Environmental conditions

Chapter 3

3.1. Mechanical environment

3.1.1. General

During flight, the playload is subjected to static and dynamic loads induced by the launch vehicle. This environment covers the ground transportation case in Guiana.

Such excitation may be of aerodynamic origin (wind, gusts, buffeting at transonic velocity), or due to the propulsion systems (longitudinal acceleration, thrust build-up or tail-off transients, structure-propulsion coupling, attitude control limit cycling, etc).

The loads quoted in para. 3.1.2. to 3.1.7. should be considered as flight loads, applying to the spacecraft. The related probability of these figures not being exceeded is 99 %.

In the following paragraphs, the spacecraft base is defined as the top of the adaptor used.

3.1.2. Steady state acceleration

The highest longitudinal acceleration occurs at 1st stage cut-off. It will not exceed 4.5 g (see fig. 3.1.2.a).

Highest lateral acceleration is 0.2 g.

3.1.3. Low frequency longitudinal vibration

The sinusoidal vibration level at the base of the spacecraft is ≤ 1 g in the frequency range from 5 to 100 Hz.

This spectrum takes into account all sinusoidal or transient vibrations in this bandwidth.

3.1.4. Low frequency lateral vibration

The sinusoïdal vibration level at the base of the spacecraft is ≤ 0.8 g from 2 to 18 Hz and ≤ 0.6 g from 18 to 100 Hz.

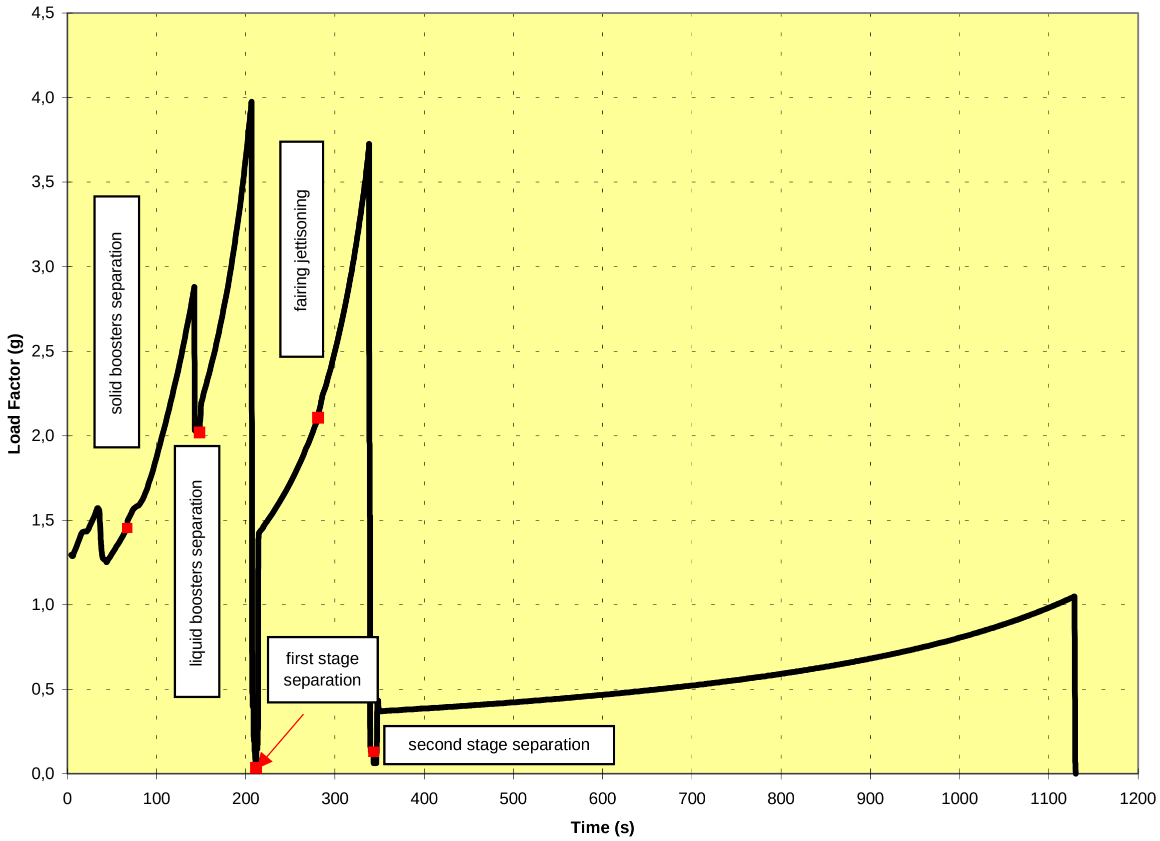


Fig. 3.1.2.a - Typical longitudinal static accelerations (flight levels for AR44LP in GTO)

3.1.5. Random vibrations

Random vibrations are generated by functioning mechanical elements (e.g. turbopumps), combustion phenomena or structural elements excited by the acoustic environment.

Such vibrations are transmitted to spacecraft via the launch vehicle structure (see fig. 3.1.5.a). The rms level is 7.3 g.

