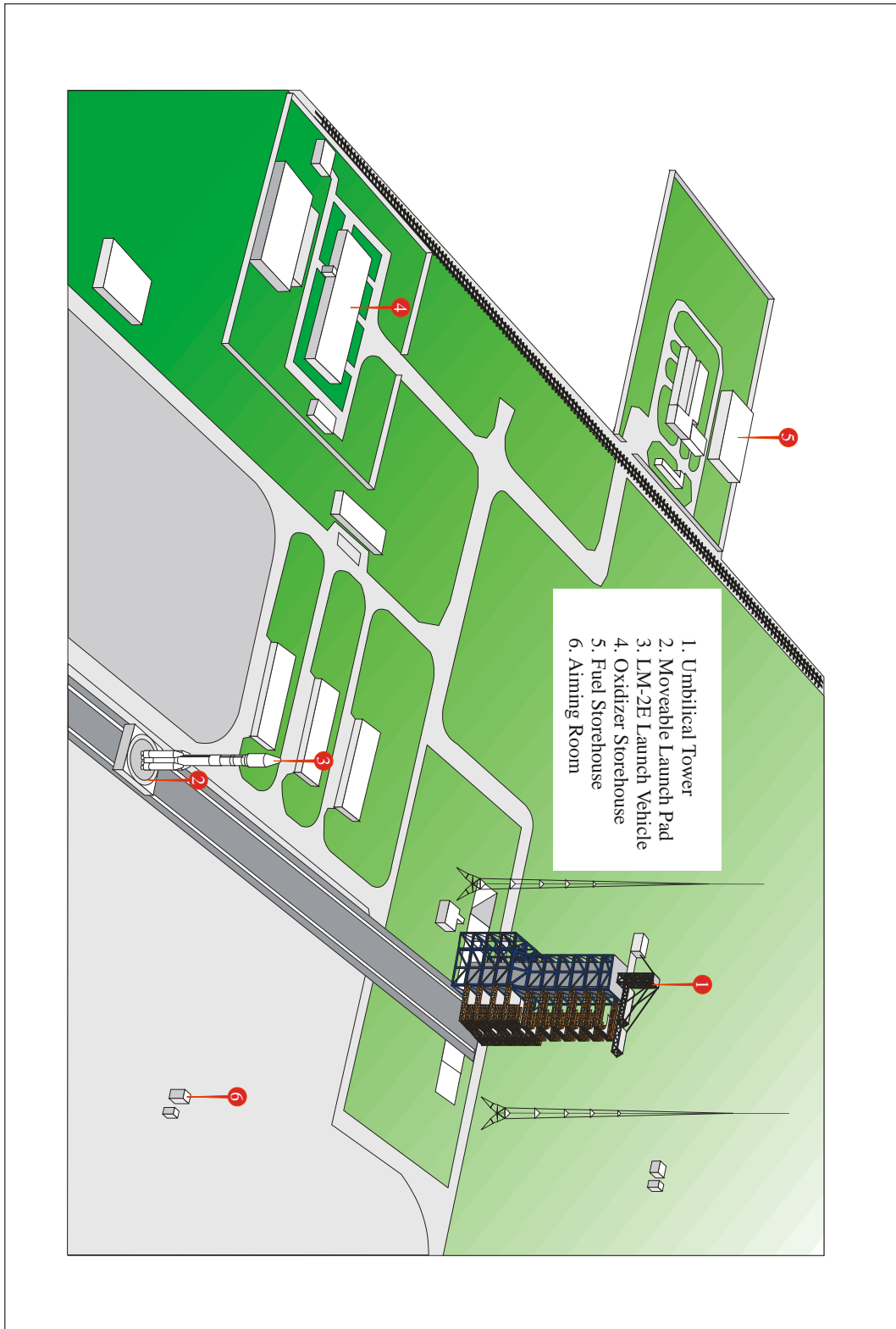
Longitude: 100°17.4'E,

Latitude: 40°57.4'N

Elevation: 1073m

The launch site is 1.5 km away from the South Technical Center. Facilities in the launch area are umbilical tower, moveable launch pad, underground equipment room, fuel storehouse, oxidizer storehouse, fuelling system, power-supply system, gas-supply system, communication system, etc. Refer to **Figure B7-7**.

Figure B7-7 South Launch Center



7-30

B7.2.2 Umbilical Tower

The umbilical tower is an 11-floor fixed steel structure with height of 75m. The tower is to support electrical connections, gas pipelines, liquid pipelines, as well as their connectors for both SC and LV. The umbilical tower has a rotating-platform system, whose load-bearing capability is 15kN for each single platform. There is also a rotary crane on the top of the umbilical tower. See **Figure B7-8**.

The umbilical tower provides an air-conditioned SC operation area, in which the temperature, humidity and air cleanliness can be guaranteed. The area is well grounded, the grounding resistance is less than 1 Ω .

The umbilical tower is equipped with hydrant system and powder fire extinguishers.

