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-2E 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-2E Fairing Configuration. The fairing encapsulation procedures are introduced in **Chapter 8**.

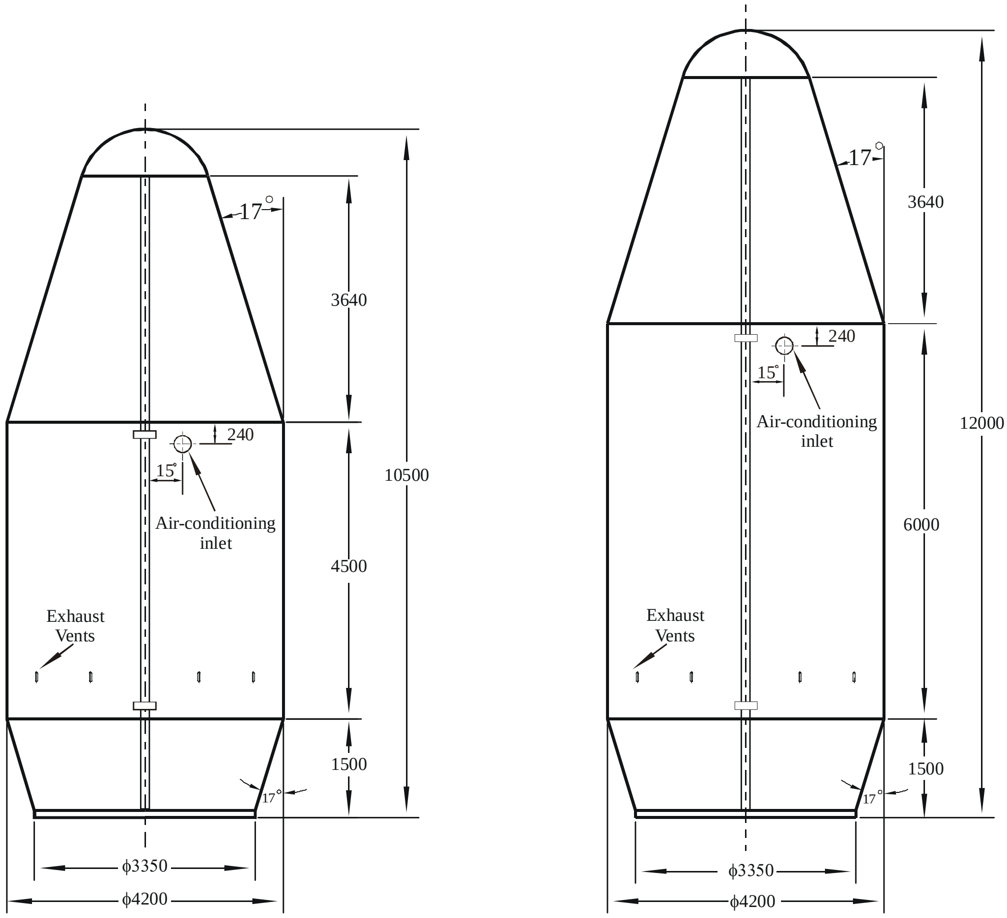
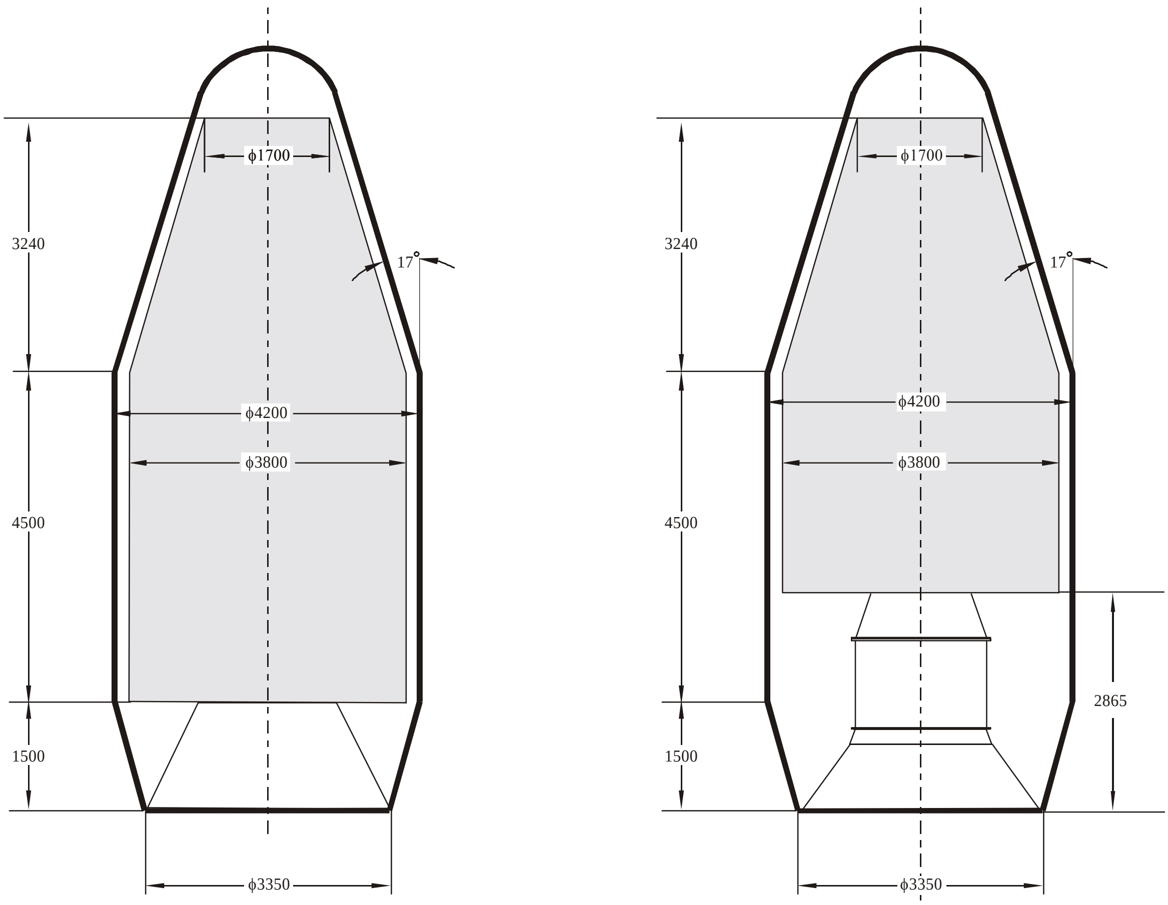


