CHAPTER 4

PAYLOAD FAIRING

4.1 Fairing Introduction

4.1.1 Summary

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

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

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

The configuration of LM-3A fairing is shown in **Figure 4-1**.

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

During launch operation, LM-3A fairing is encapsulated on the launch pad. Refer to **Chapter 8**.

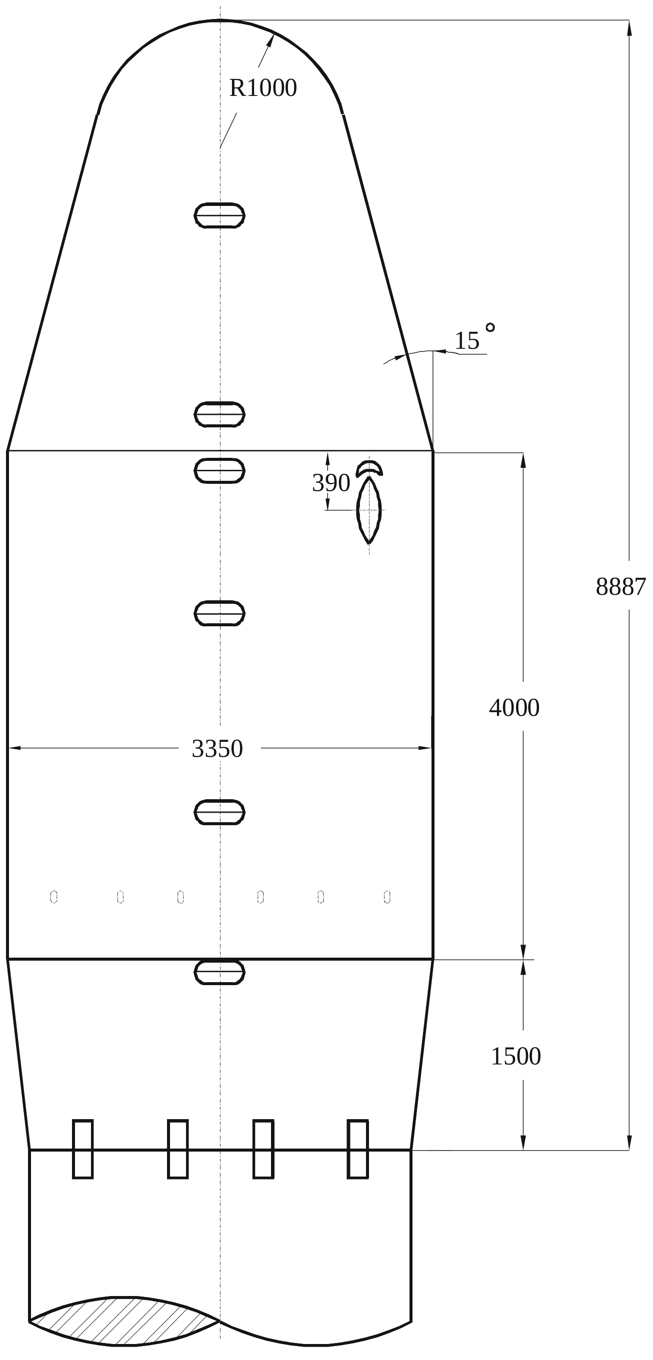

Figure 4-1 Fairing Configuration

4.1.2 How to Use the Fairing Static Envelope

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

It is allowed that a few extrusions of SC can exceed the maximum static envelope (Φ3000) in the fairing cylindrical section. However, the extrusion issue shall be resolved by technical coordination between SC side and CALT.

