von KARMAN INSTITUTE FOR FLUID DYNAMICS INPA
INSTITUT von KARMAN DE DYNAMIQUE DES FLUIDES AISBL
von KARMAN INSTITUUT VOOR STROMINGSDYNAMICA IVZW

AANGETEKEND SCHRIJVEN

REF.

AGA000/JM/cdt/201
25 april 2014

De heer Philippe Courard
Staatssecretaris voor Wetenschapsbeleid
Ernest Blérotstraat, 1
1070 Brussel

Geachte heer Staatssecretaris,

Het von Karman instituut voor stromingsdynamica (VKI) werd in 2011 door de Europese Commissie geselecteerd als coördinator van een project gericht op het lanceren van 50 nanosatellieten in een baan om de aarde. Het project, dat de naam QB50 kreeg, verenigt onderzoeksinstellingen en universiteiten over de hele wereld in een onderzoek naar de samenstelling van de thermosfeer en de terugkeer in de atmosfeer van kleine satellieten ("CubeSats").

Voor het VKI is het QB50 project uitermate belangrijk op wetenschappelijk en strategisch vlak. Niet alleen betekent dit voor het instituut een nieuwe activiteit in het domein van de nanosatellieten, maar opent het project eveneens toekomstige opportuniteiten van samenwerking met andere onderzoeks- en onderwijsinstellingen. Daarenboven verhoogt het de zichtbaarheid en de bekendheid van het VKI op nationaal en internationaal vlak. Tot slot is de (prestigieuze) rol van coördinator een erkenning van de jarenlange expertise van het instituut.

Teneinde de mogelijke technische en programmatorische valkuilen verbonden aan de lancering van 50 CubeSats tot een minimum te beperken, plant het VKI testlancering (precursor lancering) in de loop van de maand juni 2014 om de belangrijkste technologieën te testen. De lancering zal plaatsvinden te Yasny (Rusland) met een Dnepr lanceerraket. De verantwoordelijkheid voor de lancering ligt bij het lanceerbedrijf ISC Kosmotras.

In uitvoering van de wet van 17 september 2005 over de lancering, het bedienen in de vlucht of het geleiden van ruimtevoorwerpen, heeft het VKI de eer met dit schrijven een machtiging aan te vragen om de bedoelde activiteit uit te voeren onder de Belgische jurisdictie en bescherming. U gelieve daartoe als bijlage de aanvraag voor de machtiging te willen vinden, alsook de milieueffectenstudie en andere informatie betreffende de precursor lancering.

We hopen dat België zich als lanceerstaat met deze activiteit kan identificeren en op die manier het QB50 project zijn verdere steun toezegt. Mijn medewerkers en ikzelf staan ter beschikking om verdere toelichting over deze aanvraag of het project te verschaffen.

In afwachting van uw schrijven, verblijven wij,

Met de meeste hoogachting,

Jean Muylaert
Directeur

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IBAN BE57 2100 3153 3035 - SWIFT CODE: GEBABEBB

BIJLAGE

III. 1. Beschrijving van de activiteiten
Soort van activiteit

- Lancering, in een nieuwe baan brengen
- Lancering vanaf Yasny launch base (Russische Federatie)
- Duur missie : 6 maanden
- Lanceervenster : 1 maart 2014 tot 31 augustus 2014

IV. 3. Eigenaar(s)
IV.4. Constructeur(s)

- von Karman instituut voor stromingsdynamica (VKI)
- Innovative Solutions In Space B.V. (ISIS B.V.)
  Molengraaffsingel 12-14
  2629 JD Delft
  Nederland
- Mullard Space Science Laboratory (MSSL)
  University College London
  Holmbury Hill Road, Dorking
  Surrey RH5 6NT
  Verenigd Koninkrijk
- Ecole Polytechnique fédérale de Lausanne (EPFL)
  Route Cantonale
  1015 Lausanne
  Zwitserland
- Surrey Space Centre (SSC)
  University of Surrey – Guildford
  BA Building
  Surrey GU2 7XH
  Verenigd Koninkrijk
- National Cheng Kung University (NCKU)
  University Road 1
  Tainan City 701
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BIJLAGE

QB50 Precursor lancering

Milieu-effectenstudie

(Environmental Impact Assessment)

PART I : ACTIVITIES AND OBJECTIVES

1. Objective of the activity and implementation through nano-satellites

The precursor launch has been procured by ISIS B.V. (Netherlands) on behalf of the von Karman Institute for Fluid Dynamics (VKI, Belgium) in the framework of the EU FP7 QB50 Project aiming at the in-orbit testing of technologies[1].

The technologies tested in the precursor mission will be provided later to the QB50 community consisting of 50 universities from all over the world launching their nano-satellites into orbit during the QB50 main flight. In particular, the deployment system (i.e. the dispenser, build by ISIS B.V.), the scientific sensor units (provided by the University College London, UK), the attitude control system (developed by Surrey Space Centre, UK) and the ground segment (build by and installed at VKI) will be verified during the precursor flight.

The precursor mission will test and demonstrate technologies and subsystems in order to reduce the (technological and programmatic) risks related to the future launch of the 50 CubeSats.

To this end, three double nano-satellites (three "double CubeSats") of approximate dimensions 20x10x10cm are being build and launched. Figure 1 shows a double CubeSat.

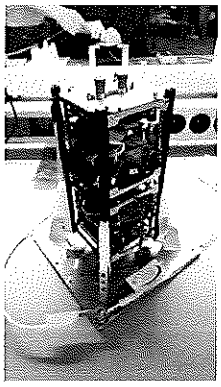


Fig. 1 - QB50p1 satellite

The launch will take place using a Ukrainian built Dnepr rocket, operated by the launch service provider ISC Kosmotras. The launch base is located in Dombarovsky (near Yasny, Russia). See Figure 2.

