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Zenit/Land Launch

Outlook

- The 2015 launch was likely the final launch of the series. Barring any further developments, this report will be archived in 2017.
- Russia will move launches to competing rockets, such as Proton and Angara, following conflict with Ukraine
- Zenit carried AMOS-4 into orbit on August 31, 2013 and Elektro-L on December 11, 2015
- Four Zenit rockets launched from Baikonur Cosmodrome in 2011, but increased launch rate proved short-lived

Orientation

Description. The Zenit is a two- and three-stage heavy-lift expendable launch vehicle.

Sponsor. Sponsored by the manufacturer.

Status. Production completed. The first Zenit launch took place in April 1985. The rocket has also been used as a strap-on booster for two Energia launch vehicle missions (four boosters per mission).

Total Produced. Approximately 38 Zenit-2 vehicles and 10 Zenit-3SLB vehicles have been produced.

Application. The Zenit can launch medium class payloads to geostationary transfer orbit (GTO) from the Baikonur space center facility in Kazakhstan.

Price Range. Zenit launches cost between \$35 million and \$50 million apiece.

Contractors

Prime

Yuzhnoye Machine Building Plant, NPO Yuzhnoye, KB Yuzhnoye, Yuzhmash	http://www.yuzhmash.com , 1 Krivorozhskaya St, Dnepropetrovsk, 49008 Ukraine, Tel: + 380 562 34 39 04, Fax: + 380 562 34 43 79, Email: market@yuzhmash.com , Prime (Zenit Manufacturer)
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Subcontractor

KB Transportnogo Mashinostreniya, KB Transmash, Design Bureau of Transport Machinery	http://www.transmash-omsk.ru/en , 101 Vernandsky Prospect, Bldg 2, Moscow, 117415 Russian Federation, Tel: + 7 095 433 3239, Fax: + 7 095 433 1548 (Launch Complex)
NPO Elektropribor	http://www.elektropribor.spb.ru , 30 Malaya Posadskaya St, Saint Petersburg, 197046 Russian Federation, Tel: + 7 812 232 59 15, Fax: + 7 812 232 33 76 (Avionics, Including Onboard Computer)

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NPO Energomash	http://www.energomash.ru/eng/ , Bldg 5, 14 Butikovskiy Ln, Moscow, 119034 Russian Federation, Tel: + 7 095 792 3954, Fax: + 7 095 792 3934, Email: corp@energomash.ru (Engine)
NPO Kommunar	http://www.tvset.com.ua/ , 10 Rudyka St, Kharkov, 61070 Ukraine, Tel: + 380 572 47 62 40, Fax: + 380 572 43 23 63, Email: tvset@kharkov.com (Inertial Guidance System)
RSC Energia PLC, RKK Energia	http://www.energia.ru , 4A Lenin St, Korolev, Moscow Area, 141070 Russian Federation, Tel: + 7 095 513 86 55, Fax: + 7 095 513 86 20 (Block DM Upper Stage)
RUAG Space AB	http://www.ruag.com/space/ , Solhusgatan 11, Göteborg, 405 15 Sweden, Tel: + 46 31 735 00 00, Fax: + 46 31 735 40 00 (Modular Payload Adapters)

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. The Zenit rocket is a two-stage (Zenit-2) or three-stage (Zenit-3) vehicle, with a first stage nearly identical to the strap-on rocket boosters used for the world's most powerful launcher, Russia's Energia. Both the Zenit and the Energia use the Glushko-designed RD-170 engine, a closed-cycle powerplant burning liquid oxygen and kerosene.

On the Zenit, a common turbopump feeds four combustion chambers. Burn time for the first stage is 144 seconds. A second stage features a single-chamber engine burning the same liquid oxygen/kerosene propellants; a burn time of up to 1,100 seconds is possible.

The Zenit can also accommodate a third stage (Zenit-3) for carrying satellites to geosynchronous transfer orbit. The third stage borrows the Proton rocket's man-rated fourth stage. The Zenit-2 and Zenit-3 vehicles both offer two payload fairings: 13.6 meters and 11.1 meters in overall length. Both fairings have an inside diameter of 3.4 meters.

