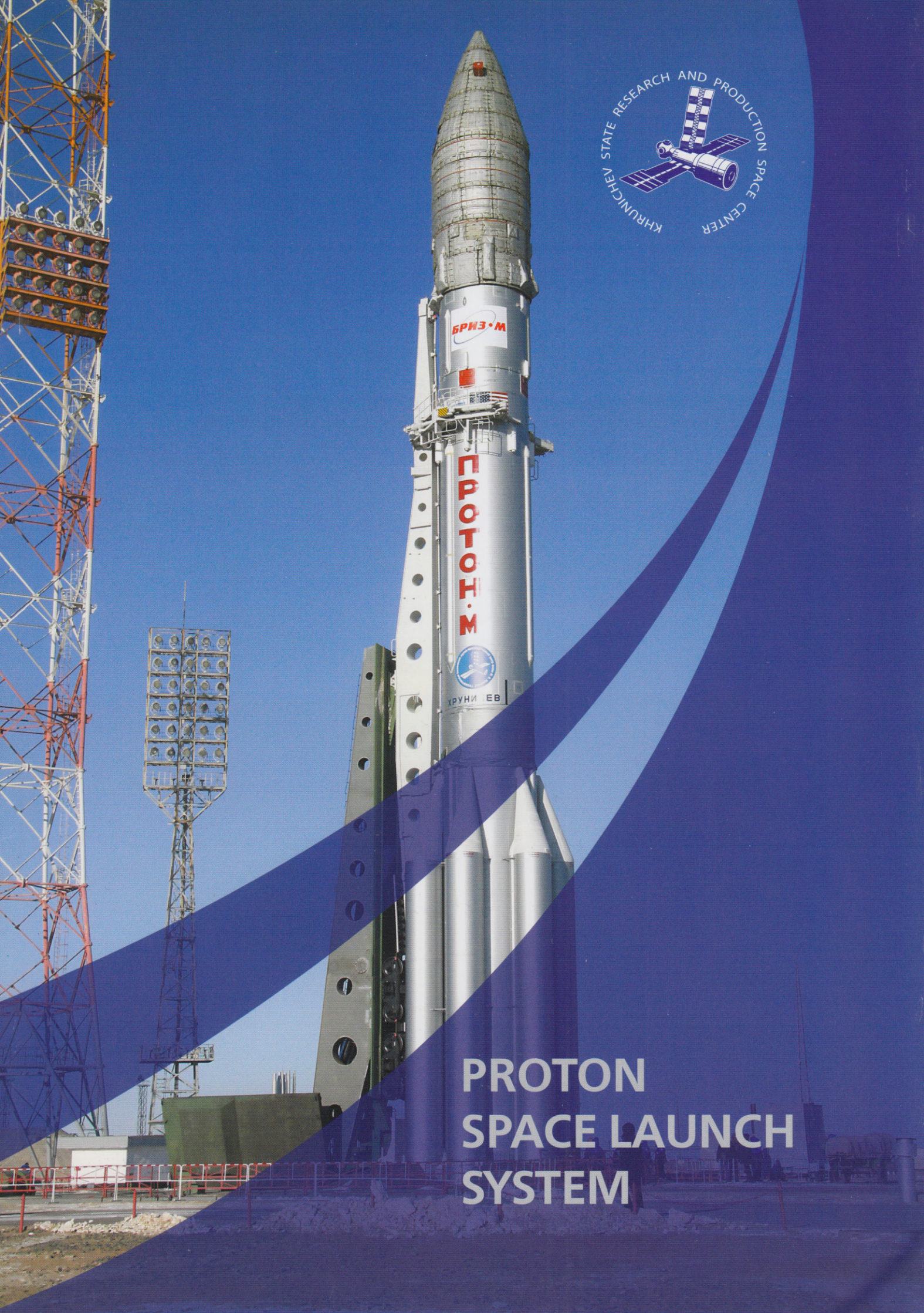


PROTON SPACE LAUNCH SYSTEM

The Breeze M upper stage burning NTO and UDMH propellants, employed by the Proton M, increases its GSO payload capability to 3.7 t and GTO payload capability to 6.0 t.