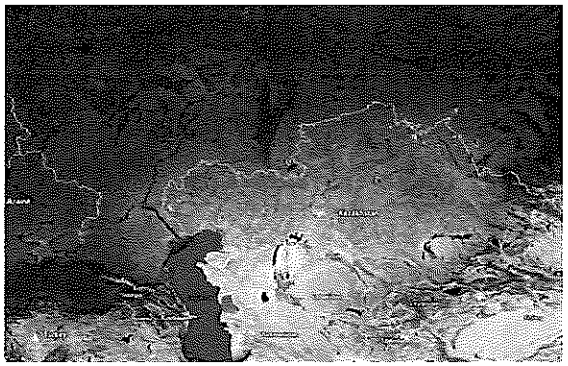


Fig. 2 – Yasny (Dombarovsky) launch base

[1] "QB50 : An international network of 50 CubeSats for multi-point, in-situ measurements in the lower thermosphere and re-entry research". EU FP7 Grant Agreement Number 284427

The launch window for the precursor flight has been established from 1 March 2014 until 31 August 2014. The (tentative) launch date is fixed at 19 June 2014.

2. Dnepr launch vehicle

2.1. General overview

The Dnepr rocket for space launches is a converted intercontinental ballistic missile for launching satellites. The launch vehicle is a basic modification of the liquid-fuelled SS-18 intercontinental ballistic missile consisting of three stages complemented by a space head module (SHM).

A general overview of the launch vehicle with the SHM is shown in Figure 3.

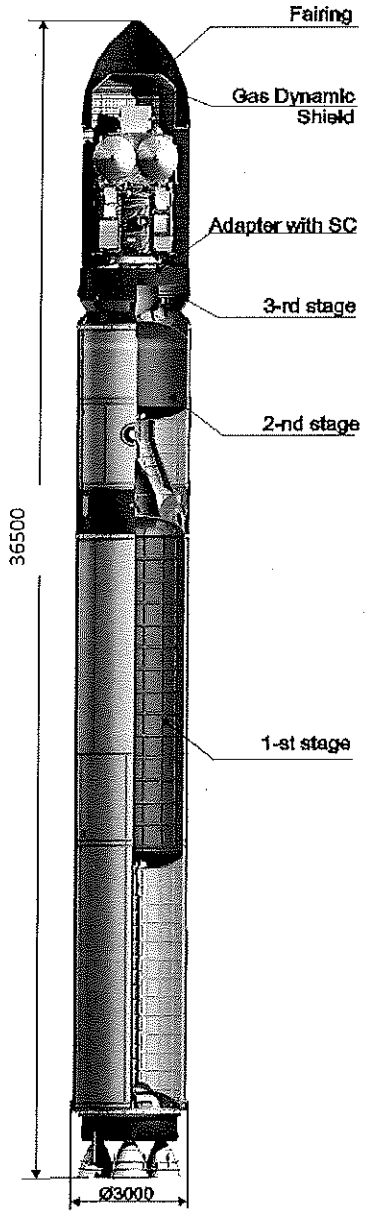


Fig. 3 - General overview of the launch vehicle with the SHM

The launch vehicle first and second stages are standard SS-18 elements and used without modification.

The first stage propulsion unit features four single-chamber motors, while the second stage propulsion unit is composed of a main single-chamber motor and a fourchamber thruster.

The third stage is a modified standard SS-18 third stage equipped with a liquid propellant and a two-mode propulsion unit that operates based on a "drag" scheme. Modifications involve only the control system in order to provide optimal flight software and electrical links with the spacecraft.

The SHM is attached to the third stage upper end. The SHM consists of a spacecraft, an intermediate section, an adapter, either a gasdynamic shield (GDS) or an Encapsulated Payload Module (EPM), a protective membrane and SS-18's standard fairing. The SHM design is based on the SS-18 front section with several design variations.

The Dnepr features a standard inertial high precision computer-based control system.

The main characteristics of the Dnepr launch vehicle are presented in table 1 hereunder:

Total launch mass	210 tons
Propellant components for all stages	UDMH + N2O4
Number of stages	3
Spacecraft injection accuracy • For altitude • For inclination • For the right ascension of the ascending node	 4,0 km 0,04 degree 0,4 min
Orbit inclination	98°, 64,5°
Flight reliability	0,976
Loads affecting the spacecraft: • Maximum axial quasi-static g-loads • Maximum lateral quasi-static g-loads • Integral level of sound pressure	 7,5 0,8 140 dB

Table 1 – Dnepr launch vehicle main characteristics

2.2. Launcher quality controls

The missiles are stored at the Rocket Forces Ministry of Defence storage facilities in compliance with Russian and international regulations for this type of missiles. The scope and sequence of the missile checkout to prepare it for launch are subject to the provisions of Operation and Maintenance Manuals. Faults detected during the operation and storage of the missiles are eliminated by following the provisions of the Operation and Maintenance Manuals.

