OUFTI-1 Environmental Impact Assessment

Reference	3_OUF_ENV_IMPACT_1.0
Issue/Rev	Issue 1 Rev 0
Date	11/02/2016
Distribution	OUFTI-1 team

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RECORD OF REVISIONS

Iss/Rev	Date	Author	Section/page	Change description
1/0	11/02/2016	X.Werner, S. De Dijcker	All	Initial issue

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1. ACTIVITIES AND OBJECTIVES

1.1. PROJECT DESCRIPTION

OUFTI-1 is the first Belgian student satellite. It has been developed at the Université de Liège (ULg), in collaboration with four other institutions of higher learning, i.e. two industrial engineering schools (HEPL-ISIL and HELMO-Gramme), one computer-science school (HEPL – INPRES), and the University of Louvain (UCL). The aim of this educational project is to provide hands-on experience to students in the design, construction, test, and operation of complete satellite systems.

OUFTI-1 is a CubeSat, which is a cube-shaped satellite with a size of 10x10x10 cm^3 and a weight of about one kilogram. The key, innovative feature of OUFTI-1 is its payload: the D-STAR digital radio communication (sub)system. OUFTI-1 consists of a single spacecraft. The satellite launch mass is less than 1 kg. The mission lifetime is one year from the launch date.

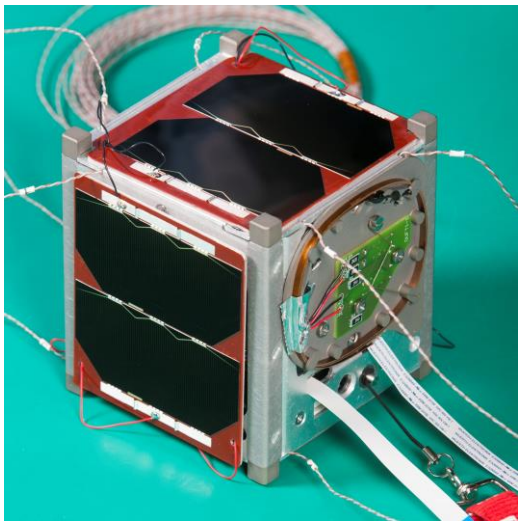


Figure 1-1: OUFTI-1 CubeSat.after integration (not in its flight configuration)
(© ULg - Jean-Louis Wertz 2013.)

The OUFTI-1 project has been selected by ESA to be part of the 'Fly Your Satellite!' Program. Therefore, the spacecraft design has been reviewed and successfully tested in collaboration with ESA experts.

Fly Your Satellite! (FYS) is an educational program whose main, but not only, focus is the verification campaign of CubeSats built by university students – a phase with high learning value for the students. The program was kicked off with the help of six CubeSat teams selected in June 2013. The program aims at offering students the opportunity to benefit from the transfer of technical competence and experience from ESA specialists. In addition, by teaching best practices for spacecraft design, development and verification, the program aims at increasing the CubeSats' chances for mission success. From the 6 selected teams, only 3 are still in the program: e-st@r-II from the Politecnico di Torino in Italy, AAUSAT4 from the Aalborg University in Demark and OUFTI-1 from the Université de Liège in Belgium.

ESA has selected a launch opportunity: it will take place along SENTINEL-1B(ESA) and MICROSCOPE(CNES) using a Soyuz rocket on 22 April 2016, operated by the launch service provider Arianespace. The launch base is located in Kourou, French Guiana.

1.2. SOYUZ LAUNCH VEHICLE

1.2.1. General overview

The Soyuz LV operated at CSG is the most recent of a long line of Soyuz family vehicles that taken together, are acknowledged to be the most frequently rockets launched in the world. Vehicles of this family, that launched both the first satellite (Sputnik, 1957) and the first man (Yuri Gagarin, 1961) into space, have been credited with more than 1780 launches to date. As the primary manned launch vehicle in Russia and the former Soviet Union and as one of the primary transport to the International Space Station, the Soyuz has benefited from these standards in both reliability and robustness. The addition of the flexible, restartable Fregat upper stage in 2000 allows the Soyuz launch vehicle to perform a full range of missions (LEO, SSO, MEO, GTO, GEO, and escape).