The Breeze M upper stage completed its inaugural flight onboard the Proton K booster in June 2000, when it placed the Gorizont communications satellite in its target orbit. The Proton M / Breeze M made its debut on 7 April 2001.

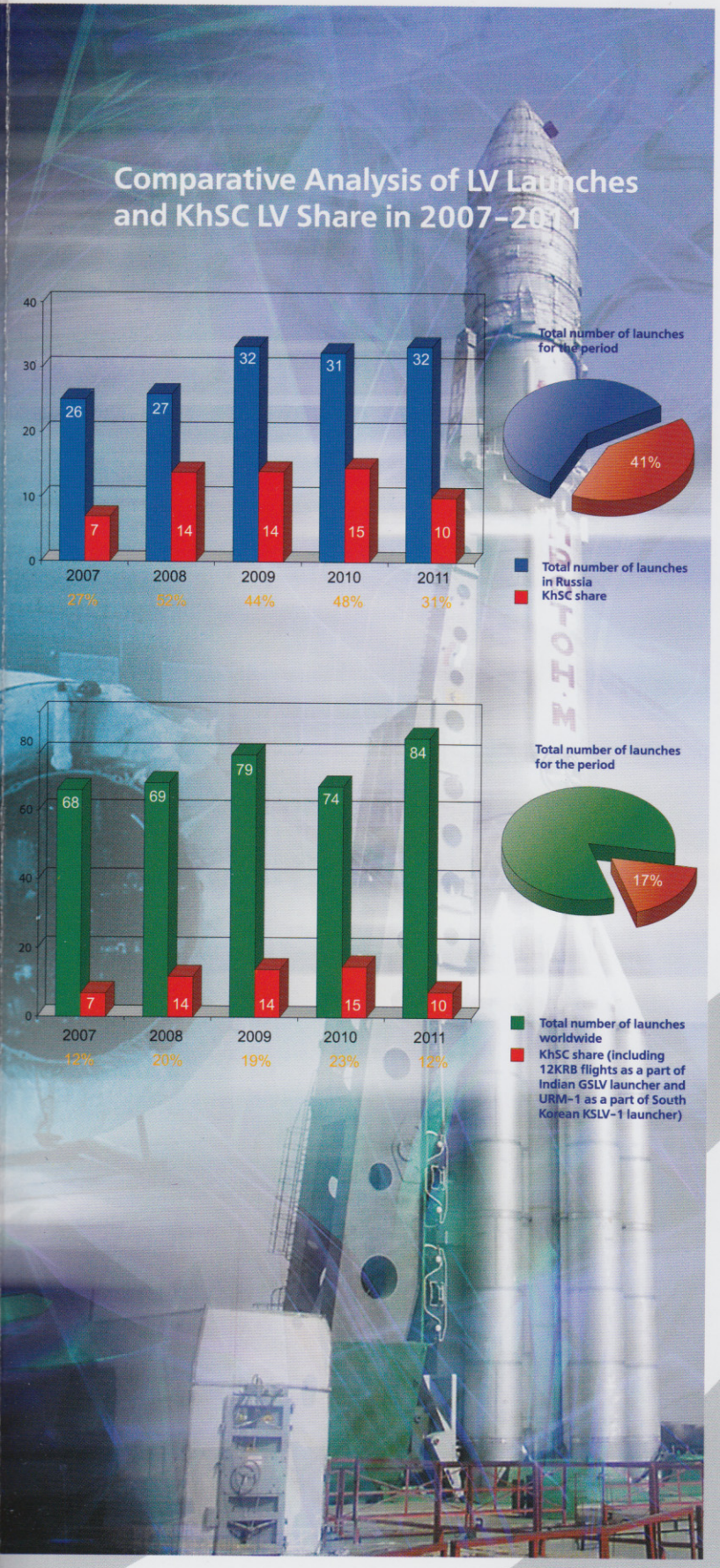
Breeze M Performance Data

Configuration	A twin upper stage consisting of a core module (using Breeze KM as the baseline) and a jettisonable add-on doughnut tank surrounding the core
Areas of application	Integration in Proton M, Angara A3 or Angara A5
Main specific features	• Overall dimensions are as small as possible • Heavy and/or large payloads • Long flight operations possible
Max. lift-off mass	22,500 kg
Max. main engine propellant reserve (NTO + UDMH)	20,000 kg
Engine types/quantities/ vacuum thrust	14D30 liquid propellant engine (main) /1 ea./ 2000 kgf 11D458 liquid propellant engines (vernier) / 4 ea. / 40 kgf 17D58E engines (attitude control and stabilization) / 12 ea. / 1.36 kgf
Max. number of main engine burns	8
Autonomous flight duration	At least 24 hrs (per Launch System Design Specifications)
Starting date of flight test	1999

Improvement of Existing Products (Proton M LV and Breeze M US)

Goal of innovations – improvement of Proton M/ Breeze M capabilities for federal and commercial SC launches.

More than 50 innovative solutions were implemented to enhance the Proton M/Breeze M performances.



The Proton-M is a highly potential player in the commercial launch services market. All Protons are commercially launched by the International Launch Services (ILS) joint venture. The majority shareholder in ILS is the Khrunichev Space Center, the designer and manufacturer of the Proton and Angara launchers.

International Launch Services (ILS) is a U.S.-Russian company with exclusive rights for the marketing and commercial operation of the Proton heavy-lift booster and the Angara next-generation launch system. Set up in 1995 in the USA, ILS is headquartered in Reston, Va., a suburb of Washington, D.C.

ILS is a complete launch services organization. Its staff of about sixty people shares decades of cumulative expertise in the international launch services market.