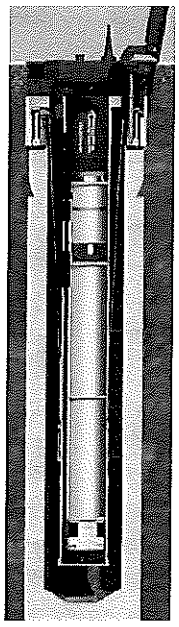
Checks are performed on the launcher and its components during storage and since retrieval from storage :

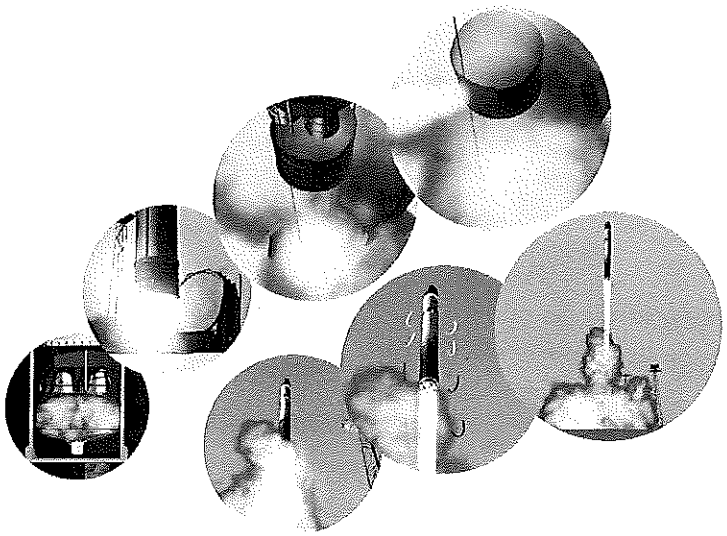
- In compliance with the Operation and Maintenance Manuals, when in storage, the verification includes periodical visual inspection, determination of the operational environment parameters, measurements of the internal pressure;
- All the SHMs used for Dnepr launches undergo the full cycle of ground testing, including the transportation and flight vibrations tests, shock tests, functional tests for separation of all separated elements;
- When in silo, during the pre-launch preparation, a launch vehicle passes four cycles of integrated electrical checks: post-shipment inspection test, after the launch vehicle upgrade modification has been performed, when the SHM is mated (without satellites inside), and, finally, in-flight configuration with the fully assembled SHM (with satellites inside) mated.

The launch vehicle safety system ensures flight abort of the first and second stages in case of an emergency (i.e. loss of flight stability). The safety system is based on the system used for the SS-18 intercontinental ballistic missiles. The launch control system has an ability to cut off the flight in case of emergency. In this case, the launch vehicle will fall down within the flight downrange with the probability of 99,7%.

2.3. Dnepr steam ejection

The Dnepr launch vehicle is steam ejected from its transport and launch canister to a height of approximately 20 meters above the ground by means of activation of the black powder gas generator. The first stage propulsion unit is ignited upon the rocket ejection from the launch canister. See Figure 4 for more information.





1. Black powder gas generator activated (top left picture)
2. launch vehicle expelled from silo
3. Protective tray separated
4. Protective tray jettisoned (top right picture)
5. First stage motor ignited (bottom left picture)
6. Sealing rings dropped
7. launch vehicle powered, flight started (bottom right)

Fig. 4 - Dnepr Steam Ejection from silo

2.4. Dnepr mission profile

The separation of stages and fairing follows the proven SS-18 procedures. Spacecraft separation from the third stage is done by the third stage taking away from the spacecraft by means of throttled-back operation of its motor. Prior to the spacecraft separation, the gas dynamic shield or EPM cover is jettisoned.

Figure 5 gives a detailed overview of the mission profile of the Dnepr launch vehicle.

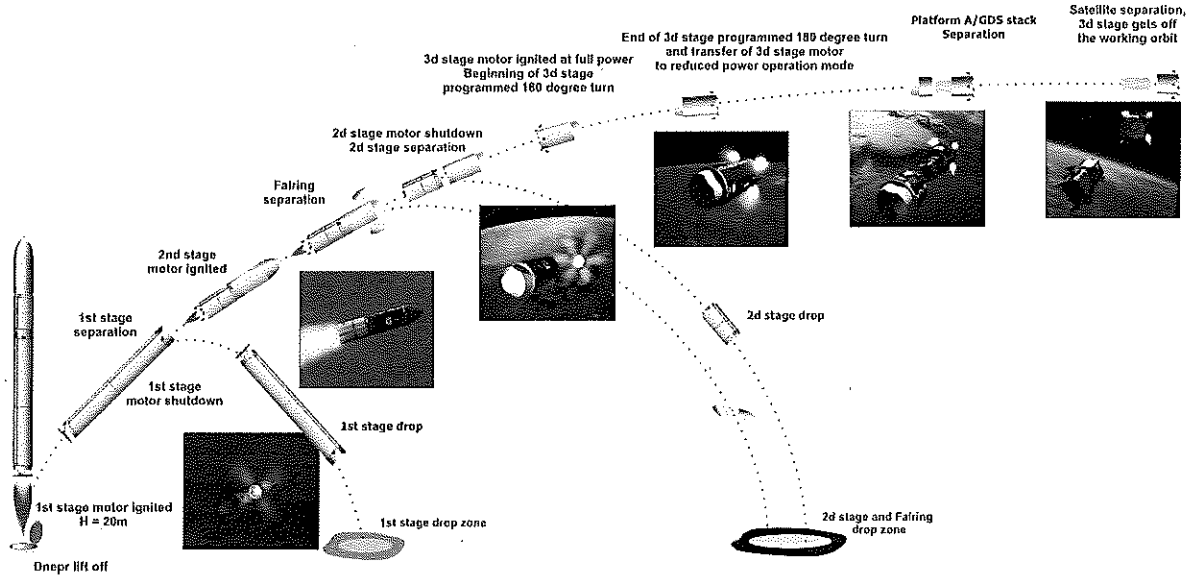


Fig. 5 - Mission Profile of Dnepr launch vehicle carrying a large spacecraft

2.5. Dnepr launch vehicle performance characteristics for circular orbits

Table 2 below gives an overview of the performance of the Dnepr launch vehicle for circular orbits, both at 98° and 65° inclination. The payload mass the launch vehicle can carry for each of the aforementioned inclinations is mentioned, taking into consideration it is fitted with a standard space head module or an extended space head module. As shown in the table, the actual performance of the Dnepr depends also on the selected launch base (Yasny or Baikonur). As mentioned before, the QB50 precursor launch will take place at Yasny launch base.

