

THE SOYUZ AT THE GUIANA SPACE CENTRE PROGRAMME

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OVERVIEW

The European Space Agency (ESA) and the Russian Federal Space Agency pursue a long-term cooperation and partnership in the field of development, implementation and use of launchers.

One of the key elements of this cooperation is the Soyuz at the CSG programme. Soyuz will complement the European launcher family, which consists of the operational Ariane 5 heavy-lift launcher and the small Vega launcher under development.

The programme started in 2004 and the construction of the Soyuz Launch Site at the European Space Port in French Guiana is progressing well towards a first launch envisaged in spring 2009.

Soyuz, in its different versions, is renowned both for the number of successful launches made - more than 1700 - and for its role in carrying astronauts from many different nations into space.

The Soyuz at the CSG Programme focuses on the construction of a launch base at CSG for unmanned Soyuz missions in a variety of orbits (GTO, SSO, MEO), the adaptation of the launcher to CSG operational conditions, and the participation to the development of a third stage with higher performance, called Soyuz 2-1b.

However, it has the growth potential for more ambitious projects in the future, such as allowing potential upgrading for human space transportation from CSG.

1. PROGRAMME OBJECTIVES AND SCOPE

The Soyuz at the CSG Programme of the European Space Agency comprises three main elements:

- the construction of a launch site in Sinnamary, French Guiana, for the exploitation of Soyuz-ST launchers,
- the adaptation of the Soyuz launcher to exploitation conditions in French Guiana, in terms of flight and range safety, climatic environment, and interfaces with the existing European ground segment,
- the European participation to the development of the Soyuz 2-1b version with a higher performance third stage engine RD-0124, replacing the RD-0110 engine.

The overall Programme cost is 344 M€ in 2002 economic conditions. It is financed by seven ESA Member States (Austria, Belgium, France, Germany, Italy, Spain, Switzerland) and the European Union for a total amount of 223M€ plus a contribution of 121M€ by Arianespace, funded through a loan of the European Investment Bank.

In its development phase, the Programme organisation is structured as follows:

- The European Space Agency is the overall Programme responsible,
- ROSKOSMOS, the Russian Federal Space Agency, is in charge of the activities within the Russian Federation,
- CNES DLA (Launchers Directorate) is ESA's main contractor as System Architect, in charge of the

Programme development, and responsible for both European and Russian activities,

- CNES CSG is responsible for range and flight safety by delegation of the French government,

- Arianespace is in charge of the Russian activities,

- TsSKB-Progress is the Soyuz ST launcher general designer and manufacturer,

- KBOM is responsible for all Russian launch zone ground equipment,

- NPO Lavochkine is the Fregat upper stage general designer and manufacturer.

2. SOYUZ LAUNCHER TO BE EXPLOITED FROM THE CSG

In the frame of the Russian Federal Space Programme, TsSKB-Progress developed a new version of Soyuz, the Soyuz-2 launcher. This has been achieved in two steps:

- The Soyuz 2-1a launcher features a new digital command and telemetry system, and the first and second stage engines have been equipped with upgraded injector heads. The maiden flight took place on 8 November, 2004 from the Plessetsk cosmodrome. The 2nd launch took place on 19 October 2006 with a Fregat upper stage, a ST-fairing and the ESA METOP satellite from the Baikonur cosmodrome. The 3rd launch took place on 24 December 2006 with a Fregat upper stage and the Meridian satellite from the Plessetsk cosmodrome.

- The Soyuz 2-1b launcher is equipped with a more powerful third stage engine RD-0124, with an Isp of 359s, replacing the RD-0110 engine.

The 2-1b maiden flight took place on 27 December 2006 with the Fregat upper stage and the CNES COROT satellite from the Baikonur cosmodrome.

Soyuz ST is the Soyuz-2 based launcher version to be operated from CSG. The Soyuz ST-a and ST-b payload performance from CSG is presented in TAB 1 below.

	Soyuz ST-a	Soyuz ST-b
Bloc I Engine	RD-0110	RD-0124
GTO Performance	2730 kg	3060 kg
SSO Performance (660km/98.1°)	4450 kg	4900 kg

TAB 1: Soyuz ST-a and ST-b PIL capabilities

The Soyuz ST launcher is presented in Figures 1 and 2 below.