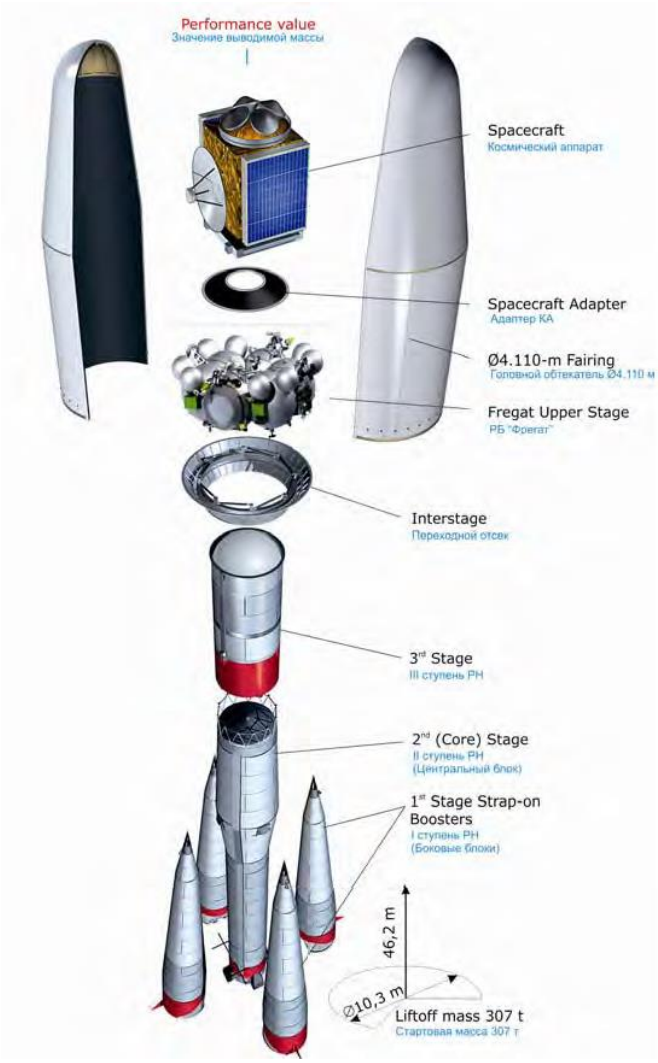


Figure 1-2: Soyuz Launch Vehicle

The Soyuz LV consists primarily of the following components:

- A lower composite consisting of four liquid-fueled boosters (first stage), a core (second) stage and a third stage;
- A restartable Fregat upper stage;
- A payload fairing and intermediate bay; and
- A payload adapter/dispenser with separation system(s). Depending on the mission requirements, a variety of different adapters/dispensers or carrying structures may be used.

