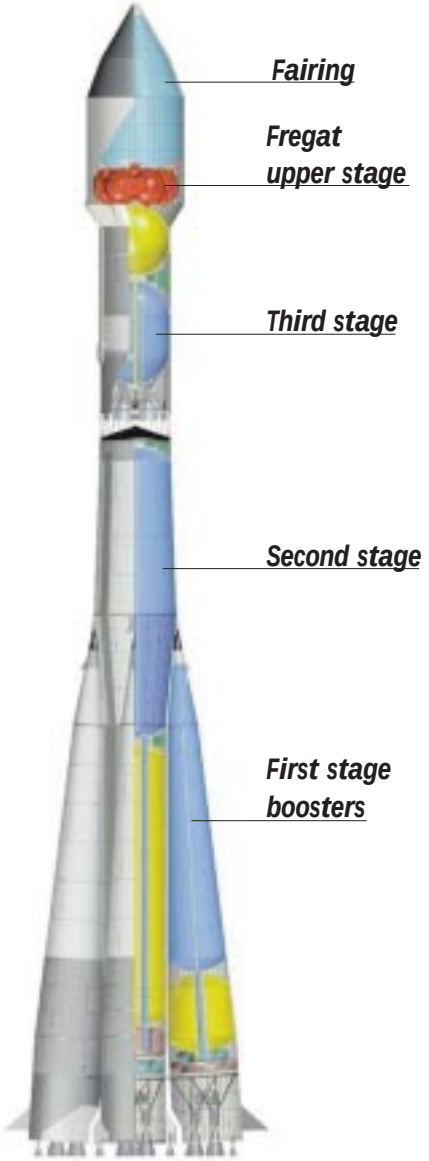
FLIGHT ST 08 Cluster II mission validation flight

PRESS KIT

Baikonur, March 2000

Artist view of Fregat upper stage and “DUMSAT” payload mock-up.

Soyuz-Fregat launch vehicle



After the successful Fregat qualification flight on February 9, 2000, the mission planned for this month will mark Fregat second use on Soyuz.

Designed to offer cost-effective solutions for missions to medium and high Earth orbits, including constellation deployment and escape trajectories, Soyuz-Fregat is a key asset in STARSEM's commercial launch service offering.

Soyuz-Fregat is a multiple stage vehicle comprising a lower composite grouping four boosters, a central core second stage, a third stage and an upper composite combining a Fregat upper stage and a fairing.

Using flight-proven technologies, the launcher's Fregat stage is constituted by a main engine and propulsion subsystem inspired by spacecraft propulsion systems proven on 27 lunar and deep space missions. During these missions, the engine functioned under extreme conditions. Fregat control system is also qualified to severe Russian domestic specifications.

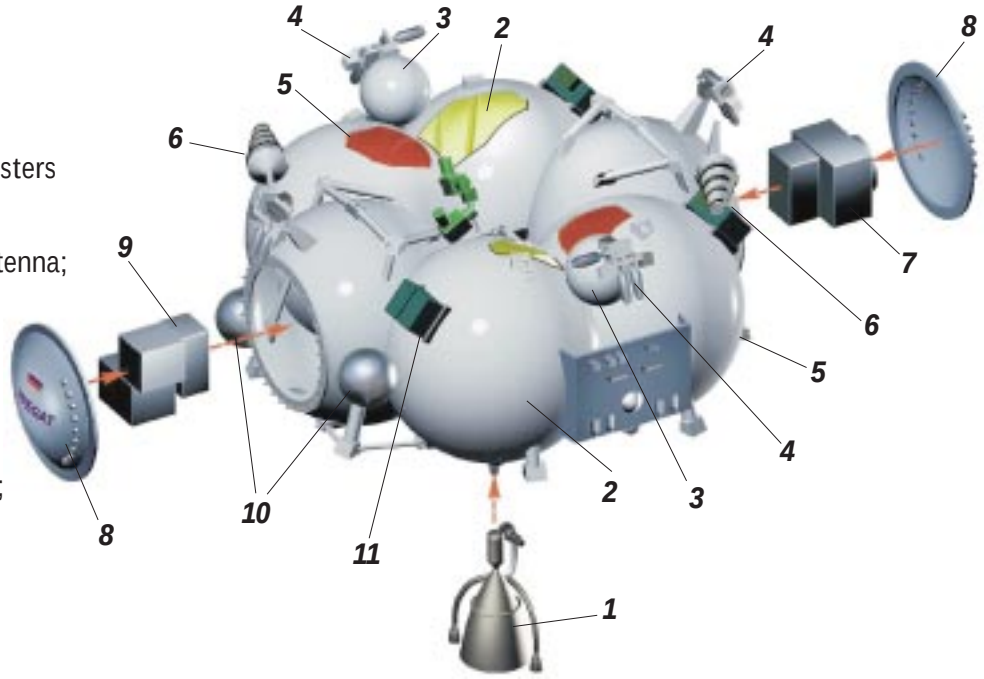
Incorporating numerous flight proven innovative design solutions, the Fregat upper stage offers compact design and low dry mass, multistart capabilities and 3-axis orientation, for versatile spacecraft delivery.

