



The SB>1 Defiant made its fifth flight on Oct. 31. (Sikorsky-Boeing photo)

# JMR — Demonstrating Valor But Still Defiant

Bell and Sikorsky-Boeing are planning the final phase of flight testing for their JMR Technology Demonstrators

By Dan Parsons

The US Army's Joint Multirole Technology Demonstration (JMR-TD), which has resulted in two of the most advanced prototype military rotorcraft in history, will effectively draw to a close in early 2020 as the service moves into a program of record to find a replacement for the UH-60 Black Hawk.

Both the Sikorsky-Boeing SB>1 Defiant compound coaxial helicopter and Bell V-280 Valor advanced tiltrotor are deep into ongoing flight test programs that are informing requirements for the upcoming Future Long Range Assault Aircraft (FLRAA) competition.

White papers describing each company's FLRAA entries were due to the Army Oct. 1. Those submissions — essentially the data-driven application to compete in the program, along with the prototype aircraft themselves and the data each company has gathered — will be used to choose an aircraft to replace the UH-60 fleet.

"The intent of JMR-TD effort is to maximize the knowledge gain and risk reduction toward an anticipated Future Vertical Lift acquisition program," Dan Bailey, program manager for the Joint Multi-Role at US Army Combat Capabilities Development Command, recently said.

Bell is working on an extension to its JMR-TD effort that will carry it into early 2020 — about 25 more flight hours — and allow for demonstrating both sling loads and autonomous flight.

The Valor now has a total of 148 flight test hours and about 280

total operational hours including ground runs, taxi, flight and restrained flight, Ryan Ehinger, Bell's V-280 program manager, said in a recent interview. It has flown faster than 300 kt (555 km/hr), performed 50-degree banked turns, ascended to 11,500 ft (3,500 m) and pulled 500-foot-per-minute (2.5-m/s) climbs. The V-280's longest single flight was more than 320 nm (nearly 600 km) from Amarillo to Arlington, Texas.

## Still Defiant

As dead-ahead as Bell is on JMR-TD, Sikorsky is playing its progress very close to the tarmac.

Sikorsky, despite ongoing success with its 11,000-lb (5-metric ton) S-97 Raider, has been reticent to speak even to the flight hours Defiant has achieved. Defiant was parked for several months after "bearing creep" was found on the ground-based propulsion system test bed (PSTB). The 33,000-lb (15-t) aircraft returned to flight Sept. 24 (see "Future Vertical Lift — Fulfilling Its Promise," *Vertiflite*, Nov/Dec 2019).

In October, Sikorsky unveiled the 14,500-lb (6.6-t) Raider X, a growth version of the S-97, in a five-way race to build the Army's Future Attack Reconnaissance Aircraft (FARA).

By press time, Defiant had flown five sorties: March 21, April 5, April 23, Sept. 24 and the latest on Oct. 31. The SB>1 had been flown at 20 kt (37 km/h) in every direction, including hover-out-of-ground-effect (HOGE). A spokesperson for the program said the aircraft demonstrated "exceptional performance of our active vibration control."

Another envelope-expansion flight is planned for December, according to the Defiant team. Plans are to expand the performance envelope to 40 kt (74 km/h), and then to increase speed in 40-knot increments out to 250 kt (463 km/h).

“The Sikorsky-Boeing team continues to advance Defiant’s rigorous test flight program and expand the envelope on Defiant,” the team told Vertiflite in an email. “With our next flight taking place in the coming days, we look forward to continuing to fly and further expand our speed and maneuverability envelopes well into 2020.”

Defiant’s test flight program has not been without hiccups. Following the first three test flights, the Boeing/Sikorsky engineering team disassembled and inspected the ground-based Propulsion System Test Bed (PSTB), which mimics the stress put on Defiant’s drivetrain without leaving the ground.

After it was taken apart in April, the main rotor gearbox was found to have ground some of its bearings. The situation is caused when slippage occurs between fitted surfaces like gear teeth, which causes clearance and is not uncommon in new-build rotorcraft. Bearing creep was not found on the Defiant itself.

### Valor on Auto Pilot

With the FLRAA program of record in the offing, there are no sure winners. In addition to the two flying demonstrator teams, Karem Aircraft and AVX Aircraft also submitted white papers based on their studies and individual demonstrations conducted under the JMR-TD program.