Launch Base	Orbit Altitude (km)	98° Inclination		65° Inclination	
		Standard SHM	Extended SHM	Standard SHM	Extended SHM
		Payload mass (kg)			
Yasny	300	1800	1650	3200	2950
Baikonur		1500	1450	-	-
Yasny	400	2000	1850	2950	2700
Baikonur		1700	1470	-	-
Yasny	500	2100	1850	2650	2400
Baikonur		1650	1450	-	-
Yasny	600	1700	1500	2000	1800
Baikonur		1350	1150	-	-
Yasny	700	1100	1000	1350	1200
Baikonur		800	750	-	-
Yasny	800	600	450	700	600
Baikonur		450	350	-	-

Table 2 – Dnepr launch vehicle performance

2.6. Launch and track record

More than 170 launches of SS-18 intercontinental ballistic missiles were performed with a reliability of 97%.

A total of 18 successful launches (out of 19) of the Dnepr launch vehicle have been performed under the Dnepr program beginning from April 1999 through 2013. Before this failure launch of 26 July 2006 (launch number 7), the confirmed flight reliability of the Dnepr launch vehicle was 97%. After the failure, the reliability was evaluated as 96,7%.

An Inter-Agency Commission chaired by Nikolay A. Anfimov, member of the Russian Academy of Sciences, was set-up to investigate the cause of the failure of the seventh launch. High level representatives of key organizations of the Dnepr launch program[2] joined the Commission as its members. The Commission identified a short-time malfunctioning of the hydraulic drive caused by an overheating in the pipeline due to a problem with the pipeline heat insulation. As recommended by the Inter-Agency Commission, the heat insulation of pipelines carrying combustion to hydraulic drives was modified for all subsequent Dnepr launches.

After the successful cluster launch of 17 April 2007 and subsequent launches, during which the pipelines' heat insulation modification was validated, the Dnepr reliability index is currently rated at 0.976 (97,6%).

The detailed launch and track record of the Dnepr launch vehicle is shown in annex 1.

2.7. Conclusion

The Dnepr launch vehicle has an excellent technical success rate and a proven track record with a launch reliability index currently evaluated at 97,6%. The launch vehicle offers a high value-for-money ratio. The launch service provider ISC Kosmotras has a credible customer oriented reputation. For these reasons, VKI and ISIS B.V. have chosen the Dnepr launch vehicle for the QB50 precursor launch.

[2] e.g. Rocket Forces department of the Ministry of Defence, ISC Kosmotras, Khartron Entrerprise, YuzhMash Plant, TsENKI, etc.

PART II : 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 ISC Kosmotras 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.

1. On the ground

Continuous environmental monitoring of all the environment components is performed at Yasny launch base during the Dnepr launch vehicle pre-launch preparation. In accordance with the Russian State Standards requirements, the environment impact assessment is made with respect to the following factors:

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

The most serious problems that may arise during the Dnepr launch vehicle operation and launch are related to the first factor out of those mentioned above. 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 as compared with the hazard resulted from using the amyl and heptyl as propellant. There are no radioactive substances used in the Dnepr launch vehicle.

Samples are taken two days prior to the launch vehicle fuelling in the launch silo area and the settlements, which are located close to the launch base ground track and rivers. Approximately 20 minutes after the launch, new environmental samples are taken. According to previous analysis procured by ISC Kosmotras, approximately 30 to 40 minutes after the launch, no toxic agents that may be created due to the launch, are found in the air.

2. On the launch site

The Dnepr launch site for the QB50 precursor flight is located at the Dombarovsky launch base, near Yasny, in the Orenburg region of Russia. The launch base is located 110 km from the airport of the city of Orsk. This is a Rocket Forces Ministry of Defence facility.

In the framework of the environmental monitoring program of the Dnepr launches, the following environmental samples are taken:

- Soil;
- Vegetation;

- Water from reservoirs and wells;
- Air (snow in winter time);

The following measures are taken to ensure the launch site security:

- No foreign visitors are admitted to the launch silo. The Rocket Forces Ministry of Defence access policy rules apply to the launch silo premises;
- General security provisions outlined in official documentation are in effect in the Yasny Launch Base Payload Processing Facility and the Administration and Hotel Complex. The general security provisions are endorsed by both ISC Kosmotras and the customer(s).

Two or three Dnepr launches from the Dombarovsky launch base are scheduled each year. The previous Dnepr launches demonstrate that 24 hours are sufficient to restore the environmental parameters.

While implementing the Dnepr program, ISC Kosmotras has been conducting continuous environmental monitoring at the launch site, along the ground track and in the launch vehicle first stage drop zone. There is no difference between the forthcoming QB50 precursor launch and the rocket "typical" launch in terms of the environmental impact.

3. In the atmosphere

After the propellant burn-out, the Dnepr launch vehicle 1st stage drops in the designated area on the territory of the Republic of Kazakhstan. The launch vehicle 2nd stage, after the engine switch-off, drops in the designated area of the Indian Ocean. The launch vehicle 3rd stage, after the propellant burn-out, stays in the Earth elliptical orbit until it is completely burnt in the Earth atmosphere.

