User’s Manual

Prepared by: G. PONT, L. ROLO, M. DUARTE
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Issue: 1
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Project promoted by
Departamento de Engenharia Electrotécnica e de Computadores (DEEC-FEUP)

In cooperation with:

Amateur Radio Group @ FEUP (NRA-FEUP)
Approval Record

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Table 1: Approval record.

Change Record

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**ABBREVIATIONS**

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<tr>
<td>ADP</td>
<td>Acceptance Data Package</td>
</tr>
<tr>
<td>CoG</td>
<td>Centre of Gravity</td>
</tr>
<tr>
<td>CPE</td>
<td>Control Platform Equipment/Enclosure</td>
</tr>
<tr>
<td>EE</td>
<td>Experiment Enclosure</td>
</tr>
<tr>
<td>EGSE</td>
<td>Electrical Ground Support Equipment</td>
</tr>
<tr>
<td>EMC</td>
<td>Electro Magnetic Compatibility</td>
</tr>
<tr>
<td>ESA</td>
<td>European Space Agency</td>
</tr>
<tr>
<td>FEUP</td>
<td>Faculty of Engineering of University of Porto</td>
</tr>
<tr>
<td>GMT</td>
<td>Greenwich Mean Time</td>
</tr>
<tr>
<td>GSE</td>
<td>Ground Support Equipment</td>
</tr>
<tr>
<td>H₂</td>
<td>Hydrogen</td>
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<tr>
<td>He</td>
<td>Helium</td>
</tr>
<tr>
<td>ICD</td>
<td>Interface Control Document</td>
</tr>
<tr>
<td>I/F</td>
<td>Interface</td>
</tr>
<tr>
<td>LV</td>
<td>Launch Vehicle</td>
</tr>
<tr>
<td>MLI</td>
<td>Multi Layer Insulation</td>
</tr>
<tr>
<td>N</td>
<td>North</td>
</tr>
<tr>
<td>N₂</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>N/A</td>
<td>Non Applicable</td>
</tr>
<tr>
<td>OBC</td>
<td>On Board Computer</td>
</tr>
<tr>
<td>PFM</td>
<td>Proto-Flight Model</td>
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<tr>
<td>RF</td>
<td>Radio Frequency</td>
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<td>S/C</td>
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<td>Shock Response Spectrum</td>
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<td>STRAPLEX</td>
<td>STRAtospheric PLatform EXperiment</td>
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<tr>
<td>TBC</td>
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<tr>
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<tr>
<td>%</td>
<td>Percent</td>
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<td>Ω</td>
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GLOSSARY & DEFINITIONS

Acceptance Data Package  The Acceptance Data Package shall provide the following set of documents as a minimum:
- Experiment Registration Form;
- Design Description Document;
- Design Justification Document;
- Test Plan and Test Report;
- Mission Operations Report

Customer  The nominated person who is responsible of the investigation and achievement of the scientific objectives. He is as well the experiment supplier.

Near-space condition  Near vacuum condition:

Harsh temperature conditions:

![Atmospheric pressure profile](image)

![Atmospheric temperature profile](image)
Very low density:

![Atmosphere density profile](image)

**Figure: Atmospheric density profile (kg/m³).**

Variation of the Earth gravitational fields:

![Earth gravitational field](image)

**Figure: Earth gravitational field (m/s²) profile.**

Possible benefits of utilizing near-space conditions:

- Experiments related to Stratospheric Balloon design: Archimedes force, Balloon principles, Ascent velocity, Parachute system, Helium utilisation, etc.
- Experiments related to the Atmosphere: Temperature environment, Pressure environment, Atmosphere density, Humidity, sound propagation, pollution, etc.
- Experiments related to radiation: Solar radiation flux, solar energy, cosmic ray, etc.
• Experiments related to tele-detection: Albedo, colour photography, black and white photography, digital photography, video, data transmission, etc.
• Experiments related to biology.
• Landing systems.
• Detachable capsules (including specific localisation and recovery system).

Cheaper and quicker access to space-like conditions is offered by balloon as compared to getting a launch to orbit. Thus, it enables testing equipment that will be used on spacecraft (S/C).

High altitude cameras can see for several hundred miles and access to a given area is more flexible than with the infrequent fly-over by remote sensing satellite.

Payload/Experiment
The Payload/Experiment constitutes the specific hardware and software needed to perform the scientific measurements for the achievement of the proposed science objectives. A Payload/Experiment may consist of several units.

Standard option
The customer is required to design the payload in conformity with the Safety Regulations imposed by ESA Education Projects Division and the University of Porto.
APPLICABLE AND REFERENCE DOCUMENTS

Applicable documents [AD]

AD[1] National Scientific Balloon Facility, NSBF recommendations for gondola design, NSBF, April 1986


AD[6] www.irf.se


AD[8] www.ans.kiruna.se

AD[9] www.rymdbolaget.se


Reference documents [RD]

RD[1] STRAPLEX team, Description of the STRAPLEX capsules, STRAPLEX-A-DSC-1-1

PREFACE

This document contains the technical information which is necessary:

- To assess compatibility of an experiment with the STRAPLEX launches;
- To constitute the general launch service provisions and specifications;
- To initiate all the technical and operational documentation related to a launch of any experiments on STRAPLEX.

This document is revised periodically; comments and suggestions on all aspects of this manual will be encouraged and appreciated. Inquiries concerning clarification or interpretation of this manual should be directed to:

STRAPLEX@esa.int

For more information, contact:

www.STRAPLEX.org

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ESA Education Projects Division
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FOREWORD

STRAtospheric PLatform EXperiment

STRAPLEX is a program by the University of Porto, Portugal in collaboration with the Education Projects Division of the European Space Agency (ESA). STRAPLEX offers students the possibility to send experiments for educational purposes into the stratosphere using balloons filled with Helium, and to participate in future capsule development. Depending on the mass of the experiment, STRAPLEX can reach up to 40 km altitude. Two balloon campaigns, each involving six flights, are envisaged every year, starting in 2006.

STRAPLEX is a new launcher scheduled to be operational end 2005 for missions with small educational experiments. The capsule is tailored to carry small educational experiments, targeted on a payload lift capacity of 3.5 kg at a maximum altitude of 35 km.

STRAPLEX is a useful opportunity for performing short duration scientific and technological experiments in near-space conditions due to its short turnaround time, low cost, and flexible experiment approach.

Customers can benefit from a participation in the STRAPLEX program in the following ways:
- Testing as part of a quality approach to manufacturing space hardware;
- Acquiring a better understanding of near-space conditions;
- Gain hands-on experience in a real scientific projects;
- Provide a launch opportunity and interact with ESA experts;
- End to end project with quick turn around.

STRAPLEX can offer two different flight configurations:

Standard flight campaigns: consists of six flights on 3 consecutive days. STRAPLEX can also accommodate several different customers who can share the payload accommodation.

Specialized flight campaigns: can be customized to the desires and needs of individual independent customers. These customers may decide on the number of flights, the duration, and the profile of each flight.

The ESA Education Projects Division and the University of Porto will operate STRAPLEX from Évora, in Portugal. Launch sites as Madeira, in Portugal, and Esrange, in Sweden are being planned for future missions.

The STRAPLEX program passed successfully major milestones, with the Approval Decision Design, in September 2005, and with the first qualification flight in December 2005.
ACKNOWLEDGEMENTS

The ESA Education Projects Division and the University of Porto would like to thank the following people for their interest, time and knowledge. The expertise and effort of these people helped us a lot during tradeoffs, meetings and everyday design work.

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1 Introduction

This User’s Manual (UM) describes the environmental conditions and services provided by the ESA Education Projects Division and the University of Porto and offers to the customers.

The document furthermore describes the design boundaries and programmatic requirements applicable to each individual experiment which must be satisfy in order to certify an experiment for integration and flight onto STRAPLEX launch vehicle (LV).

1.1 Purpose of the User’s Manual

The content of this User’s Manual encompasses the following chapters:

- Chapter 1: General information about the STRAPLEX programme, and the project organization;
- Chapter 2: Launch vehicle description;
- Chapter 3: Launch vehicle performance and mission profile;
- Chapter 4: Environmental conditions imposed by the launch vehicle and corresponding requirements for experiment design and verification;
- Chapter 5: Description of interfaces between experiment and launch vehicle;
- Chapter 6: Verification approach and Schedule management;
- Chapter 7: Mission operations;
- Chapter 8: Payload processing and ground operations performed at the launch site.

Appendix 1 gives a detail description of the capsule geometry, providing mechanical drawings and internal configuration.

Appendix 2 gives a detail description of the payload adapter geometry, providing mechanical drawings and internal configuration.

Appendix 3 gives the external temperature, external pressure and other relevant parameters for a certain mission profile.

Appendix 4 gives some general information about the Évora aerodrome.

Appendix 5 gives detailed information about the data acquired on the first flight.

Appendix 6 gives detailed information about the data acquired on the second flight.

It will give readers sufficient information to assess the suitability of the STRAPLEX LV and its associated launch services to perform its mission and to assess the compatibility with the proposed launch vehicle.

Furthermore, available on-line is a form, Experiment Registration Form, which shall be filled-out by interested customers for a first assessment whether a proposed payload is a potential candidate to be accommodated onto STRAPLEX.
1.2 Launch facilities

The experiment/launch vehicle integration and launch are carried out from launch sites dedicated for STRAPLEX.

Chapter 8 (Launch site) presents an overview of possible launch site opportunities. The launch site selection is done by the ESA Education Projects Division and the University of Porto. For particular request, please contact the ESA Education Projects Division.

1.3 Launch services

The STRAPLEX program benefits from a simplified procurement organization that relies on a prime supplier for each launch vehicle: the University of Porto.