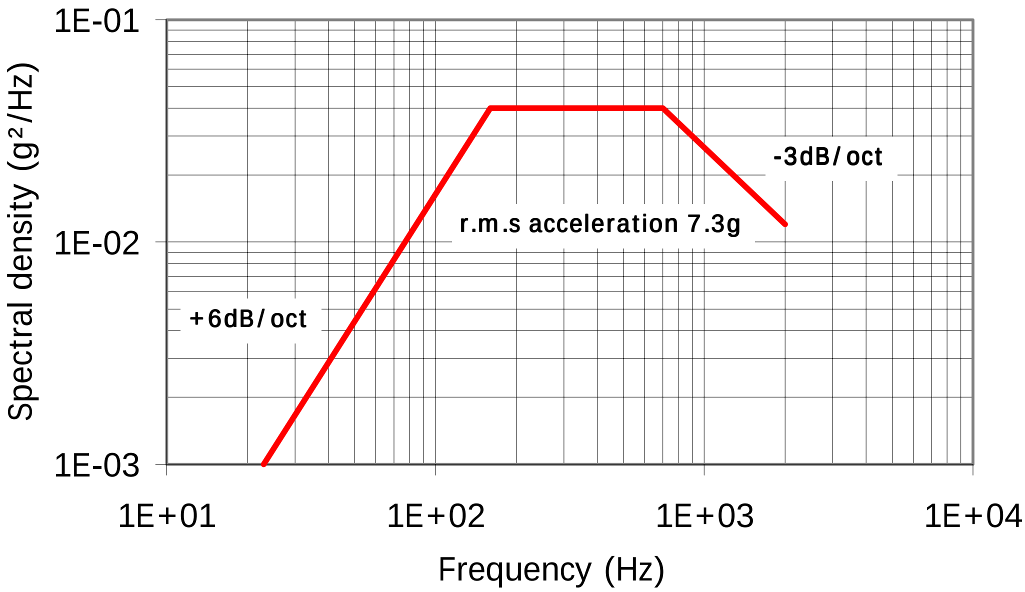
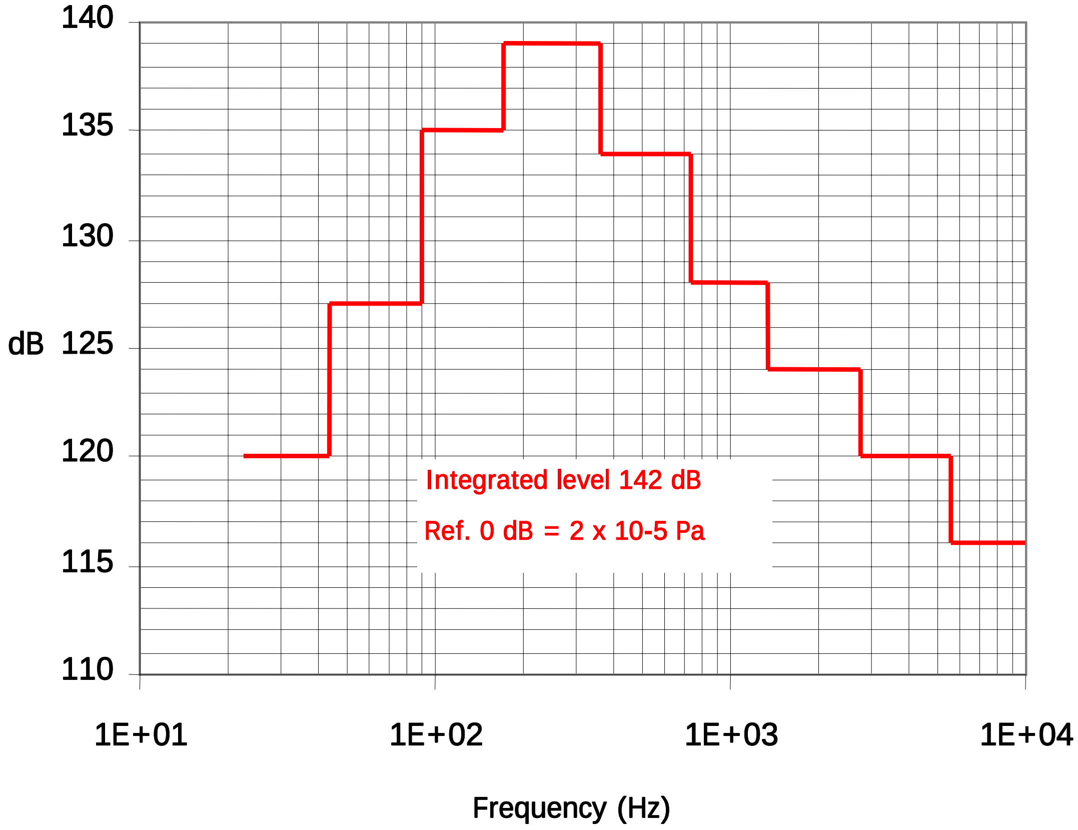


Fig. 3.1.5.a - Random Vibrations (Flight levels)

3.1.6. Acoustic vibrations

Acoustic vibrations are generated by engine noise, buffeting and boundary layer noise.

The level is the highest at lift-off and in the transonic region. It is substantially lower outside these periods. (The related noise spectrum is shown in figure 3.1.6.a).



3.1.7. Shock

The spacecraft is subjected to shocks principally during separation of the fairing and on actual spacecraft separation. On Ariane 4, the fairing, the dual launch carrying structures and the third stage separation systems do not generate a noticeable shock at the spacecraft interface.

The dimensioning case remains the actual spacecraft separation.

3.1.7.1. Standard adaptor

The levels experienced at the spacecraft interface are presented in the annexes describing the various separation systems.