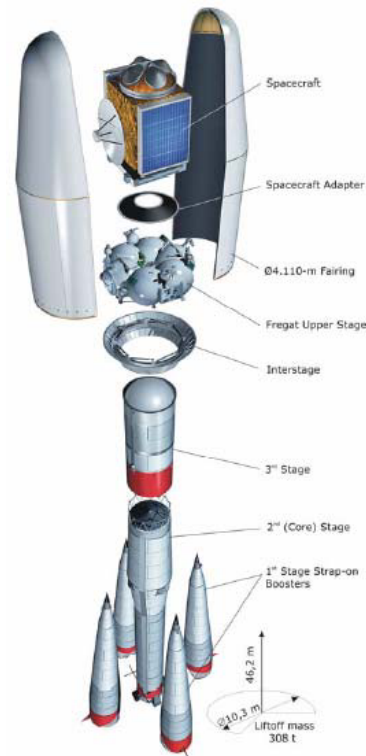


FIG 1: Soyuz ST launcher

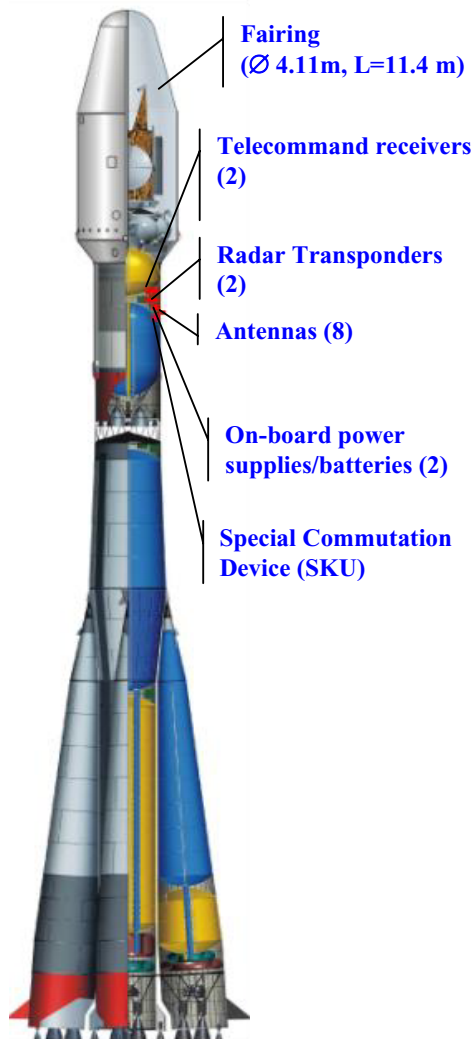


FIG 2: Soyuz ST launcher

The Soyuz-ST launcher is a Soyuz-2 launcher version with the following adaptations:

- equipped with a payload fairing of 4.11m diameter and 11.4 m length,
- Fregat upper stage,
- adapted to its exploitation from French Guiana, e.g. tropical climatic conditions (sea proximity, high level of humidity, etc.), as well as to flight and range safety requirements.
- boosters adapted to sink after separation and sea splash-down,
- equipped with new S-band telemetry systems.

The flight termination system is based on emergency engine shutdown (closing of main engine valves), triggered either by the existing

Soyuz automatic internal system or by specific telecommand from the ground.

The emergency engine shutdown system telecommanded from the ground has been implemented to comply with CSG safety regulations. For this, a European Safety Kit has been developed for installation on-board the launcher.

The main functions of the European Safety Kit are summarised below:

- Launcher positioning by radar transponders, as presently also used by Ariane 5,
- Receiving of neutralisation orders by telecommand similar to Ariane 5,
- On-board transmission of neutralisation orders to the existing command system of Soyuz-ST.

Auxiliary functions of the European Safety Kit include the transmission of telemasures to Soyuz-ST, and the supply of electrical power for its own needs.

3. THE SOYUZ LAUNCH SITE

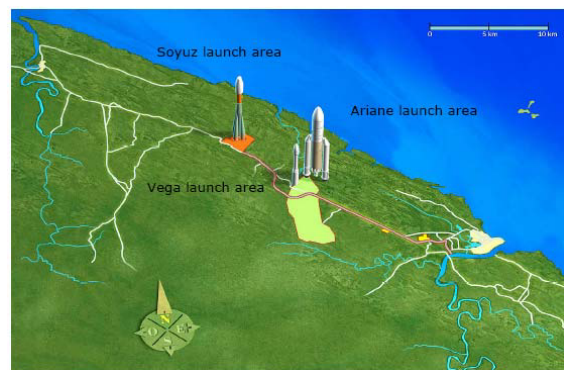


FIG 3: Soyuz launch site in French Guiana

The Soyuz launch area is situated on the North-Western part of the European Space Port CSG, as shown in FIG 3.

This zone is 27 km away from the town of Kourou and 18 km from the community of Sinnamary.



FIG 4: Soyuz Launch Site

The Soyuz launch site, shown in overview on FIG 4, features a total of 17 buildings located on a 120 ha area, which required earthworks of a volume of 1 million m³.

The launch site main elements include:

- The launch pad itself (FIG 5), sitting on a flame trench of about 200.00 m³ volume, and featuring four lightning protection rods.
- The mobile gantry (FIG 6), protecting the launcher and the upper composite during launch preparation. The gantry was recently decided to be motorised and equipped with natural ventilation means.
- The Launch Control Center (FIG 7). The Launch Control Center is an all-concrete 420 m² three-level building serving launch monitoring and command operations. It protects the operations teams during the launch phase.
- The Integration Building (MIK), located in the Preparation Zone (ZPS) (FIG 8 and 9). The MIK is used for the horizontal integration and preparation of the launcher's three stages. It is not used for the Upper Composite (Fregat upper stage, fairing, payload) preparation and integration. These vertical operations take place in the existing Payload Preparation Complex (EPCU), in building S5 and S3B, respectively.