Fregat upper stage's main purposes:

- spacecraft injection into MEO, HEO, Sun-synchronous, geotransfer, geostationary orbits and Earth escape trajectories;
- spacecraft dispersal into operational orbits in case of multisatellite launch;
- spacecraft transfer from suborbital trajectory into parking orbit (additional injection);
- spacecraft orientation and spinning-up before separation;
- performance of non-coplanar orbital maneuvers;
- Fregat collision avoidance maneuvers and deorbitation in a safe drop zone

FREGAT upper stage main components

1) S5.92 main engine;
2) fuel tank (UDMH);
3) hydrazine tank;
4) Attitude control thrusters
5) oxidizer tank (N_2O_4);
6) telemetry system antenna;
7) control system;
8) equipment bay cover;
9) telemetry and orbit radio control system;
10) helium tanks;
11) chemical battery.



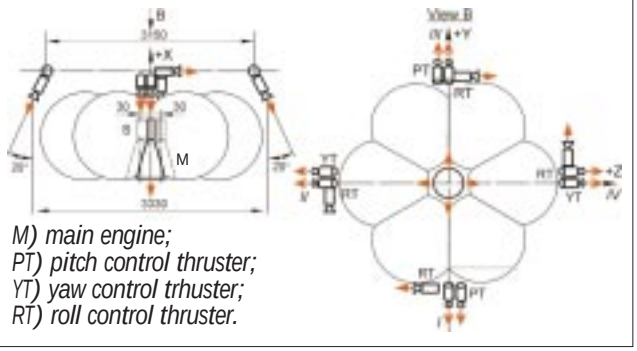
FREGAT upper stage main characteristics:

Dimensions:	
❑ Height (m)	1.5
❑ Diameter (m)	3.3

Mass:	
❑ Dry mass (kg)	950 - 1150
❑ Lift-off mass (kg)	up to 6535
❑ Propellant mass (kg)	up to 5350
❑ Propellant	UDMH-N_2O_4

Control:	
❑ Pitch, Yaw	by main engine (active leg) by thrusters (coast leg)
❑ Roll	thrusters
❑ Guidance	autonomous inertial 3-axis
❑ Lifetime (hours)	up to 48

Fregat attitude control



M) main engine;
PT) pitch control thruster;
YT) yaw control trhuster;
RT) roll control thruster.

Functions of attitude control thrusters:

- Main engine start-up acceleration
- Roll stabilization during the main engine operations
- Small maneuvers
- Attitude control
- Spin-up