3.1.7.2. Client adaptor

The acceptable levels at the launch vehicle bolted interfaces are the following (see fig. 3.1.7.2.a).

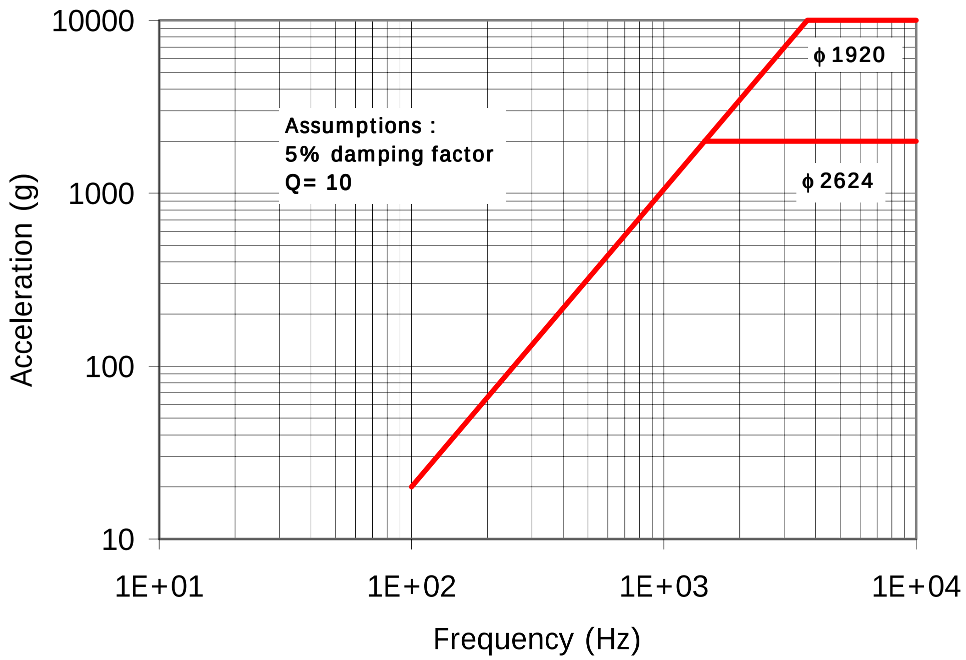


Fig. 3.1.7.2.a – Acceptable shock spectrum at launcher bolted interfaces

3.2. Thermal environment

3.2.1. General

Three phases have to be considered:

a) The spacecraft preparation phase within the EPCU buildings and transport between these buildings (refer to the EPCU Manual).

b) The spacecraft encapsulated inside the fairing or the SPELDA, and mated to the launch vehicle during the pre-launch phase*.

c) The in-flight environment phase*.

* See figures 3.2.1.a and 3.2.1.b.

3.2.2. Pre-launch temperature within the fairing or SPELDA

When mated to the launch vehicle, the spacecraft is protected by an air-conditioning system provided by ventilation through the pneumatic umbilicals (see fig. 3.2.2.a and 3.2.2.b).

This system is compatible with class 10,000 cleanliness and has the following characteristics:

- Inlet temperature of injected air: adjustable between $13°C^{+0}_{-1}$ and 25°C.

  Note : Temperature less than 13°C cannot be guaranteed.
  A feasibility study can be carried out in a case by case basis.

- Outlet temperature of air (fairing or SPELDA venting holes) $\leq$ 25°C for spacecraft radiating less than 200 watts (400 watts for single launch).
- Relative humidity $\simeq$ 1 %.
- Filtration: 0.3 µm.
- Main air velocity within the fairing: < 2 m/s (locally, near air inlet (A), the velocity may exceed this value — contact ARIANESPACE in case of specific concern).
- The noise level generated by the ventilation system does not exceed 90 dB.

  Note : The high airflow rate (2.000 Nm^3/h) is normally scheduled at H0 – 10:25 (44LP) at the earliest.

3.2.3. In-flight temperature under fairing, SPELDA or SYLDA

The net flux density radiated by the fairing, and the SPELDA or the SYLDA does not exceed 500 W/m^2 at any point.

3.2.4. Aerothermal flux at fairing jettisoning

(Not applicable to the inner passenger of a dual flight which remains protected by the SPELDA or the SYLDA).

The nominal time for jettisoning the fairing on all flights is determined in order not to exceed the aerothermal flux of 1135 W/m^2. This flux is calculated as a free molecular flow acting on a plane surface perpendicular to the velocity direction (atmosphere US 66, latitude 15° North).

For a dedicated launch, lower flux exposure can be accomodated on request. Arianespace should be contacted to study the impact on performance.

Solar-radiation flux, albedo and terrestrial infrared must be added to this aerothermal flux. In calculating the incident flux on spacecraft, account must be taken of the altitude of the launch vehicle, its orientation, the position of the sun with respect to the launch vehicle, and the orientation of the spacecraft surfaces considered.