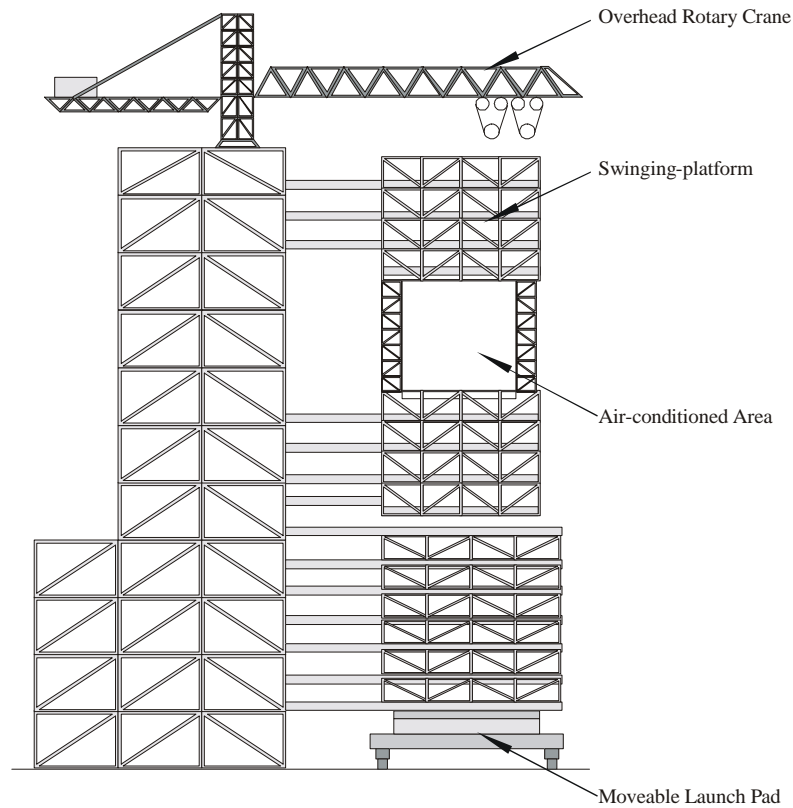
A common elevator and explosion-proof elevator are available in the umbilical tower, of which carrying speeds are 1.75m/s and 1.0m/s respectively. The maximum load-bearing capability of the elevators is 1000kg.

The umbilical tower has a sealed cable tunnel, in which the umbilical cables connect the LV, SC and underground equipment room. The resistance of each cable is less than 1 Ω .

B7.2.3 Moveable Launch Pad

The moveable launch pad is mainly used for performing LV vertical integration and checkouts in BLS, transferring the LV from BLS to the launch area vertically, and locating and locking itself beside the umbilical tower. The moveable launch pad can also vertically adjust the position of the launch vehicle to make the preliminary aiming. The ignition flame can be exhausted through the moveable launch pad.

The moveable launch pad is 24.4m long, 21.7m wide, 8.34m high, and weighs 750t. It can continuously change its moving speed in 0~28m/min., and the moving acceleration is less than 0.2m/s. It takes the moveable launch pad, carrying the LV, about 40 minutes to move from BLS to umbilical tower (1.5km).

**Figure B7-8 Umbilical Tower**

B7.2.4 Underground Equipment Room

The underground equipment room is located under the umbilical tower, whose construction area is 800m^2 . It mainly includes power-supply room, equipment rooms, power distribution room, optic cable terminal room, room of air-conditioning unit, etc. The underground equipment room is air-conditioned, the internal temperature is $20\pm 5^\circ\text{C}$ and relative humidity is not greater than 65%. The equipment room is well grounded with resistance less than 1Ω . A 3-ton crane is equipped inside the equipment room.

B7.2.5 Mission Command & Control Center (MCCC)

MCCC includes command and control hall, computer room, internal communication room and offices, etc. **Figure B7-9** shows the layout of MCCC.

MCCC is of following main functions:

- ✧ 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 SC Control Center (XSCC);
- ✧ Provide display information to the SC working-team console;
- ✧ Perform post-mission data processing.

The Configuration of MCCC is as follows:

- ✧ 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 telecommand system.
- ✧ Communication system.
- ✧ Timing and data transmission system.
- ✧ Film developing and printing equipment.