The Proton made its inaugural commercial launch back in 1996 with the SES's ASTRA 1F spacecraft.

Over 60 ILS Protons have flown since 1996. The company has launched most commercial satellite platforms and worked with all major satellite operators.

Over these years, Proton mission integration efforts were undertaken to launch payloads made by all world-renowned SC manufacturers. A fully refurbished Proton processing facility and launch complex available at Baikonur, rank among the world's best.

This experience helps ILS keep mission integration cycles and launch campaigns short, while maintaining a steady launch pace.

It is the kind of professionalism that has helped ILS become the launch provider of choice for customers worldwide. The ILS launch backlog now stands at 22 Proton missions.

Eight ILS Protons were launched in 2010, marking a record number of missions by the same rocket over the entire history of the international commercial launch services market.

The Proton is the premier heavy-duty vehicle of the Russian space program and has been widely used to inject governmental and commercial payloads into Earth orbits and escape trajectories. The Proton is mainly relied upon to deliver Russian-made modules within the ISS project.

The Proton boasts an efficient design, high power and performance characteristics. These advantages, coupled with Proton's exceptionally high accuracy of payload injection into target orbits, make it possible to maximize customer satisfaction, assure business plan implementation, while mitigating potential risks.

The Proton is regarded as one of the most reliable, flight-proven (with over 360 launches) and cost-effective heavy-lift launchers.

Launch Site: Baikonur. All Proton launches are conducted from the Baikonur Cosmodrome. Baikonur celebrated its 55th anniversary in 2010 and is home to a well-developed ground infrastructure with state-of-the-art facilities to support ILV launch processing and launch activities.

Three Proton launch pads are available at Baikonur, which provides the ability to sustain exceptionally high launch rates.

Facts & Figures

The UR-500 two-stage launch vehicle was the Proton's baseline design.