Figure 1 shows the STRAPLEX program organization location.

The customer is in charge of production. The ESA Education Projects Division and the University of Porto are responsible for integration of the payload, and launch preparation of the launch vehicle.

Figure 2 shows the STRAPLEX program organization.
The STRAPLEX operational team is based on ESA and University of Porto representatives who are responsible for STRAPLEX LV preparation.

2 System description

2.1 Launch vehicle

The STRAPLEX LV consists of the following components:
- A capsule for payload accommodation, divided into two separated compartments:	- One CPE (Control Platform Enclosure);	- One EE (Experiment Enclosure).
- A parachute system and a capsule separation system;
- A Helium balloon and a parachute-capsule separation system.
The STRAPLEX configuration and corresponded vehicle data is shown in Table 3.

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<td>kg</td>
</tr>
<tr>
<td><strong>Filled with</strong></td>
<td>He</td>
<td></td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>Latex</td>
<td></td>
</tr>
<tr>
<td><strong>Separation</strong></td>
<td>Parachute-capsule separation system</td>
<td></td>
</tr>
<tr>
<td><strong>Burst pressure</strong></td>
<td>3.7</td>
<td>hPa</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Parachute system</strong></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area</strong></td>
<td>2.63</td>
<td>m²</td>
</tr>
<tr>
<td><strong>Dry mass</strong></td>
<td>0.5</td>
<td>kg</td>
</tr>
<tr>
<td><strong>Longitudinal load</strong></td>
<td>+1/-2.5</td>
<td>g</td>
</tr>
<tr>
<td><strong>Lateral load</strong></td>
<td>+/-0.5</td>
<td>g</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>Apex canopy</td>
<td></td>
</tr>
<tr>
<td><strong>Thermal protection</strong></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Separation</strong></td>
<td>Capsule separation system</td>
<td></td>
</tr>
<tr>
<td><strong>Maximum capacity</strong></td>
<td>6</td>
<td>kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Payload fairing</strong></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mass</strong></td>
<td>2.5</td>
<td>kg</td>
</tr>
<tr>
<td><strong>Power supplied</strong></td>
<td>1</td>
<td>W</td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td>Hexagonal - Regular Polygon</td>
<td></td>
</tr>
<tr>
<td><strong>Dimension 1</strong></td>
<td>207.85</td>
<td>mm</td>
</tr>
<tr>
<td><strong>Dimension 2</strong></td>
<td>207.85</td>
<td>mm</td>
</tr>
<tr>
<td><strong>Dimension 3</strong></td>
<td>310</td>
<td>mm</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>30 mm and 50 mm Styrofoam</td>
<td></td>
</tr>
<tr>
<td><strong>Thermal protection</strong></td>
<td>Mylar and Styrofoam</td>
<td></td>
</tr>
<tr>
<td><strong>Separation</strong></td>
<td>Vertical separation</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: LV properties data.

(*) Standard value depending on target altitude.
(**) No particular requirement; Additional power supply can be brought on board.

### 2.2 Balloon system

The balloon will be provided by Kaymont (New York, USA). Balloon performance data for typical STRAPLEX missions with different weights and altitudes between 30 and 40 km are given in Figure 8.

### 2.3 Separation conditions

Before theoretical balloon burst a separation system will be activated so that the parachute can open safely and without any obstruction from the leftovers of the balloon. This will be implemented in the On-Board Computer (OBC) and will be a fully automatic procedure, where
the separation altitude is pre-determined prior to launch. However, it can also be used for emergency purposes if it is needed to start the descent phase earlier than predicted.

The descent phase can also be activated (cutting off the balloon) by a telecommand from the ground station. This enables the possibility of in case of emergency or other need, shorten the mission duration.

As part of the flight train, the parachute is under tension during flight. The stored energy released at termination causes the parachute to recoil toward the payload. The parachute could take from 4 to 6 seconds to deploy completely.

Figure 3 illustrates a parachute deployment sequence, timed in seconds, showing the recoil of the parachute toward the payload following termination, refer to AD[1].

![Figure 3: Parachute deployment.](image)

## 2.4 Parachute system

The parachute will have a hemispheric design and will be provided by Spherachutes (Colorado, United States). This hemispheric design has brought countless capsules down safely over the years. Features 0.5 kg coated rip stop nylon and mil-spec suspension lines. The three dimensional shape of the canopy makes it difficult for these chutes to invert, a common cause of tangling. A spill hole reduces opening shock and increases stability during descent. For visibility constraint the colour of the parachute will be white and red. Refer to AD[5].
The sizes listed below in the table are measured along the top of the canopy.

<table>
<thead>
<tr>
<th>6-Panel</th>
<th>8-Panel</th>
<th>12-Panel</th>
<th>18-Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="6-Panel Diagram" /></td>
<td><img src="image" alt="8-Panel Diagram" /></td>
<td><img src="image" alt="12-Panel Diagram" /></td>
<td><img src="image" alt="18-Panel Diagram" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size of chute (m)</th>
<th>Cost in €</th>
<th>Size of chute (m)</th>
<th>Cost in €</th>
<th>Size of chute (m)</th>
<th>Cost in €</th>
<th>Size of chute (m)</th>
<th>Cost in €</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.61</td>
<td>13.1</td>
<td>1.22</td>
<td>26.2</td>
<td>2.13</td>
<td>65.4</td>
<td>3.66</td>
<td>126.9</td>
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<td>0.76</td>
<td>14.6</td>
<td>1.52</td>
<td>33.8</td>
<td>2.44</td>
<td>80.8</td>
<td>4.27</td>
<td>146.2</td>
</tr>
<tr>
<td>0.91</td>
<td>16.2</td>
<td>1.83</td>
<td>44.6</td>
<td>3.05</td>
<td>100.0</td>
<td>4.88</td>
<td>192.3</td>
</tr>
</tbody>
</table>

Table 4: Parachute sizes.

Note:
0.46 m Spherachutes are not part of our normal product line-up but are available for the same price as 0.61 m.

Calculations are based on 4.6 to 6.1 m/s descent and mass are given in kilogram.

<table>
<thead>
<tr>
<th>Size of chute (m)</th>
<th>Min. Weight</th>
<th>Max. Weight</th>
<th>Min. Weight</th>
<th>Max. Weight</th>
<th>Min. Weight</th>
<th>Max. Weight</th>
<th>Min. Weight</th>
<th>Max. Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.61</td>
<td>0.4</td>
<td>0.7</td>
<td>0.3</td>
<td>0.6</td>
<td>0.3</td>
<td>0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.76</td>
<td>0.6</td>
<td>1.0</td>
<td>0.5</td>
<td>0.9</td>
<td>0.4</td>
<td>0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.91</td>
<td>0.9</td>
<td>1.5</td>
<td>0.7</td>
<td>1.3</td>
<td>0.6</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.22</td>
<td>1.5</td>
<td>2.7</td>
<td>1.3</td>
<td>2.3</td>
<td>1.0</td>
<td>1.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.52</td>
<td>2.4</td>
<td>4.2</td>
<td>2.0</td>
<td>3.5</td>
<td>1.6</td>
<td>2.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.83</td>
<td>3.6</td>
<td>5.9</td>
<td>2.7</td>
<td>5.0</td>
<td>2.3</td>
<td>4.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.13</td>
<td>4.5</td>
<td>8.1</td>
<td>4.1</td>
<td>6.8</td>
<td>3.2</td>
<td>5.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.44</td>
<td>5.9</td>
<td>10.8</td>
<td>5.0</td>
<td>9.0</td>
<td>4.1</td>
<td>7.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.05</td>
<td>9.5</td>
<td>16.7</td>
<td>7.7</td>
<td>14.0</td>
<td>6.3</td>
<td>11.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.66</td>
<td>13.5</td>
<td>24.3</td>
<td>11.3</td>
<td>20.3</td>
<td>9.5</td>
<td>16.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.27</td>
<td>18.5</td>
<td>32.9</td>
<td>15.3</td>
<td>27.5</td>
<td>12.6</td>
<td>22.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.88</td>
<td>24.3</td>
<td>43.2</td>
<td>20.3</td>
<td>36.0</td>
<td>16.7</td>
<td>29.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Payloads sizes.

The parachute chosen to perform the qualification flight has a 1.83 m size of chute.

An Anti-torch ring will be implemented in order to increase parachute system reliability. A ring of 20 cm diameter (TBC), fixed with 8 (TBC) stringing at parachute-ring interface and 3 (TBC) stringing at ring-capsule interface will be used. The anti-torch ring prevents parachute stringing to mix up and to hinder parachute deployment.
The stress induced at parachute deployment on the fixation is defined in the table hereafter.

![Figure 4: Anti-torch ring configuration.](image)

<table>
<thead>
<tr>
<th>Constraint@deployment</th>
<th>165,321</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmosphere density</td>
<td>1.3</td>
<td>g/1</td>
</tr>
<tr>
<td>Parachute area</td>
<td>2.54</td>
<td>m²</td>
</tr>
<tr>
<td>Aerodynamic coefficient</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>V@deployment</td>
<td>10</td>
<td>m/s</td>
</tr>
</tbody>
</table>

Table 6: Stress at Parachute deployment.

3 Performance and launch mission

3.1 Introduction

This section provides the information necessary to make preliminary performance assessments for the STRAPLEX LV. The paragraphs that follow present the vehicle reference performance.

The provided data covers a wide range of missions from experiment delivery into low altitude, to injection into the atmosphere upper layers (up to 40 km).

Performance data presented in this manual will be optimized taking into account the specificity of the customer's mission.

