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IN REVIEW



TWO BAD DAYS
Questioning conventional wisdom after Antares, Virgin Galactic/Page 4

Active year for government, commercial launches

by Jim Knauf and the Space Transportation Technical Committee

The Space Transportation Technical Committee works to foster continuous improvements to civil, commercial and military launch vehicles.

NASA Kennedy Space Center



An Atlas 5 with RD-180 rocket engines built by the Russian company NPO Energomash.

Manufacturing of Space Launch System flight hardware is underway at the Michoud Assembly Facility in Louisiana.



The year saw a brisk worldwide launch pace, milestones for new government and commercial launchers, a U.S. commercial crew capability decision and advances on new launch sites.

NASA completed a critical design review for the **Space Launch System** heavy-lift rocket to carry humans beyond Earth orbit and committed to a \$7 billion development program with initial flight scheduled in 2018. The agency's Stennis Space Center began testing the modified space shuttle engine that will power the vehicle's core stage.

In September, NASA awarded contracts to Boeing and SpaceX for its **Commercial Crew Program** to develop a capability to deliver astronauts to the International Space Station. Boeing is developing the CST-100 capsule to be launched on Atlas 5 rockets, and SpaceX is producing the Dragon v2 capsule for its own Falcon 9 launcher.

Orbital Sciences flew two ISS resupply missions with its **Antares** launcher and **Cygnus** cargo spacecraft, and considered replacement of the booster's modified Russian engines. A third mission in October failed when the Antares launcher exploded shortly after liftoff.

SpaceX sustained an active **Falcon 9** launch pace with three ISS cargo and four commercial satellite missions, and partially demonstrated a first stage soft ocean landing. The company completed vertical landing demonstrations with its Grasshopper single-engine test vehicle. A subsequent three-engine vehicle was lost, but high-altitude demonstration tests are planned for New Mexico's Spaceport America.

The U.S. Air Force's Space and Missile Systems Center and NASA's Launch Services Program continued intensive efforts to certify Falcon 9 for government missions. SMC conducted engineering integration for two low-risk Falcon 9 flights and held the first Evolved Expendable Launch Vehicle competitive acquisition since 2006.

United Launch Alliance anticipated 13 **Atlas** and **Delta 4** launches, including a Delta 4 Heavy with an uncrewed test of NASA's Orion spacecraft, and one Delta 2 launch. Geopolitical events, including Western sanctions on Russia over events in Ukraine, highlighted U.S. dependence on Russian RD-180 engines for Atlas. There was no disruption to

engine deliveries, but the U.S. contemplated a new domestic hydrocarbon engine. There were similar concerns about U.S. dependence on the Russian Soyuz for crew transportation to ISS.

NASA leased Apollo/Shuttle Launch Complex 39A at Kennedy Space Center to SpaceX for commercial use. Texas and SpaceX announced plans for a commercial launch facility in that state. Russia continued construction of an eastern launch site at Vostochny while China neared completion of the Wenchang Launch Center.

Stratolaunch chose Aerojet Rocketdyne RL10 engines for stage three of its **Thunderbolt** air-launched vehicles in development by Orbital Sciences. Construction of the system's carrier aircraft, the largest in the world, was 50 percent complete. Scaled Composites is building the aircraft in Mojave, California. The system is to launch Delta 2-class satellites beginning in 2018.

Russia flew a suborbital first test of the **Angara** rocket, its first entirely new post-Soviet Union launcher. Eight Soyuz cargo and ISS crew missions, four of each, launched to the station from Baikonur, Russia. **Proton** and **Rocket** launches resumed with four and two flights, respectively. In May, Proton experienced another in a string of failures in recent years, putting the remaining launch schedule in doubt. This and a Russian-built Soyuz that put two Galileo navigation satellites into incorrect orbits from Europe's spaceport in Kourou, French Guiana, has marred Russia's historic launch success record. A restructuring of the Russian space industry is underway.

Sea Launch resumed operations with a **Zenit 3SL** launch but temporarily mothballed its maritime launch platform and cut staff to address a launch gap through 2015.

The Kourou launch site flew four Arianespace Soyuz, two **Vega** rockets and five **Ariane 5s**, including the fifth and final Automated Transfer Vehicle to the ISS.

India had three launches and a planned fourth-quarter suborbital test of the new **Geosynchronous Launch Vehicle Mk.3** with two large solid boosters, a liquid core second stage and a cryogenic third stage. Japan launched four H-2As. China launched five Long March variants.

Virgin Galactic's commercial suborbital **SpaceShipTwo** broke apart during a test flight in October, killing one pilot and injuring the other. An investigation is underway.

DARPA awarded study contracts for a reusable suborbital space plane dubbed **XS-1**. ▲