The Zenit prelaunch process is highly automated, dramatically reducing the number of ground personnel needed for each mission. Indeed, it takes only 21 hours to prepare the launch pad for both the Zenit-2 and Zenit-3. All land-based Zenit launches take place from Baikonur Cosmodrome.

	<u>Metric</u>	<u>U.S.</u>
Dimension		
<u>Overall Length</u>		
Zenit-2	57 m	187 ft
Zenit-3	61.4 m	201 ft
Payload Fairing Length, Zenit-2/3	11.1 m/13.6 m	36.4 ft/44.6 ft
<u>Payload Diameter</u>		
Zenit-2/3 (internal)	3.4 m	11.1 ft
Zenit-2/3 (external)	3.9 m	12.7 ft
Weight		
<u>Launch Weight</u>		
Zenit-2	459,000 kg	1,011,900 lb
Zenit-3	466,000 kg	1,027,350 lb
Stage 1 Propellant Mass	318,800 kg	702,826 lb
Stage 1 Gross Mass	352,700 kg	777,562 lb
Stage 2 Propellant Mass	80,600 kg	177,690 lb
Stage 2 Gross Mass	89,900 kg	198,193 lb
Stage 3 Propellant Mass (Zenit-3)	15,000-17,300 kg	33,069-38,139 lb
Stage 3 Gross Mass (Zenit-3)	17,650-19,950 kg	38,911-43,981 lb

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	<u>Metric</u>	<u>U.S.</u>
Performance		
<u>Zenit-3</u>		
Stage 1 Thrust (sea level)	7,259 kN	1,631,800 lbst
Stage 1 Thrust (vacuum)	7,911 kN	778,392 lbst
Stage 2 Thrust (vacuum)	834 kN	187,483 lbst
Stage 3 Thrust (vacuum)	86.5 kN	19,445 lbst
Stage 1 Isp (sea level)	309 s	
Stage 1 Isp (vacuum)	337 s	
Stage 2 Isp (vacuum)	350 s	
Stage 3 Isp (vacuum)	351.8 s	
Stage 1 Nominal Burn Time	140-150 s	
Stage 2 Nominal Burn Time	200-315 s	
Stage 3 Nominal Burn Time	0.8-650 s (up to 7 restarts)	
<u>Payload to LEO</u>		
Zenit-2	13,740 kg	30,300 lb
<u>Payload to GTO</u>		
Zenit-3	4,300 kg	9,480 lb
<u>Payload to GEO</u>		
Zenit-3	1,100 kg	2,425 lb
<u>Accuracy of Orbital Injection (Zenit-2/3)</u>		
Altitude	+/-3.5 km/+/-300 km	+/-2.1 mi/+/-186.4 mi
Inclination (minutes)	+/-2/+/-42	
Period of Orbit (seconds)	+/-2.5/+/-900	
Reliability	0.96/0.95	

Land Launch Zenit-2SLB

Source: NPO Yuzhnoye

Land Launch Zenit-3SLB

Source: NPO Yuzhnoye

Zenit/Land Launch

Variants/Upgrades

Zenit-2. Two-stage vehicle for placing payloads into low-Earth orbit (LEO).

Zenit-3. Three-stage vehicle for placing payloads into geosynchronous orbit or for planetary missions.

Sea Launch (Zenit-3SL). Boeing and NPO Energia developed a three-stage Zenit vehicle that is launched from a seagoing platform. Part of the Sea Launch program, this booster uses the Proton Block DM fourth stage and can be launched at sea near the equator to increase the payload capacity to geosynchronous orbit (see separate "Sea Launch" report in this service).

Land Launch (Zenit-2SLB and Zenit-3SLB). The Zenit-2SLB and Zenit-3SLB represent the family of rockets developed for the Land Launch program. These launch vehicles are based on the two-stage launch vehicle Zenit-2S and the DM-SL upper stage.

Mayak. Two smaller versions of the Zenit-2, called Mayak, were proposed by Yuzhnoye. The Mayak 12 is designed to place 1.5 tons into sun-synchronous orbit. The Mayak 23 has a 3-ton lift capability to GTO. If the program is able to find a foreign investor, the Mayak 12 will replace the Cyclone, also produced by Yuzhnoye, and the Mayak 23 will provide a lift capability above that of the Mayak 12 but below that of the Zenit. The first test flight is pending, as Yuzhnoye still has not found an investor to accelerate the program.