The flight trajectory is computed by the Dnepr launch vehicle General Designer considering the known coordinates of the 1st and 2nd stages drop zones. Therefore, engines of the 1st (2nd) stage are switched off upon receiving signals from the rocket control system, which computes the ballistic trajectory of descend and drop of the 1st (2nd) stage in the designated area.

During the in-flight operation of the 1st stage main engines, only the initial phase of the trajectory powered flight is important in terms of the environmental impact on the atmospheric ground layer. The carbon oxide (CO) and nitrogen dioxide (NO2) are the main toxic combustion products created during the 1st stage motor operation. The CO and NO2 content in the air is drastically decreasing as the rocket is getting away from the launch point, while the NO2 concentration is approximately 6 times lower than that of CO. The concentration level exceeding the threshold limit value is maintained within a relatively short period of time: 5 to 10 minutes for NO2 and 2 to 3 minutes for CO. The propagation area in the atmospheric ground layer is ~11 km for NO2 and ~3 km for CO.

The control system continuously monitors the status of the rocket units and systems and the correctness of the rocket flight along the design trajectory. In case of the rocket deviation from the flight trajectory and a (potential) failure to counteract, the control system sends a

signal for the engine emergency cut-off. In that case, the control system computes the optimal fall track of the rocket to prevent it falling on human settlements. In case of flight cut off, there will be no adverse atmospheric effect, since, when the rocket hits the ground and an explosion follows, the propellant components are self-destructed.

On 22 December 2005, ISC Kosmotras was awarded with the BVQI Certificate for the Management System in compliance with the ISO Standards 14001:2004 and ISO 9001:2000 requirements[3]. The certification scope is: "Organization of spacecraft launch management using the Dnepr Space Launch System". ISC Kosmotras is constantly working on the optimization of its environmental management system. The launch service provider has never received negative feedback from its customers with regard to the environmental impact of the Dnepr launches.

[3] 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

PART III : POTENTIAL IMPACT ON OUTER SPACE

According to previous studies conducted by ISC Kosmotras, the potential impact on the outer space of the Dnepr launches is extremely minimal.

As a general conclusion, no adverse effect of the Dnepr launch vehicle on the outer space occurs because of its mission and launch profile:

- During the 3rd stage engine operation, the rocket propellant components are completely burned out. As a consequence, the potential negative impact of the rocket propellant components on outer space is extremely low;
- The launch vehicle engine is automatically switched off when the rocket propellant is burned out ensuring no impact of the engine on the outer space;
- After the spacecraft injection into low Earth orbit, the 3rd stage continues its coast flight during the period of up to 100-150 years until its re-entry and burning above the Earth. The 3rd stage is completely disintegrated after the aforementioned timeframe.

PART IV : NON-TECHNICAL SUMMARY

In the framework of the EU FP7 Project aiming at the launch of 50 CubeSats for atmospheric research, the VKI as coordinator of the project and its subcontractor ISIS B.V., have procured by the launch service provider ISC Kosmotras a test and risk reduction precursor launch scheduled in June 2014.

As an Operator located in Belgium and therefore subject to the Belgian law of 17 September 2005 (revised by the law of 1 December 2013) on the activities of launching, flight operation or guidance of space objects, the VKI is responsible to providing to the Belgian authorities an environmental impact assessment of the foreseen launch activity.

As shown in this document, ISC Kosmotras uses detailed internal procedures and documents 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. ISC Kosmotras' environmental monitoring program offers a framework in which environmental monitoring is conducted on a permanent basis. The launch service provider will continue the good environmental practices already being employed at its facilities and surroundings.

Several mitigation activities and ongoing environmental practices contribute to reduce or limit the potential environmental impact of the launch:

- Safety policies and procedures employed at the launch site which are designed to protect the employees and high-value property;
- Samples are taken before and after the launch on the ground and on the launch site;
- The mission profile ensures no adverse effect of the launch in the atmosphere. The rocket propellant components are completely burned out after which the engine is automatically switched off. The 3rd stage however stays approximately up to 100-150 years in the atmosphere before disintegrating completely;
- No radioactive substances or components are used in the selected launch vehicle;
- The launch vehicle has a track record and a reliability index evaluated at 97,6%.

Based on financial, technical and programmatic assumptions, the selected launch vehicle offers the best guarantees for the realization of the precursor launch objectives. ISC Kosmotras has a credible customer oriented reputation and will continue the good environmental practices already in place. For these reasons, VKI and ISIS B.V. have chosen the Dnepr launch vehicle for the QB50 precursor launch.

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 QB50 project, being a scientific endeavor with limited budget, the selected launch vehicle offers the best value for money.

PART V : MEMO ON THE EXPERTISE OF THE VON KARMAN INSTITUTE FOR FLUID DYNAMICS AS OPERATOR

1. Introduction: Implementation of the Belgian space law

The QB50 project, funded by the European Commission and executed by the von Karman Institute for Fluid Dynamics (VKI) intends to launch three nano-satellites called QB50p1, QB50p2 and PACE of the approximate size of 20x10x10cm into Low Earth Orbit to an altitude of 624 km at an inclination of approximately 98 degrees. The VKI will act as the Operator in the framework of the Belgian space law, but implements the launch activity through a Dutch partner (ISIS B.V.) and a Russian launch service provider (ISC Kosmotras).

The relationship between the aforementioned partners is illustrated in Figure 7.

