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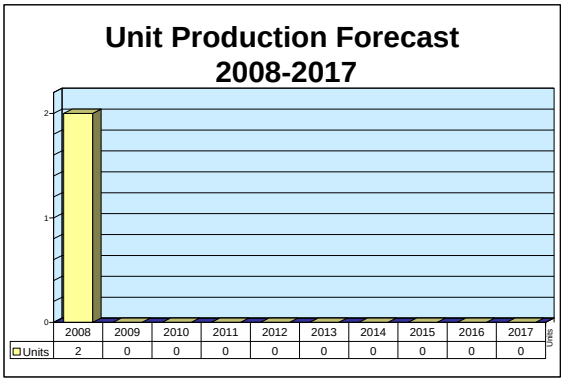
Molniya - Archived 1/2009

Outlook

- Molniyas have about a 92 percent success rate
- Outpaced and outshined by Proton
- Still in use; Russia occasionally uses them to place military payloads
- All future production has been stopped with the last planned launch in 2008



Orientation

Description. A three-stage, liquid-fueled medium-lift launch vehicle based on the Soyuz rocket.

Sponsor. The Soviet Union developed the Molniya for use by the Soviet Union Strategic Rocket Forces. Now backed by the Russian Space Agency.

Status. Operational with retirement planned for 2008.

Total Produced. As of October 2007, 294 were launched, 21 of which failed.

Application. Originally developed for lunar and planetary missions, the Molniya is now used to place 1,600- to 1,800-kilogram payloads into highly elliptical (~400 km x 40,000 km) Earth orbits.

Price Range. Launch cost was $25 million in 1994 U.S. dollars. Flyaway cost was $39 million in 1985 U.S. dollars. Since the Molniya is rarely (if ever) used for commercial launches, pricing data is difficult to ascertain.

Contractors

Prime

TsSKB Progress, Progress Central Specialized Design Bureau	http://www.samspace.ru, 18 ulitsa Pskovskaya, Samara, 443009 Russia, Tel: + 7 8462 55 13 61, Fax: + 7 8462 97 18 86, Email: mail@progress.samara.ru, Prime

Subcontractor

NPO Energomash JSC	http://www.energomash.ru/english, 1, Burdenko St, Khimki, 141400 Russia, Tel: + 7 095 572 2200, Fax: + 7 095 251 7504, Email: energo@on-line.ru (Propulsion Development)
NPO Lavochkin	http://www.laspace.ru, 24 Leningradskoye Hwy, Moscow Region, Khimki, 141400 Russia, Tel: + 7 095 575 5002, Fax: + 7 095 573 3595 (Fregat Upperstage)

Molniya

RNII Kosmicheskogo Priborostroyeniya, RNII-KP (NII-885)	http://www.rniikp.ru/, 53 Aviamotornaya St, Moscow, 111250 Russia, Tel: + 7 095 273 1628, Fax: + 7 095 273 1131 (Control System)

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Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

Design Features. Russia's Special Design Bureau #1 (OKB-1) developed the Molniya space booster in 1958/60 based on the Vostok space booster originally derived from the ICBM R-7 missile (U.S. designation SL-6). Molniya's main purpose is to lift lightweight probes to Mars and Venus and heavier probes to the Moon.

Essentially the same vehicle as the Soyuz, the Molniya features an additional upper stage, which makes it slightly more powerful. It is said to be capable of lifting up to 3,564 pounds to the Moon, 2,596 pounds to Venus, and 2,090 pounds to Mars.

Molniya's strap-ons and first and second stages are similar to those on Soyuz. Its third-stage engine, designated Stage I, is a modified version of the S.A. Kongsberg model used as the second stage of the P-9 rocket. This liquid oxygen/kerosene motor produces a vacuum thrust of 67 kN. This stage also features two solid-propellant settling motors that are ignited before the main engine fires.

Molniya's additional third stage (some call it the fourth) is the Stage-L designed by OKB-1. Like the lower stages, this third stage is powered by liquid oxygen and kerosene. Also part of this stage is the OKB-1 model 11D33 closed-cycle liquid-propellant engine. The Block-L rocket stage was the beginning of a series of engines leading to the Block D for the N1 and Proton rockets.

A Molniya Sits on the Pad for Launch.
Source: IKI

Molniya-M

	Metric	U.S.
Dimensions		
Length	43.24 m (45.2 m)	141.8 ft (148.3 ft)
Diameter	3 m	9.8 ft
Diameter of booster cluster	10.3 m	33.8 ft
Weight		
Launch weight	305,460 kg	673,540 lb
Payload weight (LEO)	1,800 kg	3,979 lb
Payload weight (GTO)	1,600 kg	3,528 lb
Performance		
Propellant	Kerosene/Liquid O_2	
Engines[(a)]		
Stage 1[(b)]	RD108	167,000 lbst
	4 strap-ons	740,000 lbst
Stage 2	RD 1461	67,000 lbst
Stage 3	RD 107	15,000 lbst
Stage 3+/4	OKB-1 model 11D33 (S1.5400A)	14,700 lbst

[(a)] All stages burn Lox/Kerosene propellant.
[(b)] Core is one RD-108 booster engine; strap-ons have one RD-107 engine each.

