

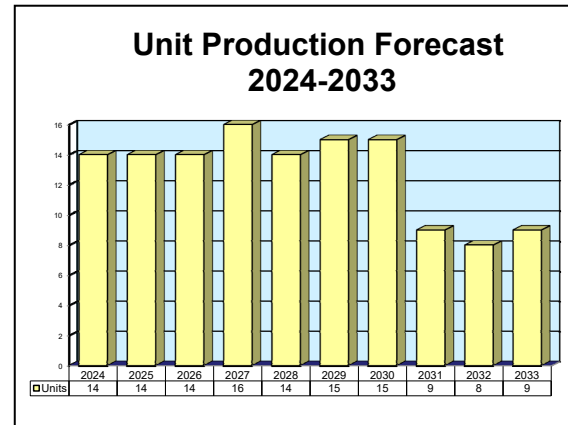
ARCHIVED REPORT

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Sea Launch

Outlook

- The cost to restore and retrofit Sea Launch with Russian equipment will be approximately \$470 million
- Status of Sea Launch is uncertain
- Both *Sea Launch Commander* and *Odyssey* have been relocated to a port near Vladivostok, Russia
- Russia's invasion of Ukraine likely added delays to further launches using the Sea Launch platform



Orientation

Description. Sea Launch is a commercial satellite delivery system provider that launched Zenit launch vehicles from a sea-based platform to deliver payloads into orbit. A new Russian-designed and -built launch vehicle will likely be the successor to Zenit.

Sponsor. Formerly based in Long Beach, California, Sea Launch is owned by S7 Group of Russia. The current location of Sea Launch's assets is at a port near Vladivostok, Russia.

Status. S7 is cooperating with Roscosmos and Energia to refurbish Sea Launch assets. All U.S. and

Ukrainian equipment has been removed. S7 has relocated the platform and command ship to Russia.

Total Produced. Thirty-six Sea Launch launches.

Application. Sea Launch uses a converted oil rig to conduct launches from the Pacific Ocean. The Sea Launch Zenit 3SL rocket delivered large satellites to a variety of geosynchronous transfer orbits (GTOs). The maximum payload capability was 6,100 kilograms. Soyuz-5, if fully developed, will likely replace Zenit.

Price Range. The cost of a single launch is estimated to range between \$105 million and \$114 million.

Contractors

Prime

TsSKB Progress, Progress Central Specialized Design Bureau	http://www.samspace.ru , 18 Ulitsa Pskovskaya, Samara, Russian Federation, Tel: + 7 8462 55 13 61, Fax: + 7 8462 97 18 86, Email: mail@progress.samara.ru , Prime
S7 Space	http://s7space.ru , Petrovka 7, Moscow, Russian Federation, Tel: + 7 495777110, Launch Contractor

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 75 Glen Road, Suite 302, Sandy Hook, CT 06482, USA; rich.pettibone@forecast1.com

Sea Launch

Technical Data

Design Features. What most distinguishes Sea Launch is that its launches take place from a platform at sea. For Sea Launch, Kvaerner acquired and modified a self-propelled, semi-submersible oil-drilling platform. The vessel, called the *Odyssey*, features a weatherproof hangar for transporting the Sea Launch Zenit 3SL rocket and the automated rocket transporter-erector system, and for storing fuel. Kvaerner also built a 198-meter-long, 30,844-kilogram assembly and command ship called the *Sea Launch Commander*. While moored at Long Beach, homeport of the Sea Launch venture, the *Sea Launch Commander* served as the rocket assembly and vehicle integration facility. At sea, the ship serves as the launch control center.

Low-Earth orbit (LEO), medium-Earth orbit (MEO), and polar launches took place from the Pacific Ocean northeast of Hawaii; GTO and geosynchronous Earth orbit (GEO) launches took place near Kiritimati (Christmas Island).

Key components of the Sea Launch booster include the first and second stage of the Zenit, a horizontally integrated, self-erecting, self-fueling rocket. The Sea Launch Zenit 3SL's upper stage is the Block DM now used on the Russian Proton expendable launch vehicle.