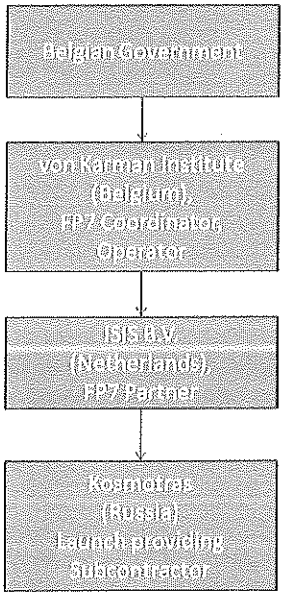


Fig. 7 – Implementation of the Belgian space law with respect to the QB50 precursor launch

2. Expertise as an Operator

VKI is a non-profit international educational and scientific organization, hosting three departments[4]. It provides post-graduate education in fluid dynamics and encourages "training in research through research". The VKI undertakes and promotes research in the field of fluid dynamics. It possesses about fifty different wind tunnels, turbomachinery and other specialized test facilities, some of which are unique or the largest in the world. Extensive research on experimental, computational and theoretical aspects of gas and liquid flows is carried under the direction of the faculty and research engineers, sponsored mainly by governmental and international agencies as well as industries.

[4] Aeronautics and Aerospace (AR), Environmental and Applied Fluid Dynamics (EA), Turbomachinery and Propulsion (TU)

The VKI is or was involved in the instrumentation of all ESA re-entry spacecraft such as the Atmospheric Reentry Demonstrator (ARD), European eXPErimental Reentry Testbed (EXPERT), the Intermediate eXperimental Vehicle (IXV) and has started in 2010 to design, end-to-end, its own miniaturized re-entry vehicle called Qarman. As of 2011, the VKI is charged with the management of the QB50 project consisting of the launch of 50 CubeSats. In the framework of the QB50 project, a precursor launch is scheduled and is the object of the current document.

The QB50 team of VKI and ISIS B.V. involved in (the preparation of) the precursor launch consists of the following persons:

Name	Organization	Responsibility
Dr. Jean Muylaert	VKI	Director VKI, FP7 QB50 General Supervisor
Dr. Jan Thoemel	VKI	QB50 Project Manager
Thorsten Scholz	VKI	Ground Segment Engineer and Mission Analyst
Paride Testani	VKI	Launch System Engineer
Abe Bonnema	ISIS	ISIS Marketing Director, Launch Campaign Manager
Michiel VAN BOLHUIS	ISIS	Launch mission manager

Detailed curriculum vitae of the persons involved from VKI and ISIS B.V. is attached in annex 2.

3. Alternative launcher scenario's analysis

In accordance with the provisions of the Belgian space law, VKI and ISIS B.V. conducted an in depth analysis of the European and international launchers potentially available for realizing the objectives of the QB50 precursor launch. The results of this analysis are described in this chapter.

The launch scenario consisting of the choice of provider, the launch site and further characteristics such as contractual conditions have been analysed to best match the needs of the QB50 project, the Regulations of the EU FP7 program and other constraints. The disregarded alternatives and the reasons are given below:

Launch Provider and Launcher	Reason for disregard
ESA/Arianespace • VEGA • ARIANE 5	In particular the launch cost is prohibitively high. Further reason for disregard is the timely unavailability of a launch into a suitable Low Earth Orbit
American Launch providers such as United Launch Alliance, Orbital Science, SpaceX • Atlas 5 • Antares • Falcon 9	The costs for the launch are prohibitively high. Further reason for disregard is the timely unavailability of a launch into a suitable low Earth Orbit
Chinese launch providers such as China Great Wall Industry Corporation (CGWIC) • MLVT • Long March	Mostly export related issues prevented the consideration of Chinese provided launch vehicles.

ANNEX 1 – DNEPR DETAILED LAUNCH AND TRACK RECORD

Launch No.	Satellite(s)	Customer	Launch date / Launch Base/ Orbit (LEO) / Remarks	Total
1	UoSat-12	SSTL, UK	21.04 1999 / Baikonur / 65° / Successful launch	1 SC
2	MegSat-1	MegSat s.P.a Company	26.09.2000 / Baikonur / 65° / Successful launch	5 SC
	UniSat	"La Sapienza" University of Rome, Italy		
	SaudiSat-1A	SRI, Saudi Arabia		
	SaudiSat-1B	SRI, Saudi Arabia		
	TiungSat-1	ATSB Company, Malaysia		
3	UniSat-2	"La Sapienza" University of Rome, Italy	20.12.2002 / Baikonur / 65° / Successful launch	6 SC
	Rubin-2	OHB-System, Germany		
	SaudiSat-1C	SRI, Saudi Arabia		
	LatinSat-A and -B	SpaceQuest, USA		
	SC simulator	TransOrbital, USA		
4	Demeter	CNES, France	29.06.2004 / Baikonur / 98° / Successful launch	8 SC
	SaudiSat-2 and SaudiComSat-1, -2	SRI, Saudi Arabia		
	LatinSat-C, -D and AmSat-Echo	SpaceQuest, USA		
	UniSat-3	"La Sapienza" University of Rome, Italy		
5	OICETS	Japan Aerospace Exploration Agency, Japan	24.08.2005 / Baikonur / 98° / Successful launch	2 SC
	INDEX			
6	Genesis -1	Bigelow Development Aerospace Division LLC, USA	12.07.2006 / Yasny/ 65° / Successful launch	1 SC
7	BelKA	Academy of Sciences, Republic of Belarus	26.07.2006/ Baikonur/ 98°/ Launch failure	18 SC
	Baumanets	NPO Mashinostroeniya, Russia		
	UniSat-4	"La Sapienza" University of Rome, Italy		
	PicPot	"La Sapienza" University of Rome, Italy		

