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# How a 1960s Soviet Engine Appeared on an Exploded U.S. Rocket (Video)

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NASA Administrator Charles Bolden overseeing the first test of a modified Russian NK-33 engine at the NASA Stennis Space Center in 2011.

A U.S. commercial rocket powered by a Soviet-built Russian rocket engine exploded seconds after liftoff early Wednesday morning Moscow time, adding fire to debates concerning the U.S. space industry's heavy use of Russian rocket engines.

While unfortunate, the incident does not threaten the International Space Station (ISS), which was hoping to receive supplies from the ill-fated rocket. The ISS crew has supplies to last until the middle of next year, and a Russian Progress cargo ship successfully lifted off from Kazakhstan's Baikonur Cosmodrome on Wednesday with goods for the station.

Regardless, the failure of the Antares rocket — which uses a Russian engine and Ukrainian components in the rocket's body — shines light on the deeply co-dependent nature of space flight after the Cold War.

As Dr. James Oberg, a former NASA engineer and expert on the Russian space program, told The Moscow Times by phone on Wednesday: "In the end, we are too mutually co-dependent to do anything but scream and shout and then take the money."

### The NK-33

The story of the engine used in Wednesday's launch — the NK-33 — is a perfect illustration of this co-dependence. Originally built for the Soviet's massive N1 moon rocket, Russia's Kuznetsov design bureau dumped its stock of NK-33s on the market in the 1990s for purchase by Western aerospace firms.

### The NK-33 Engine

**Designer:** Kuznetsov Design Bureau

**Upgraded:** Early 1970s, originally built for the unused N1 moon rocket in the late 1960s.

**Production Volume:** While it is unclear how many were made, about 150 to 200 are reported to have survived destruction when the N1 program was canceled in 1974.

**Cost:** $1.1 million each under the original contract for the delivery of 36 engines to Aerojet in the mid-1990s.

**Weight:** 2,723 pounds (1,235 kilograms)

**Length:** 12 feet (3.7 meters)

**Diameter:** 6 feet, 7 inches (2 meters)

**Fuel:** Liquid oxygen and kerosene mixture

**Thrust:** 338,000 pounds of force (1,505 kilonewtons)

A testament to Soviet engineering prowess, the NK-33 today is purchased by U.S. middleman Aerojet-Rocketdyne in bulk from Kuznetsov for restoration under contract for Orbital Sciences another U.S. firm. Orbital Sciences then plugs them in to the first stage of its Antares rocket.

But the decision to use a 40-year-old rocket engine has not been without its critics. Shortly after the explosion on Wednesday, an excerpt from a 2012 interview in Wired magazine with

Elon Musk, founder of U.S. space firm SpaceX, made the rounds on Twitter: "One of our competitors, Orbital Sciences, has a contract to resupply the International Space Station, and their rocket honestly sounds like the punch line to a joke. It uses Russian rocket engines that were built in the '60s. I don't mean their design is from the '60s. I mean they start with engines that were literally made in the '60s and, like, packed away in Siberia somewhere."

But according to Oberg, this misses the point.

"High-pressure liquid engines [like the NK-33] were really perfected back during the moon race," Oberg said. "The designs since then have been marginally improved but not enough to justify the fabrication [production] expenses." This makes buying existing engines extremely economical for private space companies worried about their bottom line.

### Glory Days

The NK-33 was a child of the 1960s space race, a result of failed Soviet efforts to answer U.S. President John F. Kennedy's challenge in 1961 to land a man on the moon by 1970.

The Soviets were slow to rally a response. Only in 1964 did Soviet premier Nikita Khrushchev finally gave his ace in the hole — genius Ukrainian-born rocket designer Sergei Korolyov — the go-ahead to build a heavy-lifting rocket to eventually challenge NASA's Saturn V in the race to the moon.

But the program was troubled from inception. As with any large technological project, key design decisions and bureaucratic competition for lucrative contracts sparked serious internal power struggles between factions of Soviet space officials.