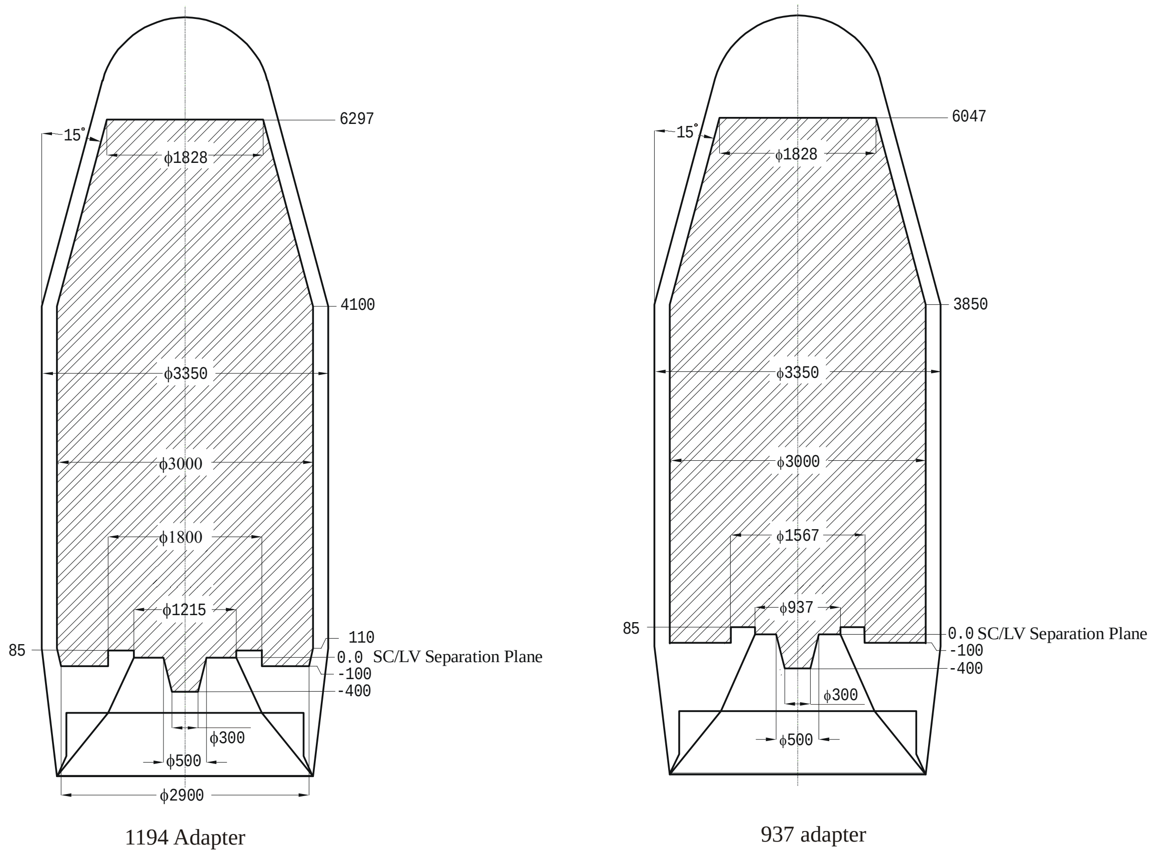

Figure 4-2 Fairing Static Envelope

4.2 Fairing Structure

The structure of the fairing consists of dome, forward cone section, and cylindrical section and reverse cone section. Refer to **Figure 4-3**.

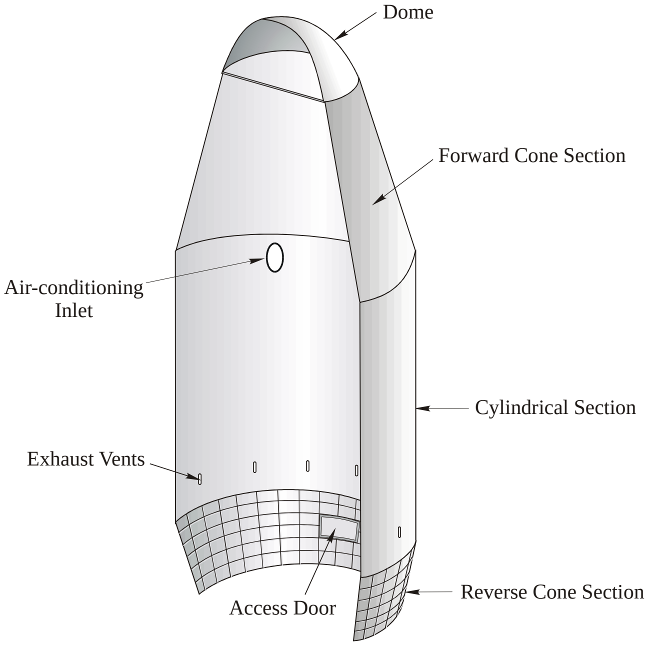

Figure 4-3 Fairing Structure

4.2.1 Dome

The dome is a semi-sphere body with radius of 1000mm, height of 740mm and base ring diameter of ϕ1930mm. It consists of dome shell, base ring, encapsulation ring and stiffeners. Refer to **Figure 4-4**.