Figure 4-1 Fairing Configurations

4.1.2 Fairing Static Envelope

The outer diameter of the fairing is 4200mm, and its height is 10500mm. The length of cylindrical section is 4500mm. If necessary, the cylindrical section can be extended to 6000mm according to User's requirements. The maximum diameter of the static envelope is Φ3800mm. The static envelopes are shown in **Figure 4-2** for different missions.



For LEO Missions

For GTO Mission

Figure 4-2 Fairing Static Envelope

4.1.3 How to Use the Fairing Static Envelope

The static envelope of the fairing is the limitation to the maximum dimensions of Payload configuration. The static envelope is determined considering the 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 Payload can exceed the maximum static envelope (Φ3800) in the fairing cylindrical section. However, the extrusion issue shall be resolved by technical coordination between the user and CALT.

4.2 Fairing Structure

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

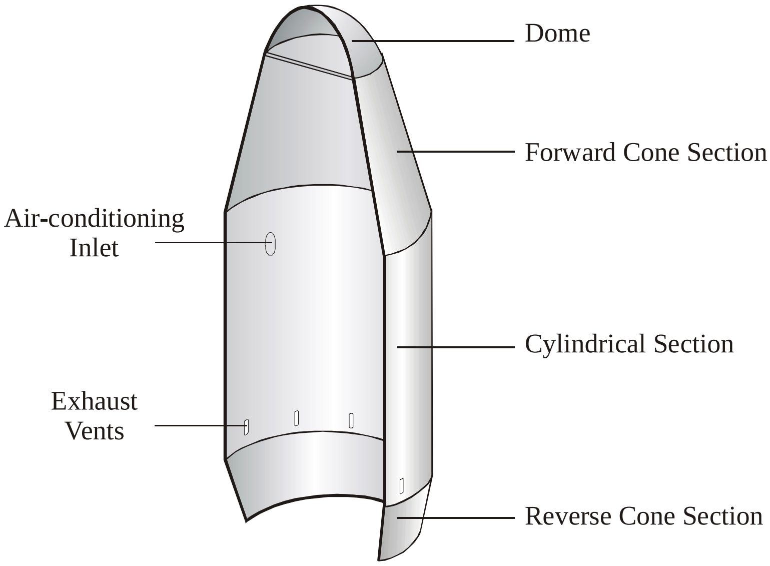


Figure 4-3 Fairing Structure

4.2.1 Dome

The dome is a semi-sphere body with radius of 1000mm, height of 812mm and base ring diameter of ϕ1997mm. It consists of dome shell, base ring, encapsulation ring and stiffeners. Refer to **Figure 4-4**.

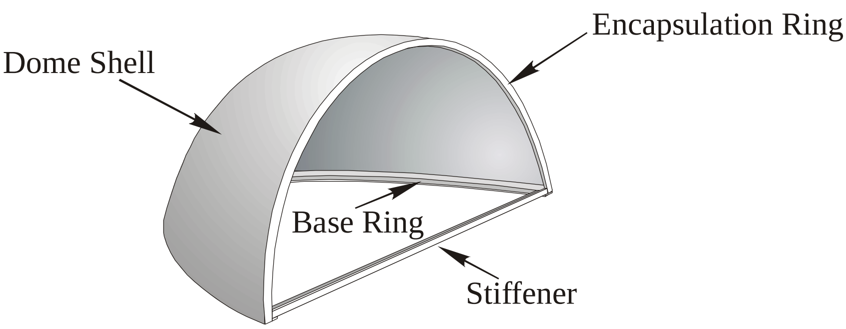


Figure 4-4 Structure of the Fairing Dome

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 17°-cone with height of 3636mm. It is made of fiberglass honeycomb sandwich structure with thickness of 40mm.

4.2.3 Cylindrical Section

The cylindrical section is composed of two cylinders with height of 1500mm and 3000mm respectively. The section is made of aluminum honeycomb sandwich with thickness of 40mm. There are two air-conditioning inlets opened on the upper part of the cylindrical section, and 12 exhaust vents with total area of $230cm^2$ on the lower part. Refer to **Figure 4-1**.

4.2.4 Reverse Cone Section

The reverse cone section is 17°-cone with top ring diameter of Φ4200mm and bottom ring diameter of Φ3350mm. It is an aluminum honeycomb sandwich structure with thickness of 40mm.

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 lower than 80°C.

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 with thickness from 1.0mm to 1.2mm.

4.4 Fairing Jettisoning Mechanism

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

4.4.1 Lateral Unlocking Mechanism

The base ring of the fairing is connected with the LV second stage by 12 non-contamination explosive bolts. The reliability of the explosive bolt is 0.9999, and its tensile strength is 176.6kN. See **Figure 4-5a&b**.

4.4.2 Longitudinal Unlocking Mechanism

The longitudinal separation plane of the fairing is I-III quadrant. The longitudinal unlocking mechanism consists of a non-contamination explosive cord, two initiators, a steel hose with many small holes (attenuator), a gasbag hose, rivets, two sets of jointers and four explosive bolts, etc. see **Figure 4-5a**.