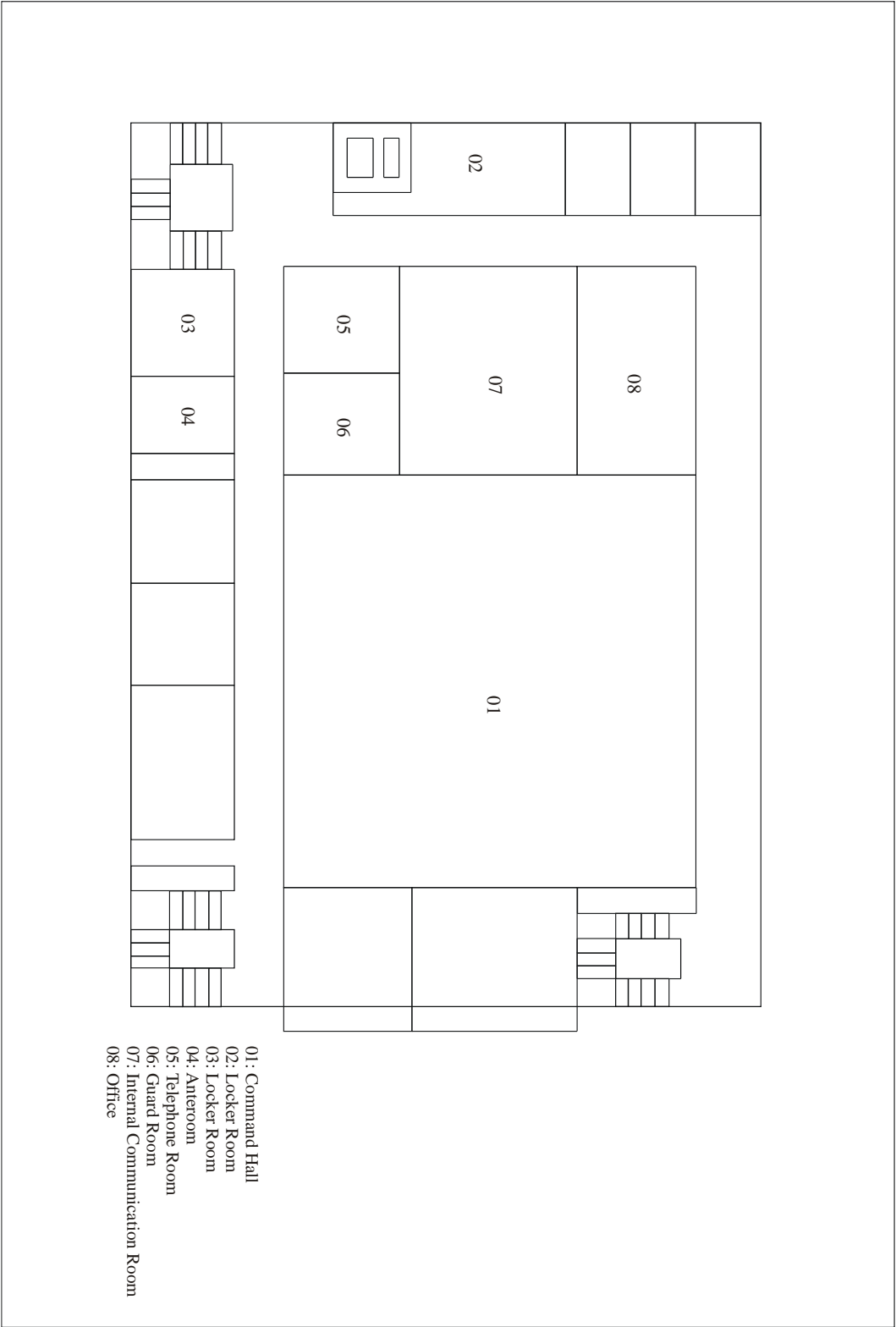


Figure B7-9 MCCC Layout

B7.3 Tracking, Telemetry and Control System (TT&C)

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

The TT&C system of JSLC mainly consists of:

- ✧ MCCC;
- ✧ Radar Stations;
- ✧ Optical Tracking Stations;
- ✧ Mobile Tracking Stations.

The TT&C system of XSCC mainly includes:

- ✧ Weinan Tracking Station;
- ✧ Nanning Tracking Station;
- ✧ Mobile Tracking Stations.

Main Functions of TT&C are described as follows:

- ✧ 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 SC;
- ✧ Making flight range safety decision;
- ✧ Computing the SC/LV separation status and injection parameters.

CHAPTER 8

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.

LM-2C uses JSLC as its main launch site. The launch site operations in JSLC are focused in this Chapter. The operations in XSLC are similar.

8.1 LV Checkouts and Processing

Two-stage LM-2C or LM-2C/CTS launch vehicle is transported from CALT facility (Beijing, China) to JSLC (Gansu Province, China) and undergoes various checkouts and processing in the North Technical Center and the South Launch Center. The typical LV working flow in the launch site is shown in **Table 8-1**.

Table 8-1 LV Working Flow in Launch Site

	No.	Item	Working Period	Accumulative Period
T E C H .	1	To Unload LV from the Train and Transfer LV to LV Test Building (BL).	1 day	1 day
	2	Unit Tests of Electrical System	7 days	8 days
	3	LV Status Recovery before Transfer	3 days	11 days
L A U N C H C E N T E R	4	To Transfer LV to the Launch Center and Erect LV on the Launch Tower	1 days	12 days
	5	Tests to Separate Subsystems	2 days	14 days
	6	Matching Test Among Subsystems	2 days	16 days
	7	overall checkout on the first and second stages	2 days	18 days
	8	To Mate SC/Fairing Stack with LV	1 days	19 days
	9	CTS subsystem tests and matching tests	1 days	20 days
	10	The First Overall Checkout	1 day	21 days
	11	The Second Overall Checkout (Launch Rehearsal, SC Involved)	1 day	22 days
	12	The Third Overall Checkout	1 day	23 days
	13	Reviews on Checkout Results	1 days	24 days
	14	Functional Check before Fueling, Gas Replacement of Tanks	1 days	25 days
	15	N ₂ O ₄ /UDMH Fueling and Launch	2 day	27 days
	Total		27 days	27 days

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

8.2 Combined Operation Procedures

Take LM-2C/CTS launching multiple SCs as an example.

8.2.1 SC/LV Integration and Fairing Encapsulation in North Technical Center

In BS2 & BS3, SC team carries out all the SC operations. LV side is responsible for mating SCs with CTS and installing SC/LV separation devices. The following describes the typical working procedure:

1. In BS3, CALT to clean up the fairing halves and install wires and sensors on the inner surface of the fairing, and glue the thermal blanket (cork panel) on the outer surface of the fairing; SC side to prepare and perform SC testing;
2. In the assembly area of BS3, CALT to install the solid rocket motor on the CTS; CALT to move the CTS to the fueling area, to fuel RCS with hydrazine and perform gas-filling for the gas bottles; CALT to move the CTS back to the assembly area;
3. CALT to bolt the CTS with the supporting table through the LV Adapter;
4. SC side to hoist the fueled & weighed SCs overhead the CTS; CALT to mate SCs with CTS one by one;
5. CALT to encapsulate the fairing;
6. CALT to install explosive bolts on the fairing, and finally form a SC/Fairing stack;

Refer to **Figure 8-1**.

