Parallel flight test programs aim to prove the T901 Improved Turbine Engine in the US Army’s competing FARA prototypes and in the Black Hawks and Apaches of the Enduring Fleet.

By Frank Colucci

The GE Aerospace T901 turboshaft promises to give US Army helicopters the high-hot performance and fuel-efficient range they need for multi-domain operations. The Improved Turbine Engine (ITE) also introduces an insightful engine health management system (EHMS) to advance predictive and prognostic maintenance (PPMx). The Army delivered XT901 test engines to Bell and Sikorsky in October to fly in their Future Attack Reconnaissance Aircraft (FARA) competitive prototypes (CPs) later this year. The Program Executive Office (PEO) Aviation and the Army Test and Evaluation Command (ATEC) also plan to fly the 3,000-shp (2,200-kW)-class engine in the UH-60M Black Hawk in 2024 and in the AH-64E Apache in 2025. A T901-GE-900 low-rate initial production (LRIP) decision around fiscal year 2026 extends ITE integration to the digitized, recapitalized UH-60V and starts a potential run of about 6,500 engines to power FARA and the Enduring Fleet.

FARA is the speedy, single-engine scout of the Army’s Future Vertical Lift (FVL) initiative. The Aviation Turbine Engines (ATE) project office within PEO Aviation will allocate two engines plus two spares to begin FARA CP flight tests after the engine receives its preliminary flight rating (PFR). With PFR complete, the Army re-designates XT901 test engines as YT901s. Successful full qualification testing, including ground and flight tests, ultimately makes the ITE the T901, ready for production and fielding.

At the start of T901 engineering and manufacturing development (EMD), Boeing and Sikorsky received separate integration contracts to put the new engine in the twin-engine Apache and Black Hawk. According to PEO Aviation, once ground testing is complete, the Army airworthiness authority will issue separate airworthiness releases for UH-60M and AH-64E developmental flight testing. The program projects approximately 3,000 flight test hours to support qualification of the new engine in the H-60M and AH-64E.

GE won the ITE EMD contract in February 2019 and ran its first engine to test (FETT) in 2022. The FETT was instrumented with about 700 sensors to collect performance data during the run-up to full power. FETT light-off also started PFR component tests. At the VFS Propulsion and Power Technical Meeting in November (see “VFS Propulsion Meeting Powers Forward,” pg. 20), GE project manager Mike Sousa noted full T901 production qualification will involve eight XT901 factory test engines running around 5,000 hours in upgraded test cells at Lynn, Massachusetts, and Evendale, Ohio.

Once engine and platform qualification tests are done, the Army airworthiness authority will issue follow-on releases to train Army maintainers, install engines in operational aircraft, and clear the ITE to be used by operational Army pilots. Operational test and evaluation by fiscal year 2027 will inform leadership for the T901 full-rate production decision. A full-rate production contract is expected in fiscal 2028 or 2029, according to ATE Deputy Program Manager Bob Sheibley.

The science and technology of the ITE came from the Advanced Affordable Turbine Engine program that aimed for 50% more installed power and 25% better specific fuel consumption than the state-of-the art GE T700. The T901 leverages 3D computer modeling tools, ceramic matrix composites, and 3D-printed parts to maximize its power-to-weight ratio and fuel efficiency, and to enhance durability for longer time on wing (see “The Power of FVL,” Vertiflite, May/June 2022).

The agile FARA with its fly-by-wire flight controls is positioned to get maximum benefit from the T901 full-authority digital electronic control (FADEC). However, the 3,000-shp (2,200 kW) engine was also designed to work with mechanical flight controls and fit existing Black Hawk and Apache nacelles to replace the 2,000-shp (1,491-kW) T700-GE-701D common across today’s utility and attack fleets (see “Transition of Power,” Vertiflite, March/April 2020). For the enduring fleet, the battlefield payoff of more power and reduced fuel burn should be the elimination of forward arming and refueling points (FARPs), longer times on station at air assault objectives.
and added payload at mountain density altitudes around 6,000 ft on a 95°F (1,830 m and 35°C) day (“6K/95”).

Speed, range and endurance all enhance survivability by enabling helicopters to avoid and evade advanced air defenses with their greater standoff ranges. The Government Accountability Office (GAO) noted in 2023 that the Army expects FARA to fly 1.5 times as fast and 1.5 times as far as the bigger, heavier Apache. FARA specifications defined a 14,000-lb (6,400-kg) helicopter with a desired maximum speed of 180 kt (330 km/h) or more. In March 2020, Bell and Sikorsky were chosen to build FARA CPs — the Bell Model 360 Invictus and Sikorsky S-102 Raider X — with each prototype powered by a T901 supplied as government-furnished equipment (GFE).