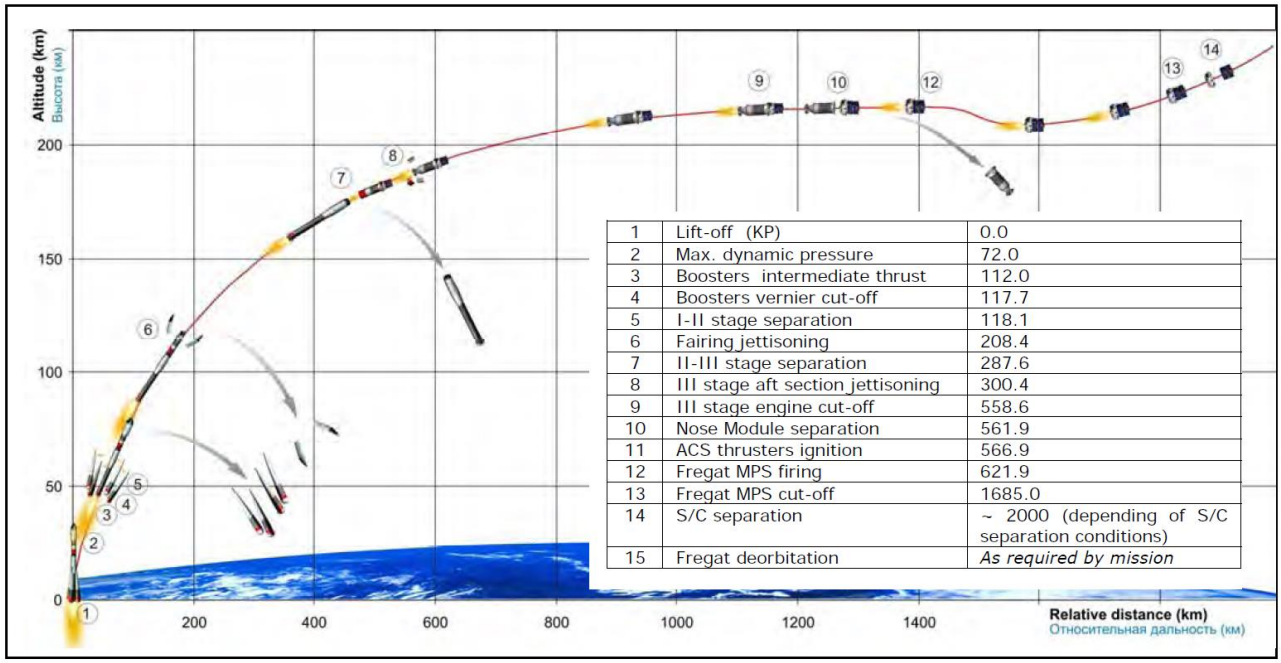
The Soyuz configuration and relevant vehicle data are shown in Figure 1-2.

1.2.2. Mission profile

A typical Soyuz mission includes the following three phases:

- Ascent of the Soyuz three-stage;
- Fregat upper stage flight profile for payload(s) delivery to final orbit(s); and
- Fregat deorbitation or orbit disposal maneuvers.

A typical ascent profile is depicted on Figure 1-3.



1	Lift-off (KP)	0.0
2	Max. dynamic pressure	72.0
3	Boosters intermediate thrust	112.0
4	Boosters vernier cut-off	117.7
5	I-II stage separation	118.1
6	Fairing jettisoning	208.4
7	II-III stage separation	287.6
8	III stage aft section jettisoning	300.4
9	III stage engine cut-off	558.6
10	Nose Module separation	561.9
11	ACS thrusters ignition	566.9
12	Fregat MPS firing	621.9
13	Fregat MPS cut-off	1685.0
14	S/C separation	~ 2000 (depending of S/C separation conditions)
15	Fregat deorbitation	*As required by mission*

Figure 1-3: Soyuz typical ascent profile

1.2.1. Soyuz reliability

The table hereunder shows the information on Soyuz reliability. Reliability figures are presented individually for the lower three stages of the vehicle and for the Fregat upper stage. To provide the most relevant data, these reliability figures correspond to the flights performed in the past 20 years with Soyuz U, Soyuz FG and Soyuz 2 as these configurations have the same heritage.

COMPONENT/VEHICLE	SOYUZ	FREGAT UPPER STAGE
TIME FRAME	1991-2011	2000-2011
NUMBER OF FLIGHTS	261	28
NUMBER OF FAILURES	5	0
FLIGHT SUCCESS RATE (%)	98.1	100

1.3. ARIANESPACE

Arianespace is a French joint stock company ("Société Anonyme") which was incorporated on 26 March 1980 as the first commercial space transportation company.

Arianespace is the international leader in commercial launch services and today holds an important part of the world market for satellites launched to the geostationary transfer orbit. From its creation in 1980 up to end 2011, Arianespace has successfully performed over 204 Ariane launches. In 2011, Arianespace performed successfully the two first Soyuz launches at the Guiana Space Center. In parallel, Arianespace continues the Soyuz commercial operations started in 1999 at Baikonur by its affiliate Starsem holding as of end 2011 a record of 24 successful launches. Arianespace signed contracts for more than 300 payloads with some 80 operators/Customers. Arianespace provides each Customer a true end-to-end service, from manufacture of the launch vehicle to mission preparation at the Guiana Space Centre and successful in-orbit delivery of payloads for a broad range of mission.