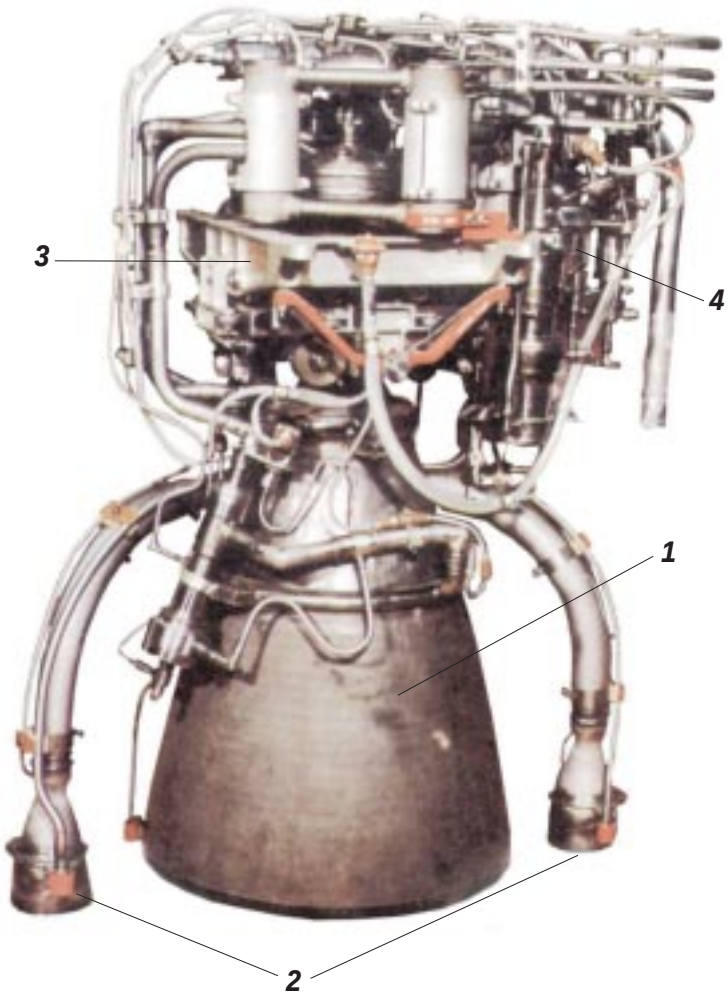
Manufacturers:

- ***Structure, integration and tests*** - NPO Lavochkin
- ***Main engine and small thrusters*** - A.M. Isayev Design Bureau of Chemical Machine Building, Ust-Katav Mechanical Plant
- ***Control system*** - N.A. Pilyugin Scientific and Production Centre of Automatic Instrument Engineering
- ***Telemetry system*** - Izhevsk Radio plant
- ***Power supply system*** - Design Bureau ORIONT-HIT

S5.92 ENGINE

The S5.92 engine is a single chamber, with a turbopump feeding system.
The turbopump assembly turbine works with the main propellant components. The exhaust is implemented through two fixed exhaust nozzles.
The salient feature of S5.92 engine consists in installation of its chamber not in the gimbal mount, as usual, but in the hinge ensuring plane-parallel motion of the engine inside the propulsion system.
The engine S5.92 is capable to operate in two modes : large and small thrust. On the first mode the spacecraft maneuvers connected with large velocity change are performed, on second, maneuvers requiring high accuracy or relatively small velocity increment.

1) main chamber;
2) exhaust nozzles;
3) hinge ensuring plane-parallel motion;
4) turbopump assembly.



Propulsion system characteristics:

Thrust mode	Large thrust	Small thrust
Dry mass (kg)	75	
Overall dimensions (m)	0.677 x 0.838 x 1.028	
Propellant	UDMH/N_2O_4	
Main chamber thrust (kN)	19.6	14.7
Isp (s)	327 s	316 s
Pressure in chamber (MPa)	9.80	6.85
Mixture ratio	1.95 - 2.05	2.00 - 2.10
Feed system	Turbopump	
Total burn time* (s)	870	
Restart capability	up to 20	

* Depending on propellant capacity

FREGAT performances:

Examples	SOYUZ-FREGAT
Circular orbits	
h=500 km; i=51.8°	5300 kg
h=1000 km; i=51.8°	4900 kg
h=1500 km; i=51.8°	4500 kg
Elliptical orbits	
hp=200 km; ha=10000 km; i=51.8°	3100 kg
Escape mission	
Mission to Mars	1100 kg

Description of flight ST 08

Mission overview

The Soyuz-Fregat Cluster II mission validation flight ST 08 is a second milestone in the new launcher configuration's qualification program before transition to the commercial flights.
The subject of the mission is to launch a Cluster II type dummy satellite to the Cluster II type separation orbit with simulation of this mission to validate Fregat operations and Soyuz-Fregat environment.
Starsem is in charge of this flight's payload and mission scenario definition.