The explosive cord goes along the split line of the fairing. Two initiators are attached at the each end of the explosive cord. Four explosive bolts are mounted on the fairing shoulders and bottom of the fairing cylindrical section. The four explosive bolts, together with 12 explosive bolt on the lateral separation plane, unfasten firstly. Then, the initiators ignite the explosive cord, and high-pressure gas is generated instantly, which rushes out from the small holes on the steel hose and makes the gasbag hose expand, and the rivets are cut off. In that sequence, the two sets of the jointers separate with the two fairing halves, i.e. the fairing separates into two halves. The gas generated by the explosive cords is sealed in the gasbag, so there is no contamination to the Payload. The steel hose attenuates the energy generated by high-pressure gas to the needed level that gives the fairing certain separation velocity. See **Figure 4-5c**.The explosive cord consists of two separate sub-cords which can be ignited simutaneously. If one sub-cord is ignited, the other one will be ignited consequently, and all the rivets can be cut off, i.e. fairing can separate. Therefore, the reliability of the longitudinal separation is very high.

4.4.3 Fairing Separation Mechanism

The fairing separation mechanism is composed of hinges and springs. See **Figure 4-5a**. Each half of the fairing is supported by two hinges, which locate at quadrant II and IV. There are 6 separation springs mounted on each half of the fairing, the maximum acting force of each spring is 37.8kN. After fairing unlocking, each half of the fairing turns around the hinge. When the roll-over rate of the fairing half is larger than 18°/s, the fairing is jettisoned.