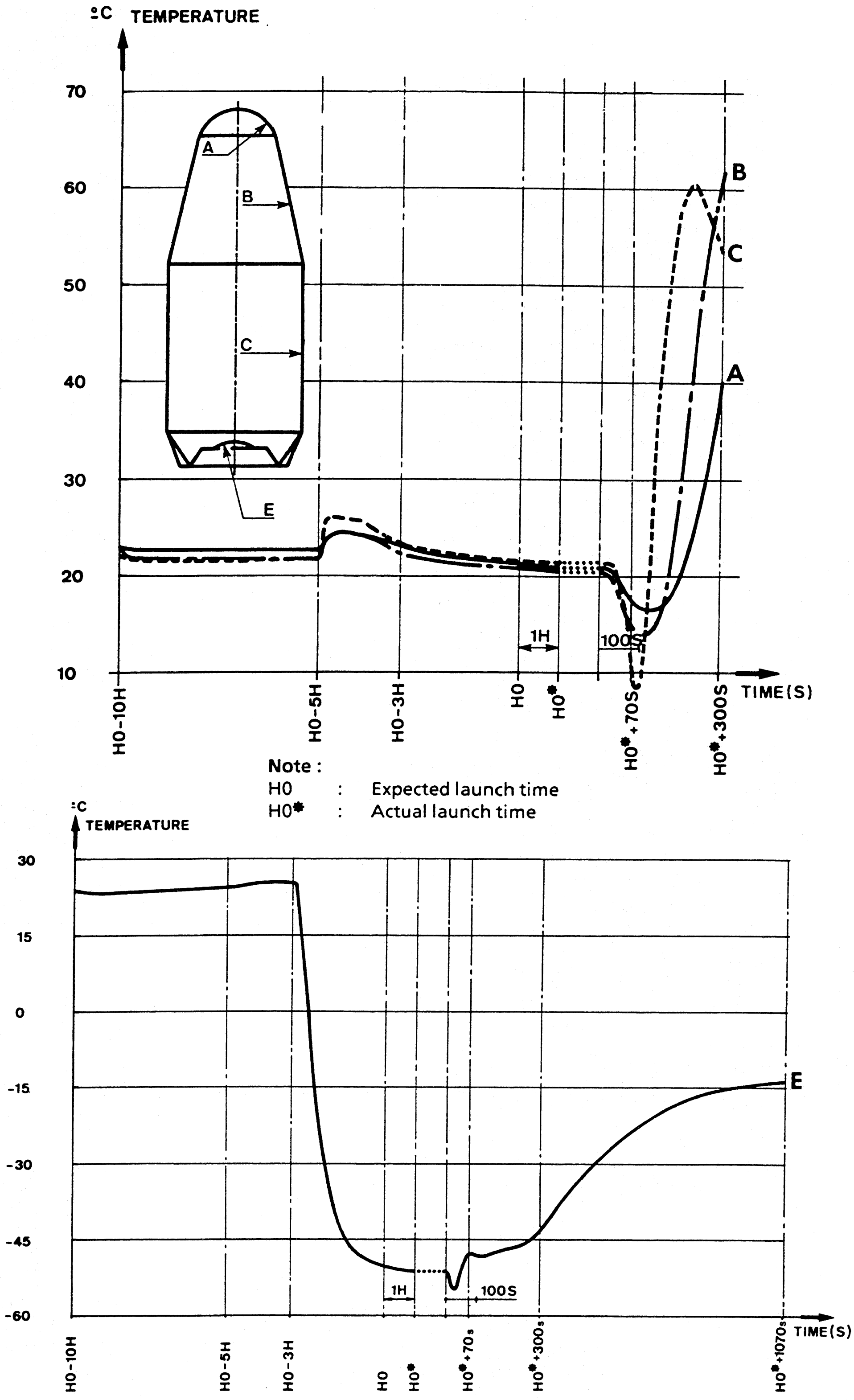
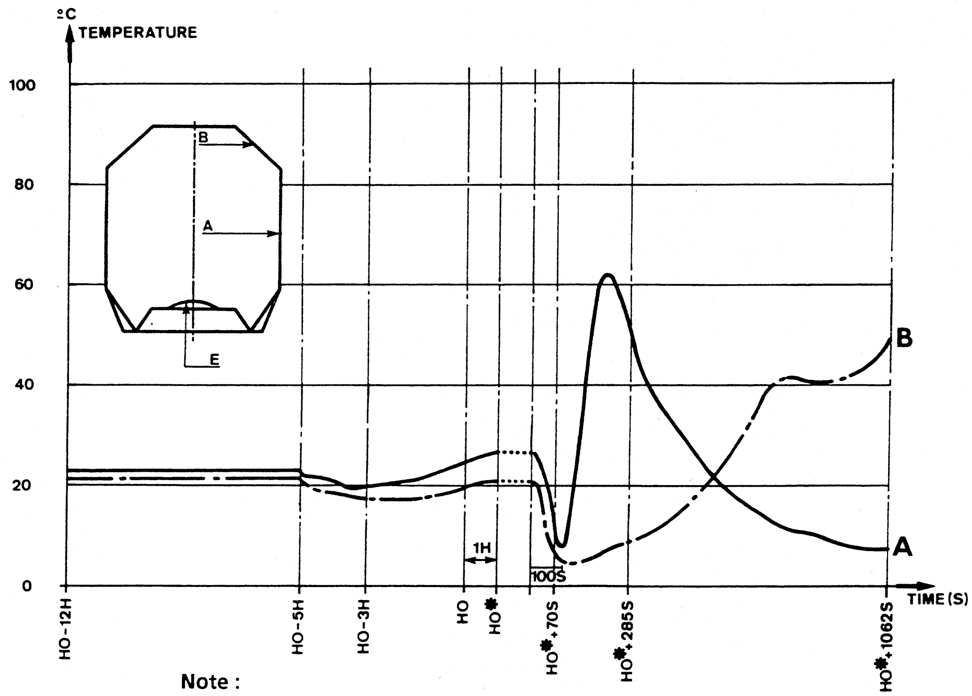