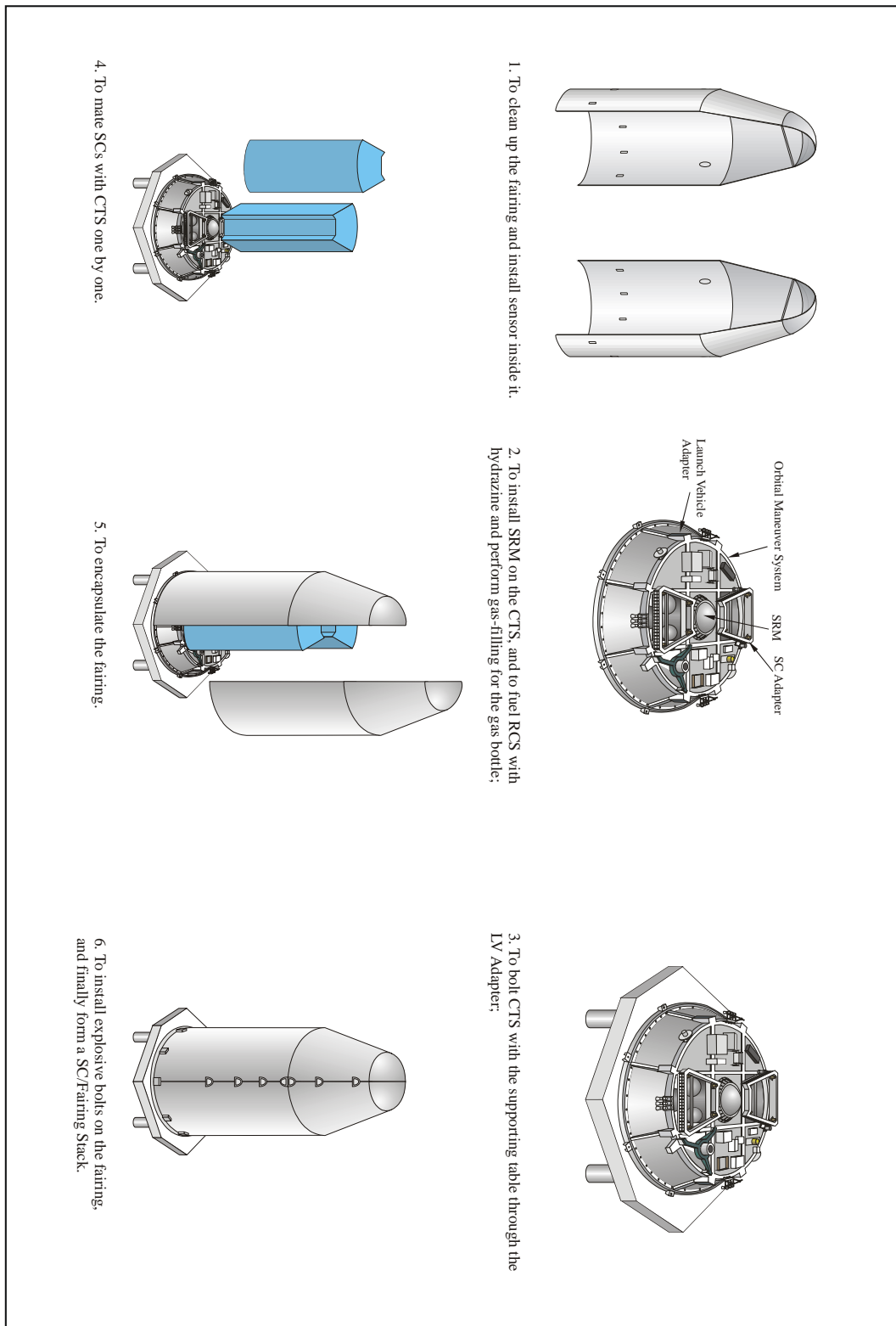


Figure 8-1 SC/LV Integration and Fairing Encapsulation

8.2.2 SC Transfer and Fairing/Stage-2 Integration

CLTC is responsible for transferring the encapsulated fairing from BS3 to the North Launch Center. The following working procedures are performed:

7. CLTC to load the SC/Fairing stack onto the transfer trailer; CLTC to connect the transfer trailer with the tractor, and make the air-conditioning pipe connected to the encapsulated fairing, then get the temperature and humidity monitoring system ready; CLTC to transfer the SC/Fairing stack to the Launch Center;
8. CLTC to move the encapsulated fairing stack under the launch tower, and install hoisting sling;
9. CLTC to lift up the encapsulated fairing stack onto the stage-2 of LM-2C, which is already erected;
10. CALT to mate the encapsulated fairing with stage-2 of LM-2C;

Refer to **Figure 8-2**.

11. CALT to set up an air-conditioned closure for the SC/Fairing stack, and connect the air-conditioning pipes to the encapsulated fairing air-conditioned, then record the environment parameters inside the fairing;
12. CALT to connect the umbilical cable, SC side to monitor SC status and charge SC battery;
13. CALT to perform subsystem tests and matching test for CTS, SC side to perform SC testing;
14. CALT and SC side to conduct launch rehearsal (SC involved). This is the end of combined operations.