	P-Pod containers with CubeSat satellites	Cal Poly Corporation, USA		
8	EgyptSat-1	SDO Yuzhnoye, Ukraine	17.04.2007/ Baikonur/ 98° / Successful launch	14 SC
	SaudiSat-3, SaudiComSat-3,-4,-5,6,-7	SRI, Saudi Arabia		
	P-Pod containers with CubeSat satellites	Cal Poly Corporation, USA		
9	Genesis-2	Bigelow Development Aerospace Division LLC, USA	28.06.2007 / Yasny/ 65° / Successful launch	1 SC
10	TerraSAR-X	EADS Astrium GmbH	15.06.2007 / Baikonur/ 98° / Successful launch	1 SC
11	RapidEye constellation	SSTL, UK	29.08.2008 / Baikonur/ 98° / Successful launch	5 SC
12	THEOS	EADS Astrium	1.10.2008 / Yasny/ 98° / Successful launch	1 SC
13	DubaiSat-1	EIAST, United Arab Emirates	29.07.2009 / Baikonur/ 98° / Successful launch	6 SC
	Deimos-1	Deimos Imaging, Spain		
	UK-DMC-2	SSTL, UK		
	NanoSat-1B	INTA, Spain		
	AprizeSat-3,-4	SpaceQuest, USA		
14	CryoSat-2	EADS Astrium GmbH	8.04.2010 / Baikonur/ 92° / Successful launch	1 SC
15	PRISMA	Swedish Space Corporation, Sweden	15.06.2010 / Yasny/ 98° / Successful launch	2 SC
	PICARD	CNES, France		
16	Tandem-X	EADS Astrium GmbH	21.06.2010 / Baikonur/ 98° / Successful launch	1 SC
17	SICH-2	SSAU, Ukraine	17.08.2011 / Yasny/ 98° / Successful launch	7 SC
	NIGERIASAT-2	SSTL, UK, Nigeria		
	NIGERIASAT-X	SSTL, UK, Nigeria		
	RASAT	TUBITAK UZAY, Turkey		
	EDUSAT	"La Sapienza" University of Rome, Italy		
	APRIZESAT-5,-6	SpaceQuest, USA		
18	KOMPSAT-5	KARI, South Korea	22.08.13/ Yasny/ 98° / Successful	1 SC

			launch	
19	DubaiSat-2	EIAST, UAE	21.11.13/ Yasny/ 98° / Successful launch	24 SC
	STSAT-3	KARI, Republic of Korea		
	SkySat-1	Skybox Imaging Inc., USA		
	BPA-3	SSAU, Ukraine		
	UniSat-5	GAUSS, Italy		
	APRIZESAT-7, -8	SpaceQuest, USA		
	XPOD Systems: WNISAT-1 (Japan) BRITE-PL (Poland) GOMX-1 (Denmark)	Space Flight Laboratory (SFL), Canada		
	9 ISIPOD Systems: 14 CubeSats	Innovative Space Logistics BV (ISL), The Netherlands		
TOTAL SPACECRAFT/PAYLOADS LAUNCHED: 89				

ANNEX 3 – FREQUENCY PUBLICATION AND PRINCIPAL SPECIFICATIONS OF THE EMBARKED SATELLITES

- Satellite QB50p1
- Satellite QB50p2
- Satellite PACE

DS14-8524-8

IBPT

Monsieur Kris Vanderhauwaert
Aeronautics & Aerospace Dept.
Von Karman Institute for Fluid Dynamics
Waterloosesteenweg 72
1640 Sint-Genesius-Rode

Gestionnaire du dossier - Brigitte Wayembergh (Fr)
Grade - Correspondant

Service - Service des Fréquences
e-mail - freqadmin@ibpt.be

Nos références
14/FRE/2014-000057-2-66808BWM/SAT/205/QB50
Vos références

Votre e-mail du 23/03/2014

tél +32 2 226 88 78
fax +32 2 226 88 82

Bruxelles, le 07 -05- 2014

Objet : Coordination et notification du satellite QB50P.

Monsieur,

Dans le cadre de votre demande d'autorisation de lancement à la Politique scientifique fédéral (BELSPO), l'IBPT confirme qu'il a bien entamé la coordination du satellite QB50P prévue à l'article 9 du Règlement des Radiocommunications de l'Union Internationale des Télécommunications (UIT). Au reçu des renseignements complets, le Bureau des Radiocommunications de l'UIT les publie dans un délai de 3 mois dans une section spéciale de sa Circulaire de la BR IFIC. Dans ce cas précis, la publication a été faite le 29/04/2014. La date limite pour la réception des commentaires est le 29/08/2014.

Je vous prie d'agréer, Monsieur, mes sincères salutations.

Au nom du Conseil
M. Vandroogenbroek
Premier Ingénieur Conseiller

Annexe(s):

von KARMAN INSTITUTE FOR FLUID DYNAMICS INPA
INSTITUT von KARMAN DE DYNAMIQUE DES FLUIDES AISBL
von KARMAN INSTITUUT VOOR STROMINGSDYNAMICA IVZW

REF. AGA000/JM/dl/808
19 June 2014

BELSPO
Mr. Jean-François Mayence
Legal Service / International Relations
Avenue Louise 231
1050 Brussels

Dear Mr. Mayence,

In response to your request d.d. 10 June 2014, please find hereunder a formal statement concerning the maneuverability of the satellites involved in the QB50 precursor launch scheduled for 19 June 2014 (20 June local time in Russia).

The three CubeSats, identified as QB50p1, QB50p2 and PACE, will be placed into their orbit by a Dnepr launch vehicle provided by the company ISC Kosmotras. Upon release from the upper stage, the CubeSats will rotate to change their positioning ensuring that the science sensor point into the predefined flight direction. The CubeSats have no maneuvering capabilities that allow them to change their orbit (altitude, inclination) which is fixed at 600 km (low Earth orbit). The orbit of the launched CubeSats will decay naturally due to residual atmospheric drag in space.