Fig. 3.2.1.a – Typical internal temperatures under fairing single and dual launch



Note :
H0 : Expected launch time
H0* : Actual launch time

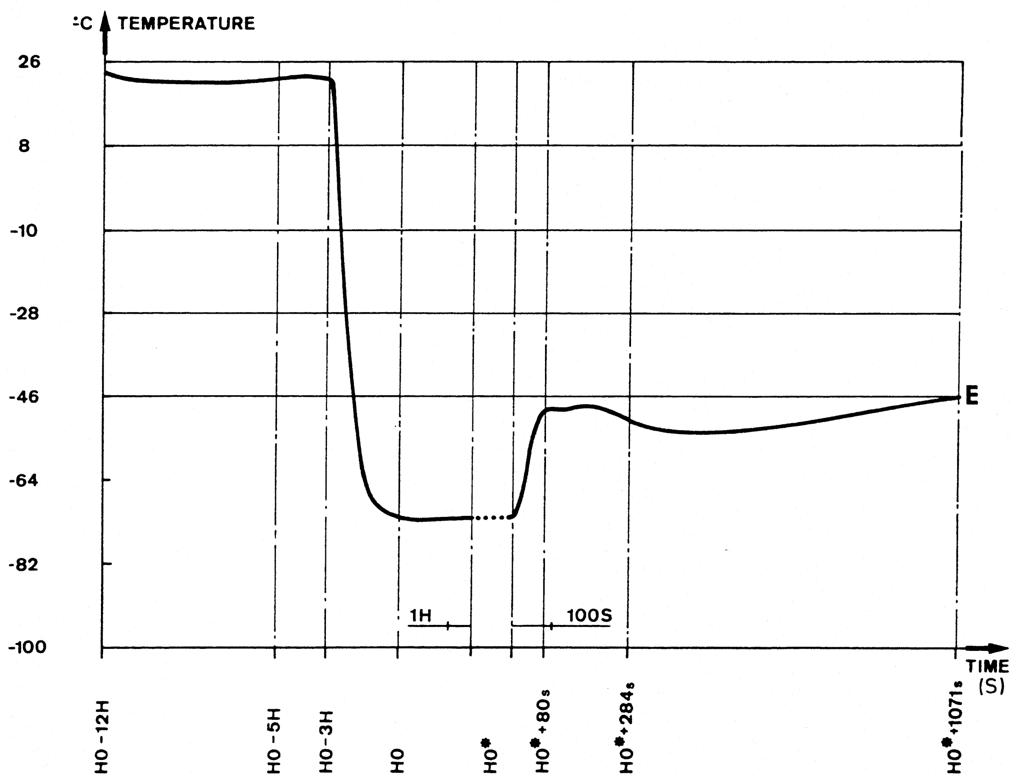


Fig. 3.2.1.b – Typical internal temperatures under SPELDA

Ventilation characteristics	
• Main air inlet	2000 Nm^3/h
• Temperature	between 13°C and 25°C
• Accuracy	± 1°C
• Cleanliness	Class 100 000
• Filtration	0.3 µm
• Filtration efficiency	98 %
• Noise level (ref 2.10-5 Pa)	< 90 dB
• Internal air velocity	
• local (A)	≈ 5 m/s
• average	< 2m/s

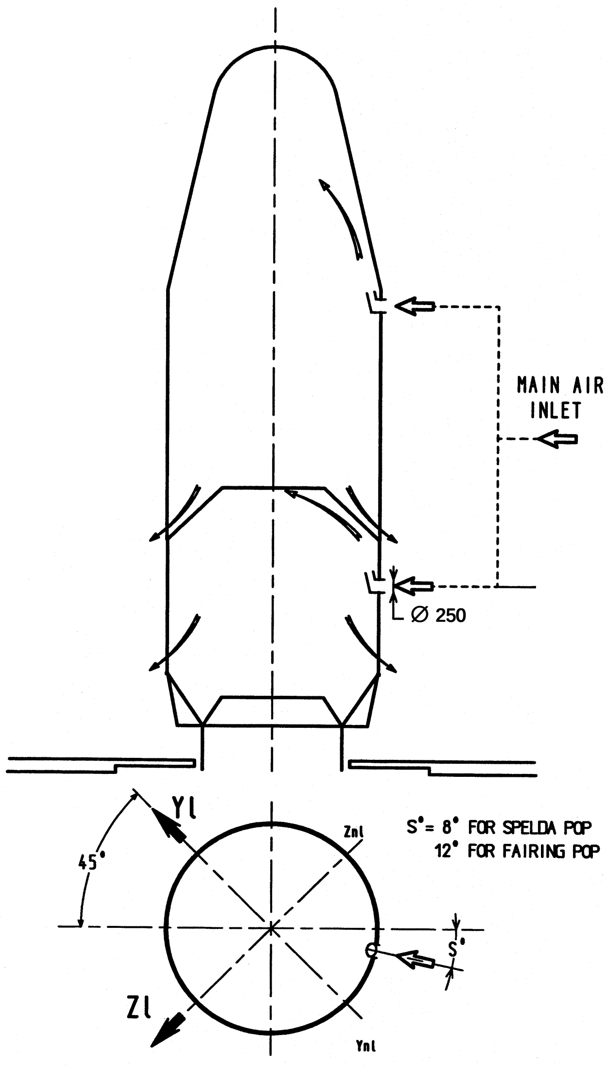


Fig. 3.2.2.a – Schematic of ventilation under fairing and SPELDA

Ventilation characteristics	
• Main air inlet	2000 Nm^3/h
• Temperature	between 13°C and 25°C
• Accuracy	± 1°C
• Cleanliness	Class 100 000
• Filtration	0.3 µm
• Filtration efficiency	98 %
• Noise level (ref 2.10-5 Pa)	< 90 dB
• Internal air velocity	
• local (A)	≈ 5 m/s
• average	< 2m/s