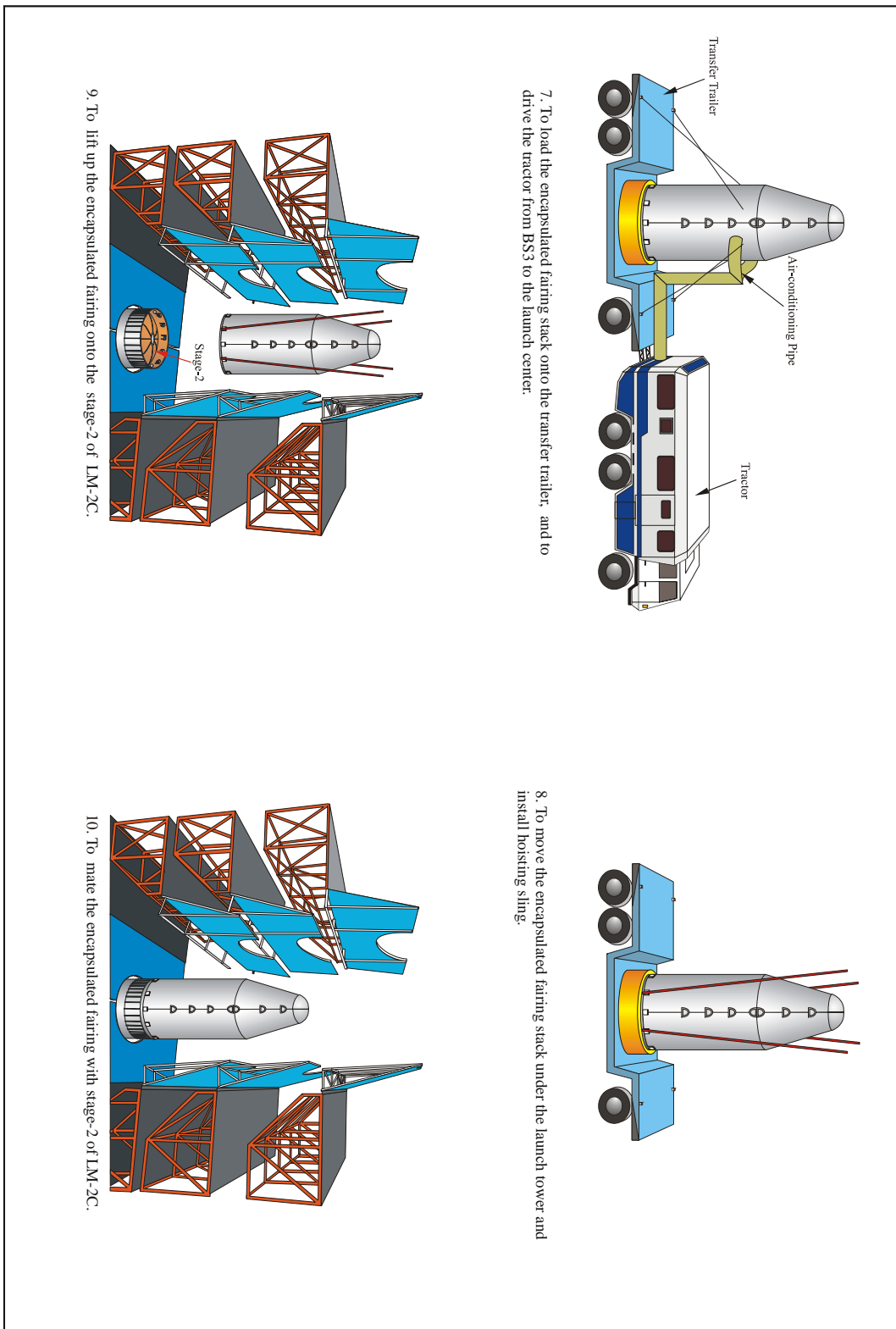


Figure 8-2 SC Transfer and Fairing/stage-2 integration

8.3 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 SCs.

8.4 Launch Limitation

8.4.1 Weather Limitation

- Ambient temperature: $-10^{\circ}\text{C}\sim+40^{\circ}\text{C}$;
- Relative humidity: $\leq 98\%$ (corresponding to $20\pm 5^{\circ}\text{C}$)
- The average ground wind velocity in the launch area is lower than 10m/s
- The winds aloft limitation: $q\times\alpha\leq 4000\text{N/m}^2\cdot\text{rad}$ ($q\times\alpha$ 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 20 km.
- 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 SCs' 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	Launch Status Preparation;
2	-5 hours	LV Power-on, Functional Checkouts on Each Sub-system
3	-4 hours	Connecting Plugs for Battery and Pyrotechnics
4	-3 hours	LV Status Checkouts, Sealing;

5	-2 hours	GSE Status Checkouts;
6	-90 minutes	Final Launch Status Preparation;
7	-60 minutes	SC side send "GO" signal; Battery air-conditioning stops; LV tanks are pressurized; Aiming;
8	-40 minutes	Flight Software Loading; One of Air-conditioning Pipes Drop-off;
9	-30 minutes	Moveable Platforms on the Umbilical Tower Withdrawal;
10	-15 minutes	Umbilical Disconnection;
11	-7 minutes	The Final Air-conditioning Pipe Drop-off;
12	-2 minutes	LV Power Switch Over, In-Flight-Disconnectors (IFD) Drop-off;
13	-1 minute	Swinging Arms Withdrawal;
14	-40 seconds	TT&C Systems Starting;
15	-5 seconds	Camera On
16	0	Ignition

8.6 Post-launch Activities

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

The launch evaluation 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 loss in case of a flight anomaly following lift-off in JSLC.

9.1 Safety Responsibility and Requirements

The Launch Center 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 be completed and a ground damage is possible.

9.2 Safety Control Plan and Procedure

9.2.1 Safety Control Plan

CALT should provide the detailed safety flight scenario to the safety commander for approval. The following contents related to the flight safety should be included in the flight scenario.

- (1) The difference with the previous flight scenario.
- (2) The characteristics of the launch vehicle.
- (3) The flight trajectory.
- (4) The launch vehicle maximum ability to change flight direction.
- (5) The launch vehicle transient drop-down area along with the launch trajectory.
- (6) The allowed maximum variation limits for LV flight direction.
- (7) The impact area and damage for the boosters and stages.
- (8) The primary failure modes and their effects of the launch vehicle.