1.4. CONCLUSION

The Soyuz launch vehicle has an excellent technical success rate and a proven track record with an excellent launch reliability. The launch service provider Arianespace has a credible customer oriented reputation. For these reasons, the ESA and the Université de Liège are confident that the launch of OUFTI-1 will be a success.

2. POTENTIAL IMPACT OF THE ACTIVITIES ON THE TERRESTRIAL ENVIRONMENT, THE ATMOSPHERE AND THE NATURAL AND HUMAN ENVIRONMENT OF THE PLACE OF LAUNCHING

The environmental monitoring program of Soyuz of Centre National d'Etudes Spatiales - Centre Spatial Guyanais (CNES/CSG) defines the environmental study monitoring points. Throughout the text hereunder, the different monitoring points will be highlighted, together with an assessment of the potential impact of the launch activity and the measures taken to minimize the eventual impact on the environment.

2.1. ON THE GROUND

Continuous environmental monitoring of all the environment components is performed at Kourou launch base but also in the cities of Kourou and Sinnamary during the Soyuz launch vehicle pre-launch preparation.

The environment impact assessment is made with respect to the following factors:

- Emission of harmful chemical substances;
- Electromagnetic effect;
- Ozone-depleting effect;
- Acoustic effect;
- Mechanical contamination of the Earth's surface.

The most serious problems that may arise during the Soyuz launch vehicle operation and launch are related to emission of harmful chemical substances. Based on the previous assessments and operating experience, the electromagnetic and acoustic effects, mechanical contamination of the Earth's surface and near-earth outer space pose much lower environmental risks.

Samples are taken continuously before, during and after the launch to verify that no toxic agents that may be created due to the launch, are found in the air.

2.2. ON THE LAUNCH SITE

The Soyuz launch site for OUFTI-1 flight is located at the CSG in French Guiana near the city of Kourou. This spaceport is managed by CNES and ESA. In the framework of the environmental monitoring program, the following environmental samples are taken:

- Measurements of air quality: monitoring the impact of all products of combustion (passive sensors, adaptive air analyzers to revenue from Soyuz, etc.),
- Measures of Soil Quality: monitoring the penetration of pollutants in the soil, study of deposits on the ground, monitoring of fauna and flora,
- Measuring the water quality of nearby creeks (automatic samplers, piezometers),
- Vibration and acoustic measurements,
- Monitoring of the vegetation,
- Monitoring of birds, fish fauna and aquatic invertebrates.

The facility is in compliance with the ISO Standards ISO 14001 and ISO 9001. ISO 14001 is a globally recognized management system standard for environmental impact assessment. It is an instrument to identify and control the effects of a company and its activities on the environment. It consists of an environmental policy, an environmental plan, an implementation plan, corrective and monitoring actions and management review. By applying a policy based on the continuous protection of the ecosystem around the space center, each launch are ensure to have only a limited impact on the environment.

More information about the environment impact are available on the CSG, Arianespace and CNES websites.

3. POTENTIAL IMPACT ON OUTER SPACE

Since the Fregat conducts a deorbitation or orbit disposal maneuver, no adverse effect of the Soyuz launch vehicle on the outer space occurs because of the launch profile.

Analyses show that OUFTI-1 will re-enter the atmosphere within the 25-years limit and that no fragment will survive, thus, there is no impact on outer space either.

4. CONCLUSION

As shown in this document, Arianespace uses an environmental monitoring program ensuring both the safety and the security of the launch activity and reducing, to the maximum extend, the potential negative impact of the launches on the environment

Nevertheless, launching space objects into outer space is never without risks and especially potential negative impact on the environment can never be completely excluded. We think however the environmental impact has been assessed and has been analyzed.

For the OUFTI-1 project, which has limited budget, this launch opportunity that the European Space Agency offers us, is a hope for all the students (48) that have been involved in the project to see their achievement be placed in orbit!