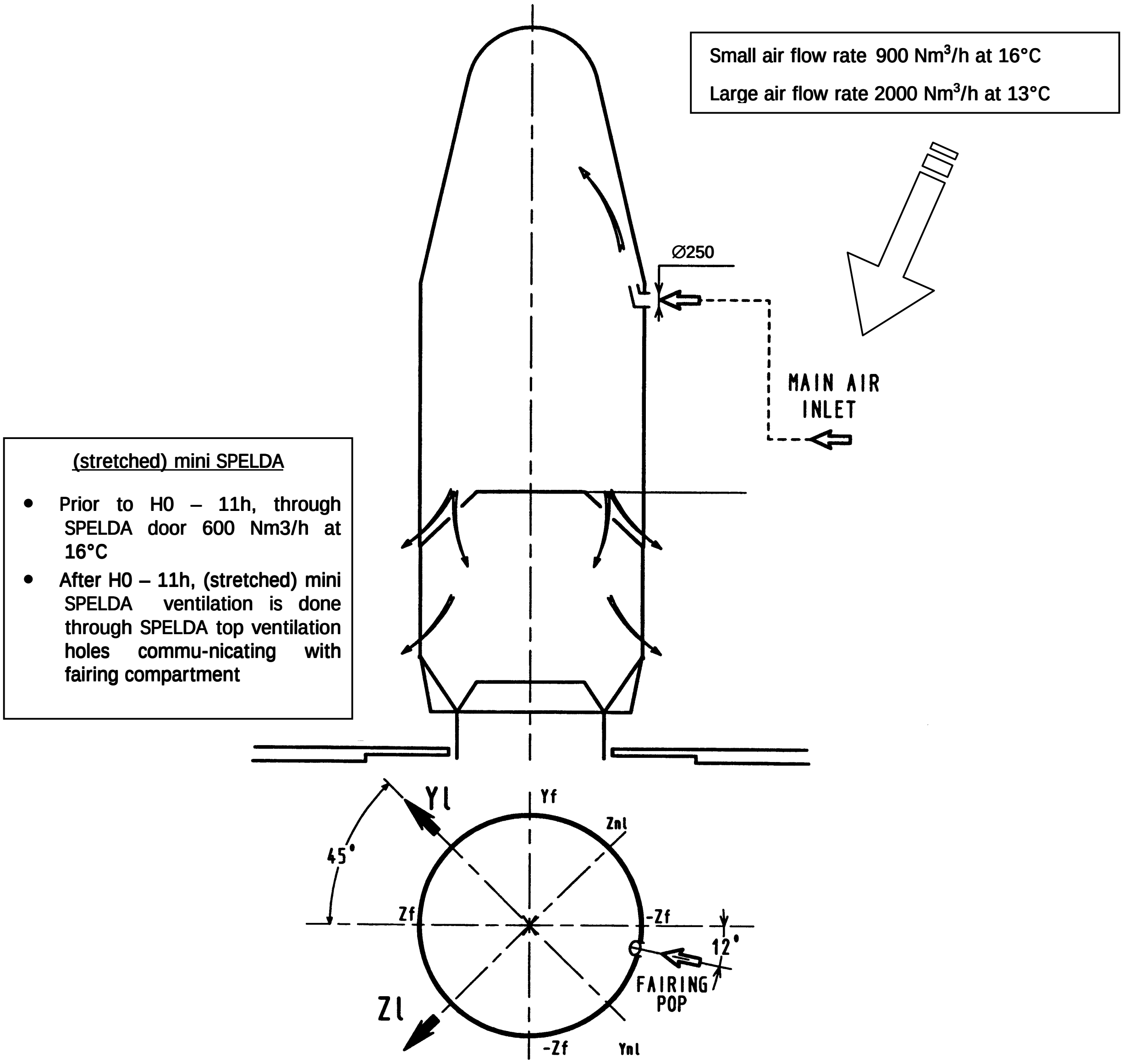


Fig. 3.2.2.b – Schematic of ventilation under fairing and mini SPELDA or stretched mini SPELDA

3.2.5. Thermal flux from stage separation retro rockets

The maximum flux is due to the second stage retro rockets. This flux is generated for the period of 1 second. Its maximum value, at the base of spacecraft, is:

$$\leq 3 \text{ kW/m}^2$$

(Flux is calulated on a plane surface perpendicular to the longitudinal axis of the launch vehicle).

Radial flux is less than 0.5 kW/m^2

3.3. Variation of static pressure within the fairing, SPELDA and SYLDA

The static pressure evolution is shown figure 3.3.a.

The typical slope is 20 mbar/s (locally 32 mbar/s during transonic phase).

3.4. Contamination and cleanliness

3.4.1. Organic contamination on the spacecraft

The clean rooms of S1 and S3 buildings do not generate organic deposits exceeding 2 mg/m^2/week.