9.2.2 Safety Control Procedure

Even though a flight anomaly occurs, the launch vehicle will not be destroyed by the ground command during the first 20 seconds following lift-off. The launch vehicle will go 400 meters from the launch pad during the 20 seconds to protect the launch facilities.

The destruction to the launch vehicle can be conducted from 20 seconds of flight to the second stage shut-down and performed by the Command Destruction System (CDS) and Automatic Destruction System (ADS) together.

(1) Command Destruction System (CDS)

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 (ADS)

The launch vehicle system makes the decision according to flight attitude. If the attitude angle of Launch Vehicle exceeds safety limits for about 2 seconds, 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**.

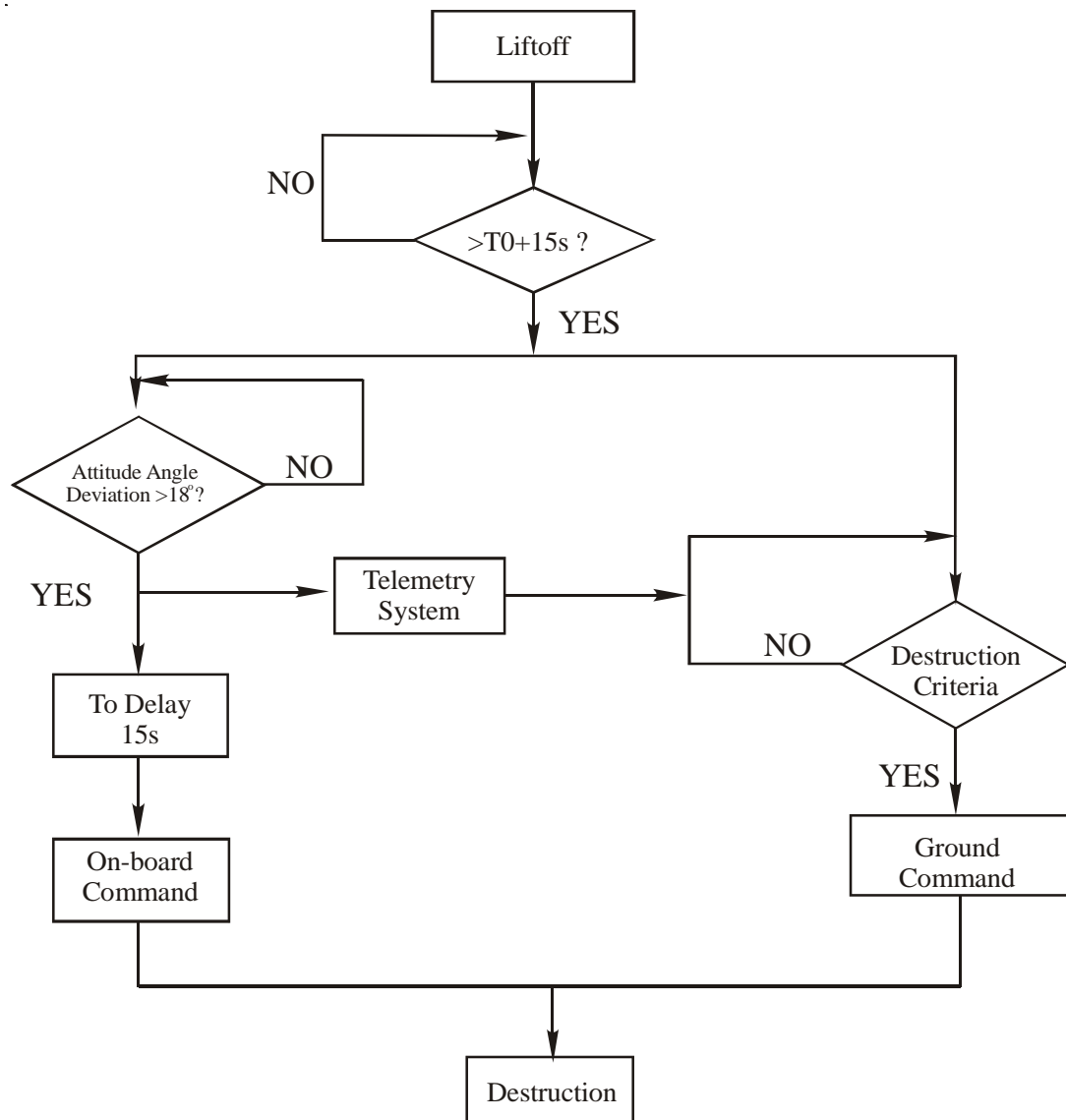


Figure 9-1 Flowchart of Control System

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** for range safety in launch site.

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 JSLC, reviewed by CALT and CLTC and approved by the safety commander.

9.4.2 Common Criteria

- 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 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 North Technical Center during 20~30 seconds, i.e. $Z \geq 400\text{m}$ or $X \leq -400\text{m}$, the launch vehicle will be destroyed immediately to protect the North Technical Center. (Where Z is the distance between launch vehicle and the normal launch plane, X is the horizontal distance between the launch vehicle and the launch pad.)

9.5 Emergency Measures

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

JSLC 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 North 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.