3.2 Vehicle performance definition

Performance computations are based on the following main assumptions:

- The flight is assumed to be realized with standard sequence and duration, with standard telemetry provisions and electrical services to the capsule;
- The performance figures given in this chapter are expressed in term of total mass;
- The flight path takes into account the relevant safety requirements.
### 3.3 Typical mission profiles

A typical mission profile consists of the following three phases:

- **Phase I**: Ascent trajectory;
- **Phase II**: Descent trajectory;
- **Phase III**: Capsule recovery.

Jettisoning of the capsule can take place at different times depending on the functional requirements of the payload. Typically, capsule separation takes place at balloon burst, between approximately 70 (30 km) and 80 minutes (40 km) from lift-off. Typical ascent velocity is about 7 m/s.

The typical STRAPLEX mission profile and associated sequence of events are shown in Figure 5.

#### Phase 1: Ascent trajectory

The duration of this phase depends on the mission profile. It encompasses the ascent phase from launch to balloon burst. A temperature minimum between 11 to 25 km altitudes (around -56 °C according to the standard atmospheric profile) will be experienced. Frozen condensation formed during ascent through the troposphere usually sublimes before the capsule reaches 25 km altitude. The ascent phase is completed in approximately 75 minutes. Thus, an average velocity of 7 m/s can be assumed. Accurate positioning system is assumed to be under the responsibility of the University of Porto. Accurate pointing system is assumed to be under the responsibility of the instruments specialist.
Another example of the flight parameters during the ascent profile is presented in Annex 2.

**Phase 2: Descent trajectory**

The descent trajectory is divided into two sub-phases:
- Balloon burst to parachute deployment
- Parachute deployment to landing

The duration of this phase depends on the mission profile. It encompasses the descent phase from parachute deployment to landing. On descent the capsule encounters the same conditions than for ascent. As external components cool during descent, water may condense and freeze on the capsule. Moisture accumulation usually begins below 15 km on descent. The capsule will be disassembled and cleaned soon after flight to avoid moisture damages sensitive, unprotected components of the payload or may start corrosion. Parachute deployment is planned without introduction of free fall sub-phase (deployment within 4 to 6 seconds is foreseen, refer to chapter 2.3 (Separation conditions). This phase will be neglected.

Accurate positioning and pointing systems are assumed to be under the responsibility of the instruments specialist.
Figure 7: Descent velocity profile.
Another example of the flight parameters during the descent profile is presented in Annex 2. For additional information please refer to chapter 2.3 (Separation conditions).

Phase 3: Capsule recovery

The recovery procedure varies depending on the actual impact location. For instance, although the ground recovery team uses recovery vehicles, it is often impossible to reach payloads on a maintained road. Recovery crews must often negotiate with landowners to enter private property or to cut roads into inaccessible spots. These conditions can delay recovery of the entire package from a few hours to a few days, and have to be avoided.

Typical impact sites include open fields, densely wooded areas, swamps, and farm ponds. An open field is the most desirable site and is preferred for landing when possible. However, landings in trees or shallow water are not uncommon. In wooded areas, the parachute or capsule may become entangled in branches, suspending the payload above the ground.

For additional information please refer to chapter 2.3 (refer to Separation conditions). For additional information please refer to chapter 3.7 (Capsule recovery).

3.4 General performance data

LV performance data for typical STRAPLEX missions with different weights and altitudes between 30 and 40 km are presented in Figure 8.

Note: At this time only XS balloon types are available.
3.5 Mission duration

Mission duration from lift-off, balloon burst until payload recovery depends on the selected mission profile. This mission profile is dependent on payload weight, size of the balloon and size of the parachute. These variables can be controlled in order to obtain a fast/slow flight, or to aim for the higher altitude possible. The size of the parachute controls the descent speed, thus setting the horizontal distance of the land site and the mission duration time.

The customer sets up its own mission profile, in agreement with the ESA Education Projects Division.

![Mission Duration and Characteristics](image.png)

**Figure 9:** Mission duration and characteristics.

3.6 Launch windows and frequency

The STRAPLEX LV can be launched any day of the year, depending on the weather conditions, during day light to respect the specified capsule recovery conditions.

Wherever possible, a launch window will be defined in order to provide launch flexibility and to cope with any perturbation (weather, launch hold, etc.).

Launch window and launch frequency depends on the launch site selection, refer to chapter 8 (Launch site).
3.7 Capsule recovery

Upon impact, the ground recovery team releases the parachute from the capsule by radio command to prevent a re-inflated parachute from dragging the payload. The OBC can detect when the capsule touch down and then fires the parachute cutaway. When the parachute cannot be cut away after impact, it may re-inflate and tip the capsule over. In extreme cases, the parachute may drag the capsule.

Several teams, depending on the launch site selection, will be near the predicted land position fully equipped with portable/mobile radio stations capable of receiving telemetry and computing the new expected landing site with the latest heading information from the CPE so that recovery can be done right after landing. The OBC is also capable of computing the predicted landing location. This information will be sent in different packet frames so that ground teams can be aware of the last landing prediction information.

Ground recovery:
Depending on the mission profile, the speed of landing will be controlled so that no damage can occur to the payload during impact.

Splash-down recovery:
The capsules are designed in such a way that in case of water landing the stable position is unique and is the one of most interest (ensured by the self-levelling design).

For more detailed information about the design of this feature please refer to AD[2].

3.8 Features

3.8.1 Optional separation

Separation capability from the STRAPLEX capsule can be provided, if required (TBC).

3.8.2 Possibility of free-fall phase

Free-fall capability can be provided, if required (TBC).

3.8.3 Possibility of floating phase

Floating capability can be provided for days or weeks, if required (TBC).
4 Environmental conditions

In order to reduce the amount of system tests, the margin of safety for the payload must be 10% (for standard option). If lower margins are not to be avoiding by the payload, additional tests on the experiments side must be performed.

4.1 General

During the preparation for launch at the launch site and then during the flight, the capsule is exposed to a variety of mechanical, thermal, and electromagnetic environments. This chapter provides a description of the environment that the payload is intended to withstand.

All environmental data given in the following paragraphs should be considered as limit loads, applying to the payload.

Without special notice all environmental data are defined at the payload/capsule interface.

4.2 Mechanical environment

The following paragraph is giving an overview of the dynamic environmental loads for every payload.

4.2.1 Design requirements

Payload mass and position of CoG shall comply with buoyancy requirements, referred in Figure 10

Figure 10: Payload mass versus CoG position.

The design load factors (static and dynamic loads):

TO BE ISSUED LATER
4.2.2 Steady state acceleration

During ground preparation, the flight steady state accelerations cover the load to which the payload is exposed.

During flight, the payload is subject to static and dynamic loads. Such excitations may be of aerodynamic origin (e.g., wind, gusts) or due to the propulsion systems (e.g., longitudinal acceleration, or structure-propulsion coupling, etc.).

4.2.3 Shock

As the parachute deployment is smooth due to the gradual increase of the atmosphere density during the descendent phase, the payload is not subjected to shock.

4.2.4 Static pressure under the capsule fairing

The anticipate atmospheric pressure will drop from 1013 mbar (Sea level) to approximately 3 mbar (depending on desired float altitude) over a period of 3-5 hours, the ascent time of a typical balloon mission.
The payload compartment is vented during the ascent phase if necessary through vent holes insuring a low depressurization rate of the payload compartment. On the other hand, the capsule can also be pressurised.

### 4.3 Thermal environment

The thermal environment provided during payload preparation and launch has to be considered during the following phases:
- Ground operations:
  - The payload preparation within the launch facility;
  - The payload encapsulated inside the capsule fairing.
- Flight environment.

The thermal design of STRAPLEX has been chosen such that a moderate temperature of the STRAPLEX platform with as far as possible minimized temperature variation may be achieved.

#### 4.3.1 Ground operations

The environment that the payload experiences both during its preparation and once it is encapsulated under the capsule fairing is controlled in terms of temperature, relative humidity; please refer to chapter 8 (Launch site) for additional information.

##### 4.3.1.1 Launch facility environment

The typical thermal environment within the air-conditioned facilities is kept around 0 to 40 °C for temperature and 55% ± 10% for relative humidity. More detailed values for each specific hall and buildings are presented in the chapter 8 (Launch site).

##### 4.3.1.2 Thermal conditions under capsule fairing

After encapsulation under the capsule fairing, the environment around the payload is ensured by the insulation capability of the capsule fairing. The capsule fairing cavity is vented since encapsulation, up to the lift-off, except during short maintaining operation.

#### 4.3.2 Flight environment

Capsule pressure is maintained at approximately 1 atm during the all flight duration in case of pressurised capsule implementation. A further loss of capsule pressure must be considered in the design of the equipment.
Capsule temperature varies from 0 to 40°C in flight. For equipment installed outside of the capsule are exposed to the atmospheric conditions, refer to Near-space conditions definition.

For the complete estimation of the thermal environment under the fairing the payload dissipated power shall be taken into account.

### 4.4 Cleanliness and contamination

The environment that the payload experiences both during its preparation and once it is encapsulated under the capsule fairing is controlled in terms of cleanliness, and contamination.

No specific requirements, regarding cleanliness and contamination level, are expected.

No gas, liquid or material, even known as not toxic, can be released from an experiment into the atmosphere without agreement with the ESA Education Projects Division.

If possible, avoid hazardous liquids and gases, including high pressure, toxic, corrosive, explosive, and flammable materials. A current Material Safety Data Sheet must be supplied for each hazardous material.

### 4.5 Electromagnetic environment

The LV and launch range RF systems and electronic equipments are generating electromagnetic fields that may interfere with payload equipment and RF systems. The electromagnetic environment depends on the characteristics of the emitters and the configuration of their antennas.

Special attention must be paid with the capsule antennas. They should never be in contact with any other king of object (particularly conducting metallic) or be touched while transmitting under the risk of damage of the equipment.