Air-Launched Zenit. Yuzhnoye has studied an air-launched version of the Zenit to be launched piggyback atop a six-engine Antonov 225 transport. The booster would carry 8,100 kilograms to LEO or 900 kilograms to geosynchronous orbit. However, Yuzhnoye currently has no plans to develop this capability.

Program Review

Background. Also known as the SL-16 to Western defense observers, the Zenit has its roots in the liquid strap-on boosters of the massive Energia booster developed by the Yuzhnoye missile and spacecraft manufacturer beginning in 1974. The two-stage Zenit underwent its maiden suborbital test launch in 1985. During the 1980s, it was primarily used to carry Soviet electronic intelligence (ELINT) satellites into LEO.

Between 1990 and 1992, three Zenit launches failed. Following the failure in 1992, 10 Zenits launched successfully; however, another failure occurred in 1997. A successful launch occurred in July 1998, followed by yet another failure in September 1998 carrying a commercial payload for LEO satellite operator Globalstar.

Despite a record of launch failures, Sea Launch – which markets the Zenit 3SL – created the Land Launch service to market Zenit launches from the Baikonur Cosmodrome. PanAmSat was the launch customer, signing a contract in 2005 for one launch with options for additional missions. However, a January 2007 Sea Launch failure grounded Land Launch as well, forcing PanAmSat to switch its launch contract to Arianespace.

Land Launch Orbits AMOS-3

Israel Aerospace Industries contracted Land Launch to orbit the AMOS-3 Ku/Ka-band telecommunications

satellite. The mission took place in April 2008 from Baikonur.

Measat-3A Launched

In February 2009, Land Launch lifted the Telstar 11N into orbit. Measat Satellite Systems Sdn Bhd chose Land Launch to orbit its Measat-3A. Under the contract, the satellite was launched from the Baikonur space center via a Zenit-3 SLB expendable launch vehicle in June. In November 2009, the company launched the Intelsat 15.

Four Zenit-3 launches occurred in 2011. On January 20, a Zenit-3 launched the Elektro-L satellite, and the Spektr-R was launched on July 18. The Intelsat 18 was launched by a Zenit-3SLB in October, although that rocket was operated by Sea Launch (rather than Land Launch) from Baikonur Cosmodrome. On November 10, a Zenit-2 carried the Phobos-Grunt Mars mission into space; however, the mission failed when the satellite did not reach the appropriate orbit.

A Zenit-3SLB successfully carried the AMOS-4 satellite for Israel's Spacecom on August 31, 2013.

Russia's Elektro-L meteorological satellite lifted off aboard a Zenit-3SLBF on December 11, 2015.