Brief mission data

The "Dumsat" payload mock-up will be injected into the high elliptical orbit from the Baikonur cosmodrome. "Dumsat" is representing the mass-center of gravity-stiffness properties of the stack of two ESA's Cluster II satellites. The mission scenario is close to the one for Cluster II spacecraft injection to the separation orbit. The payload mock-up «Dumsat» will be installed on the standard payload adapter, the same as for Cluster II mission. For this flight as well as for the Cluster II mission, the Soyuz launch pad #6 will be used with the same ground track and drop zones for launch vehicle separated parts. The flight will occur on Monday, March 20, 2000 at 11:28 p.m. local time (07:28 p.m. Paris time).
The launch window is defined for the injection orbit corresponding to the first Cluster II launch.
The payload mass is 2382kg.

MISSION PROFILE

Soyuz launch vehicle flight:

The Soyuz launcher will inject the upper composite into a suborbital trajectory. The fairing is ejected under the same conditions as for the Cluster II mission. The drop zone for the III-rd stage of Soyuz launcher is allocated in the Okhotsk Sea (the same as for Cluster II mission).

Fregat upper stage flight:

1) The first Fregat burn:
After separation from the III-rd stage of Soyuz, Fregat will inject the upper composite from the suborbital trajectory to the circular parking orbit:

- Minimum height -202 km
- Maximum height -226 km

2) Fregat coast phase of flight
After the first burn begins the coast phase which is similar to the ESA's Cluster II mission. During the coast phase Fregat provide the three-axis stabilized mode for the upper composite.

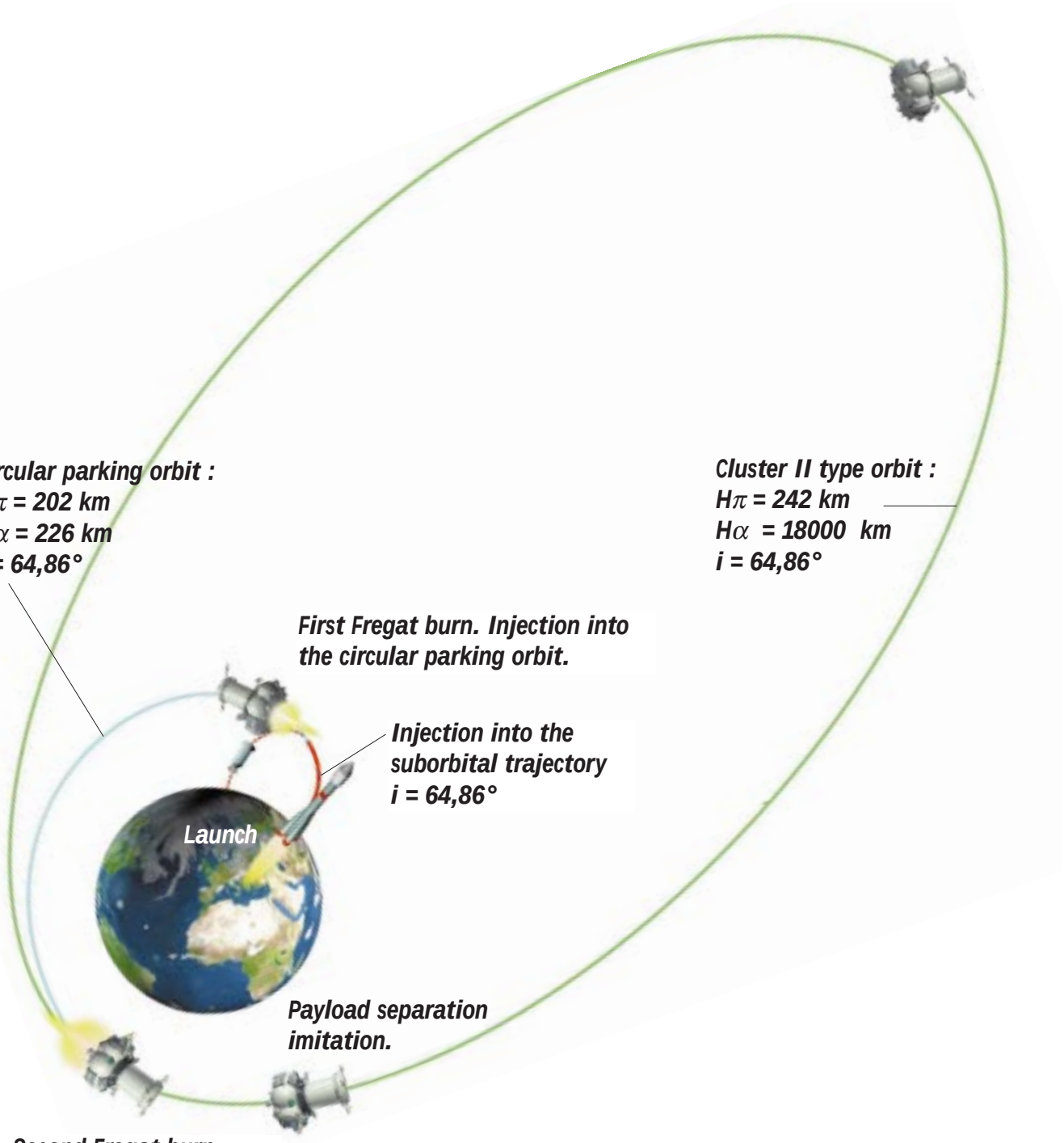
3) The second Fregat burn:
After the coast phase Fregat will inject the upper composite to the high elliptical Cluster II type separation orbit:
Minimum height -242 km
Maximum height -18000 km