In particular, the payload must not overlap the frequency bands of the LV receivers/transmitters.

### 5 Capsule and payload interfaces

The accommodation of the Control Platform Enclosure (CPE) will not be introduced in this document. This compartment hosts the control, power, communication and positioning systems. Only the accommodation of the Experiment Enclosure (EE) hosting the customer’s payload, referred as the payload adapter, will be discussed hereafter.
5.1 Introduction

This chapter covers the definition of the interfaces with the payload, the capsule fairing and the on-board and ground electrical equipment.

![Figure 13: Capsule overview](image1)

The payload is mated to the capsule through a dedicated structure the payload adapter, refer to Figure 16. Mechanical interface, electrical harnesses routing and systems are provided throughout the payload interface.

![Figure 14: Payload adapter.](image2)

The payload adaptor and capsule fairing protect the payload from external environment on ground and in flight.

The electrical interface provides communication with the launch vehicle and the ground support equipment during all phases of payload preparation, launch and flight.

These elements could be subject of mission specific adaptation, as necessary, to fit with the customer requirements.
5.2 Reference axes

All definition and requirements shall be expressed in the same reference axis system to facilitate the interface configuration control and verification.

Figure 15 shows the STRAPLEX coordinate system that will be serving as the reference axis system.

5.3 Encapsulated interfaces

5.3.1 Payload usable volume definition

The payload usable volume is the area under the capsule fairing available to the payload mated in the payload adaptor. This volume constitutes the limits that the static dimensions of the payload, including manufacturing tolerance, thermal protection installation, appendices …, shall not exceed.

The payload usable volume is shown in Figure 16. Dimension of the payload adapter will be presented in chapter 5.4.2 (Payload compartment structures description).
In the event of local protrusions located slightly outside the above-mentioned envelope, the ESA Education Projects Division, the University of Porto and the customer can conduct a joint investigation in order to find the most suitable layout.

### 5.3.2 Payload accessibility

The encapsulated payload can be accessible for direct operations up to 2 hours before lift-off, through capsule top structure. The entire payload can be removed via this access.

If access to specific areas of the payload is required, additional doors as option can be provided on a mission-specific basis. Doors can be installed in most parts of the capsule fairing except in areas close to the parachute system.

The access areas are presented in Figure 17.

---

**Figure 16:** Maximum and minimum payload adapter dimensions.

**Figure 17:** Payload adapter access.

Avoid sharp edges and corners on all equipment.

---

**TO BE ISSUED LATER**
5.3.3 Special on-fairing insignia

A special mission insignia based on customer supplied artwork can be placed by the ESA Education Projects Division and the University of Porto on the cylindrical section of the fairing. The dimensions, colours, and location of each such insignia are the subject of mutual agreement. The artwork shall be supplied not later than 30 days before launch.

5.4 Mechanical interface

5.4.1 Capsule structures description

STRAPLEX offers a standard flexible payload adapter, compatible with different platforms height. The capsule fairing consists of hexagonal Styrofoam segments. Each segment is 50 mm thick, refer to Figure 19. Top and bottom covers are 30 mm thick.

The electrical connectors are mated on two brackets installed on the adapter and payload side. On the payload side, the umbilical connector’s brackets must be stiff enough to prevent any deformation greater than 0.5 mm under the maximum force of the connector spring.

The capsule fairing dimensions and the payload adapter volume are shown in Figure 19.
5.4.2 Payload compartment structures description

The payload adapter has a regular hexagonal shape of 125 mm per side and consists of two hexagonal expanded PVC segments. The thickness of these two panels is 3 mm. The height is flexible by step of 3 cm from 3 to 12 cm.

The payload adapter is equipped with two PVC flat plates connected using six attachment rods, brackets for electrical connectors and, if needed, by mission specific hardware additional aperture.

Hereafter is presented the capsule payload adapter accommodation. The general characteristics of adapter are presented in the Table 7. A more detailed description is provided in the Appendix 1.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>P/L</th>
<th>Unit</th>
<th>Comments</th>
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<tbody>
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<td>&lt;5</td>
<td>kg</td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td>Hexagonal</td>
<td>-</td>
<td>Regular</td>
</tr>
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<td>125</td>
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<td>Side length</td>
</tr>
<tr>
<td>Dimension 2</td>
<td>125</td>
<td>mm</td>
<td>Side length</td>
</tr>
<tr>
<td>Dimension 3</td>
<td>120</td>
<td>mm</td>
<td>Height</td>
</tr>
</tbody>
</table>

Table 7: Payload mechanical interface

These dimensions were chosen taking into account the volume occupied by the CPE (Control Platform Enclosure) and the free space available for the payload. These limits are also imposed by the overall height of the capsule for buoyancy characteristics in the case of splash down.

The fixation between the experiment and the payload adapter should satisfy the following requirements:
- Attachment interface type: the payload adapter should slide into the capsule smoothly,
- Easily accessible.
Adaptation for a N\textsubscript{2} purging connector at the payload interface can be provided as option, to prevent water condensation (TBD). Customer is requested to contact the ESA Education Projects Division for further details.

### 5.5 Electrical and radio electrical interface

The needs of communication with the payload during the launch preparation and the flight require electrical and RF links between the payload, and the EGSE located at the launch site and preparation facilities.

The electrical interface composition between payload and the STRAPLEX LV is presented in the Table 8.

<table>
<thead>
<tr>
<th>Service</th>
<th>Description</th>
<th>Lines definition</th>
<th>Provided as</th>
<th>I/F connectors</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Umbilical lines</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Communication</td>
<td>RS-232C Serial Port</td>
<td>Standard</td>
<td>DB-9</td>
<td></td>
</tr>
<tr>
<td>Data Acquisition</td>
<td>4 A/D Converters</td>
<td>Standard</td>
<td>DB-15</td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td>Power Supply</td>
<td>Standard</td>
<td>DB-15</td>
<td></td>
</tr>
</tbody>
</table>

*Table 8: Payload electrical and radio electrical interfaces.*

#### 5.5.1 Electrical functions

The launch vehicle provides electrical functions used by the payload during flight, as optional or standard service.

Due to the payload to launch vehicle interface, the customer is required to protect the circuit against any overload or voltage overshoot induced by his circuits both at circuits switching and in the case of circuit degradation.

The electrical characteristics of the STRAPLEX LV power supply follow in Table 9.

<table>
<thead>
<tr>
<th>Electrical characteristics</th>
<th>Power supplied</th>
<th>Voltage</th>
<th>Current</th>
<th>Capacity</th>
<th>(*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supplied</td>
<td>2 W</td>
<td>5/12 V</td>
<td>100/100 mA</td>
<td>1600 mAh</td>
<td></td>
</tr>
</tbody>
</table>

*Table 9: Electrical characteristics of the STRAPLEX LV power supply.*

Note:

(*) Additional power supply can be bringing on board.
It is expected that the payload has its own power supply and its own batteries if the power needed is superior to 1 W. The capsule will only be able to offer +5 V, -5 V and +12 V, -12 V regulated voltage with maximum continuous current consumption of 100mA.

The available power is determined by the available battery power and the available power provided by solar cells.

All exposed power leads and electrical contacts should be covered to protect people and equipment. The experiment electrical equipments must meet the standard for electromagnetic compatibility of equipment on board.

Figure 20 presents an overview of the electrical interface diagram. The payload’s connector must be a DB-15 male type. The CPE is equipped with a DB-15 female type connector. Table 10 presents the electrical interface pin configuration. It is highly recommended to contact the STRAPLEX team to avoid any last minute compatibility problem with electrical interface.

![Figure 20: Electrical interface diagram](image-url)
Table 10: Electrical interface pin configuration

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+5 V</td>
</tr>
<tr>
<td>2</td>
<td>-5 V</td>
</tr>
<tr>
<td>3</td>
<td>+12 V</td>
</tr>
<tr>
<td>4</td>
<td>-12 V</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
</tr>
<tr>
<td>6</td>
<td>Not Connected</td>
</tr>
<tr>
<td>7</td>
<td>Not Connected</td>
</tr>
<tr>
<td>8</td>
<td>Not Connected</td>
</tr>
<tr>
<td>9</td>
<td>Not Connected</td>
</tr>
<tr>
<td>10</td>
<td>GND</td>
</tr>
<tr>
<td>11</td>
<td>Analog to Digital Converter 1</td>
</tr>
<tr>
<td>12</td>
<td>Analog to Digital Converter 2</td>
</tr>
<tr>
<td>13</td>
<td>Analog to Digital Converter 3</td>
</tr>
<tr>
<td>14</td>
<td>Analog to Digital Converter 4</td>
</tr>
<tr>
<td>15</td>
<td>GND</td>
</tr>
</tbody>
</table>

Table 11 presents the characteristics of the analog to digital converter’s lines.

Table 11: Analog to Digital converters characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Rate</td>
<td>1 sample per second</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>&gt; 1 MΩ</td>
</tr>
<tr>
<td>Resolution</td>
<td>12 bits</td>
</tr>
<tr>
<td>Dynamic range</td>
<td>0 to 4.5 V</td>
</tr>
<tr>
<td>Input Protection</td>
<td>Zener Diodes</td>
</tr>
</tbody>
</table>

5.5.2 RF communication link

A direct reception of RF emission from the payload antenna is provided as a standard service.

The telemetry data signal characteristics of the STRAPLEX LV follow in Table 12.

Table 12: Telemetry data signal characteristics of the STRAPLEX LV.

<table>
<thead>
<tr>
<th>Frequency Band</th>
<th>Data Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>144 MHz</td>
<td>1200 bps</td>
</tr>
<tr>
<td>433 MHz</td>
<td>1200 bps</td>
</tr>
</tbody>
</table>

Table 12: Telemetry data signal characteristics of the STRAPLEX LV.
5.6 EGSE I/F

Refer to chapter 8 (Launch site) for additional information.