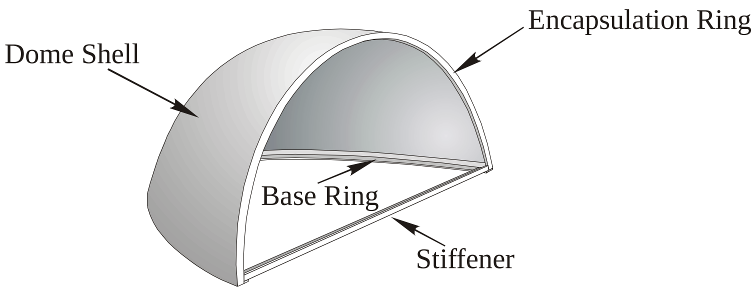

Figure 4-4 Structure of the Fairing Dome

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

4.2.2 Forward Cone Section

The forward cone section is a 15°-cone with height of 2647mm. The diameter of the top ring is 1930mm, and the diameter of the bottom ring is 3350mm. The forward cone section is made of aluminum honeycomb sandwich.

4.2.3. Cylindrical Section

The structure of the cylindrical section is identical to that of forward cone section, i.e. aluminum honeycomb sandwich.

4.2.4 Reverse Cone Section

The reverse cone section is a ring-stiffened semi-monocoque structure. It is composed of top ring, intermediate ring, bottom ring, inner longitudinal stiffeners and chemical-milled skin. several access doors are available on this section.

4.3 Heating-proof Function of the Fairing

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

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

4.4 Fairing Jettisoning Mechanism

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

4.4.1 Lateral Unlocking Mechanism

The base ring of the fairing is connected with forward short skirt of the third stage cryogenic tank by 8 non-contamination explosive bolts, refer to **Figure 4-4a**. The distribution of the explosive bolts is shown in **Figure 4-4b**.

4.4.2 Longitudinal Unlocking Mechanism

The longitudinal separation plane of the fairing is II-IV quadrant (XOZ). The two halves of the fairing are connected by 12 non-contamination explosive bolts, see **Figure 4-4a**.

4.4.3 Fairing Separation Mechanism

The fairing separation mechanism is composed of hinges and springs, see **Figure 4-4c**. Each half of the fairing is supported by two hinges, which locate at quadrant I and III. There are 4 separation springs mounted on each half of the fairing, the maximum acting force of each spring is 37.8kN. After fairing unlocking, each half of the fairing turns around the hinge. When the roll-over rate of the fairing half is larger than 18°/s, the fairing is jettisoned. The kinematical process is shown in **Figure 4-5**.