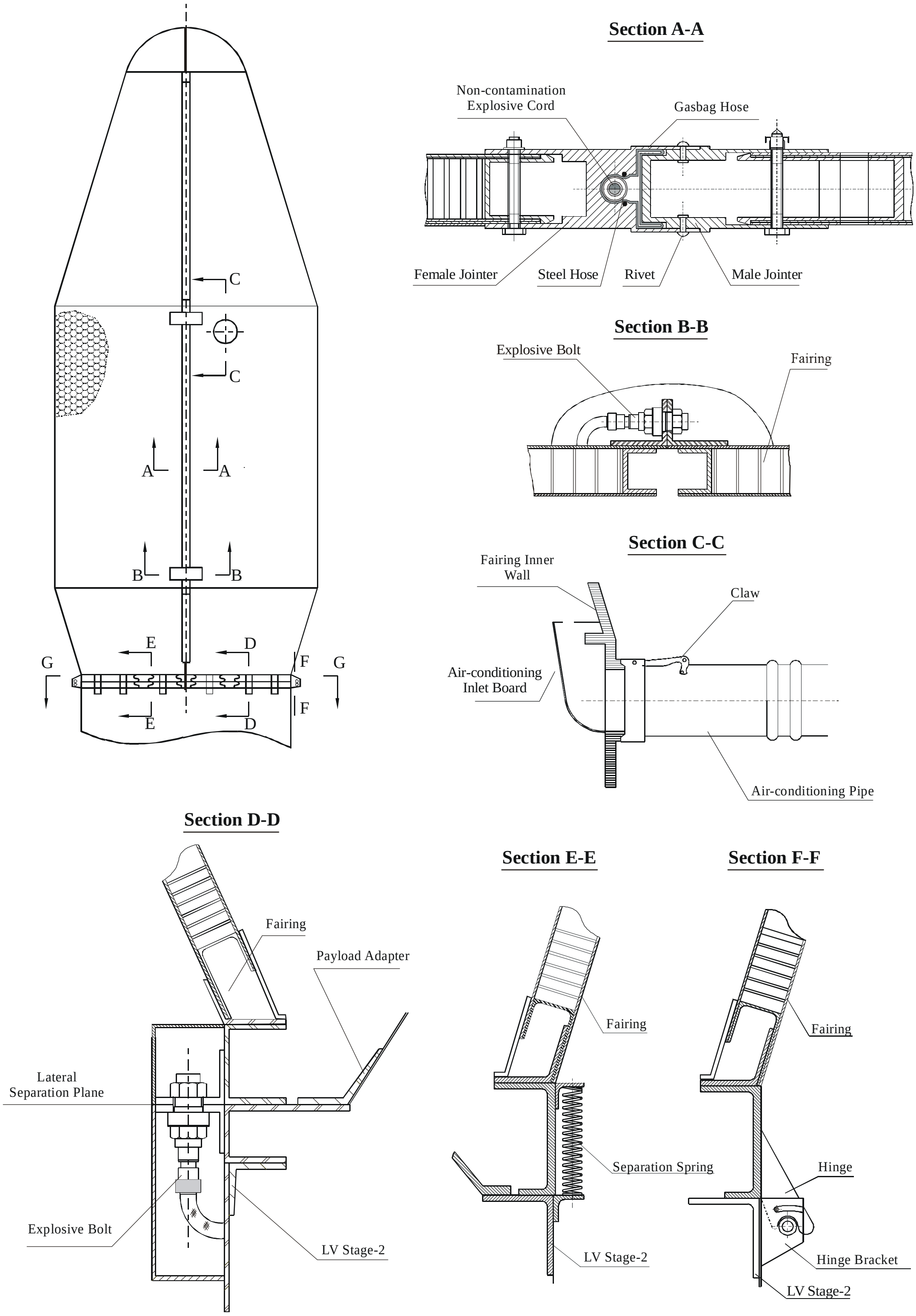


Figure 4-5a Fairing Unlocking Mechanism

Section G-G

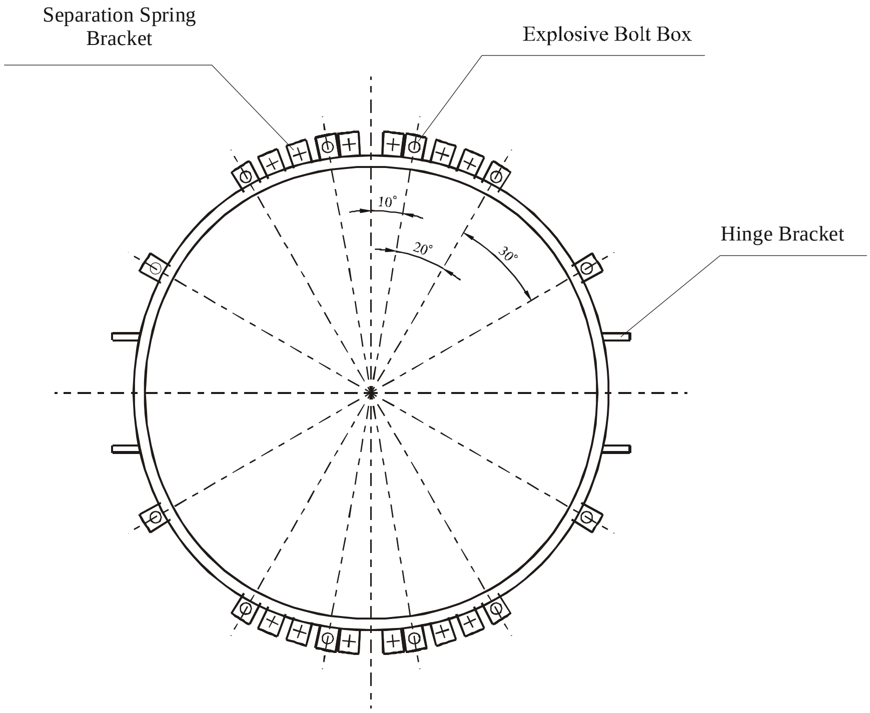


Figure 4-5b Distribution of the LV Lateral Unlocking Explosive Bolts

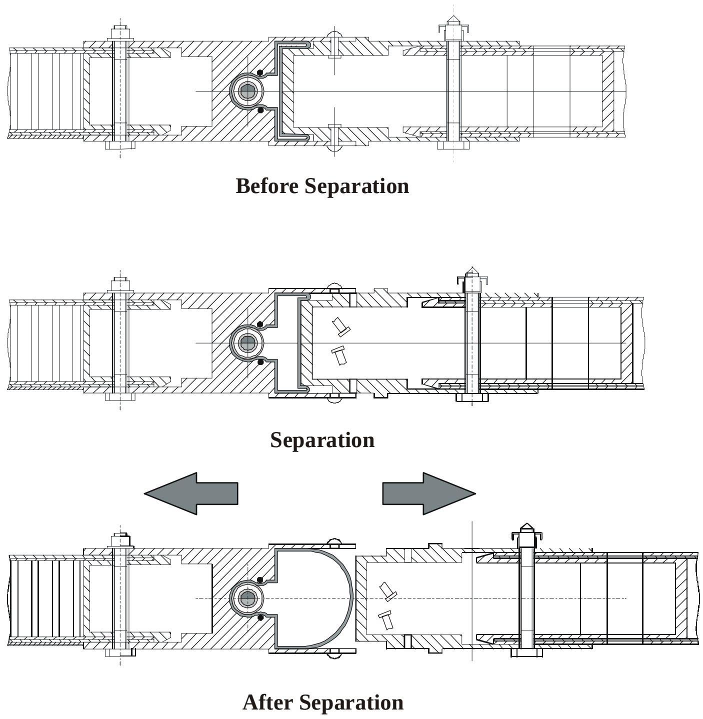


Figure 4-5c LV Longitudinal Unlocking Illustration

4.5 RF Windows and Access Doors

The dome of the fairing is made of fiberglass, and the forward cone section is made of fiberglass honeycomb sandwich except for the aluminum frames on quadrant line I, II, III, IV. The RF transparency rates of dome and forward cone section are all larger than 85%. Therefore, there is no RF window on the fairing.

Six standard access doors are provided in the cylindrical section to permit limited access to the Payload after the fairing encapsulation, according to User's needs. See **Figure 4-6**. Some area on the fairing can not be selected as the locations of access doors, see **Figure 4-7**. User can propose the requirements on access doors and RF windows to CALT. However, such requirements should be finalized 8 months prior to launch.