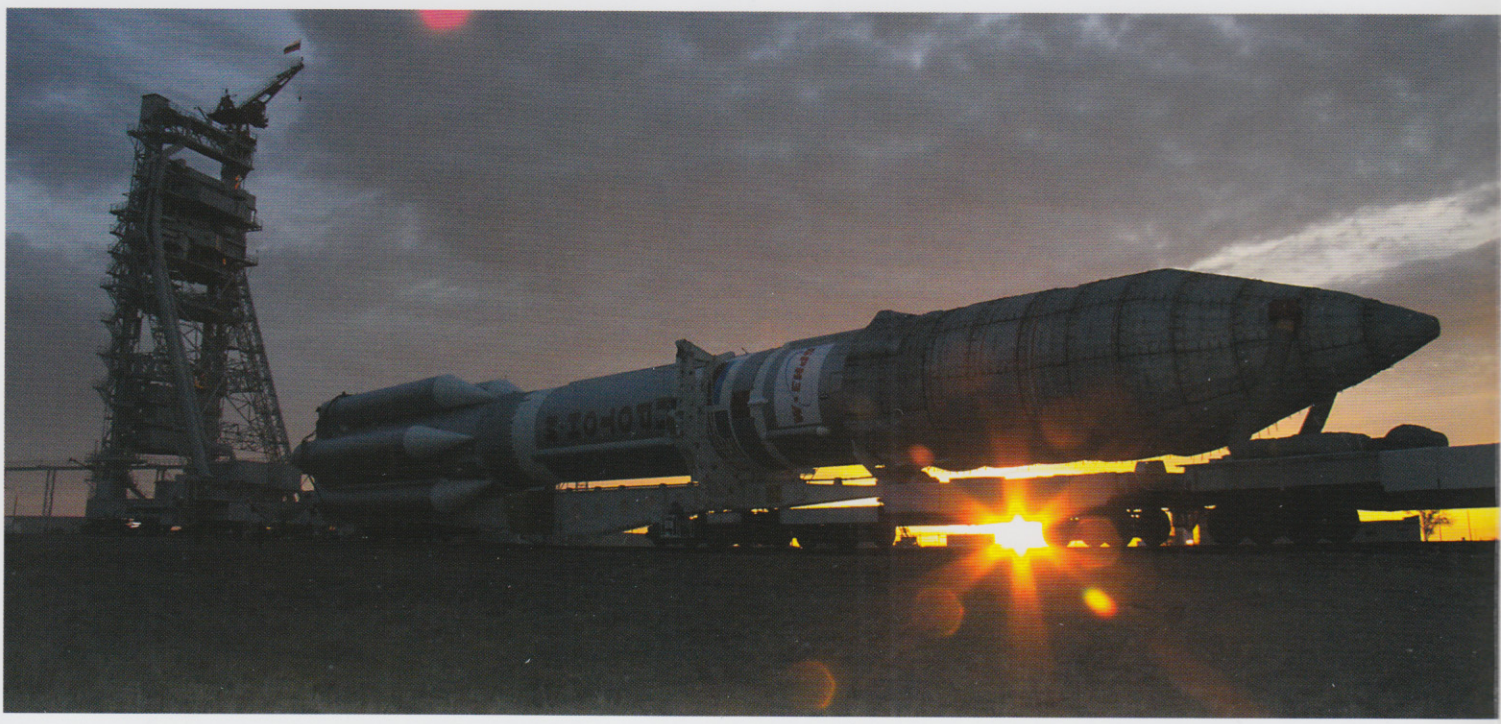
On 16 July 1965, the two-stage LV performed its maiden flight, placing a scientific satellite, called the Proton, into a low-earth orbit. The satellite was the source of the name for the Proton launch vehicle.

Since 1967, the Proton has been launched in three- and four-stage configurations available today: its three-stage version (Proton-K) to deliver payloads to low-earth orbits (Zarya and Zvezda modules for the ISS, heavy spacecraft), while its four-stage option to launch spacecraft into high-energy orbits (including GTO, GSO and escape trajectories).