Variants/Upgrades

Molniya-L. Revised model (1963 through 1965).

Molniya-M. Stage L upgrade model (1964 to present).

Program Review

Background. The R-7A intercontinental ballistic missile (ICBM) forms the basis for such launch vehicles as Sputnik, Voskhod, Molniya, and Soyuz. The Molniya, originally developed for lunar and planetary missions in 1960, is now used to place communications satellites into highly elliptical orbits.

Test Models Launched

Two test models of the Molniya-L were launched from Baikonur Cosmodrome in January 1960. Both were considered two-stage rockets, since the third stage – the payload – was a dummy (Blok L). The first stage used an RD-107 plus four strap-ons, and the second an RD-108.

Molniya Enters Market with a Bang

Molniya's actual market entry was a bit more explosive. The first launches with an actual payload occurred in October 1960, when a Molniya hoisted the Mars 1M-1 and a few days later, the Mars 1M-2. These missions – Russia's first attempts at launching planetary probes – both failed when the rockets malfunctioned. But the third mission was a real gem. In October 1962, a Molniya blasted off carrying the Sputnik 22 Mars observation capsule. The payload exploded into many pieces, which floated around in the atmosphere for a while. The U.S. later picked them up on radar and thought it was seeing the early phases of a Soviet nuclear attack – since it was the height of the Cuban missile crisis.

In the early phases, between October 1960 and March 1964, Molniya rockets suffered a number of failures when the Stage L engines would not ignite properly. It was later determined that a design error resulted in a failure to ignite the Stage L engine. Apparently, the control system had to switch power for the attitude control and stabilization system from the engine ignition batteries over to the Stage L batteries to fire the engine. To correct the problem, a separate ignition unit was installed on Stage L that also contained an attitude control/stabilization system and storage batteries. The improved model was dubbed the Molniya-M Block ML, the first of which launched in 1964. The last recorded Molniya failure was in 1990.

Lavochkin later developed a new liquid restartable upper stage, dubbed Fregat, which can deliver to GEO up to 3,600 kilograms of payload (with the Proton) or

2,100 kilograms (with the Molniya LV). The Fregat can be commercially offered for launches of different Western satellites.

For the first 12 years, Molniyas were used for planetary missions. In 1973, Russia began using it to launch communications payloads. Over the years, Molniyas have lofted Luna, Prognoz, Molniya, Zond, MARS, Venera, and MAS satellites from either the Plesetsk or Baikonur launch pads. Launches now take place exclusively from Plesetsk.

The Russian rocket has taken part in nearly 300 launches. Most recent was in July 2006, when a Molniya-M successfully launched a classified Kosmos spacecraft. The 1,900-kilogram (4,188-lb) spacecraft is thought to be an early-warning satellite manufactured by NPO Lavochkin. The spacecraft will be operated by the Russian Defense Ministry.

2005 Launch Failure. In June 2005, a Molniya launch vehicle failed to insert a Molniya 3K satellite into its proper orbit. Following launch, the spacecraft never established communications with ground control, and flight data indicated that the launch vehicle failure took place around six minutes into the flight, sometime during the third-stage burn. The second and the third stage reportedly did not separate, and the engine on the third stage, which normally ignites before the separation, shut down. The launch vehicle's payload – a Russian Molniya 3K military communications satellite – was destroyed.

Russian Milsat Launched

A Molniya rocket launched a Russian military satellite July 21, 2006. The Molniya-M rocket lifted off from the Plesetsk Cosmodrome in northern Russia at 12:20 a.m. EDT (0420 GMT) and placed the Kosmos 2422 satellite into orbit. Russian reports did not disclose the purpose of the satellite other than it will serve the Russian military. However, the choice of launch vehicle and anticipated orbit lead Forecast International to believe that the spacecraft may be an Oko class early-warning satellite.

Funding

Funding for the program is provided by the Russian Space Agency.