The MIK building, made of concrete and metallic frames comprises:

- a 2275 m², approx. 22 m-high hangar with a metallic frame structure; roof and side walls are made of sheets and sandwich panels,
- a 440m² 3-level 13m-high aisle (called « Laboratories ») to the West side made of concrete and metallic frames,
- a 440m² 2-level 8.5m-high aisle (called « Technical Buildings ») to the East side made of concrete and metallic frames,

The Soyuz launch site further includes:

- The air, nitrogen, and helium storage areas.
- The Energy and air conditioning buildings.
- The Kerosene storage area.
- The Liquid Oxygen storage area.
- The Hydrogen Peroxide storage area.



FIG 5: Construction of launch pad block



FIG 6: Mobile gantry



FIG 9: MLP



FIG 7: Launch Control Center



FIG 10: Launch site in December 2005



FIG 8: MLP framework



FIG 11: Launch site in spring 2007

4. OPERATIONS SCENARIO

The transport and launch operations sequence is the following:

Soyuz launch vehicle manufacturing and integration takes place at TsSKB-Progress in Samara, Russia. The Fregat upper stage is produced at NPO-Lavochkine, Moscow. The launcher and upper stage are transported to the St-Petersburg harbour, where they will leave for Kourou in French Guiana (FIG 12).

At the CSG, the three-stage launch vehicle is integrated horizontally in the MIK and then rolled out horizontally to the launch pad where it is erected. The mobile gantry is then moved to the launcher in order to proceed with the upper composite mating and the final launch operations (FIG 13).

In parallel, the Fregat upper stage is prepared in the MIK building, and then transported by road to the S3B building where it is filled and later mated to the satellite and fairing (FIG 13).

The upper composite is then transported to the launch zone, where it is lifted to the upper platform of the mobile gantry and mated onto the launch vehicle.

A few hours before launch, the filling operations take place while the mobile gantry is still in place protecting the launcher.

About one hour before launch, the mobile gantry is moved to its rear position around 80 m away from the launch vehicle.

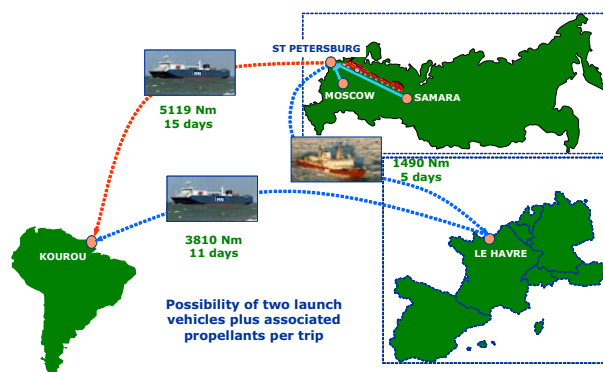


FIG 12: Transport scheme

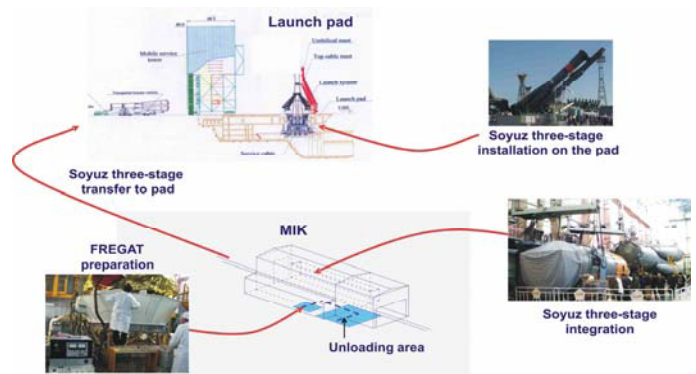


FIG 13: Launch preparation operations

5. STATUS OF DEVELOPMENT AND OUTLOOK

In 2004 preliminary earth works started near the community of Sinnamary. Specific earth works started on the site in early 2005. In December 2005 the Ground Segment industrial companies were selected, i.e. VINCI, Clemessy, MT, and Acia. In early 2006 the digging of the flame trench started and in January 2007 the construction of the buildings began.

As of June 2007, the Soyuz launch site has reached the following status in line with the overall schedule:

- launch table underground floors, main pillars and metallic flame exhaust panels nearing completion
- flame trench walls completed
- MIK metallic structure erected and railway foundations to launch table poured
- Launch control center building completed
- Air conditioning and energy buildings completed.

In parallel to the construction of the buildings, the design and development of the Russian deliveries is progressing in line with the following schedule of planned activities:

- End 2007: Completion of construction of the launch pad block and arrival of the mobile gantry and of the first Russian teams.
- Early 2008 to spring 2009: arrival, assembly and testing of the European and Russian equipment, including the technical and operational qualification.
- Spring 2009: first launch campaign by Arianespace.