The Boeing website states a re-engined Apache with drivetrain and structural improvements to exploit T901 power will double the reach of today’s AH-64E, giving the attack helicopter a 135-nm (250-km) radius plus a full hour on station. For the UH-60M utility helicopter, Sikorsky Black Hawk Research and Development Program Manager Jesse Lesperance observed, “The T901 fuel savings and increased power will enable the H-60M to meet operational requirements at 6K/95, exceeding technical performance measures, returning lost payload capacity due to airframe weight growth as other capabilities have been added to the H-60 platform.”

**Fly in FARA**

Army acquisition plans have yet to fix the number of Future Attack Reconnaissance Aircraft helicopters in the future force, but fleet guesses range from 300 to 500 aircraft, with initial operational capability around 2030. Detailed FARA performance specifications have not been made public. However, with its single T901 turboshaft, FARA is the Army’s latest iteration of an armed scout helicopter with a gun, missiles, multi-sensor payload and digital connectivity. Boeing and Sikorsky packaged similar capabilities in the twin-engine RAH-66 Comanche canceled in 2004.

Comanche engines added power in steps. With two 1,400-shp (1,030-kW) LHTEC T800-LHT-800 engines, the first Comanche prototype cruised at 165 kt (305 km/h). The second prototype with 1,563-shp (1,150-kW) -801 engines was credited with a dash speed of 177 kt (328 km/h). Loaded for its primary armed reconnaissance mission, the production Comanche with radar would have weighed nearly 12,900 lb (5,900 kg) and would have needed two 1,721-shp (1,266-kW) -802 engines to sustain required performance.

Fast FARA still needs exceptional high-hot performance and, like the Comanche, will self-deploy over long distances. T901 growth steps have not been revealed, but the T700 doubled horsepower from early production engines to current CT7 versions.

FARA with a 20 mm gun, Hellfire missiles, launched effects and targeting sensors should weigh-in around 14,000 lb (6,400 kg). Comanche performance was based on density altitudes to 4,000 ft on a 95°F day (1,220 m/35°C). Experience in Afghanistan initially upped the FVL reference battlefield to 6,000 ft (1,830 m) for FARA and the Future Long Range Assault Aircraft (FLRAA), but development cost and risk led the service to revert to the 4K/95 standard (see “The Calculus of Future Vertical Lift,” *Vertiflite*, July/Aug 2021, and “FVL Risks and Rewards,” *Vertiflite*, Nov/Dec 2021).

Given the same T901 engine, Bell and Sikorsky have taken different approaches to FARA requirements. The Bell Model 360 Invictus augments its articulated main rotor and canted tail rotor with Hind-like lift-sharing wings for speed. Where the Comanche had a secondary power unit to cool mission equipment, the Invictus has a supplemental power unit for more power when needed. The Sikorsky S-102 Raider X leverages the company’s X2 technologies, demonstrated on its S-97 Raider, with high-lift rigid coaxial rotors and an integrated tail thruster. Tradeoffs in high-speed dash, agile attack and hover performance are to be determined, but like the Comanche, both FARA prototypes interface engine FADEC with fly-by-wire flight controls.

The Comanche design prioritized low-observable technology to minimize radar, infrared (IR) and acoustic signatures.
The FARA CPs likewise use internally stowed weapons and rotor head fairings to reduce drag and radar returns, but they take different approaches to infrared suppression. The Bell Invictus shows a single exhaust turned to the side under the main rotor. The Sikorsky Raider X apparently integrates a Comanche-like ribbon exhaust pointed down from the empennage.

Helicopter infrared suppressors are typically the work of the airframer, but the GAO noted the objective T901 engine should have an IR exhaust and radiance signature less than that of the T700-GE-701D at maximum rated power. The FARA objective solution is also supposed to include integrated IR suppression controlled by the pilot to manage power losses. Signature remains fully suppressed in case of control damage or failure. The T901 program begins ballistic testing during PFR, and Army requirements call for redundant digital engine controls so a single round shall not cause loss of automatic engine control.

