

## **Affordable Engineering Service (AES) Commercial Unmanned Systems**

Affordable Engineering Service (AES) is performing cutting edge research engineering including the design and development of unmanned aircraft avionics. We are currently testing a full avionics suite and ground station that augments and enhances capability of a manned Kaman K-MAX utility helicopter to enable optional unmanned remote-piloted operation, thus making it an Optionally Piloted Vehicle (OPV).

Kaman AeroSystems, a division of Kaman Corporation, awarded a commercial contract to Affordable Engineering Service (AES) in 2019 to design, develop, integrate, and test a complete unmanned avionics suite for the K-MAX. The new OPV avionics kit is designed, developed, and tested as an optional upgrade add-on for existing K-MAX owners. In 2020, we were awarded two Navy contracts... One FFP contract for parts, and one CPFF contract for the comprehensive engineering tasks – hardware and software designs, Hardware In The Loop (HITL) test, Simulation, Reliability and System Safety analysis, Component Analysis, Ground Test and the Flight Test.

The OPV K-MAX test airframe is a production K-MAX helicopter with all existing manned operation capability preserved. A flight mode switch can be toggled between normal manned operation, remote-piloted (unmanned OPV) operation, or an OPV test mode with Safety Pilot on-board during OPV test operation. In normal piloted operation all OPV avionics are powered off, the OPV actuators are disengaged, and the pilot is not allowed to engage OPV operation in air. In Safety Pilot OPV mode the pilot can assume control and override actuators (with sheer pin breakout, if needed). Also, in Safety pilot mode the pilot may switch between piloted and unmanned mode for test purposes.

The commercial K-MAX OPV system, operating in the unmanned mode, is designed for unmanned cargo and fuel resupply missions, electrical tower installations and, potentially, aerial firefighting. The intended customers are both US domestic and foreign K-MAX operators, with the OPV kit design based on ITAR unrestricted components. The modular systems design of the avionics suite and the system software allows for customization to meet the unique needs of both commercial and US military KMAX customers.



*Figure 1: K-MAX HELICOPTER – Courtesy of Kaman Aerosystems*

The modular AES design of the OPV Avionics Suite is readily adaptable for integration into any fixed-wing or rotary-wing aircraft to convert that aircraft into an unmanned system, an OPV system, or an unmanned target drone.

The AES OPV Avionics Suite consists of two major components: 1.) The Air Vehicle (AV) OPV Kit and 2.) The OPV Ground Control Station (GCS). Within these components, there are four functional elements for the Commercial K-MAX OPV:

- Flight Critical
- Mission Critical
- Ground Control
- Ground Support

The aircraft avionics required to unman the AV are classified as either Flight Critical or Mission Critical. Flight critical subsystems are any software or hardware component whose failure would result in the loss of

the aircraft. Mission critical subsystems are systems whose failure would prevent the completion of the mission.

**Flight Critical Hardware:** Includes the flight control computer (FCC), Actuators, GPS/INS Sensors, Air Data Computer, Outside Air Temperature sensor, and Power Distribution Module.

**Mission Critical Hardware:** Includes the Mission Computer, Cameras, Line-of-Sight (LOS) TxRx Radio, Beyond Line-of-Sight BLOS TxRx Radio, Radar Altimeter, and the Flight Mode Switch and Indicator Panel.

**Ground Control Station:** The GCS comes in three different configurations and provides the following functions: Mission Planning and Validation, Primary Mission Control, Display Status and State of GCS, Payload Management, Display Video from FPV and Sling Load Cameras, Display of Payload Information, Command and Control of the Payload, Vehicle Management, and Display Status and State of the AV.

**Ground Support Equipment (GSE):** Includes the Portable Maintenance Computer, Mission Planning and Upload, Configuration File Management, Maintenance, Engineering Flight Test, and Mission Planning and Validation.

The program was executed in several major phases including customer requirements definitions and documents, design and development, Hardware-in-the-Loop (HITL) system testing, OPV Ground Testing, and OPV Flight testing. HITL Testing was done at an AES contracted lab in San Diego and ground testing and flight testing are conducted at Kaman facilities as well as leased flight test locations on the East Coast.

### **Affordable Engineering Service (AES) Military Unmanned Systems**

In 2019, Kaman Aerosystems was awarded a contract from the U.S. Navy - Naval Air Systems Command (NAVAIR) to reactivate two U.S. Marine Corps unmanned K-MAX helicopters. In 2020, NAVIR awarded Kaman another contract to outfit one of those USMC K-MAX helicopters with the new unmanned/ OPV avionics suite designed and developed by AES. AES was put on contract by Kaman to provide them with a complete avionics hardware suite and ground station for the USMC K-MAX. AES is tasked with integrating and testing that OPV avionics suite and demonstrating the system for NAVAIR and the U.S. Marine Corps at Ft. Pickett, VA in 2021.

In addition to providing the avionics hardware suite and ground station for the USMC K-MAX, AES is also subcontracting to Kaman Aerosystems to integrate an autonomous obstacle avoidance system (designed and developed by Pittsburgh -based Near Earth Autonomy) into the commercial OPV K-MAX System. The autonomous obstacle avoidance system uses a scanning Light Detection and Ranging (LIDAR) system to map an area on the ground around the Unmanned K-MAX, identify obstacles, and provide command inputs into the OPV Unmanned Flight Control System (UFCS) to avoid such obstacles.



*Figure 2: Autonomy System Mounted on the K-MAX. -  
Courtesy of Near Earth Autonomy*

### **Conclusion**

Affordable Engineering Services can provide a custom avionics solution for any manned rotary wing or fixed wing aircraft to convert it into an Unmanned/ OPV variant at a fraction of the cost of one of the OEM companies. AES stands ready to provide the architecture design solutions, guidance and control expertise,

and hardware and software design expertise for custom commercial and government/ military OPV and unmanned systems.