Timetable

Month	Year	Major Events
	1960s	62 Molniyas launched by USSR between 1960 and 1969
	1970s	81 Molniyas launched by USSR between 1970 and 1979
	1980s	102 Molniyas launched by USSR between 1980 and 1989
	1990-94	Russia launched 36 Molniyas
Jun	1995	Molniya-M (Blok-2BL) launches Kosmos 2312 [Oko #80]
Aug	1995	Molniya-M (Blok-2BL) launches Interbol 1/Magion 4
Aug	1995	Molniya-M (Blok-ML) launches Molniya-3 47
Dec	1995	Molniya-M (Blok-2BL) launches IRS 1C/Skipper
Aug	1996	Molniya-M (Blok-ML) launches Molniya-1 89
Aug	1996	Molniya-M (Blok-2BL) launches Interbol 2/Magion 5/Musat 1
Nov	1996	Molniya-M (Blok-ML) launches Molniya-3 48
Apr	1997	Molniya-M (Blok-2BL) launches Kosmos 2340 [Oko #81]
May	1997	Molniya-M (Blok-2BL) launches Kosmos 2342 [Oko #82]
Sep	1997	Molniya-M (Blok-ML) launches Molniya-1 90
May	1998	Molniya-M (Blok-2BL) launches Kosmos 2351 [Oko #83]
Jul	1998	Molniya-M (Blok-ML) launches Molniya-3 49
Jul	1999	Molniya-M (Blok-ML) launches Molniya-3 50
Dec	1999	Molniya-M (Blok-2BL) launches Kosmos 2368 [Oko #84]
Jul	2001	Molniya-M (Blok-ML) launches Molniya-1K 1
Oct	2001	Molniya-M (Blok-ML) launches Molniya-3 51
Jan	2002	Molniya-M (Blok-2BL) launches Kosmos 2388 [Oko #85]
Apr	2003	Molniya-M (Blok-ML) launches Molniya-1T
Jun	2003	Molniya-M (Blok-ML) launches Molniya-3 65
Feb	2004	Molniya-M (Blok-2BL) launches Kosmos-1T 93
Jun	2005	Molniya-M (Blok-ML) fails to launch Molniya-3K
Jul	2006	Molniya-M (Blok-2BL) launches Kosmos-2422 [Oko #87]
Oct	2007	Molniya-M (Blok-2BL) scheduled for retirement
	2008	Last two launches of Molniya-M (Blok-ML) scheduled before Molniya retirement

Forecast Rationale

The Molniya launches once or twice per year on average. After only launching once in 2002, Russia managed to launch it twice in 2003, but only once in 2004. The one launch that took place in 2005 was a failure. The Molniya returned to flight in July 2006, launching what was reportedly a Russian Oko military early-warning satellite. This mediocre level of launch activity has been the norm for the Molniya, which launches military payloads for Russia and Molniya.

The Molniyas face competition from the Rokot launch vehicles, which are converted RS-18 ICBMs and have similar lift capacity. Rokots sport a Briz (Breeze) upper stage and are venturing into a new phase of service – deploying piggyback payloads into separate orbits. Molniyas are still a viable option but are not able to keep up with these new advances.

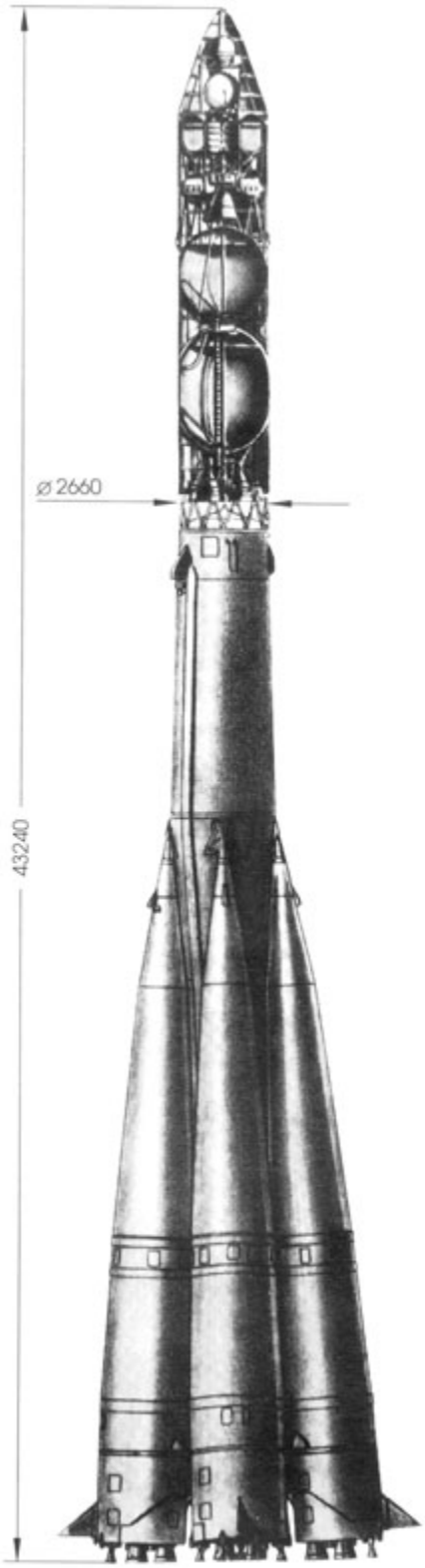
Production should continue to serve the occasional Russian requirement for another year. It's worth noting that the newly revived Russian interest in Mars exploration could prompt a surprise comeback for Molniya. However, we believe it is more likely that the Dnepr launch vehicle will be chosen for these missions. Between Russia and Ukraine, there are about 150 Dnepr vehicles available for orbital missions. These must be destroyed by 2020 under current arms control treaties, so Russia will most likely look to put them to use before they are wasted.

Those developments, plus the anticipated rollout of the Angara launch vehicle family around 2009, will severely limit Molniya activity. Our forecast remains low and Forecast International has set a target date of 2008 for permanent retirement.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program	**High Confidence**					**Good Confidence**			**Speculative**			
	Thru 2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total**
TsSKB Progress												
Molniya												
	290	2	0	0	0	0	0	0	0	0	0	2
Total	290	2	0	0	0	0	0	0	0	0	0	2

Molniya



Russian Molniya ELV

Source: Energia