6 Experiment design and verification requirements

6.1 Introduction

The design and dimensioning data that shall be taken into account by any customer intending to launch a payload compatible with the STRAPLEX launch vehicle are detailed in this chapter. Before manufacturing an experiment, designers should contact the ESA Education Projects Division to get first approval on the design. Thereby, experimenters can implement necessary changes, if required, already before starting the construction.

Safety Requirements:
The customer is required to design the payload in conformity with the Safety Regulations imposed by ESA Education Projects Division and the University of Porto. The STRAPLEX LV must not be influenced or damaged due to the malfunction of experiments or due to the non-compliance to STRAPLEX requirements.

Any damage caused by a customer payload suffered by the CPE shall be at the expense of the customer.

The ESA Education Projects Division and the University of Porto decline all responsibility in case of damage or destruction of the payload.

No modification of the capsule or payload adapter structure is allowed before discussion with the ESA Education Projects Division and the University of Porto.

No equipment should be left POWER ON in the capsule without any attendance. The customers shall provide a guaranteed switching-off by commands. The payload shall give free access to its attachment elements. Elements which are removed during preliminary operating procedures shall be painted in red and provided with captive fasteners or similar.

6.2 Product Assurance approach for payload

The following product assurance approach has been defined in order to compile with STRAPLEX product assurance requirements:

• All customers are requested to complete the Experiment Registration Form, in order to assess the general compatibility and to identify the selected payloads;
• All customers shall provide a detailed Design Description Documents and Design Justification Documents, presenting a detailed description of the payload interface;
• If required, all customers shall provide a Safety Analysis Report;
• All customers shall provide a Test Plan and a Test Report;
• The Mission Operations Report will cover the operational aspects.

All documents shall be provided and approved before flight qualification acceptance.

### 6.3 Payload compatibility verification requirements

The payload authority shall demonstrate that the payload structure and equipments are capable of withstanding the maximum expected launch vehicle ground and flight environments, without causing any kinds of damages to the LV.

The payload compatibility must be proven by means of adequate tests. The verification logic with respect to the payload development program approach is depending on the payload and mission profile selected.

It is suggested, that customers will implement tests to verify the susceptibility of the payload to the mechanical, thermal and electromagnetic environment and will tune, this way, the corresponding payload models used for the mission analysis.

Payload qualification and acceptance test levels are determined by increasing the design load factors (the flight limit levels) by safety factors (10% for standard option), previously agreed with ESA Education Projects Division and the University of Porto.

### 6.4 Interface verifications

#### 6.4.1 General

The experiments will experience the same environmental conditions as the rest of the capsule – temperature, humidity, pressure drop and acceleration. Any type of experiment can be proposed (biology, physics etc), as long as it fits in the design requirements.

#### 6.4.2 Prior to the launch campaign

Prior to the initiation of the launch campaign, the following interface checks shall be performed.

**Mechanical fit-checks:** The payload shall pass a mechanical fit check with payload adapter to confirm that its dimensional and mating parameters meet all relevant requirements as well as to verify operational accessibility to the interface and cable routing. This preliminary test is performed usually at the customer’s facility, with the adapter equipped with electrical connectors in order to avoid any last minute failure.

**Electrical fit-check:** Functional interfaces between the payload and the power supply, TM monitoring, commands, etc. if any) shall usually be checked prior to the beginning of the launch campaign.
For current mission the mechanical and electrical fit-checks can be performed at the beginning of the launch campaign, in the payload preparation facilities.

6.4.3 Pre-launch validation of the electrical I/F

The electrical interface between payload and launch vehicle is validated on each phase of the launch preparation where its configuration is changed or the harnesses are reconnected. These successive tests ensure the correct integration of the payload with the launcher and allow proceeding with the non reversible operations.

Depending on the test configuration, the flight hardware, the dedicated harness and/or the functional simulator will be used. The payload simulator used to simulate payload functions during pre-integration tests and ground patch panel cables will be provided by customer.

The following customer’s equipment will be used for the interface validation tests:

- Payload test and monitoring equipment,
- Specific front end check-out equipment, providing payload monitoring and control, ground power supply,
- Set of the ground cables for payload verification.

6.5 Data recording

After the launch campaign, the ESA Education Projects Division and the University of Porto will provide a set of data recorded during the flight. These include position, attitude, temperature (in and outside the capsule), humidity, and other relevant information required.

Data recorded during the flight by the customer should be access free on request.

6.6 Verification Program

The customer shall implement a program for the verification of its payload.

Figure 21 shows the integrated experiment Verification Approach.
6.6.1 Model Philosophy

The recommended development approach is the Proto-Flight Model (PFM) philosophy: a unique experiment flight model will be built on which proto-qualification will be performed (but with low levels or stress duration).

6.6.2 Test Philosophy

As a minimum, the following tests have to be envisaged for the experiment PFM, However, more tests may be required to verify the experiment compliance with the applicable documents:

- Physical properties (dimension, mass, CoG);
- Interface Verification (mechanical, electrical and radio electrical I/Fs);
- Performances and functional tests (as applicable);
- Mechanical test (if applicable), including functional checks;
- Thermal Vacuum/Thermal Cycling Tests including functional checks (if applicable);
- EMC test (if applicable).

6.7 Schedule management

For the two annual standard flight campaigns, the schedule has to be compliant with the Table 13.
6.8 Acceptance and delivery of experiments

The acceptance of the experiment will be performed according to the following sequence of events:

- Completion of all verification activities, including in particular the acceptance tests, to verify that the experiment and associated equipment meet all interface and environmental specifications and that the experiment is ready for integration onto STRAPLEX LV;
- Delivery of the Acceptance Data Package (ADP);
- Delivery of the experiment and associated equipment and software to the integration site (following shipment under the customer responsibility);
- Experiment inspection.

Following successful completion of the above activities, the experiment will be released for integration onto STRAPLEX LV.

The following hardware has to be delivered to the integration site:

- Payload (Proto-) Flight Model including software;
- Associated cables, harnesses, interface equipments;
- Required GSE for integration if required.
7 Mission Operations

For the standard flight campaigns, the mission operations prior launch will comply with the following activity schedule. Depending on the launch conditions, the launch of the capsule can be postponed.

| Table 14: Mission operation launch preparation. |

<table>
<thead>
<tr>
<th>Launch area</th>
<th>Monitoring system</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set-up of the Launch area:</strong> Instruments (binoculars, compass), antenna, capsule, balloon, parachute, plastic cover, He bottle.</td>
<td><strong>Set-up of the Monitoring system:</strong> Environmental conditions initial check up.</td>
</tr>
<tr>
<td><strong>Weight estimation:</strong> Weight of the overall system.</td>
<td><strong>Power supply:</strong> Power supply check up.</td>
</tr>
<tr>
<td><strong>Capsule power ON:</strong> Switch ON the capsule instruments.</td>
<td><strong>Calibration:</strong> Calibration of the different instruments.</td>
</tr>
<tr>
<td><strong>Integration of the different flight units:</strong> Balloon-Parachute-Capsule chain.</td>
<td><strong>Tests:</strong> Test of the overall system (Reception...).</td>
</tr>
<tr>
<td><strong>He filling:</strong> Balloon He filling process.</td>
<td><strong>Final Environmental check up:</strong> Environmental conditions final check up.</td>
</tr>
<tr>
<td><strong>Final Mission check up prior launch:</strong> Final check up.</td>
<td><strong>Final system check up prior launch:</strong> Final system check up.</td>
</tr>
</tbody>
</table>

8 Launch site

During the launch campaign, all customer personnel will be under the direction of the ESA Education Projects Division. Strict adherence to the authority is strongly advised. Any deviation from the flight plan must be discussed with the ESA Education Projects Division before its implementation.

At this time of the project, regarding the launch site selection, only Évora will be considered. Information about Madeira Island and Esrange will be issued later.
Depending on the launch location, all equipment delivery should be done to:

**AERODROME of ÉVORA**
Rua Unidade nº 11
7000 Évora
PORTUGAL

**AEROPORTO da MADEIRA**
ANAM – Aeroportos e Navegação Aérea da Madeira
9100-105 Santa Cruz (Madeira Island)
PORTUGAL

**SWEDISH SPACE CORPORATION**
Esrange, P.O. Box 802,
SE-981 28 Kiruna
SWEDEN

### 8.1 Évora

#### 8.1.1 Introduction

The launch preparation and launch can be carried out from the Évora launch site - Local airport operational since 1968 in Portugal. Évora accommodates STRAPLEX separated launch facilities with common Payload Preparation Complex and launch support services.

The launch facility provides state-of-the-art Payload Preparation Facilities. The facilities are capable to process several capsules of different customers in the same time, thanks to large facilities and supporting infrastructures.

Figure 22 shows an overview of the Évora launch site.

![Figure 22: Évora launch site overview.](image)

For detailed mapping of the launch site, please refer to Figure 23.

The moderate climate, the regular air and land connection, accessible local transportation, and excellent accommodation facilities for business– all that devoted to user’s team and invest to the success of the launch mission.
8.1.2 General presentation

The payload and customer’s ground support equipment can be delivered to the launch site by aircraft, landing at either Lisbon International airport or Porto international airport or Évora aerodrome, and by “commercial” ship at the Lisbon international harbour.

Figure 23 and AD[4] provide some general information on how to reach the Évora launch site.

8.1.3 Payload preparation complex

Room (10*8 m²) including tables, power supply, fire extinguisher and fridge if required.

Figure 24: Évora payload preparation complex.
8.1.4 General characteristics

Geographical conditions
The launch site is located in Évora, Portugal. It is a wide field, in the middle of the country side, reachable by terrestrial vehicles but also by small airplanes.