The most prominent internal struggle led to the creation of the NK-33. Korolyov had a long-standing dispute with another major player in the Soviet space industry — Valentin Glushko. The two had testified against the each other during Stalin's purges, resulting in both of them being thrown in the gulag.

Glushko and Korolyov tried to work together on the N1, but Glushko wanted to use a type of engine with poisonous fuel, something unacceptable to Korolyov. So, in an effort to find a designer that would remain loyal to his projects he had to look outside the space industry.

Nikolai Kuznetsov's design bureau, which had only ever built engines for aircraft and cruise missiles, stepped up to the task and produced the engines Korolyov needed for his massive rocket — first the NK-15, and later the NK-33.

Before the rocket even began testing in 1969, Korolyov died. Internal bleeding during an operation in 1966 took the rocket designer's life, and Soviet lunar aspirations went with him.

Without Korolyov to rally the disparate elements of the Soviet space-industrial complex, the N1 project was eventually torpedoed by Glushko and his political patrons in 1974, after the rocket had exploded on four consecutive launch attempts.

While Glushko would lead the Soviet space industry to several great accomplishments over

the next 15 years, including its pioneering space station program and the Soviet space shuttle program, the Soviets would never land on the moon.

Korolyov's legacy lived on, however. His N1 was a huge rocket, using 30 of the NK-33 engines. Some 200 of the engines were built for the program, and after the N1 was scrapped no one was quite sure what to do with them.

### Decades in Limbo

With the engines already built, the waning years of the Soviet empire saw numerous proposals to integrate the powerful NK-33s into existing and developing rocket designs. None of them came to fruition. The engines sat in storage.

"Evidently, the people who built these engines took very good care in mothballing them," Oberg said. "Russians use the word 'konservirovat' — which I always have fun translating into 'greasing', as they are referring to the process with [maintaining] weapons. Anyway, whoever did the onservirovat on these engines did a very good job."

When the Soviet Union collapsed and Soviet space firms were forced to improvise during the chaotic privatization process of the 1990s, they turned to Western markets and surprised aerospace companies with their high-quality hardware and relatively low prices.

Kuznetsov had hundreds of NK-33s sitting in storage. In the late 1990s, it went into partnership with Aerojet-Rocketdyne to refurbish the engines and sell them to commercial space upstarts in the U.S.

Lockheed Martin was interested in the engines for its Atlas V rocket, but in the end opted for another Russian engine — NPO Energomash's RD-180, which is still in production.

The engines waited in the U.S. for a new potential buyer until 2010, when Orbital Sciences bought 20 of the engines from Aerojet in 2010 for its Antares rocket, which was competing for a NASA contract to take over resupply launches for ISS from the retiring space shuttle fleet.

Back in Russia, there has been increasingly serious talk of restarting production of the NK-33 at the Kuznetsov factory in Samara, a city in central Russia. Russian media reports last year said Russian space officials were interested in resurrecting the engine for use in future Russian rockets.

The loss of the Antares rocket with a Russian engine on Wednesday is not likely to unravel U.S.-Russia commercial space cooperation. Both industries have become close over the past 20 years, engaging in a number of joint-ventures. Russian rockets are called upon frequently to launch Western commercial satellites, while the U.S. Air Force relies on another Russian rocket engine — the RD-180 — to power the Atlas V rocket for military launches.

Orbital will eventually have to find itself a new engine, as plans to restart production of the NK-33 have not materialized. Indeed, there appears to be no need for the engine in Russia or abroad, as the direction of the industry is changing to embrace cheaper and easier to produce technologies — philosophies enshrined in SpaceX's Falcon 9 rocket and Russia's new Angara.

"Perhaps the future of high efficiency Russian engines like the NK-33 is already behind us. It's not the type of approach that the vehicles now on the drawing boards and approaching the launch pad are using," Oberg explained.

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