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For the U.S., a defensive shift away from monolithic satellites has proved harder than envisioned. PAGE 18



The U.S. struggles to free itself of Russian RD-180 engines

.S. Atlas 5 rockets have proved amazingly reliable at launching national security satellites. For that reason, the Air Force remains reluctant to do anything rash about the fact that each Atlas 5 first stage is powered by a Russian RD-180 engine. Another camp, led by Sen. John McCain, R-Ariz., wants to move away from RD-180s as quickly as possible. This timeline shows the complex chain of actions by the Air Force, White House, Congress and industry.

March

 U.S. imposes sanctions on Russia in response to annexation of Crimea.

April

 Judge issues injunction against RD-180 purchases for upcoming Air Force launch competitions pending sanctions review.

September

- United Launch Alliance, Blue Origin announce partnership to develop BE-4 engine.
- Aerojet Rocketdyne announces funds from ULA for AR1 engine.

December

- SpaceX drops lawsuit against Air Force after service agrees to open more near-term launches to competition.
- Congress appropriates \$220 million toward RD-180 alternative and authorizes a limit of five RD-180s beyond those already assigned for launches.

2014

February

Air Force tells
Congress it's not
feasible to replace
RD-180s by 2019, as
required by law.

April

▶ ULA unveils details of proposed Atlas 5 replacement, the Vulcan.

December

 Air Force awards rocket research contracts to Aerojet Rocketdyne, Orbital ATK and Northrop Grumman.

Apri

- Sen. John McCain contests Air Force estimate of \$5 billion to replace Atlas 5s with Delta 4s and Falcon 9s.
- Air Force announces a contract with SpaceX to launch a GPS 3 satellite; ULA did not bid Atlas 5, citing RD-180 limit among reasons.
- House committee's 2017 defense authorization draft would permit up to 18 RD-180s for military launches, double the previous limit.

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- Obama administration lauds House proposal to relax RD-180 limit, but objects to barring funds for broader rocket development.
- Senate committee proposes limit of nine RD-180s beyond those already assigned for Atlas 5 launches.

2015

2016

June

Senate version of 2017 defense authorization sets RD-180 limit at 18 beyond those already assigned for Atlas 5 launches.

September

ULA defers choice between BE-4 and ARI engine to "spring" 2017, according to SpaceNews.

December

Obama signs 2017 defense authorization limiting U.S. to 18 more RD-180s for upcoming competitions through 2022. Air Force gets to spend up to 31 percent of replacement funds on broader work.

February

ARI engine testing yields highest chamber pressure ever for a kerosene-fueled main combustion system, says Aerojet Rocketdyne.

March

► Twitter photos from Blue Origin's Jeff Bezos show first fully assembled BE-4 rolling off production line.

2016

2017

Research by Warren Ferster