Zenit/Land Launch**Timetable**

Month	Year	Major Development
Apr	1985	Zenit first launch with Tselina-2 ELINT satellite mockup; rocket fails to reach orbit after second stage engine shuts down prematurely
Jun	1985	Tselina-2 dummy payload; fails to orbit after second stage shuts down prematurely
Oct	1985	Cosmos 1697, Tselina-2 mockup
Dec	1985	Cosmos 1714, Tselina-2; second stage malfunction places satellite in wrong orbit
Jul	1986	Cosmos 1767, Tselina-2 mockup
Oct	1986	Cosmos 1786, unknown payload; spacecraft fails to circularize orbit
Feb	1987	Cosmos 1820, Tselina-2 mockup
Mar	1987	Cosmos 1833, Tselina-2 mockup
May	1987	Cosmos 1844, Tselina-2
Aug	1987	Cosmos 1871, Tselina-2 mockup
Aug	1987	Cosmos 1873, Tselina-2 mockup and last test of Zenit-2
May	1988	Cosmos 1943, Tselina-2
Nov	1988	Cosmos 1980, Tselina-2
May	1990	Cosmos 2082, Tselina-2
Oct	1990	Tselina-2; Zenit-2 fails four seconds after launch
Aug	1991	Second stage failure places payload in wrong orbit
Feb	1992	Second stage failure places payload in wrong orbit
Nov	1992	Cosmos 2219, Tselina-2
Dec	1992	Cosmos 2227, Tselina-2
Mar	1993	Cosmos 2237, Tselina-2
Sep	1993	Cosmos 2263, Tselina-2
Apr	1994	Cosmos 2278, ELINT satellite (?)
Aug	1994	Cosmos 2290, Orlets photo reconnaissance satellite
Nov	1994	Resurs 01-3, science satellite with SAFIR-1 data relay payload
Nov	1994	Cosmos 2297, Tselina-2
Oct	1995	Cosmos 2322, Tselina-2
Sep	1996	Cosmos 2333, Tselina-2
May	1997	Tselina-2; Zenit-2 fails 48 seconds after launch
Jul	1998	Resurs 01-4 plus five microsattellites
Jul	1998	Cosmos 2360, Tselina-2
Sep	1998	12 Globalstar satcoms lost in Zenit-2 crash after onboard flight control system fails
Mar	1999	Zenit-3SL debuts from Sea Launch with dummy payload
Jul	1999	Okean O-N1 ocean resources satellite on Zenit-2
Feb	2000	Cosmos 2369, Tselina-2
Sep	2000	Cosmos 2372, Yenisei-2 optical reconnaissance spacecraft
Dec	2001	Russian Meteor-3M (Moroccan Maroc-Tubsat, Pakistani Badr-2, and Kompass)
Jun	2004	Cosmos 2406 (was to be renamed), Tselina-2
Jan	2007	Sea Launch Zenit-3SL fails with NSS-8; Sea Launch and Land Launch grounded
Jun	2007	Zenit-2 launches Tselina-2 satellite
Apr	2008	Land Launch Zenit-3SLB debuts with AMOS-3
Feb	2009	Telstar 11N launched on Zenit-3SLB
Jun	2009	Measat-3A launched on Zenit-3SLB
Nov	2009	Intelsat 15 launched on Zenit-3SLB
Jan	2011	Elektro-L launched on Zenit-3SLB
Jul	2011	Spektr-R launched on Zenit-3SLB
Oct	2011	Intelsat 18 launched on Zenit-3SLB
Nov	2011	Phobos-Grunt launched on Zenit-2, mission failed
Aug	2013	AMOS-4 launched on Zenit-3SLB
Dec	2015	Elektro-L launched on Zenit-3SLBF

Zenit/Land Launch

Forecast Rationale

Land Launch and the Zenit launch vehicles have faced problems in recent years. Sea Launch, which also operates Zenit launch vehicles and originally owned Land Launch, declared bankruptcy in June 2009. This drastically reduced Zenit launches and production rates, driving costs up and making components difficult to obtain.

Contract disputes caused a reduction in launch rates as well. During bankruptcy proceedings, Sea Launch's contract to launch the Intelsat 18 satellite was transferred to Land Launch. However, Land Launch had difficulty obtaining components for its Zenit rockets, and as a result, Intelsat's contract was transferred back to Sea Launch.

Industrial problems also caused a shortage of components. Some blamed the fact that the Russian government, Sea Launch, and Land Launch were all squabbling over components for Zenit rockets. Whatever the reason, Land Launch was not able to get components needed to build rockets.

In 2011, Zenit production finally got off the ground. Zenit-3 and Zenit-2 rockets launched from Baikonur

four times that year. Most of these were for the Russian government. However, the boost in launch rates proved short-lived. Another launch did not occur until 2013, followed by another in 2015. The 2015 launch is expected to be the last.

The reason for the reduced launch rate is the conflict between Russia and Ukraine. Zenit relies on components from both countries. As a result of this conflict, obtaining parts has become much more difficult. In addition, Russia has vowed to end reliance on the vehicle. Satellites that were to be carried by the Zenit, such as the Spektr-RG science spacecraft, will instead be carried into orbit aboard Proton vehicles.

The Zenit is also facing increased competition. Newer launch vehicles, such as the Angara, promise lower prices, flexible payload configurations, more reliability, and more stable supply chains.

For all these reasons, production of the Zenit-3SLB is not expected to continue. The 2015 launch was likely the final launch of the series. Barring any further developments, this report will be archived in 2017.

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