<table>
<thead>
<tr>
<th>Launch site characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>City name</td>
</tr>
<tr>
<td>Latitude</td>
</tr>
<tr>
<td>Longitude</td>
</tr>
</tbody>
</table>

Table 15: Évora launch site on the map.

The local time is Greenwich Mean Time (GMT).

Environmental conditions
The climatic conditions at the Évora launch site are defined as follows:
- The ambient air temperature varies between: 0 and 42 °C;
- The relative humidity varies between: 20 and 80%.

Communication network
No internet connection is available on site at the time of writing. This is an issue that the University of Porto will try to solve for the launch campaigns.

Power supply
All facilities used by the customer for payload activity during autonomous and combined operations are equipped with an uninterrupted power supply, European standard (230V/400V - 50 Hz). For non-critical equipment like general lighting, power outlets, site services, etc. a public network (220 V/50 Hz) is used.

Figure 25: GSE configuration at Évora launch site.
Ground preparation thermal condition
The environment that the payload experiences both during its preparation and once it is encapsulated under the capsule fairing is room-temperature. The typical thermal environment within the air-conditioned facilities is kept around 10 to 40 °C for temperature and 55% ± 10% for relative humidity.

Transport and handling
For all inter-site transportation including transportation from the port of arrival of payload and support equipment, the launch authorities provide a Fenwick as payload transportation system. These means is not adapted to hazardous, fragile, oversized loads freight.

Fluids and gases
Quantity, concentration, containment, state (solid, fluid, or gas) and nature of products need to be documented and provided to the ESA Education Projects Division and the University of Porto.

8.1.5 Launch campaign
At least, the customer shall perform one final functional check-out test. However, it is not mandatory that the customer will be present during the launch preparation, if detailed ICD is provided.

After integration of STRAPLEX, no further access to the payload is possible.

Launch preparation will start approximately 2 days prior the launch. The activities have to be synchronized with the activities of all other payloads as well as the STRAPLEX LV preparation.

Firemen will be present in case of hazardous event during the launch.

![Figure 26: Mission operation in Évora.](image)

Whenever possible, a launch window will be defined in order to provide launch flexibility and to cope with any perturbation (weather, launch hold, etc.).
From Évora, the STRAPLEX LV can be launched any day of the year, depending on the weather conditions, during daylight to respect the specified capsule recovery conditions.

Three teams will be near the predicted land position fully equipped with portable/mobile radio stations capable of receiving telemetry and computing the new expected landing site with the latest heading information from the CPE so that recovery can be done right after landing.

### 8.1.6 Launch Operations Policy

Access to launch facilities shall comply with the launch authorities’ safety requirements:

- No hazardous operation in the vicinity;
- No facility configuration change;
- Handling equipment shall be used only by certified personnel;

Any activity involving a potential source of danger is to be reported to the ESA Education projects Division, which in return takes all actions necessary to provide and operate adequate collective protection equipment, and to activate the emergency facilities.

The access badges to the launch facility will be provided by the ESA Education projects Division and the University of Porto according to customer request.

Contact the ESA Education projects Division for further information.

### 8.2 Madeira Island

#### 8.2.1 Introduction

The launch preparation and launch can be carried out from the Madeira Island launch site - Local airport operational since July 8th 1964 in Portugal, and situated 15 km from the capital Funchal. Madeira Island accommodates STRAPLEX separated launch facilities with common Payload Preparation Complex and launch support services.

The launch facility provides state-of-the-art Payload Preparation Facilities. The facilities are capable to process several capsules of different customers in the same time, thanks to large facilities and supporting infrastructures.

Figure 27 shows an overview of the Madeira Island launch site.
8.2.2 General presentation

The payload and customer’s ground support equipment can be delivered to the launch site by aircraft, landing at Madeira international airport, and by “commercial” ship at the Madeira harbour.

Figure 28 provides some general information on how to reach the Madeira Island launch site.

For detailed mapping of the launch site, please refer to Figure 28.

The moderate climate, the regular air and land connection, accessible local transportation, and excellent accommodation facilities for business— all that devoted to user’s team and invest to the success of the launch mission.

The possibility of Madeira’s International Airport as a balloon launch site is still being discussed due to the heavy airborne traffic that the area has.
8.2.3 General characteristics

Geographical conditions
The launch site is located in Madeira Island, Portugal. It is an international airport facility, reachable by private/public transportation.

<table>
<thead>
<tr>
<th>Launch site characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>City name</strong></td>
</tr>
<tr>
<td>Santa Cruz, Madeira Island, Portugal</td>
</tr>
<tr>
<td><strong>Latitude</strong></td>
</tr>
<tr>
<td>32° 41' 52&quot; N</td>
</tr>
<tr>
<td><strong>Longitude</strong></td>
</tr>
<tr>
<td>16° 46' 28&quot;W</td>
</tr>
</tbody>
</table>

Table 16: Madeira Island launch site on the map.

The local time is Greenwich Mean Time (GMT).
Environmental conditions
The climatic conditions at the Madeira Island launch site are defined as follows:
- The ambient air temperature varies between: 18° and 25° Celsius average;
- The relative humidity varies between: 30 and 70%.

<table>
<thead>
<tr>
<th>Month</th>
<th>Value (avg.)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>18.6</td>
<td>Celsius</td>
</tr>
<tr>
<td>February</td>
<td>18.5</td>
<td>Celsius</td>
</tr>
<tr>
<td>March</td>
<td>18.8</td>
<td>Celsius</td>
</tr>
<tr>
<td>April</td>
<td>19.6</td>
<td>Celsius</td>
</tr>
<tr>
<td>May</td>
<td>20.4</td>
<td>Celsius</td>
</tr>
<tr>
<td>June</td>
<td>22.1</td>
<td>Celsius</td>
</tr>
<tr>
<td>July</td>
<td>23.6</td>
<td>Celsius</td>
</tr>
<tr>
<td>August</td>
<td>24.6</td>
<td>Celsius</td>
</tr>
<tr>
<td>September</td>
<td>24.7</td>
<td>Celsius</td>
</tr>
<tr>
<td>October</td>
<td>23.6</td>
<td>Celsius</td>
</tr>
<tr>
<td>November</td>
<td>21.5</td>
<td>Celsius</td>
</tr>
<tr>
<td>December</td>
<td>19.6</td>
<td>Celsius</td>
</tr>
</tbody>
</table>

*Table 17: Monthly weather report for Madeira Island*

In June the day temperature is about 22.1 °C and the night temperature is around 17.5 °C. The days have an average of 6.4 sun hours and the rain must come down only in a day.

Figure 29 shows a satellite view with clouds density above the Madeira Island. The METEOSAT-7 will support the STRAPLEX team to confirm the forecast, prior to the day of the launching.

**Communication network**
The multifunctional communication network provides customer with different ways to communicate internally and externally by voice and data.

**Power supply**
All facilities used by the customer for payload activity during autonomous and combined operations are equipped with an uninterrupted power supply, European standard (230V/400V -
50 Hz). For non-critical equipment like general lighting, power outlets, site services, etc. a public network (220 V/50 Hz) is used.

**Ground preparation thermal condition**
The environment that the payload experiences both during its preparation and once it is encapsulated under the capsule fairing is controlled in terms of temperature, relative humidity. The typical thermal environment within the air-conditioned facilities is kept around 0 to 40 °C (TBC) for temperature and 55% ± 5% (TBC) for relative humidity.

**Transport and handling**
For all inter-site transportation including transportation from the port of arrival of payload and support equipment, the customers shall provide its own mean of payload transportation system, such as road trailers, trolleys and trucks. These means have to be adapted to the various freight categories: standard, hazardous, fragile, oversized loads, low speed drive, etc.

**Fluids and gases**
Quantity, concentration, containment, state (solid, fluid, or gas) and nature of products need to be documented and provided to the ESA Education Projects Division and the University of Porto.

### 8.2.4 Launch campaign

At least, the customer shall perform one final functional check-out test. However, it is not mandatory that the customer will be present during the launch preparation, if detailed ICD is provided.

After integration of STRAPLEX, no further access to the payload is possible.

Launch preparation will start approximately 2 days prior the launch. The activities have to be synchronized with the activities of all other payloads as well as the STRAPLEX LV preparation.

Wherever possible, a 60 minutes launch window will be defined in order to provide launch flexibility and to cope with any perturbation (weather, launch hold, etc.).

From Madeira Island, the STRAPLEX LV can be launched any day of the year, depending on the weather conditions, during day light to respect the specified capsule recovery conditions. June, along with July, is the month with less rainfall during the year.

Teams will be near the predicted land position fully equipped with portable/mobile radio stations capable of receiving telemetry and computing the new expected landing site with the latest heading information from the CPE so that recovery can be done right after landing.

### 8.2.5 Launch Operations Policy

Access to launch facilities shall comply with the launch authorities’ safety requirements:
- No hazardous operation in the vicinity;
• No facility configuration change;
• Handling equipment shall be used only by certified personnel;

Any activity involving a potential source of danger is to be reported to the ESA Education projects Division, which in return takes all actions necessary to provide and operate adequate collective protection equipment, and to activate the emergency facilities.

The access badges to the launch facility will be provided by the ESA Education projects Division and the University of Porto according to customer request.

Contact the ESA Education projects Division for further information.

8.3 Esrange

8.3.1 Introduction

Esrange was built by ESRO - the European Space Research Organisation - and inaugurated in 1966. A great number of projects were executed between November 1966 and June 1972, mainly by ESRO. Since July 1, 1972, Esrange has been managed by the Swedish Space Corporation (headquarter in Stockholm). In 1974 Esrange completed a launching facility for scientific balloons. This facility has been continuously upgraded to enable launchings of 1,000,000 m³ balloons. Esrange plays, since 1978, an important role in various satellite projects. A number of ground segments for the support of national and international spacecraft programmes are now in operation. Refer to AD[9].