Ariane 4 and ELA 2 dot not generate organic deposits exceeding 4 mg/m^2 * on the spacecraft, from the begining of its encapsulation (closure of fairing or the SPELDA) up to its separation from the launcher.

***Note**:
Made up of:

- material outgassing $\leq$ 2 mg/m^2,
- interstage separation system $\leq$ 2 mg/m^2,
- the fairing and SPELDA pyrotechnic separation systems are leak proof and do not cause any contamination.

3.4.2. Air cleanliness

In S1 and S3 buildings, in the spacecraft containers (CCU), inside the fairing or SPELDA, on the playload platform (PFCU) as well as during transfer between buildings, the air cleaniness class 100 000 is guaranteed.

3.4.3. Design and test requirements for the spacecraft

The spacecraft materials must satisfy the following outgassing criteria:

- Total Mass Loss (TML) $\leq$ 1%,
- Collected Volatile Condensable Material (CVCM) $\leq$ 0.1%,

measured in accordance with the procedure "ESA PSS-01-702".

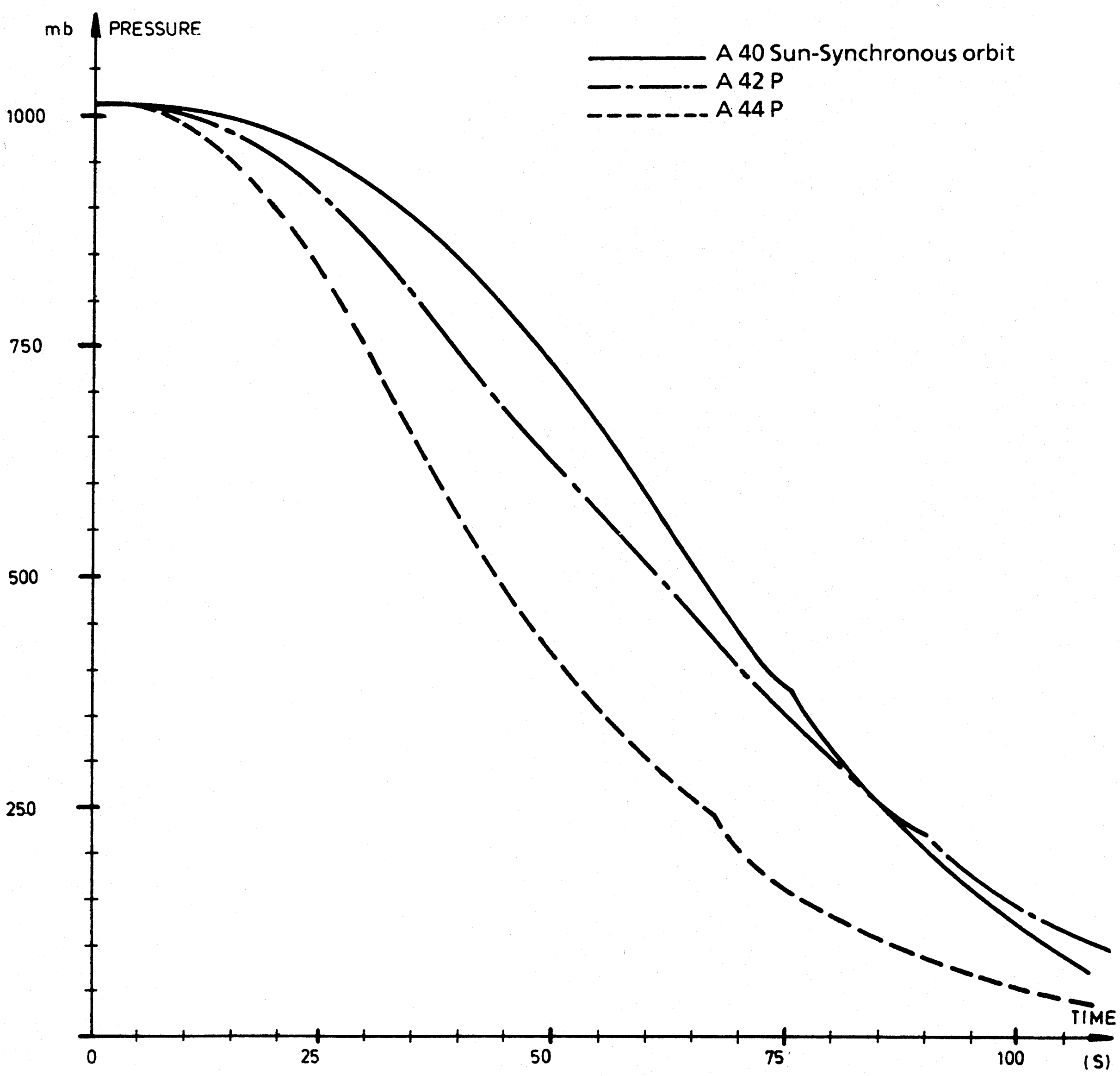


Fig. 3.3.a – Variation of static pressure within fairing SPELDA and SYLDA

3.5. Radio and electromagnetic environment

In order to ensure the radio compatibility between the launch vehicle and the spacecraft, a frequency plan is drawn up for each launch. The user will be required to supply all data needed for the preparation of this plan within the "Application to use Ariane" document (see chapter 6.2.1).