While Defiant has fewer flight hours than the V-280, Sikorsky does have several years of flight test data from the S-97 Raider that it believes translates to the larger aircraft.

Bell, meanwhile, is taking the V-280 on the road. It recently performed for thousands of people at the Bell Fort Worth Alliance Air Show. The V-280 was able to fly four sorties over four days, during which it was reliable and consistently flight-ready, Ehinger said. During the show, it flew a little over four total hours. While Bell test pilots did not expand the V-280’s flight envelope, flight test data was gathered during all of the demonstration sorties, he said.

Bell is convinced it has proven the V-280’s performance and that it can fulfill the Army’s requirements for a medium-lift assault aircraft to replace the UH-60 Black Hawk.

Based upon the wealth of flight test data, the company has submitted a white paper pitch — effectively its application to compete in the Army’s FLRAA program.

The white papers, using data gathered during JMR-TD were based on the Army’s draft FLRAA requirements. The Army is expected to choose two “project agreement holders” based on the extended white papers before the end of March 2020, Horner said. Those two teams will continue to refine the service’s desired FLRAA performance characteristics.

A downselect to one aircraft design that will go on to engineering and manufacturing development (EMD) is expected in 2023. The Army’s first unit equipped (FUE) is scheduled to receive its first FLRAA aircraft in 2030, according to the Army’s current timeline.

Other than showing off for an estimated 125,000 people at the air show, Bell has been focused on readying the Valor and its fly-by-wire flight control system for autonomous flight. After test flying the autonomous flight control software in the systems integration lab (SIL) — a full-up, ground-based representation of the V-280’s electrical and hydraulic control systems — the software was



The Sikorsky-Boeing team added the rotor fairings after to its fourth flight, which was made on Sept. 24. (Image from Sikorsky-Boeing video)



Bell had flown for more than 150 hours and planned another 25 hours, including an autonomous and sling load flights. (Bell photo)



As of press time, the SB1 had been flown at 20 kt (37 km/h) in every direction, including hover-out-of-ground-effect (HOGE). (Sikorsky-Boeing photo)

loaded onto the vehicle and is undergoing regression flight tests before the autonomous mode is turned on.

“Autonomy is the next big thing we’re going after and things have been going really well,” Ehinger said. “We have been working on releasing the software, making enhancements to our control laws to perform altitude hold, position hold, that sort of thing.

“In the SIL, we inject various failure modes, probable or improbable, to make sure the system behaves properly in a range of conditions,” he said.

The autonomous flight test card, while not finalized, will be relatively simple. A pilot, without hands on the controls, will be in the cockpit to keep an eye on things. The aircraft will take off,



AVX Aircraft (left) and Karem Aircraft (right) have also submitted proposals for FLRAA studies. (AVX and Karem graphics)

convert to cruise mode, fly around the pattern and then land, all by itself, Ehinger said.

Bell also has been fine tuning the pilotage distributed aperture system (PDAS), an array of six cameras that capture a 360-degree external view of the Valor and transmit full-motion video to displays in the pilot's helmet, cockpit screens and to passengers and crew in the back.

### FLRAA

Officially, JMR is a technology demonstrator to show what industry can do and not directly tied to the FLRAA acquisition program of record. In addition to the Bell V-280 and Sikorsky Boeing SB>1 Defiant, AVX Aircraft and Karem Aircraft have also been conducting non-flying component demonstrations. All four teams were invited to submit white paper proposals for additional FLRAA studies.

The Army already has reams of test data to inform its requirements. Neither the Service nor industry had that advantage going into some of its well-publicized, unsuccessful

attempts to develop new rotorcraft (see Commentary, pg. 4). All four teams have more or less finalized their eventual FLRAA pitches, which are dependent on the final requirements decisions for the Army and the other services.

Provided the Army sticks with its self-prescribed timeline and funding profile — the US defense budget process is never certain and new programs cannot launch under stopgap funding measures — the Black Hawk replacement aircraft will be fielded in the next 10 years or so.

#### About the Author

Dan Parsons is a freelance writer covering aerospace and defense. He writes for *Vertical Magazine* and [eVTOL.com](http://eVTOL.com), and was previously the executive editor of *Rotor & Wing International* magazine and has covered aviation and military matters at several other industry publications. He is on Twitter at [@sharkparsons](https://twitter.com/sharkparsons) and can be reached at [Dan.Parsons@mhmpub.com](mailto:Dan.Parsons@mhmpub.com).

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