Sea Launch Ships

ACS

Launch control facilities on upper decks
 Rocket vehicle assembly facilities below decks
 Customer and crew quarters
 Approximate length: 198 meters
 Approximate displacement: 30.8 metric tons

Launch platform

Modified self-propelled, semi-submersible, ocean-drilling platform
 Houses rocket hangar, transporter-erector-launcher system, fuel
 Approximate length: 131 meters
 Approximate displacement: 28.1 metric tons



Sea Launch Self-Propelled, Oceangoing Platform (foreground) and Assembly & Command Ship

Source: Sea Launch

Sea Launch**Variants/Upgrades**

Upgraded Engines. NPO Energomash increased the power of the Zenit 3SL first- and second-stage engines. The upgraded RD-171M served as the first-stage engine and is now expected to deliver 7,840 kN (1.76 million lbf). For the upgraded second-stage engine, which was first used on the DirecTV-7S launch in 2004, the thrust

was increased from 187,000 pounds to 205,000 pounds. In addition, Sea Launch streamlined its integration cycle time to less than one year after a launch order was placed. The previous integration time was 12 to 18 months.

Program Review

Background. Sea Launch was established in 1995 as a result of Boeing investigations into launching satellites from a sea-based platform in international waters. The company conducted the first launch in 1999. It used a Zenit 3SL that launched from the *Odyssey* platform carrying the DirecTV 1-R satellite.

Only a year later, the company suffered its first launch failure when a software logic error caused the booster's second stage to follow the wrong trajectory. The March failure was followed in June by a successful launch of the PAS-9 satellite.

Sea Launch had more problems in 2002, when only one of five planned missions lifted off.

Baikonur Bound

In October 2003, Sea Launch initiated a program, dubbed Land Launch, to offer launch services from the Baikonur Cosmodrome in Kazakhstan. Launching from Baikonur lowers shipping costs. However, the launch center is farther north than Sea Launch's equatorial platform, reducing the payload mass capability of the launch vehicle from 6,000 kilograms to about 3,500 kilograms to geosynchronous orbit. As such, Sea Launch operates from both locations to best serve its customers. Launch operations at Baikonur began in 2008, with full launch capability declared in 2009.

NSS-8 Launch Failure

A Zenit 3SL carrying a New Skies NSS-8 commercial communications satellite exploded on the Sea Launch *Odyssey* launch pad on January 30, 2007. Sea Launch reported that the *Odyssey* sustained only limited damage from the blast. The explosion occurred after the RD-171 engine reached its initial first-stage ignition.

Contamination in an engine turbopump was determined to be the root cause of the Zenit 3SL rocket's failure. An investigation by Russian and Ukrainian officials concluded that a metal particle had entered a turbopump in the first-stage engine of the Zenit 3SL, causing the

engine to fail immediately upon liftoff. The rocket collapsed back onto the *Odyssey*, creating a spectacular explosion but causing only minor damage to the platform.

Sea Launch Returns to Flight

On January 15, 2008, Sea Launch successfully launched a communications satellite for UAE-based Thuraya Satellite Communications Co. The Zenit 3SL lifted off from the *Odyssey* launch platform on the equator in the Pacific Ocean at 6:48 am EST (11:48 GMT) and placed the Thuraya-3 satellite into a geosynchronous transfer orbit 99 minutes later. The launch was the first for Sea Launch since the failure of the NSS-8 satellite in January 2007.

Difficulties Mount

Sea Launch ran into major difficulties in 2009 that forced the company to declare Chapter 11 bankruptcy in June. The firm was hurt by a number of issues. The first was the fact that almost an entire year went by between the launch failure in January 2007 and the company's next launch. The lack of income created by this gap negatively impacted the company's financial outlook. At the same time, supply chain issues forced the company to recognize that it would not be able to maintain its launch schedule. The final straw was Hughes' victory in arbitration hearings, which forced Sea Launch to refund the \$52.3 million it had been paid in advance for future launches. Hughes demanded its money back after the 2007 disaster.

By July 2010, the U.S. Bankruptcy Court for the District of Delaware had approved Sea Launch's reorganization plan, and by November 2010, the company had emerged from bankruptcy. Under the reorganization plan, RSC Energia of Russia now owns 95 percent of Sea Launch. A trust representing Boeing and Aker, former owners of Sea Launch, owns the remaining 5 percent. The reorganization also separated Land Launch and Sea Launch.

Sea Launch

As part of the reorganization, Energia pumped \$140 million directly into Sea Launch and used an additional \$15 million to satisfy other creditor requirements. The \$140 million paid directly to Sea Launch was intended to upgrade and repair facilities, such as the sea platform used to conduct launches and the company's home port in Long Beach, California.

In 2011, Sea Launch carried two payloads into orbit. Eutelsat's Atlantic Bird 7 lifted off from Sea Launch's platform on September 24. On October 5, Sea Launch flew Intelsat's IS-18 into orbit from the Baikonur Cosmodrome. The IS-18 was expected to launch on a Land Launch Zenit rocket; however, Land Launch had difficulties obtaining the components needed to conduct launches. Sea Launch therefore agreed to launch the satellite, even though Sea Launch and Land Launch had become two separate companies.