4) Fregat spin-up:
Before the payload separation imitation Fregat is turned to the given attitude and spun up around longitudinal axis (as for Cluster II mission).

5) Payload separation imitation:
Two payload separations are then simulated (separation orders are sent 01h30 min after lift-off by Fregat's control system, but no physical separations are planned).
The Fregat flight will continue up to the burnout in the atmosphere after 3-4 weeks.

The successful injection into the high elliptical Cluster II type orbit represents the successful completion of the Soyuz-Fregat Cluster II mission validation flight.

Mission profile



About Starsem

Starsem was founded in 1996 to perform commercial launch services using the Soyuz launch vehicle family.
Responsibilities of Starsem are:

- Exclusive marketing, sales and management of commercial launch services using Soyuz launchers.
- Financing of Soyuz commercial launcher production.
- Servicing of Soyuz launch operations at the Baikonur Cosmodrome launch site.
- Development of new joint European and Russian space programs.

Starsem was created by four of the world's leading space-sector organizations: Europe's Arianespace, Aerospatiale Matra of France, the Russian Aviation and Space Agency and Russia's Samara Space Center. As a result, Starsem brings together the resources of integration and launch teams with years of experience gained through thousands of missions.

Aerospatiale Matra

Aerospatiale Matra is one of the world's leading aerospace companies, having been created on June 11, 1999 through the merger of France's Aerospatiale and the Lagardère group's Matra Hautes Technologies. Its business spans nearly every sector of the industry, including space transportation, satellites, commercial jetliners, regional transports, light aircraft, civil and military helicopters, missiles, system engineering and information technology. As the industrial architect and main stage integrator for Ariane launchers, Aerospatiale Matra is Western Europe's no. 1 company in space transportation systems. It has held this role since the beginning of the Ariane program.

The company has the equivalent of more than 200 years of operational in-orbit service experience with telecommunications satellites it has built, while it designs and produces both military and civil spacecraft for Earth observation/reconnaissance. Aerospatiale Matra holds the prime contractor for the ATV (Automated Transfer Vehicle) - one of the major European elements for the International Space Station, and it produced the Atmospheric Reentry Demonstrator (ARD) capsule that demonstrated Europe's ability to construct and operate a guided and controlled reentry vehicle.

Arianespace

Arianespace is the international leader in commercial launch services, and today holds more than 50 percent of the world market for satellites launched to geostationary transfer orbit (GTO). From its creation in 1980 as the first commercial space transportation company, Arianespace has successfully performed more than 100 launches and signed contracts with approximately 50 operators/customers for more than 200 payloads.