The launch facility provides state-of-the-art Payload Preparation Facilities. The facilities are capable to process several capsules of different customers in the same time, thanks to large facilities and supporting infrastructures.

Figure 30 shows a view of the Esrange launch facilities.

Figure 30: Esrange launch site overview.
Scientists and technicians come to Esrange with balloon payloads for various reasons:

- Ozone studies, as Esrange is placed within the Polar Vortex.
- Circum Polar Flights, due to the Polar Vortex.
- Astronomy studies, as the instruments can measure above the disturbing atmosphere.
- Astrophysical studies, due to the disturbing atmosphere.
- Micro gravity studies, as we have a large restricted landing area.
- Tests of new aerospace vehicles, due to the large restricted landing area.

### 8.3.2 General presentation

The town closest to the range is Sweden's principal mining town Kiruna (approximately 25,000 inhabitants), which is about half an hour away by car. Access to Kiruna is very good with several daily jet flight connections with Stockholm.

Kiruna has good air, rail, and road connections. It is recommended to use winter tyres from mid-October until mid-April. There are daily flights from Stockholm, Arlanda to Kiruna. Flight time from Stockholm to Kiruna is about 1 hour and 30 minutes. The Kiruna airport is situated a few kilometres outside Kiruna. The local taxi service or rental cars are recommended for transport from the airport. Two trains from Stockholm arrive daily at Kiruna. The travelling time from Stockholm to Kiruna is around 17 hours. The Kiruna railway station is situated close to the city centre, but taxi transport is still recommended. Esrange is accessible from Kiruna by road. There is no public transportation available; cars or taxis must be used. The distance is 45 km, and the driving time is about 45 minutes.

An extensive network of ground based scientific instrumentation has been established in northern Scandinavia, such as the Swedish Institute of Space Physics (IRF) the European Incoherent Scatter Facility (EISCAT) comprising a system of stations at Tromsø (Norway), Kiruna (Sweden) and Sodankylä (Finland). In Abisko north of Kiruna is a climate research centre, which provides possibilities for scientific research in arctic regions and location of ground based instrumentation. Refer to AD[6], AD[7] and AD[8].

Figure 31 provides some general information on how to reach the Esrange launch site.
8.3.3 Payload preparation complex

The Main Building was erected in 1964-65. It has four storeys with a total floor area of 3,930 m². The basement is used as storage for spare parts. It also contains mechanical, electrical and carpentry workshops. For staff and guests there is a sauna and showers. The ground floor houses offices for Esrange administration and technical facilities, a front desk, a switch-board, a canteen, two conference rooms for 15 and 30 people and a lounge. The first floor has offices for operational staff, the operations centre for sounding rockets and rooms for timing, telemetry and scientific instruments (Scientific Centre). In an annex on the same floor there are offices and guest rooms. The top floor (second floor) has a large conference room for about 80 people, and offices. The Main Building area also includes a warehouse with a total area of 490 m², warm and cold garages for cars and accommodation buildings with 93 single rooms of different standards, showers and kitchens. The central complex includes all facilities that are necessary for a pleasant stay at Esrange, including accommodations, restaurants and recreation areas. There are four conference rooms in the main building. They are all equipped with data video projection and one of the conference rooms has world-wide video conferencing. The conference rooms hold seats from twelve up to seventy persons. Refer to AD[10].
8.3.4 General characteristics

Geographical conditions
The launch site is located in Esrange, Sweden, above the Arctic Circle. The Esrange premises are located in an area of 20 km² about 40 km east of Kiruna. The Main Building area is located in the Vittangi river valley and comprises the Main Building, the Telecom building, Hotel Albert, Hotel Herbert, Hotel Dagobert, Hotel Dilbert and garages. Close to the main building area is the area for balloon launchings including two buildings for operations control and payload preparation.

Further east is the launching area for rockets, which includes a blockhouse, rocket and payload preparation halls, chemical laboratories and launch pads. The radar station, the satellite receiving station, and a GPS reference station are situated on top of a hill 2 km southwest of the Main Building. A ground observation station, KEOPS, is located on another hilltop about 1 km further west.
The local time is GMT 1 h.

**Environmental conditions**
The climatic conditions at Esrange launch site are defined as follows:
- The ambient air temperature varies between: -48 to 30 °C;
- The relative humidity varies between: TBD.

For additional information, especially on winds conditions, refer to AD[10].

**Communication network**
The multifunctional communication network provides customer with different ways to communicate internally and externally by voice and data. Refer to AD[10].

**Power supply**
All facilities used by the customer for payload activity during autonomous and combined operations are equipped with an uninterrupted power supply, European standard (230V/400V - 50 Hz). For non-critical equipment like general lighting, power outlets, site services, etc. a public network (220 V/50 Hz) is used.

**Other GSE I/F**
Esrange assist in providing supplies of articles not stored at Esrange. Standard items are normally delivered in less than one week. Special orders, for instance helium, neon, hydrogen, and dry nitrogen gases, are delivered in 1 to 6 weeks.

---

**Launch site characteristics**

<table>
<thead>
<tr>
<th>City name</th>
<th>Esrange, Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude</td>
<td>67° 53’ N</td>
</tr>
<tr>
<td>Longitude</td>
<td>21° 04’ E</td>
</tr>
</tbody>
</table>

**Table 18:** Esrange launch site on the map.

---

**Figure 34:** GSE configuration at Esrange.
Ground preparation thermal condition
The environment that the payload experiences both during its preparation and once it is encapsulated under the capsule fairing is controlled in terms of temperature, relative humidity. The typical thermal environment within the air-conditioned facilities is kept around 0 to 40 °C (TBC) for temperature and 55% ± 5% (TBC) for relative humidity.

Transport and handling
For special transports, the following vehicles are available at Esrange: a small lorry, pick-ups, a truck, and snowmobiles. For loading and unloading there are forklifts.

Fluids and gases
Quantity, concentration, containment, state (solid, fluid, or gas) and nature of products need to be documented and provided to the ESA Education Projects Division and the University of Porto.

8.3.5 Launch campaign
At least, the customer shall perform one final functional check-out test. However, it is not mandatory that the customer will be present during the launch preparation, if detailed ICD is provided.

After integration of STRAPLEX, no further access to the payload is possible.

Launch preparation will start approximately 2 days (TBC) prior the launch. The activities have to be synchronized with the activities of all other payloads as well as the STRAPLEX LV preparation.

Wherever possible, a 60 minutes launch window will be defined in order to provide launch flexibility and to cope with any perturbation (weather, launch hold, etc.).

From Esrange, the STRAPLEX LV can be launched any day of the year, depending on the weather conditions, during day light to respect the specified capsule recovery conditions.
Teams will be near the predicted land position fully equipped with portable/mobile radio stations capable of receiving telemetry and computing the new expected landing site with the latest heading information from the CPE so that recovery can be done right after landing.

8.3.6 Launch Operations Policy

Access to launch facilities shall comply with the launch authorities’ safety requirements:
- No hazardous operation in the vicinity;
- No facility configuration change;
- Handling equipment shall be used only by certified personnel;

Any activity involving a potential source of danger is to be reported to the ESA Education projects Division, which in return takes all actions necessary to provide and operate adequate collective protection equipment, and to activate the emergency facilities.

The access badges to the launch facility will be provided by the ESA Education projects Division and the University of Porto according to customer request.

Contact the ESA Education projects Division for further information.
Appendix 1

Annex 1 gives a detail description of the capsule geometry, providing mechanical drawings and internal configuration.

Figure 36: Mechanical drawings of the capsule.
Appendix 2

Annex 4 gives a detail description of the payload adapter geometry, providing mechanical drawings and internal configuration.

Figure 37: Detail description of the payload adapter geometry
Appendix 3

Annex 3 gives the external temperature, external pressure and other relevant parameters for a certain mission profile.

This data was collected by a weather balloon launched in Spain in December 2004, refer to AD[3]. Assuming that this profile will be similar to the one of this mission, it will be used as a reference. All the following plots were made using MATLAB software, with the values obtained from AD[3].

External temperature profile

![External temperature profile](image1.png)

**Figure 38**: Foreseen external temperature profile

External pressure profile

![External pressure profile](image2.png)

**Figure 39**: Foreseen external pressure profile
Altitude versus Time profile

![Figure 40: Foreseen altitude versus time profile.](image)

Capsule Vertical Velocity

The following values are average ones and assumed to be approximately constant during most of each flight phase.

Ascend phase: 7 m/s  
Descend phase: 4 m/s

![Figure 41: Foreseen vertical velocity](image)

These velocity values were obtained from the altitude versus time plot above. They can be easily controlled due to their dependency on the capsule weight, the balloon lift and the parachute used. Note that the above record is for the case where the parachute opens immediately the after balloon burst.
Appendix 4

Appendix 4 gives some general information about the Évora aerodrome.

**ÉVORA AERODROME - LPEV**

### 1. GENERAL

**LOCATION:** Évora  
**POSITION:** Lat. 3°33'19"N Long. 7°55'51"W  
**MAGNETIC VARIATION:** 4°30'W (1995)  
**Annual Variation:** +0.4'  
**DISTANCE AND DIRECTION FROM TOWN:** 1.5 NM at 026°  
**ELEVATION:** 244 m (800 ft)

**ADMINISTRATIVE AUTHORITY:** Câmara Municipal de Évora - Praça do Sertório - 7031 ÉVORA

**Telephone numbers:** (351) 266704111 to (351) 266704106  
**ADM/AVIATION:** CEM SHSU  266704311  
**Address:** rua S. Bento Menel nº 2 - 3ª A, 1805-664 Lisboa  
**Mobile Phone:** 937308638  
**AERODROME TELEPHONE NUMBERS:** (351) 266702221  
**Fax:** (351) 266772202  
**E-mail:** evora.aerodrome@gmail.com  
**AERODROME GUARD:** Permanently  
**Telephone:** (351) 266702220

### 2. LIMITATIONS

**OPERATIONAL HOURS:** HJ.  
**CONDITIONS ON USE OF AERODROME:**  
VFR flights only; small aircraft (MTOM - or - 5700 kg).