Sea Launch continued its success in 2012. The company carried three satellites into orbit on board its Zenit 3SL rocket. The Intelsat 19 was carried into orbit on June 1. The Intelsat 21 launched on August 19, and the Eutelsat 70B followed on December 3.

The company experienced a failure on February 1, 2013, while carrying the Intelsat 27 into orbit. Detecting an anomaly, the rocket's onboard computer shut down the RD-171 main engine after about 25 seconds of flight. A failure review oversight board set up by Sea Launch and Energia found that a manufacturing defect with the first-stage hydraulic power supply unit caused the launch failure.

Sea Launch returned to flight in 2014 when it carried the Eutelsat 3B into orbit on May 26.

Even as the company returned to flight, it faced renewed pressure. Sea Launch was hurt by a market shift to smaller payloads, turmoil in Ukraine, and unreliability. Russia vowed not to use Ukrainian-built launch vehicles due to the conflict between the two countries.

In response to a lack of launches, Sea Launch announced in August 2014 that it was laying off staff and temporarily ceasing *Odysey* operations.

Forecast Rationale

S7 Space's Sea Launch offers an innovative way to launch payloads into space. As the entire operation is sea-based, launch sites are near the equator to maximize carrying capacity. This arrangement also mitigates risk to populated areas.

The Sea Launch program finds itself in a unique situation due to the current war between Russia and Ukraine. Traditionally, Sea Launch has used the Zenit family of rockets for its launches. A significant portion

of the Zenit is produced in Ukraine by Yuzhmash, while S7 is a Russian company.

In September 2016, Russian airline owner S7 Group signed a deal to purchase Sea Launch and restart its operations. The deal closed in December of that year. In January 2017, Energia and Boeing settled the long simmering issue over debt owed to the American aerospace company. In return for debt forgiveness, Boeing received two seats aboard Russia's Soyuz Spacecraft to the International Space Station, with an option for three more in late 2018 and early 2019.

S7 has ambitious plans to restart Zenit operations, first from Baikonur and later from the Sea Launch platform. In order to realize those plans, S7 signed a contract with Yuzhnoye in June 2017 to restart Zenit production. S7 is also working with Energia and Roscosmos to refurbish Sea Launch's assets.

This activity appeared to be paying off when S7 was able to conduct the launch of a Zenit 3SLBF from Baikonur on December 26, 2017. The launch vehicle carried AngoSat-1 into orbit.

In January 2018, S7 began sending payments to Yuzhnoye for Zenit production. Still, problems remain. Yuzhnoye reports that it lost access to required components because rebels control certain areas of Ukraine.

All Russian Gear

Recent reports indicate that S7 has stripped its Sea Launch assets of all American and Ukrainian equipment. The platform and ship were sent to Russia for re-equipping. The reported cost of refurbishing the platform and ship will be about \$470 million.

Zenit will likely never be used again with Sea Launch. Zenit is a Ukrainian launch vehicle, and the recent Russian invasion of that country means there will be no further cooperation between the two nations in the space domain. A variant of Soyuz, namely Soyuz 5, is reportedly under development and will likely be used with Sea Launch.

Russia has been looking domestically for technology across many sectors, and, in alignment with this emphasis, S7 Space is apparently looking for a replacement launch vehicle. A variant of the Soyuz, the Soyuz 5, is currently under development for this purpose. Delays have mired many projects of the

Sea Launch

Russian space program, so development of Soyuz 5 will likely take time.

The forecast reflects a change in operations at Sea Launch. There is no indication that S7 will return to Zenit launches. It has removed all American and Ukrainian equipment from Sea Launch. Soyuz 5 is still under development, and it will likely enter service around 2025. Note that, due to the unique situation

surrounding Sea Launch, all Soyuz production is included in the forecast.

As the Russian invasion of Ukraine has ended many collaborations, launch contracts, and general-knowledge sharing, the Soyuz production forecast has been lowered in general.

Note: The forecast includes all Soyuz production. Soyuz 5 is projected for first launch in 2025.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program	Thru 2023	High Confidence				Good Confidence			Speculative			Total
		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
TsSKB Progress												
Soyuz												
Note: Includes all variants												
	1,154	14	14	14	16	14	15	15	9	8	9	128
Total	1,154	14	14	14	16	14	15	15	9	8	9	128