Launcher

The launch vehicle is equipped with the following transmission and reception systems:

A telemetry system with the transmitter in the VEB and an antenna system comprising two antennae located on the external section of the VEB structure, having an omnidirectional radiation pattern and no special polarization.
The transmission frequency is in the 2200 – 2290 MHz band, and the transmitter power is 20 W. (Allocated frequencies to the Launch Vehicle are: 2203 MHz, 2218 MHz and 2227 MHz).

A telecommand-destruct reception system, comprising two receivers operating in the 400 – 500 MHz band. Each receiver is coupled to a system of two antennae, located on the VEB, having an omnidirectional pattern and no special polarization.

A radar transponder system, comprising two identical transponders with a reception frequency of 5690 MHz and transmission frequencies in the 5400 – 5900 MHz band. The minimum pulsed (0.8 µs) transmitting power of each transponder is 400 W peak. Each transponder is coupled to a system of two antennae, located on the VEB, with an omnidirectional pattern and clockwise circular polarization.

Range

The range electromagnetic environment of the CSG is measured every 18 months.

Spurious radiation interference levels from the launch vehicle and the CSG will not exceed those given in:

- Figure 3.5.a. Spurious radiation: narrow-band electrical field.

These levels are measured at 1 m above the mounting plane of the VEB structure.

Specific spurious radiations, emanating from the launch vehicle transmission systems, in particular from telemetry system, are lower than these levels (harmonics included).

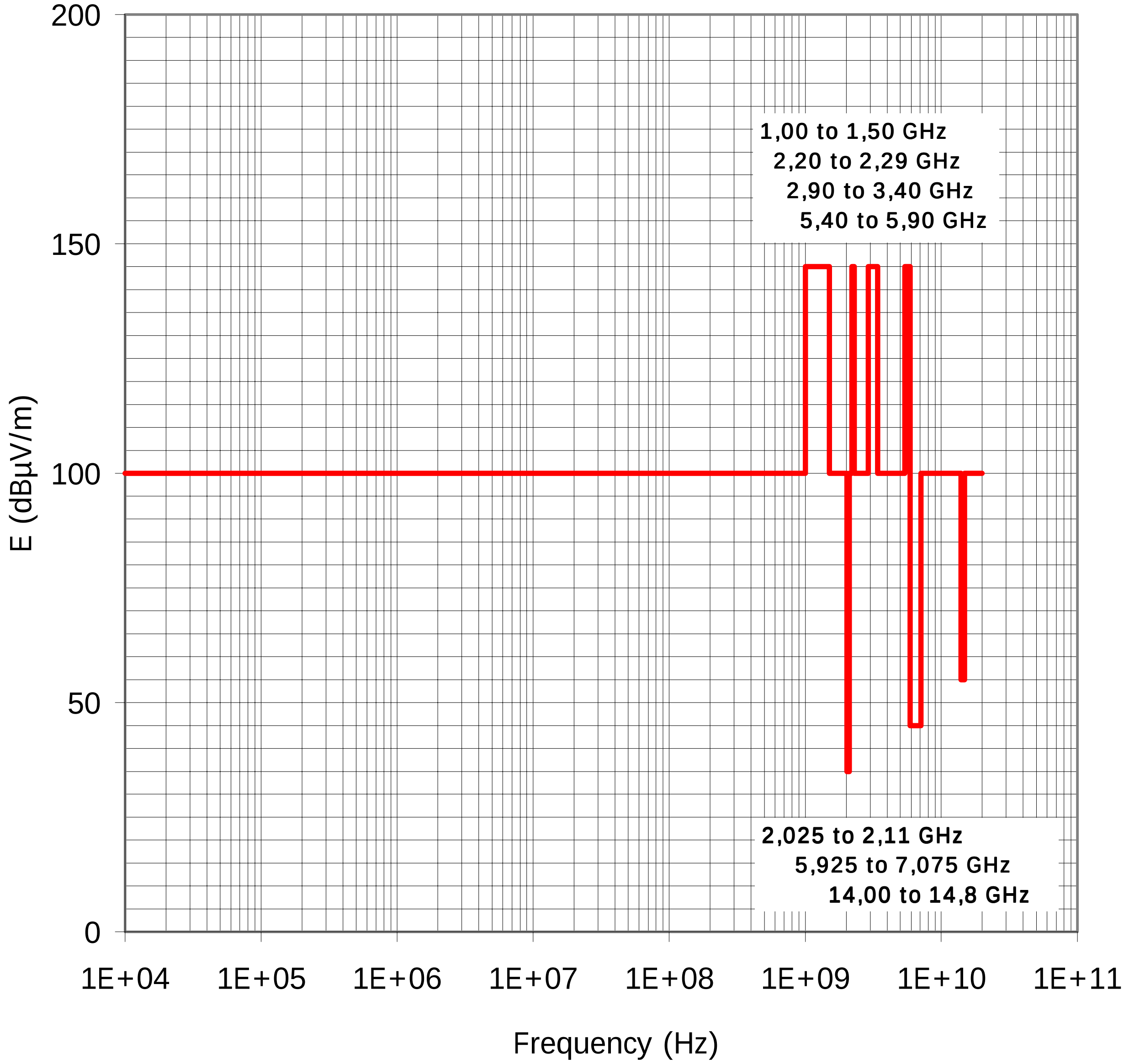


Fig. 3.5.a – Spurious radiation by Launch Vehicle and CSG
Narrow-band electrical field