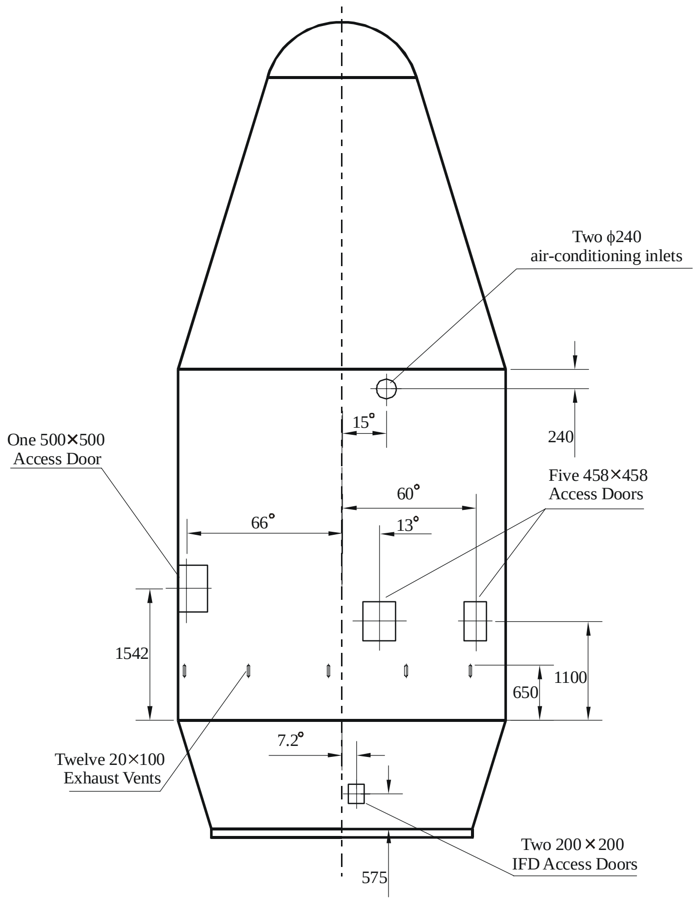


Figure 4-6 Typical Access Doors on LM-2E Fairing

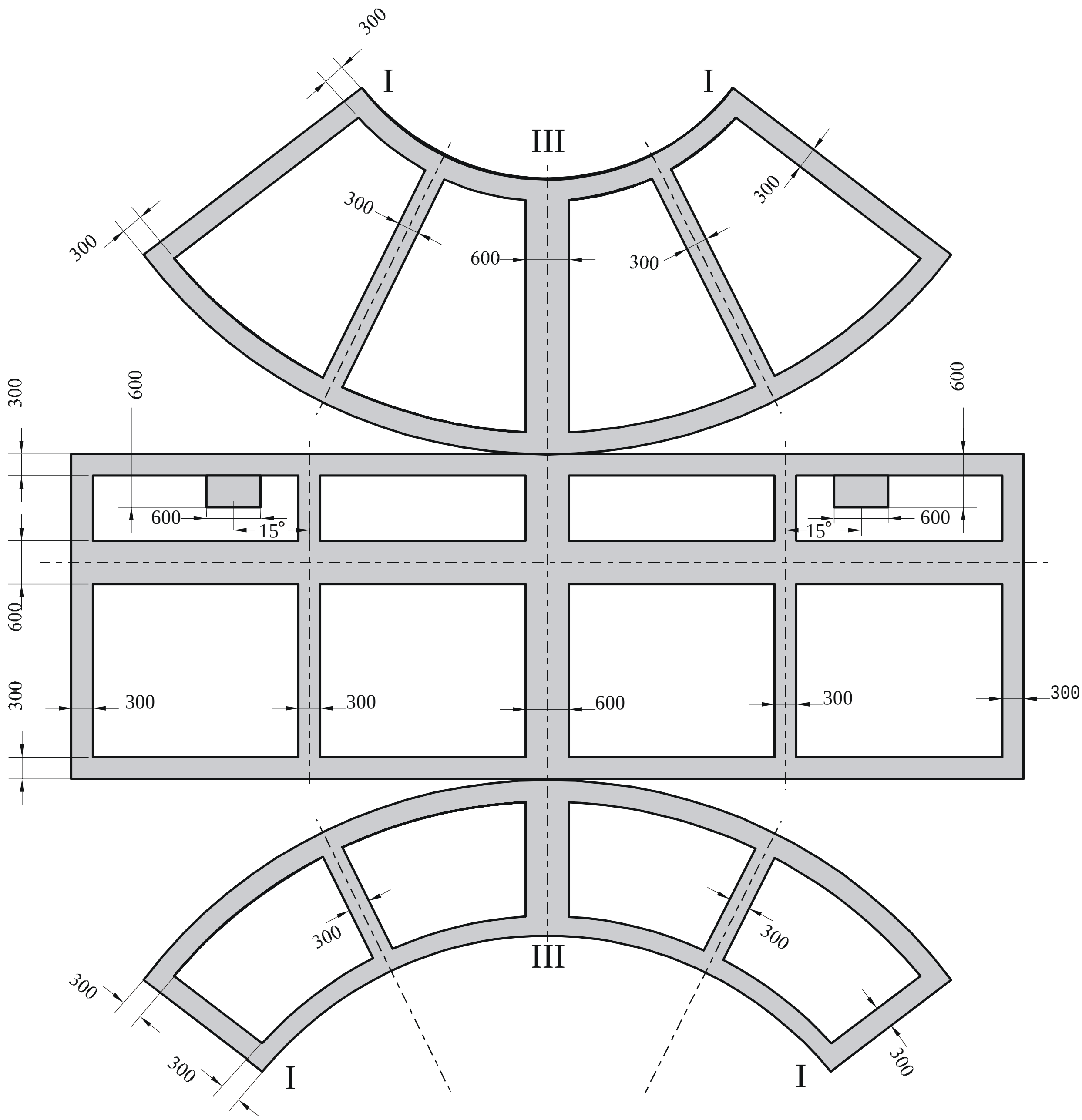


Figure 4-7 Prohibited Area for Access Doors