PROTON Serving Russia

The Proton placed into orbit the Kosmos, Ekran, Raduga, Gorizont satellites, launched all of Russia's space probes to the Moon, Mars, Venus and Comet Halley. Its service record also includes all Salyut- and Almaz-series manned orbital stations, all modules for the Mir orbital station, the Russian-built Zarya and Zvezda modules for the ISS, and heavy communications satellites.

The Proton was used to launch all of Russia's GLONASS (global satellite navigation system) satellites until 2011, and is currently the primary launcher for the Express-series digital broadcasting and communications satellites intended to upgrade Russia's civilian satellite constellation.



The Proton M, an upgraded version of the launch vehicle that features an improved control and navigation system, higher performance capability and is friendlier to the environment, has been in operation since 2000.

Thanks to its modern control and navigation system and advanced Breeze M upper stage, the Proton M is capable of accommodating a considerably broader range of feasible orbits, which allows it to successfully compete with its foreign-made counterparts.

The Khrunichev Space Center developed larger and more light-weight payload fairings for the upgraded Proton booster. They offer a larger useable payload bay and can support multiple launches of various types of spacecraft.

The use of larger, including 5-meter, fairings in the Proton M configuration will more than double the usable payload volume. The larger PLF will also make it possible to employ a variety of next-generation upper stages as part of the new launch vehicle.

A new and improved computerized navigation system is installed on the upgraded launcher. Major components of this system have been successfully tested in flight on other launchers and are widely used. The new system will solve several significant problems, more specifically it will

- Make propellants utilization more efficient due to more complete depletion thereby increasing LV performance while reducing if not totally eliminating hazardous residues;
- Enable 3D maneuvering during powered flight, which will expand the range of feasible parking orbit inclinations;
- Simplify the avionics since computations performed until now by the depletion system and the safety system will in future be relegated to the onboard computer;
- Limit the dynamic pressure times pitch (yaw) product in flight, which will open the way for larger payload fairings without sacrificing noticeably the LV load capability;
- Enable on-line loading or updating the mission definition; and
- Improve the mass properties of the launch vehicle.

Another advantage will be drastically reduced drop fields for the expended launch vehicle first stages.

Facts & Figures

During a dual launch of the Express-AM44 and Express-MD1 satellites, the Proton M/Breeze M delivered a 3.7 t payload directly to GSO for the first time. Also, the Proton successfully demonstrated a unique mission profile, placing the satellites into different orbital slots.

Proton M Performance Data

Configuration	3 stages
Lift-off mass	About 702,000 kg
Payload mass:	
- Parking orbit (H circ = 200 km , i = 51.6°)	About 22,000 kg
- GTO (i = 25°, H p = 5500 km) (Breeze M/KVRB)	6000 / 6600 kg (commercial SC)
- GSO (H circ = 35,786 km, i = 0°) (Breeze M/KVRB)	Max. 3700 / Max. 4000 kg (governmental SC)
Parking orbit injection error	DHp = ± 2 km DHa = ± 4 km Di = ± 1.8 ang. min DT = ± 3 sec
Types / quantities/thrust (sea level/vacuum) of engines:	
- Stage 1	RD 275 liquid engines/6 ea./ (971,400 kgf / 1069,800 kgf)
- Stage 2	RD 0210 liquid engines/3 ea. & RD 0211 /1 ea./ (- / 237,400 kgf)
- Stage 3	RD 0213 liquid engine/1 ea./ (- / 59,360 kgf) (main) RD 0214 liquid engine/1 ea./(- / 3150 kgf) (steering)
PLF diameter / length	4.35 / 11.6 m (Breeze M) 4.35 / 15.255 m (Breeze M) 5.10 / 16.371 m (Breeze M) 5.10 / 19.65 m (KVRB) 4.35 / 12.65 m (LEO module)

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