MISSIONS ACCOMPLISHED:

How Power, Lighting, and EVS Improve Rotorcraft Safety and Performance

By Astronics Corporation

With rotorcraft serving rugged duty across a wide spectrum of mission-critical industries including firefighting, police work, emergency medical services (EMS), oil and gas transport, and search and rescue (SAR), integrating new technologies optimizes the safety and operational performance of the vehicle. Whether line-fit or retrofit, rotorcraft that operate in rugged, degraded environments depend on upgraded technologies to serve the needs for increasingly flexible power systems, more powerful enhanced vision systems, and advanced lighting systems.

Power Systems Today Must be Flexible, Configurable, and Scalable

The wide variety of rotorcraft utility functions drives the pressing need for power systems to incorporate extreme flexibility. Traditionally, rotorcraft are substantially retrofitted in aftermarket completion centers, via a complex kitting process. This may involve structural modifications, as well as extensive re-wiring of the aircraft, all of which require downtime. When outfitting or upgrading a rotorcraft with an electronic power distribution system (EPDS), consider its innate flexibility, configurability, scalability, and intelligence. For example, does it:

- Simplify kitting
- Integrate easily to reduce your manufacturing flow time
- Accept new kit configurations
- Include intelligent switching
- Reduce the complexity overall of your system with fewer wires and components

To illustrate, a single electronic circuit breaker unit (ECBU) can be installed in the rotorcraft to serve as baseline provisioning for any number of kit configurations. Perhaps a rotorcraft will employ air conditioning, a hoist, a surveillance camera, and a search light. A second, same-model rotorcraft may employ medical equipment, radar, enhanced lighting, and a vision system. In these cases, a single ECBU installation operates as both a circuit breaker and an intelligent, remote-controlled switch, and is easily reconfigured to different electrical loading profiles, load-shedding profiles, and even utility logic profiles, especially if a degree of automation is required. This saves manufacturing flow time, weight and cost. Additionally, this strategy provides a highly robust electrical system to improve safety and reduce pilot workload.

With a solid-state electrical power distribution system, a single ECBU installation operates as both a circuit breaker and an intelligent, remote-controlled switch, providing flexibility for reconfiguring to different electrical loading profiles, load-shedding profiles, and even utility logic profiles.

One of the other most pressing needs for helicopters is safety improvement. The capability of a solid-state networked power distribution system, where all aircraft electrical subsystems can be discretely controlled and monitored, provides a tremendous benefit to enable total vehicle health management.

A noteworthy example is emergency landing assist. In general, a pilot has only three seconds to initiate an autorotation procedure in case of engine failure. An EPDS system can quickly reconfigure the aircraft, implementing the automatic load shedding of key loads (e.g. fuel shutoff) as well as re-routing of electrical power for various safe-landing support functions, based on its intelligent switching capabilities.

Today's rotorcraft are evolving to incorporate increasingly electric configurations, particularly with the trends toward electric vertical take-off and landing aircraft (eVTOLs). We are in the midst of a revolution, where multi-rotor aircraft (e.g. drones) will become larger and more automated, serving all utility functions as noted above. These aircraft will require unprecedented levels of remote control, system awareness, and power efficiencies, given that they are predominantly electric. To assist, Astronics Advanced Electronic Systems (AES) offers a full suite of EPDS solutions including solid-state power distribution and conversion systems, motor controllers, and brushless power generation systems.

Enhanced Vision—Coming Soon to a Rotorcraft Near You

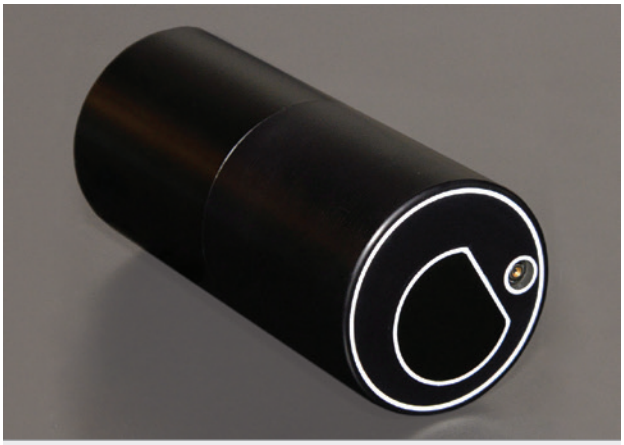
With rotorcraft, safety is always at the forefront. In addition to power systems, enhanced vision systems (EVS) are now getting a serious look. In the military, degraded visual environments such as brownout, smoke, sand, darkness, and fog caused nearly 44% of aviation fatalities since 2002 in Afghanistan and Iraq, according to the U.S. Army Combat Readiness Center.