The durable T901 also follows the modular design concept of the T700 to facilitate removals, repairs or replacements in the field. The concept aims to speed repairs and reduce the number of engines sent back to depots. The T901 engine health management system (EHMS) integrates sensors, embedded models and algorithms to troubleshoot better and save spare parts and manhours. Maximizing fleet readiness depends in part on PPMx. The latest, information-driven iteration of condition-based maintenance (CBM+) helps maintainers plan actions based on current and forecast aircraft health and the impact on operations. With an embedded digital twin, the EHMS enables the T901 engine to diagnose itself and generate automated maintenance alerts.

According to PEO Aviation, the T901 EHMS updates power-available, incident data and remaining life of monitored components on a per-mission basis. It generates fault indications for pilots and maintainers, and downloads data to a ground station. Data shared with relevant Army databases promises to improve supply system planning and aircraft reliability. T901 test engines have EHMS hardware, but initial flight test software does not support full system capabilities. The software will be revised after initial flight testing to include additional EHMS capabilities. Current test engines are instrumented to monitor their own health and provide engine and aircraft integrators with data to support flight testing and qualification.

**Black Hawk Build-up**

Sikorsky Black Hawk production under the current multi-year contract ends in July 2027 and ultimately gives the US Army 956 UH/MH-60Ms for utility and Special Operations missions and 419 HH-60Ms for medevac. To that new-build fleet will be added 760 UH-60Vs recapitalized from UH-60Ls at Corpus Christi Aviation Depot through 2039. PEO Aviation’s ATE project office manages a T901 flight test program that includes two UH-60M utility helicopters and one HH-60M Medevac aircraft. Initial testing will be done at the Sikorsky Development Test Center in West Palm Beach, Florida, and other company facilities.

Sikorsky Innovations received a contract in June 2015 for ITE/H-60M integration risk reduction to help GE and then-competitor, the Advanced Turbine Engine Company — comprised of Pratt & Whitney and Honeywell — mature their engines for preliminary design reviews. The Black Hawk maker provided technical information, analysis and engineering data for the engine developers to design and produce an engine compatible with H-60M electrical, mechanical and software interfaces. The effort grew to include support system reviews and preliminary design reviews.

A follow-on contract in September 2019 initiated H-60M/T901 EMD and began preliminary design of the aircraft A-kit to put the new engine on the H-60M. In addition to mechanical connections for fuel lines, inlet particle separator ducts, wiring and drains, the T901 adds capability that requires systems integration. The new engine drives changes in the Black Hawk power control quadrant and requires updates to cockpit multi-function displays and the flight management system. According to Jesse Lesperance, at Sikorsky, “These changes touch nearly every aircraft system in either design modifications or performance considerations.”
The T901 dual-channel FADEC includes an engine electrical control unit, a distributed control module and the EHMS. The Black Hawk integrated vehicle health and monitoring system (see “Positive Prognosis,” Vertiflite, May/June 2012) will accommodate the EHMS modification within existing software and will accommodate emerging software. Lesperance observed, “We are giving front-line maintainers enhanced visibility and capabilities into the Black Hawk engines.”

Sikorsky, GE, and the Army provide the combined test team (CTT) for T901 test, evaluation, and qualification in the H-60M. The CTT is tasked with executing the flight test program safely and efficiently to verify flight performance documented in the ITEP capability development document. Mixed crews with one experimental test pilot from Sikorsky and one from the Army’s Redstone Test Center (RTC) will conduct most flights. After initial testing in Florida, most flying will be done at RTC in Huntsville, Alabama. Other locations will be used for specific testing requirements.

**Advancing Apache**

The current Apache program of record stretches AH-64E deliveries through November 2027 and gives the US Army 812 modernized attack helicopters. The T901 engine modification for the Apache is separate from the AH-64E V6.5 operational flight profile upgrade in progress. However, any further Modernized Apache work relies on the new engine (see “Apache Soldiers On,” Vertiflite, March/April 2018). Boeing indicates that an AH-64 strengthened to use full T901 power would afford increased payload and range, and maximize the weight potential of the airframe. The company notes two more wing pylons, for example, could enable a Modernized Apache to carry long-range precision munitions, launched effects and directed energy weapons.

T901 test plans call for three AH-64E helicopters to evaluate airworthiness and performance for T901 qualification, initially at the company’s Mesa, Arizona, facility. According to the company spokesperson, “ITE integration will unlock new improvements in reach, available power, time on station and fuel efficiency. The new engine will provide the base power architecture and springboard for future generation capability with the AH-64E and beyond.”

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