### 3. FACILITIES

**ACCOMMODATION:** In Évora  
**RESTAURANTS:** In Évora  
**RAILWAY STATION:** Évora  
**POST OFFICE:** in Évora

### 4. MOVEMENT AREA

Taxing on RWY 09/27 only.  
During periods of rainfall RWY 09/27 is out of service.

### 5. RUWAYS

<table>
<thead>
<tr>
<th>QFU</th>
<th>LP</th>
<th>ACQ</th>
<th>OB</th>
<th>SLOPE</th>
<th>LO</th>
<th>WY</th>
<th>LSH</th>
<th>WAY</th>
<th>SURFACE</th>
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<tr>
<td>190°</td>
<td>01</td>
<td>1500 X 25</td>
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<td>640</td>
<td>640</td>
<td>Gravel</td>
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<tr>
<td>060°</td>
<td>01</td>
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<td>640</td>
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<td>640</td>
<td>640</td>
<td>640</td>
<td>640</td>
<td>Concrete</td>
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</table>

Remarks: Thr of RWY 09 displaced 50 metres. Displacement due to the existence of a fence, height E +1.5 m placed before FIM 05.

### 6. VISUAL AIDS

**WIND DIRECTION INDICATOR:** Yes  
**WIND VECTORS:** Yes  
**THR MARKERS:** Yes  
**RWY DESIGNATION:** Yes  
**RWY CENTRE LINE:** Yes

### 7. OBSTACLES

<table>
<thead>
<tr>
<th>APPROACH</th>
<th>TYPE</th>
<th>DISTANCE</th>
<th>ALTITUDE</th>
<th>MARKING/LIGHTING</th>
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</thead>
<tbody>
<tr>
<td>26 Trees</td>
<td>Around 800 m</td>
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**ÉVORA**

**INSTITUTO NACIONAL DE AVIAÇÃO CIVIL**  
**JUNE 2004**

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**STRAPLEX – STRAPLEX-UM-1-8.doc**  
Faculty of Engineering of Porto - DEEC-FEUP, in cooperation with the ESA Education Projects Division  
This document is proprietary. Any dispatch or disclosure of content is authorized only after written authorization by ESA.
8. LIGHTING AIDS

9. METEOROLOGY

REFERENCE TEMPERATURE: -------
MEAN MAXIMUM TEMPERATURE: 20.4°C
MEAN MINIMUM TEMPERATURE: 10.8°C
MEAN ANNUAL PRECIPITATION: -------
PREVAILING WINDS: N - S
MEAN ANNUAL NUBULOSY: 7

10. MEDICAL FACILITIES AND FIRE PROTECTION

MEDICAL FACILITIES: in Evora
RESCUE AND FIRE FIGHTING SERVICE: not available.
Firemen at Evora (on request)

11. HANGARS

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>LENGTH</th>
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<th>REMARKS</th>
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<td></td>
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<td>15.7 m</td>
<td></td>
</tr>
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<td>35</td>
<td>9 m</td>
<td>35 m</td>
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</tr>
<tr>
<td>5</td>
<td>35</td>
<td>9 m</td>
<td>35 m</td>
<td></td>
</tr>
</tbody>
</table>

12. OTHER FACILITIES

Briefing Room, social facilities at aerodrome terminal.

13. REFUELLING FACILITIES

AVGAS 100/130
JET A1
OIL W100 e AEROHELL 100, W100, W120
(Enterprise AGROAR)

14. COMMUNICATIONS AND RADIO AIDS

<table>
<thead>
<tr>
<th>FREQUENCY</th>
<th>COVERAGE</th>
<th>TYPE OF SERVICE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>122.700 MHz</td>
<td>25 MIN/FLD 40</td>
<td>A3E</td>
<td>AFG</td>
</tr>
</tbody>
</table>

15. OTHER INFORMATION

From 09 June 2004 to 08 July 2004 (period of EURO 2004 Tournament) the use of Evora Aerodrome is subject to prior Authorization of the Director of Aerodrome.
- Fences, height 5' (1.5 m) are located 60 m and 300 m in front of THR 01 and short before THR 08.
- Usual activities: glider flights and parachuting exercises (Area - circle with 3 km radius and centre at the Aerodrome, height 2000 metres AGL.)

INSTITUTO NACIONAL DE AVIAÇÃO CIVIL

JUNE 2004
Appendix 5 gives detailed information about the data acquired on the first flight. The following data was collected from the qualification flight in December 2005.

**Launch and recovery sites map**

![Launch and recovery sites map](image)

Site 0: Launch site, Évora (Portugal)
Site 1: First qualification flight landing site (December 20, 2005)

**General Data**

- **Launch date:** Tuesday, 20 April 2005
- **Launch site:** Évora (Portugal)
- **Capsule mass:** 3.5 kg
- **Launch time:** 09:10:32
- **Burst time:** 10:53:28
- **Touch down time:** 11:28:26
- **Ascent duration:** 103 minutes
- **Descent duration:** 37 minutes
- **Maximum descending velocity:** 250 km/h (70 m/s)
- **Final touch down velocity:** 35.6 km/h (9.88 m/s)
- **Maximum reached altitude:** 33766 meters
- **Horizontal travelled distance:** 97308 meters
Figure 42: Altitude in function of the flight time

Figure 43: Capsule’s heading during ascendant phase
Figure 44: Capsule’s pitch during ascendant phase

Figure 45: Capsule’s roll during ascendant phase
Figure 46: Detail of the capsule’s roll behaviour during ascendant phase

Figure 47: Vertical velocity in function of flight time during ascendant phase
Figure 48: Vertical velocity in function of the capsule’s altitude during ascendant phase

Figure 49: Vertical velocity in function of the flight time during descendant phase
Figure 50: Vertical velocity in function of the capsule’s altitude
Several conclusions were taken taking into account this data:

The capsule rotates during the ascent phase for a few cycles (10 to 20) in one direction; then starts another series of turns in the opposite direction. The maximum angular speed is about 100 degrees per second the in troposphere; about 50 degrees per second in the stratosphere. The attached graphic shows this effect.

The capsule oscillates laterally in a pendulum motion, reaching tilt angles of about 30 degrees (sometimes more).

The vertical velocity during ascent suffers a small sinusoidal oscillation and slightly larger lateral oscillation. This agrees with the pendulum motion. It reaches amplitudes of 10 meters (peek to peek and laterally).

After burst, it took about 21 seconds for the capsule (plus parachute) to reach its maximal descent velocity (about 70 meters per second). Then it started slowing down as the air becomes denser, as expected.

**Figure 51:** Vertical velocity profile in function of the time during the whole flight
Appendix 6

Appendix 6 gives detailed information about the data acquired on the first flight. The data enclosed in this document were collected during the second qualification flight on 23 April 2006.

**Launch and recovery sites map**

Site 0: Launch site, Évora (Portugal)
Site 1: First qualification flight landing site (December 20, 2005)
Site 2: Second qualification flight landing site (April 23, 2006)

**General Data**

- **Launch date**: Sunday, 23 April 2006
- **Launch site**: Évora (Portugal)
- **Capsule mass**: 5.5 kg
- **Launch time**: 12:56:44
- **Burst time**: 15:21:37
- **Touch down time**: 15:49:51
- **Ascent duration**: 144 minutes
- **Descent duration**: 29 minutes
- **Maximum descending velocity**: 138 km/h (38.35 m/s)
- **Final touch down velocity**: 35.6 km/h (9.88 m/s)
Maximum reached altitude: 27400 meters  
Horizontal travelled distance: 55000 meters

Flight timeline

- Sun, Apr 23 2006 11:36:43  
  Computer start up  
- Sun, 23 Apr 2006 11:38:31  
  First sensor’s data  
- Sun, 23 Apr 2006 12:33:41  
  First picture  
- Sun, 23 Apr 2006 12:56:44 GMT  
  Take off based on pressure sensor’s data  
- Sun, 23 Apr 2006 15:21:37 GMT  
  Burst based on pressure sensor’s data  
- Sun, 23 Apr 2006 15:27:55 GMT  
  Parachute full deployment based on pressure sensor’s data  
- Sun, 23 Apr 2006 15:48:53  
  Last picture  
- Sun, 23 Apr 2006 15:49:51  
  Last sensor data  
  Last operating system’s log  
  Touch Down based on pressure sensor’s data

(*) Due to failure of the navigation system, no GPS data are available for the second qualification flight. Parachute deployment and touch down could be identified based on the pressure sensor’s data.
**External Pressure**

![External Pressure Graph]

**Altitude Profile**

![Altitude Profile Graph]
**Internal Temperatures**

<table>
<thead>
<tr>
<th>Enclosure</th>
<th>Minimum Temperature (°C)</th>
<th>Maximum Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment Payload</td>
<td>9.50</td>
<td>27.00</td>
</tr>
<tr>
<td>Control Platform</td>
<td>21.50</td>
<td>61.50</td>
</tr>
<tr>
<td>Batteries</td>
<td>21.50</td>
<td>48.50</td>
</tr>
</tbody>
</table>

**Temperature Profile**

[Graph showing temperature profile with key events: Burst, Parachute deployment, and Touch down.]