Arianespace oversees the marketing and sales, production and operation of the Ariane launch vehicles. The proven Ariane 4 is an industry reference for reliable launchers, and it continues to serve as Arianespace's workhorse vehicle. The increased-lift Ariane 5 was qualified for service in 1998, providing a capable launcher that will serve into the next century.

Based in Evry, France, Arianespace has 53 European corporate shareholders.

The Russian Aviation and Space Agency "ROSAVIACOSMOS"

The Russian Aviation and Space Agency (ROSAVIACOSMOS) was created in February 1992 by a decree issued by the President of the Russian Federation. It is the central body of the federal executive authority defining the Russian Federation's national policy in the field of space research and exploration. The agency also performs interdisciplinary coordination of national scientific and application space programs.

ROSAVIACOSMOS responsibilities include development and implementation of national space policy; acting in the capacity as the government customer in the development of scientific application space systems, facilities and equipment; international cooperation and collaboration in space research, and organization/coordination of commercial space programs. Operations under ROSAVIACOSMOS responsibility include TsNII Machine Building (TsNIIMash), Keldysh NII for Heat Processes (NIITP), NII of Chemical Engineering (NIIKhImMASH), the AGAT organization, and more than 40 other companies and organizations in which ROSAVIACOSMOS is a shareholder.

The Samara Space Center "TsSKB Progress"

The Samara Space Center "TsSKB Progress" was created by a Russian Presidential decree in 1996 by combining the TsSKB Central Samara Design Bureau and the Progress production plant.

TsSKB is one of the world leaders in the design of launchers, spacecraft and related systems. Its history goes back to the start of the space program in 1959 when a branch of the Moscow OKB-1 design bureau was established in the city of Kuibyshev (now known as Samara).

TsSKB evolved a family of launch vehicles from the OKB-1's R-7 intercontinental ballistic missile. Approximately 10 versions were developed, including Sputnik (which carried the first man- made satellite into orbit), Vostok (used for the initial manned space flight), Molniya and Soyuz.

The organization also has developed - or is involved in - a range of spacecraft, including the Foton, Bion, Resurs, and Nika. TsSKB has facilities for static, vibration, thermal and environmental testing, as well as simulators and test benches.

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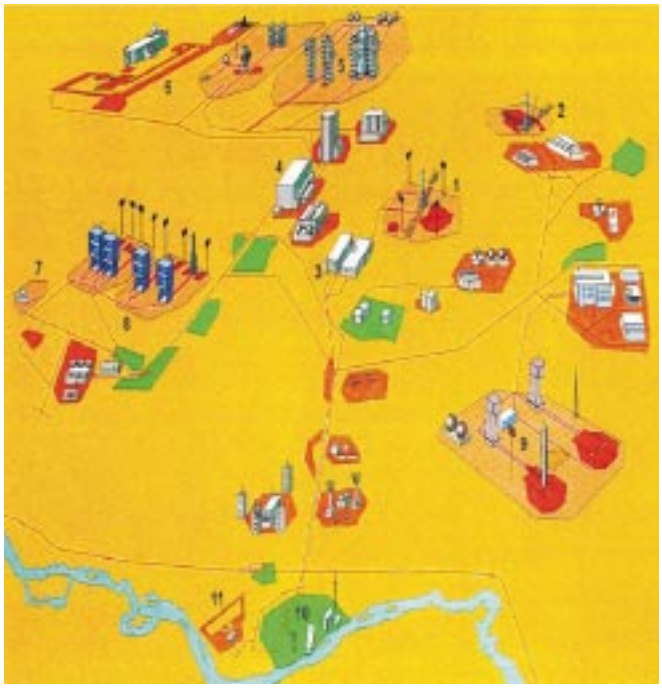
The Baikonur cosmodrome

Soyuz missions use the Baikonur Cosmodrome's proven infrastructure, and launches are performed by trained personnel with extensive operational experience.