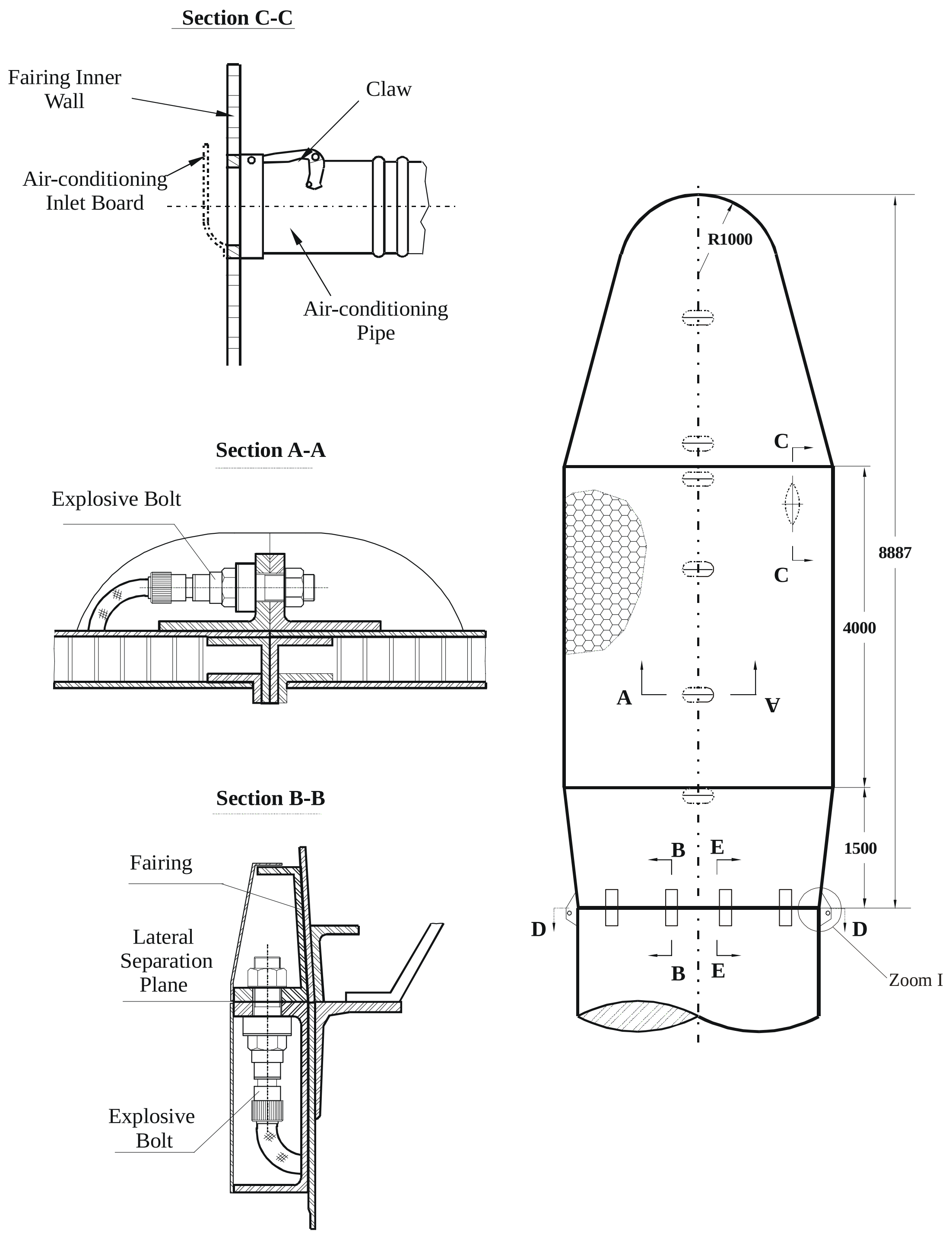

Figure 4-4a Fairing Unlocking Mechanism

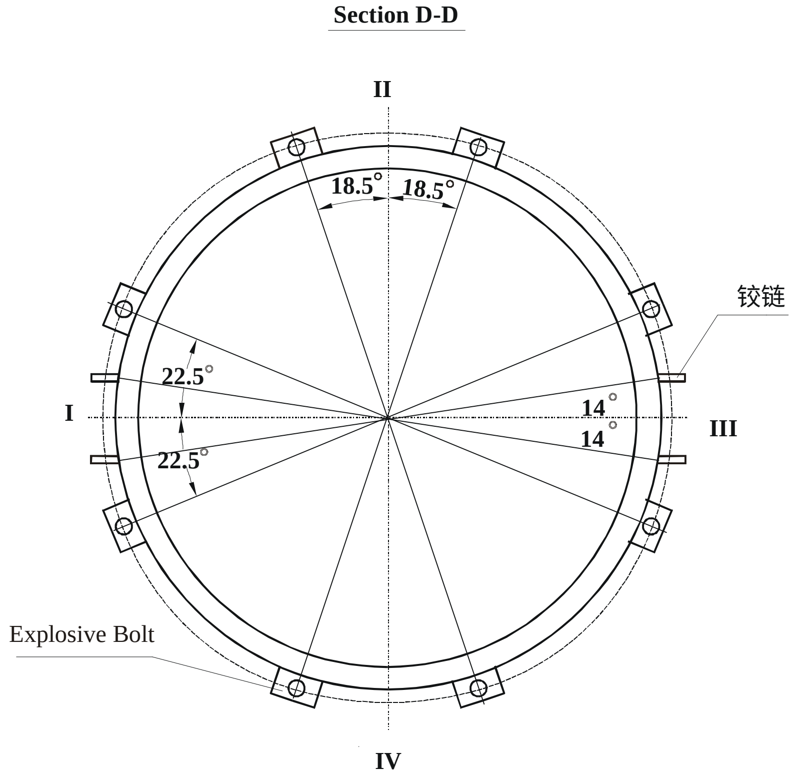

Figure 4-4b Distribution of the LV Lateral Unlocking Explosive Bolts

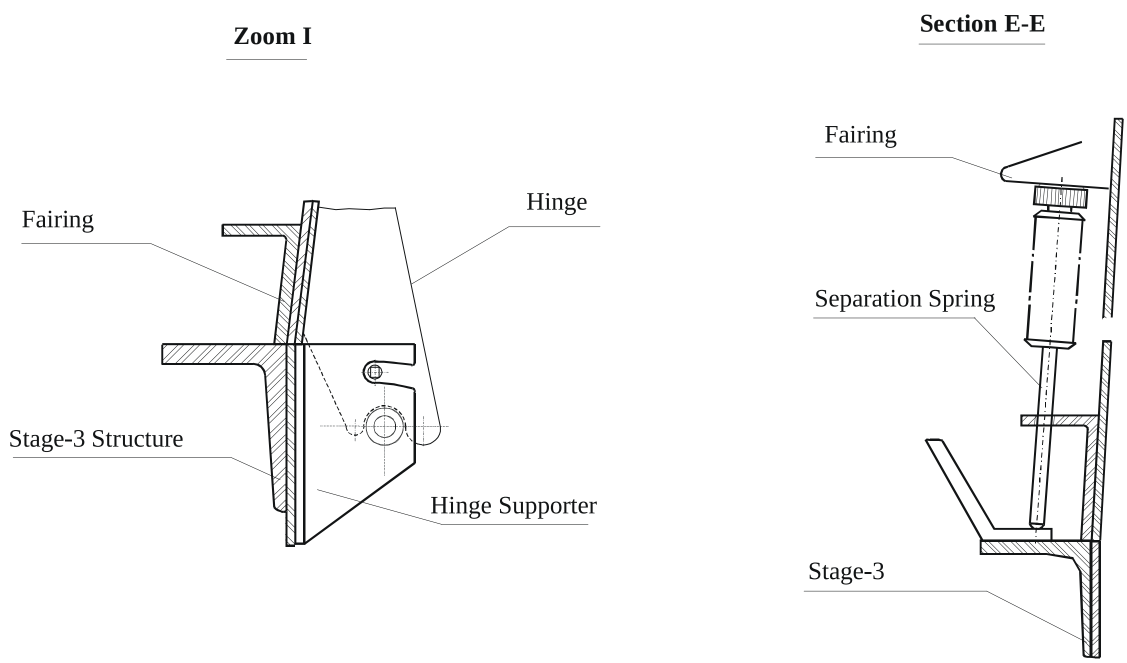

Figure 4-4c Fairing Separation Mechanism

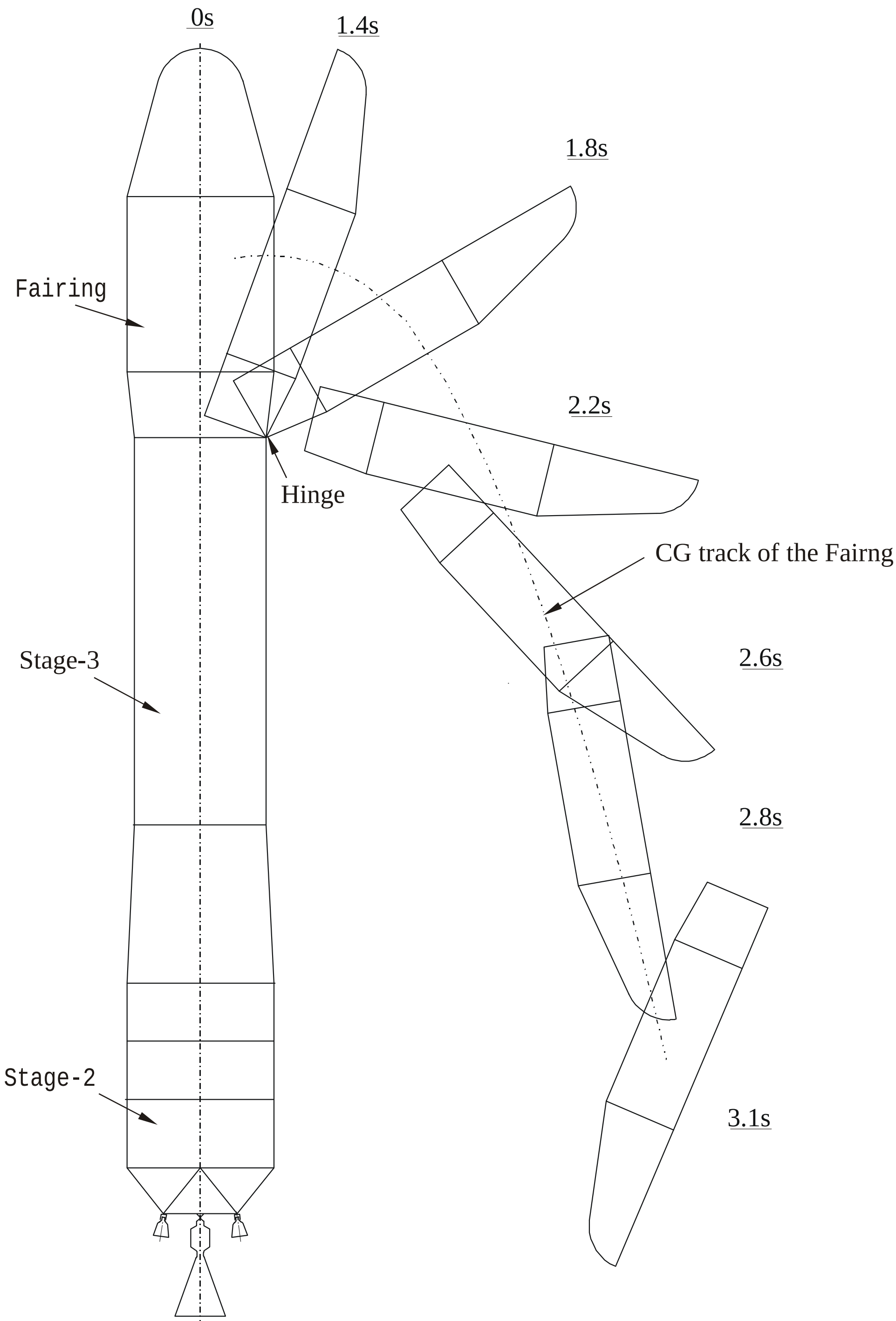

Figure 4-5 Fairing Separation Dynamic Process