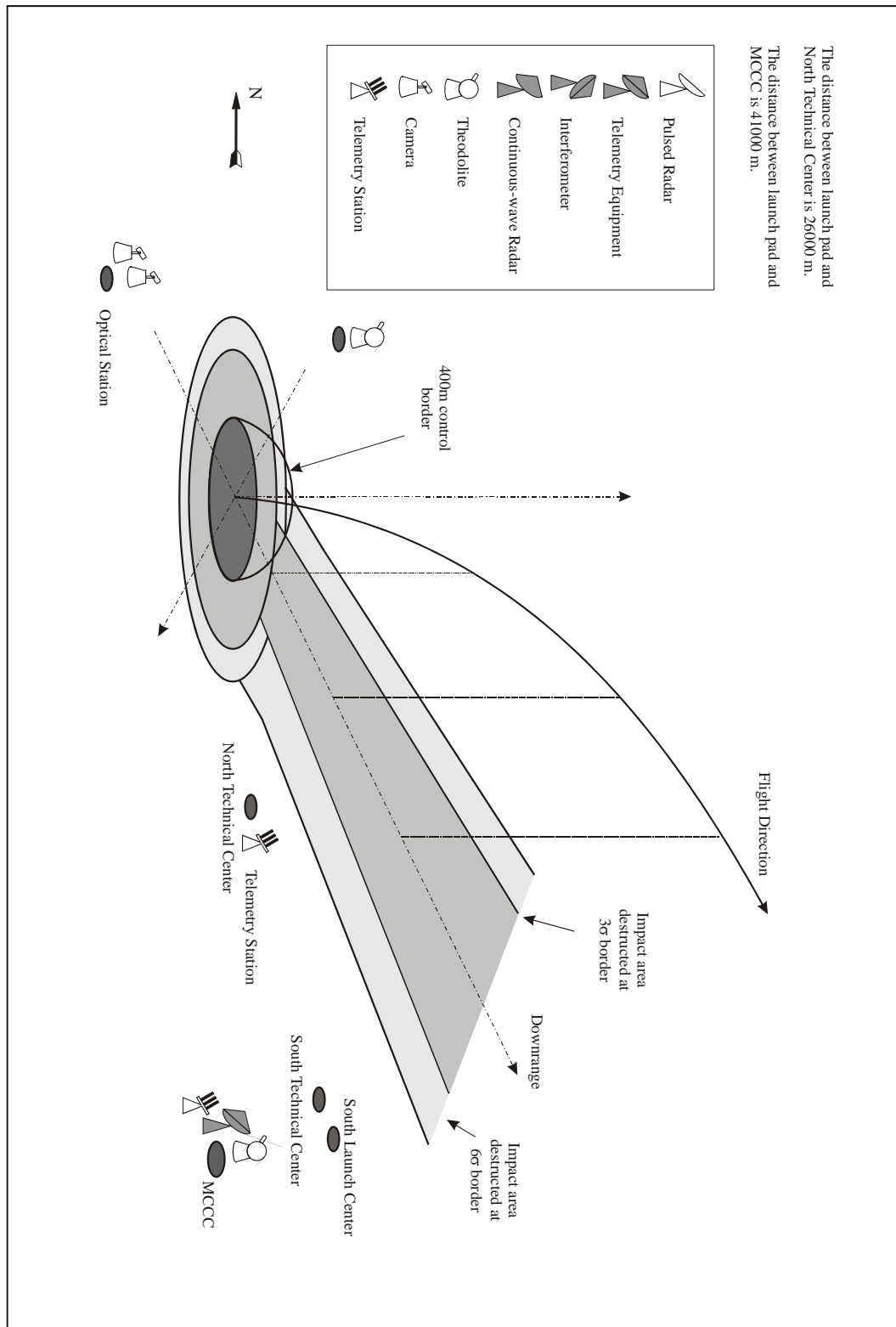


Figure 9-2 Ground Safety Control System in North Launch Center of JSLC

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 18 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 <ul style="list-style-type: none"> ✧ <i>Launch March 2C User's Manual</i> ✧ <i>Launch Site User's Manual</i> ✧ <i>Long March Safety Requirement Documents</i> ✧ <i>Format of Spacecraft Dynamic Model and Thermal Model</i> 	LV Side	1 month after EDC
2	LM-2C Application The customer will prepare the application covering following information: <ul style="list-style-type: none"> ✧ <i>General Mission Requirements</i> ✧ <i>Launch Safety and Security Requirements</i> ✧ <i>Special Requirement to Launch Vehicle and Launch Site</i> The application is used for very beginning of the program. Some technical data could be defined	Customer	2 months after EDC

No.	Documents	Provider	Due Date
	during implementation of the contract.		
3	Spacecraft Dynamic Math Model (Preliminary and Final) The customer shall provide hard copies and floppy diskettes according to <i>Format of Spacecraft Dynamic Model and Thermal Model</i> . 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 <i>Format of Spacecraft Dynamic Model and Thermal Model</i> . 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) <ul style="list-style-type: none"> ✧ <i>Launch Orbit, mass properties, launch constraints and separation conditions.</i> ✧ <i>Detailed spacecraft mechanical interfaces, electrical interfaces and RF characteristics</i> 	Customer	3 months after EDC.