Please feel free to contact us would you have further questions regarding this statement or the precursor launch in general.

Yours sincerely,

Jean MUYLAERT
Director

CHAUSSÉE DE WATERLOO, 72
1640 RHODE-SAINT-GENÈSE, BELGIQUE

WATERLOOSESTEENWEG 72
1640 SINT-GENESIUS-RODE, BELGIË

TEL: 32 (02) 359 96 11 - FAX: 32 (02) 359 96 00 - E-MAIL: secretariat@vki.ac.be - https://www.vki.ac.be - BNP PARIBAS 210-0315330-35
BTW/TVA-ONDERNEMINGS N° D'ENTREPRISE: BE 0407 185 709
IBAN BE57 2100 3153 3035 - SWIFT CODE: GEBABEBB

von KARMAN INSTITUTE FOR FLUID DYNAMICS INPA
INSTITUT von KARMAN DE DYNAMIQUE DES FLUIDES AISBL
von KARMAN INSTITUUT VOOR STROMINGSDYNAMICA IVZW

REF. **AGREEMENT IN THE FORM OF AN EXCHANGE OF LETTERS BETWEEN THE VON KARMAN INSTITUTE FOR FLUID DYNAMICS (VKI) AND INNOVATIVE SOLUTIONS IN SPACE B.V. (ISIS) RELATING TO THE PRECURSOR FLIGHT IN THE FRAMEWORK OF THE EU FP7 QB50 PROJECT**

In the framework of the EU FP7 QB50 Project, the VKI has entrusted ISIS a procurement of a risk reduction/ precursor flight scheduled on 19 June 2014.

VKI and ISIS are partners in the aforementioned EU FP7 Project, whereas ISIS has signed the launch contract with the Launch Service Provider ISC Kosmotras, Moscow, Russia for the precursor flight and whereas VKI is the Coordinator of the EU FP7 Project.

Following negotiations between VKI and ISIS with regard to the precursor flight, the Parties have reached the following understanding:

1. The precursor flight procured by VKI, in its capacity of Operator of the overall QB50 mission, falls under the provisions of the Belgian Law of 17 September 2005 on the Activities of Launching, Flight Operation or Guidance of Space Object, as subsequently amended, hereafter referred to as "Belgian Space Law".

2. According to the Belgian Space Law, VKI – in its capacity of the Operator – is responsible for applying to the Belgian competent authority for an authorization to launch and to operate both CubesSats involved in the precursor flight. The Operator exercises full authority over the definition of the launch and positioning parameters, as well as over the in-orbit manoeuvering and bears the overall responsibility towards the Belgian authorities.

3. Any orbital manoeuver of the manoeuverable satellites involved in the precursor flight, will be performed under the authority of VKI. VKI is entitled to give instructions related to the orbit and manoeuverability of the satellites to ISIS and to the Launch Service Provider, notably upon request of the Belgian authorities.

4. For the non-maneuverable satellites involved in the precursor flight, it is understood that ISIS has signed the launch service contract with ISC Kosmotras, including the technical parameters for the in-orbit delivery and the positioning of the satellites, under the authority of VKI and on the basis of the authorization of the Belgian authorities.

This Agreement shall enter into force on the date on which both Parties have signed it.

For VKI,

Date : 11/June/2014

Jean MUYLAERT
Director

For ISIS

Date : 18-6-2014

Jeroen ROTTEVEEL
CEO

CHAUSSÉE DE WATERLOO, 72
1640 RHODE-SAINT-GENÈSE, BELGIQUE

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BTW/TVA-ONDERNEMINGS N° D'ENTREPRISE: BE 0407 185 709
IBAN BE57 2100 3153 3035 - SWIFT CODE: GEBABEBB

AGREEMENT IN THE FORM OF AN EXCHANGE OF LETTERS BETWEEN THE VON KARMAN INSTITUTE FOR FLUID DYNAMICS (VKI), INNOVATIVE SOLUTIONS IN SPACE B.V. (ISIS) AND THE NATIONAL CHENG KUNG UNIVERSITY (NCKU), TAINAN, TAIWAN, RELATING TO LAUNCH OF THE PACE NANO-SATELLITE

Following negotiations between VKI, ISIS and NCKU with regard to the launch of the PACE Nano-Satellite, the Parties have reached the following understanding:

1. The launch of the PACE Nano-Satellite conducted by VKI falls under the provisions of the Belgian Law of 17 September 2005 on the Activities of Launching, Flight Operation or Guidance of Space Object, as subsequently amended, hereafter referred to as "Belgian Space Law".

2. According to the Belgian Space Law, VKI – in its capacity of the Operator – is responsible for applying to the Belgian competent authority for an authorization to launch and to operate the PACE Nano-Satellite. The Operator exercises full authority over the definition of the launch and positioning parameters, as well as over the in-orbit maneuvering and bears the overall responsibility towards the Belgian authorities.

3. Any orbital maneuver of the satellite, will be performed under the sole authority of VKI. VKI is entitled to give instructions related to the orbit and maneuverability of the satellites to ISIS and to the Launch Service Provider, notably upon request of the Belgian authorities. Moreover, it is understood that ISIS has signed the launch service contract with ISC Kosmotras, including the technical parameters for the in-orbit delivery and the positioning of the satellites, under the authority of VKI and on the basis of the authorization of the Belgian authorities.

This Agreement shall enter into force on the date on which all three Parties have signed it.

For VKI,	For ISIS	For NCKU
Date:	Date :	Date : Jan. 28. 2014
Jean MUYLAERT Director	Jeroen ROTTEVEEL CEO	Hwung-Hweng HWUNG President