4.5 RF Windows and Access Doors

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

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

Access doors can be provided in the cylindrical section to permit limited access to the spacecraft after the fairing encapsulation, according to user's needs. Some area on the fairing can not be selected as the locations of RF windows and access doors, see **Figure 4-6**. User can propose the requirements on access doors and RF windows to CALT. However, such requirements should be finalized 8 months prior to launch.

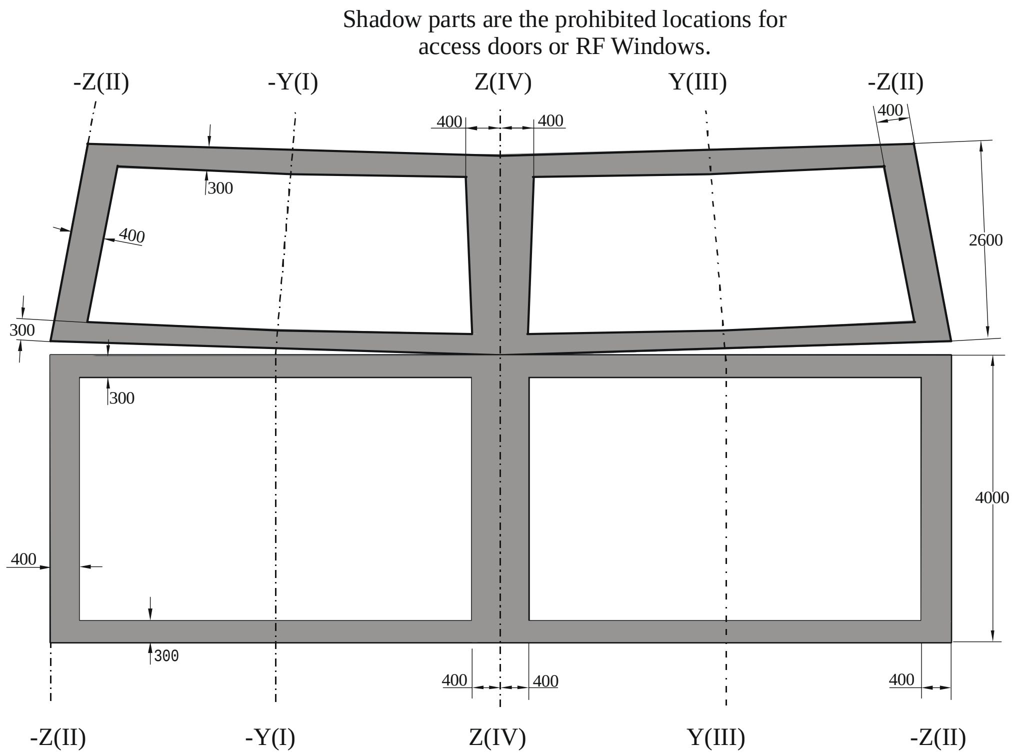

Figure 4-6 Prohibited Locations for Access Doors and RF Windows