

IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems (4)

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ARCHITECTURE AND GROUND OPERATIONS CONCEPT FOR A TWO STAGE TO ORBIT
USING SABRE ENGINES AND LAUNCHED FROM THE CSG EUROPEAN SPACEPORT**Abstract**

The French Space Agency (Centre National d'Etudes Spatiales, CNES), the UK Space Agency (UKSA), Reaction Engines Limited (REL) and the French Aerospace Lab (Office National d'Etudes et de Recherches Aérospatiales, ONERA) share a common interest for future space launch architectures and technologies. ALCADIA was involved on the ground segment systems and operations analysis. A joint study started in 2018 with the main objective of assessing and quantifying the potential advantages and benefits of air-breathing propulsion technology developed by REL named SABRE (Synergetic Air-Breathing Rocket Engine) for future systems based on a Two-Stage-To-Orbit launcher with Vertical-Take-Off-Vertical-Landing in the French Guyana Space Center, Kourou. This paper covers two areas of the study:

- The ground segment preliminary analysis, focusing on ground operations and on the needed ground systems.
- REL and ONERA's work on the TSTO architecture including vehicle sizing, ascent and re-entry trajectories.

Within the Ground Segment studies, the Concept of Operations (CONOPS) plays an important role as it influences both the Ground and the Flight Segments design and architecture. This work is based on the experience and know-how on past and current launch systems as well as those currently in development.

An iterative methodology has been used with partners to define the TSTO Sabre's CONOPS, consisting first in estimating the main operational phases of the launch system, from a ground perspective. Then setting up and defining the sequence of ground operations within the launch campaign, before, during and after the flight, as much as the current launcher definition allows it. Some preliminary conclusions are proposed for the following ground means:

- The vehicle maintenance and preparation zone.
- The second stage and payload integration preparation facility.
- The main runway and taxiways, including location, orientation, as well as safeguard and mission constraints.
- The fuelling areas.
- And the launch centre.

The paper also describes REL and ONERA's work on the TSTO architecture designed to deliver a 15T payload from Kourou into a 400km Equatorial orbit. Of key interest were the design trades required to develop a SABRE spaceplane first stage, including the ascent trajectory, recovery/return to base, abort scenarios, and the aerothermal environment encountered during 1st stage re-entry.

This work finally identified topics of interest which will need further investigation in the next step of the ongoing project.