An ongoing research project by the FAA is studying operational concepts for the use of Enhanced Flight Vision Systems (EFVS) in helicopters. This research could lead to the mandated use of EVS in helicopters flying into heliports. Currently, EFVS rules exist for approaches to runways at airports, but comparable regulations for EFVS do not exist for helicopters flying to onshore or offshore helipads at heliports.

Flight testing is underway at the FAA's William J. Hughes Technical Center, at the Atlantic City International Airport in New Jersey. The center serves as the national scientific test base for the FAA. Programs include research and development, test and evaluation, and verification and validation in air traffic control, communications, navigation, airports, aircraft safety, and security.

As part of the research study, Astronics Max-Viz is providing its EVS to the FAA for integration into a Sikorsky S-76 medium-size commercial utility helicopter test aircraft. Officials are using Astronics sensors in flight tests and data acquisition for future EVS and EFVS implementation.

With EVS, pilots enhance their real-time situational awareness and safety because they can see more precisely during the day or night and in adverse weather conditions such as haze, smoke, smog and light fog, or in "black hole" approaches. Recent economies of scale and production efficiencies



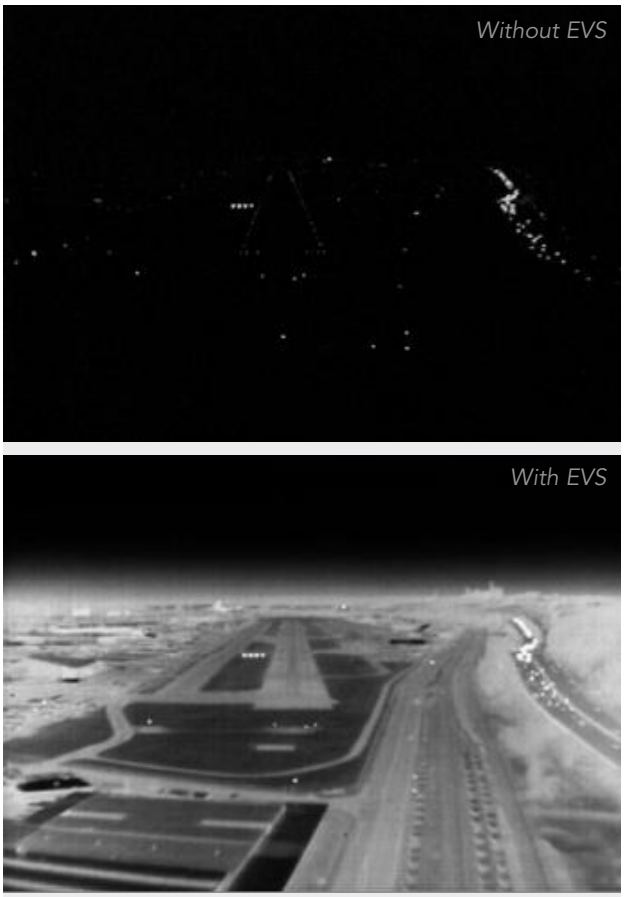
An ongoing research project by the FAA is studying operational concepts for the use of Enhanced Flight Vision Systems (EFVS) in helicopters, using the Astronics Max-Viz EVS.

have led to single sensor and multi-spectral imaging sensors that are more affordable for the marketplace.

Increasingly light weight and affordable, today's systems incorporate a multi-spectral imager that blends the separate signal from a long wave infrared sensor with a visible light sensor to present pilots with a single, sharp, real-time image. The blended thermal image is initially black and white, but a separate color HD-compatible signal from the visible light camera can route the signal to the cockpit or cabin for a complete color display.