No.	Documents	Provider	Due Date
	<p>✧ <i>Combined operation requirement and constrains.</i></p> <p>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 8 months before launch.</p>		
8	<p>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.</p> <p><u>Trajectory Analysis</u> To optimize the launch mission by determining launch sequence, flight trajectory and performance margin.</p> <p><u>Flight Mechanics Analyses</u> To determine the separation energy and post-separation kinematics conditions (including separation analysis and collision avoidance analysis).</p> <p><u>Interface Compatibility Analyses</u> To review the SC/LV compatibility (mechanical interface, electrical interface and RF link/working plan).</p>	CALT	3 month after No.7
9	<p>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.</p>	Customer	15 days after the test
10	<p>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 <i>Long March Safety Requirement Documents</i>. Both sides will jointly review this document.</p>	Customer	2 months after EDC to 5 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 <i>Combined Operation Procedure</i> based on <i>Spacecraft Operation Plan</i> . 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 <i>SC/LV Combined Operation Procedure</i> .	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 launch site or sent via telex or facsimile to a destination selected by the customer. Both sides will sign on this document.	LV Side	30 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: <ul style="list-style-type: none"> ✧ <i>Program management, interfaces and schedule</i> ✧ <i>Spacecraft program, launch requirements and interface requirements</i> ✧ <i>Launch vehicle performance and existing interfaces</i> ✧ <i>Outlines of ICD for this program</i> ✧ <i>Launch site operations and safety</i>

No.	Meetings
2	<p>Interface Control Document Review (ICDR)</p> <p>The purpose of the ICD Review is to ensure that all the interfaces meet the spacecraft's requirements.</p> <p>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.</p>
3	<p>Mission Analyses Reviews (MAR)</p> <p>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.</p>
4	<p>Spacecraft Safety Reviews</p> <p>Generally, there are three safety reviews after the three submissions of <i>Safety Control Documents</i>. The submittals and questions/answers will be reviewed in the meeting.</p>
5	<p>Launch Site Facility Acceptance Review</p> <p>This review is held at the launch site 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.</p>
6	<p>Combined Operation Procedure Review</p> <p>This review will be held at the launch site following the submission of <i>Combined Operation Procedures</i>, drafted by the customer. The <i>Combined Operation Procedure</i> will be finalized by incorporating the comments put forward in the review.</p>
7	<p>Launch Vehicle Pre-shipment Review (PSR)</p> <p>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 the launch site 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</p>
8	<p>Flight Readiness Review (FRR)</p> <p>This review is held at the launch site 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.</p>

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.

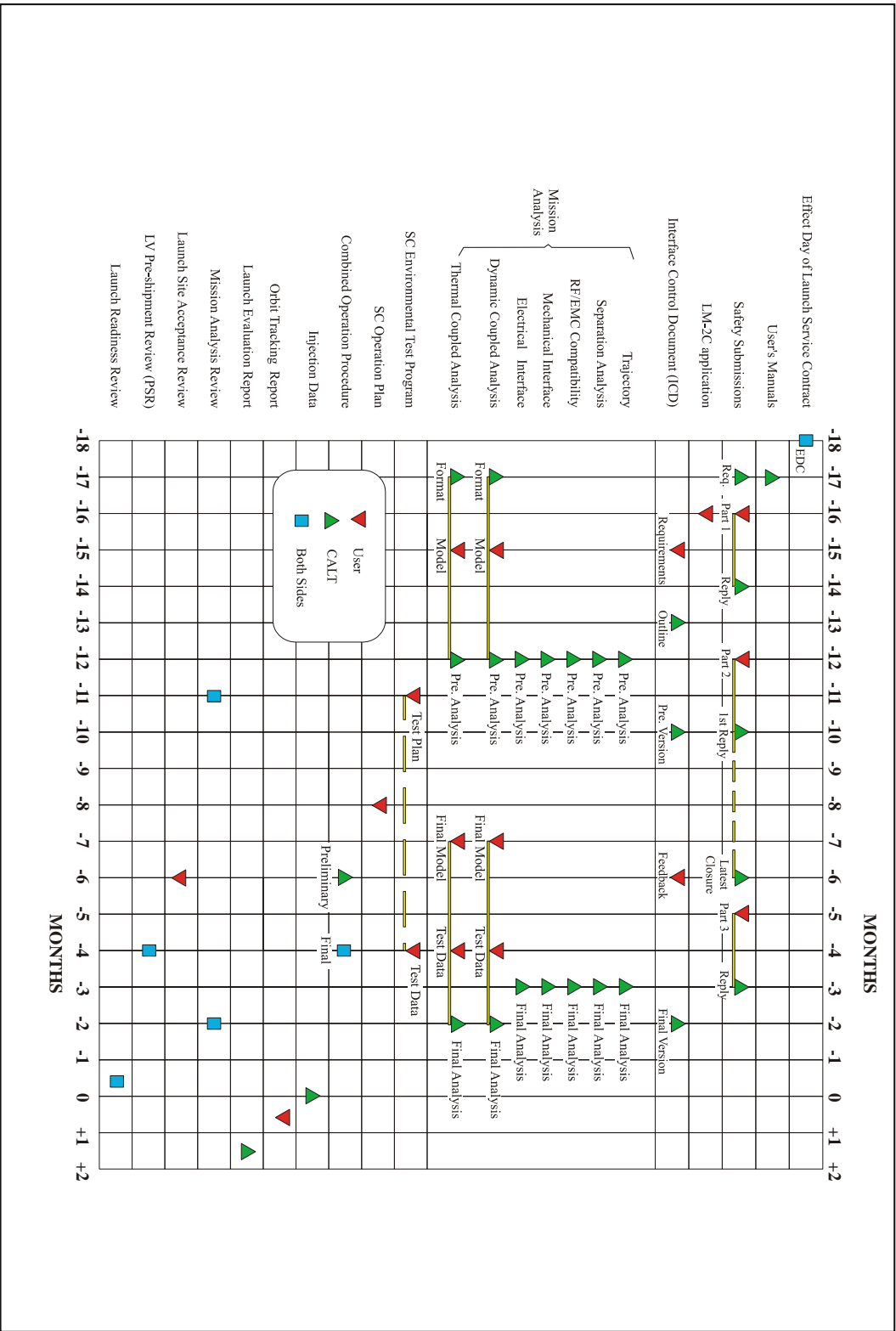


Figure 10-1 Time-schedule of Documentation and Reviews