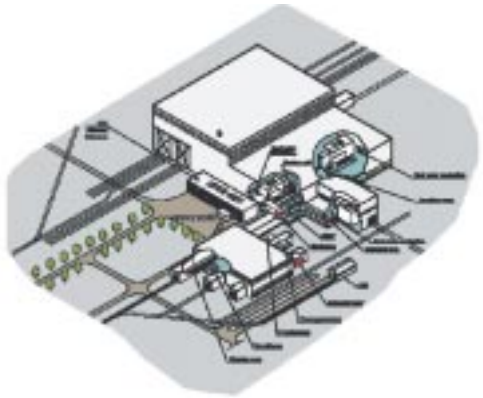
Baikonur Cosmodrome is located in the Republic of Kazakhstan in Central Asia between 45 deg. and 46 deg. North latitude and 63 deg. East longitude.



1. Soyuz launch pad
2. Soyuz launch pad used for FREGAT
3. Soyuz launch vehicle préparation building (MIK)
4. Energia hall with STARSEM PPF
5. Energia / Buran launch pads
6. Yubileyny airport
7. Cyclon launch pad
8. Proton launch pad
9. Zenith launch pad
10. Cily of Leninsk
11. Krayny airport

Two launch pads are dedicated to Soyuz missions. Areas for customers and spacecraft ground test equipment are located in dedicated rooms in the pad basement and launch bunker.

For Starsem, a modern new facility called the Starsem Payload Processing Facilities (SPPF) have been built for operations at Baikonur Cosmodrome.



This 1,158-square-meter operations complex is situated in the former Energya launcher integration bulding and consists of:

- The Payload Processing Facility (PPF) - The 286 square meter PPF includes a Class 100,000 high bay and two control rooms.
- The Hazardous Processing Facility (HPF) - The HPF covers a surface of 285 square meters, and incorporates a Class 100,000 high bay, control room and safety shower.
- The Upper Composite Integration Facility (UCIF) - This 587-square meter high bay has a Class 100,000 high bay.

Soyuz-Fregat Qualification flight
Baikonur, February 9, 2000
04:20 local time (23:20 GMT)

Baikonur facilities adapted to Soyuz-Fregat missions

Fregat upper stage in the UCIF

At the cosmodrome's facilities, Starsem has achieved, along with its Russian partners, a number of upgrades and adaptations dedicated to serve new Soyuz-Fregat pre-launch processing procedures. At the cosmodrome's Energya Hall, where Starsem has installed its **Payload Processing Facilities (PPF)**, the following upgrades have been made:

- The **Hazardous Processing Facility (HPF)**, designed to process dangerous operations like proof pressure tests and spacecraft loading, has been adapted to accommodate bi-propellant spacecraft. A new remote control room with dedicated data transmission system and color video network has been installed to improve operation's safety.

- At the **Upper Composite Integration Facility (UCIF)**, designed to handle spacecraft preparation and integration with IKAR or FREGAT upper stages, the ground cable network has been improved allowing extended S/C testing with check out equipment remaining in the PPF control room.

- Dedicated internal networks allow both voice and data exchange between rooms and offices. A VSAT system provides direct access to Paris where specialized connections can be organized by STARSEM with other locations.

MIK 40 with Fregat processing facility

Fregat bunker

Soyuz-Fregat on the launch pad #6

Two Soyuz integration buildings and two launch pads are used depending on the upper stage configuration. The complex #5 was used for SOYUZ-IKAR during GLOBALSTAR launches. The launch complex #6 will be used for the SOYUZ-FREGAT launches:

- The **Soyuz launch vehicle integration building** (MIK 40) has been revalidated to allow the preparation and integration of the Soyuz three stages.
- A specific area has been upgraded to carry out the mechanical and electrical preparation of the Fregat upper stage and was fully operational for the first campaign.
- The launch pad #6 itself received dedicated improvement to realize pre-launch and launch operations with the SOYUZ-FREGAT rocket system.

In addition to that, some other modifications are specific to the CLUSTER II launch equipment:

- New mast umbilical harness and under table dedicated room;
- A 64kbps data line for live communication to the customer's remote mission control center;
- Dedicated offices for FREGAT flight monitoring with live tracking display;
- Independent 50 m2 bunker with no break power supply to house EGSE for satellite support during pre-launch and launch sequence.