Today these state-of-the-art sensors are in use around the world, enabling safer firefighting, helicopter EMS, SAR, corporate, and military operations. EVS also integrates efficiently with night vision goggles to increase mission efficiency and safety.

For the future, look for the next-generation of blended vision systems. Potential enhancements will include high-resolution infrared and visible light sensors with very large displays, and adding more sensors/emitters merged with IR/visible light to penetrate thick obscurants like fog and clouds while integrating synthetic vision systems (SVS). Eventually, these systems will provide real-time correction of the GPS position and detection of transient or missing items in the SVS database, such as encroaching aircraft or wildlife on the runway.



Pilot view of the Boeing Field Airport shown without EVS and then with an EVS system from Astronics Max-Viz.

Improvements in Lighting Enhance Safety and Operational Efficiency in Next-Gen Rotorcraft

Rotorcraft are required to work in some of the most challenging environments, and a simple light failure can cause increased workload on a pilot and even halt a mission due to regulatory requirements. For example, a pilot, flying in a dark environment, must concentrate on the mission and the hazards associated with the flight path. The failure of a cockpit control panel backlighting may cause the pilot to divert his or her eyes. Or perhaps a pilot performing an initial operations check identifies that the anticollision light no longer flashes, and cannot begin the flight. In another example, a group of oil rig workers waiting to fly out to a station in the middle of the Gulf cannot take off due to a failure in the emergency lighting system.

The good news is that the reliability of aircraft lighting systems has dramatically improved with the use of solid-state lighting elements, including LED and electroluminescence (EL). With this technology, there are no filaments to fail. When outfitting a new rotorcraft or upgrading an existing rotorcraft, consider these newer technologies for a long-lasting, robust option that reduces operating and maintenance costs while eliminating the risk of rotocraft service interruptions due to lighting failure.

Rotorcraft pilots are increasing their use of night vision imaging systems (NVIS) to support operations through dark environments. Requiring the use of night vision goggles, this can present challenges in viewing both interior cockpit displays and external rotorcraft lighting. MIL-STD-3009 specifies the requirements for internal and external aircraft lighting systems in terms of radiant energy interfaces and test procedures. For engineers specifying lighting for rotorcraft that are expected to perform night missions, it is essential to ensure that cockpit lighting, emergency lighting, and even the external lighting are NVIS-compatible and complaint. Compliant lighting reduces a pilot's distraction to ensure safer aircraft operation and mission success.

An additional regulatory requirement calls for helicopters that fly over water to provide emergency exit illumination that is visible in a submerged or partially submerged cabin situation, and that operates up to a depth of 50 feet under water. This is to improve the chances of escape should the helicopter capsize after a ditching. Systems such as the Helicopter Emergency Egress Lighting (HEEL) system from Astronics LSI provides illuminated spatial orientation to disoriented occupants while escaping a capsized or submerged cabin.

Emergency egress systems, such as this system from Astronics LSI, are required for rotorcraft that fly over water.

Rotorcraft lighting solutions from Astronics Luminescent Systems Inc. (LSI) address both the reliability and NVIS compatibility requirements of advanced rotorcraft. Off-the-shelf and custom-designed lighting systems are available for the cockpit, cabin, exterior, and emergency lighting needs for military and commercial operations.

In Summary

These key advancements in technologies for power, lighting, and enhanced vision systems are driving improved operations of rotorcraft while ensuring pilots and crews complete extreme environment missions both successfully and safely.

Astronics Corporation (NASDAQ: ATRO) serves the world's aerospace, defense and semiconductor industries with proven, innovative technology solutions. Astronics works side-by-side with customers, integrating its array of power, connectivity, lighting, structures, interiors, and test technologies to solve complex challenges. For 50 years, Astronics has delivered creative, customer-focused solutions with exceptional responsiveness. Today, global airframe manufacturers, airlines, military branches, completion centers and Fortune 500 manufacturing organizations rely on the collaborative spirit and innovation of Astronics.

To learn more about new technologies to support rotorcraft programs, please visit **Astronics.com/Heli-Solutions**.

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