Combined USHST and ESPN-R Helicopter Safety Technology Emphasis Items | Rev. 15 December 2021

In 2014, the European Safety Promotion Network Rotorcraft (ESPN-R) and the Netherlands Research Center (NLR) conducted a sweeping analysis of helicopter safety technologies and produced a report titled The Potential of Technologies to Mitigate Helicopter Accident Factors". This study analyzed 145 different safety technologies and created a matrix of these technologies integrated with Standard Problem Statements (SPS), Technology Readiness Levels (TRL) and relative cost of implementation. The top 15 technologies were labeled as highly promising" based on their respective numerical scores on that matrix.

The United States Helicopter Safety Team and International Helicopter Safety Foundation, now working jointly as the Vertical Aviation Safety Team (VAST), has produced a set of Helicopter Safety Enhancements (HSEs) resulting in a separate list of technologies. And finally, EASA s 2018 Rotorcraft Safety Roadmap expands on the ESPN-R/NLR report, adding emphasis and reason to the mathematics of the study.

The purpose of this paper is to extract and group the common technology elements and concepts in these various studies. This list is focused on ***accident prevention*** measures and intentionally filters crash survivability measures. Crash survivability remains a concern, but one to be addressed separately.

Group I: Available and Mature Flight Deck Technology

Automatic Flight Control Systems (AFCS) with attitude recovery mode for regaining or maintaining control in reduced visibility conditions or UIMC situations, enhancing situational awareness and reducing pilot workload. AFCS can potentially meet the IFR certification stability requirements and achieve part of the requirement needed for an airframe IFR STC. *(ESPN-R, EASA Safety Roadmap and HSE-70)*

Data-derived terrain and obstacle detection systems use predicted horizontal and vertical flight path to alert pilots of potential impact with terrain, water and obstacles. Helicopter Terrain Alerting and Warning System (HTAWS) has become the generic nomenclature for these systems, however Enhanced Ground Proximity Warning System (EGPWS) serves a similar function.

A critically important feature of these systems for helicopter operations is manual and automatic vehicle operation mode selections to aid in the elimination of nuisance alerts. *(ESPN-R, EASA Safety Roadmap and HSE-91)*

Synthetic Vision Systems (SVS) are generally incorporated into the pilot s primary flight display (PFD) and feature large format attitude indicator with overlaid terrain, obstacle database information along with data-link weather display and traffic relative to the aircraft. SVS should not be confused with Enhanced Vision Systems (EVS), also a potential safety-enhancing technology but generally installed for increased low visibility mission capability. *(ESPN-R, EASA Safety Roadmap and HSE-91)*

Note: Integrated as a system, **SVS, HTAWS and AFCS** with intuitive pilot interface can greatly reduce the potential of fatal accidents in the LOC-I, LALT, UIMC and CFIT categories. Group I technologies, combined with technologies from groups II and III along with vigorous crew training programs have the potential to reduce all helicopter risk factors.

Group II: Emerging or Advancing Technology

Cost-Effective IFR Certification for new production and existing lower cost helicopters capitalizing on multiple technologies, improved vehicle and power plant reliability and helicopter-specific IFR infrastructure. Such vehicles could reduce fatalities in the UIMC and LOC-I categories, reduce the exposure to hazardous scud running" operations and assist in the needed IFR-helicopter pilot culture shift via affordable Supplemental Type Certificates for existing smaller, more affordable helicopters.

ADS-B Out" and In" for onboard weather and collision avoidance and recommendation that all helicopters be equipped standard with fixed transponder-based, 24-digit address 1090ES ADS-B out". **Note:** Recommend ICAO-EASA level ADS-B In" standards development to accelerate use of the mature and emerging capabilities of this technology in all helicopters.

Support of e-Conspicuity" Initiative intended to equip other aircraft with 1090 MHz ADS-B transmitter/receivers (including UAS, gliders and potentially anything penetrating navigable airspace). These devices are increasingly small, lightweight, low-cost and hold promise for proliferation.

Air Data Sensing Systems capable of determining precise wind information regardless of an aircraft s situation. When integrated into a display or audio alert, the systems can provide Vortex Ring State envelope warning/protection and also enhance the accuracy of take-off and landing performance calculations.

Active Terrain, Obstacle and Traffic Detection using sensors to actively and reliably monitor a protected area around the vehicle detecting wires, birds, unmanned aerial systems (UAS) cranes and other non-database obstacles.

Lightweight Health and Usage Monitoring System (HUMS) warning systems - Due to cost, weight and complexity, HUMS installations have been limited to transport helicopters and as an expensive option on Part 27 aircraft. However, anticipated technological advances in wireless technology and the miniaturization of sensors may enable development of low-cost HUMS capable of predicting imminent SCF-PP (System/Component Failure – Powerplant) and SCF-NP (System/Component Failure – Non-Powerplant) events in all classes of helicopters. Refining the capability and human interface of such systems could lead to integration of HUMS information into pilot displays allowing for in-flight systems and component monitoring.

Group III: Technology for improved operational control, risk management and airman preparedness

App-based Smart" Flight Risk Assessment Tool (FRAT) integrated with flight operations and real-time meteorological data can enhance mission risk analysis with minimal subjective pilot input. When connected to operational control personnel, such a system can enhance the risk assessment, awareness and risk mitigation processes. *(ESPN-R, EASA Safety Roadmap and EASA GA Safety Roadmap)*

Flight Simulation Training Devices - Helicopter (FSTD-H) developing, deploying and actively using high fidelity Full Flight Simulators (FFS), Flight Training Devices (FTD) and Flight and Navigation Procedures Trainer (FNPT) to reduce exposure to training accidents and improve airman preparedness. *(ESPN-R, EASA Safety Roadmap and HSE-81)*

Group III - continued

Flight Briefing/Preparation/Debriefing app/software applications designed to improve pilot and dispatcher preflight awareness of current and developing flight conditions, airspace advisories, hazards along the intended route and real-time advisories.

Helicopter Flight Data Monitoring Systems (HFDM) including standards for low-cost devices capable of recording audio, video, multi-axis acceleration, aircraft position, altitude, speed, pitch and roll. Such devices could take advantage of mobile device technology and be installed with minimal expense in all helicopters through FAA NORSEE and EASA CS-STAN process. **Note:** The ability to proliferate helicopters with HFDM systems integrated into FOQA systems is a greater priority than crashworthiness of the systems. *(ESPN-R, EASA Safety Roadmap and HSE-82)*

Flight Operations Quality Assurance (FOQA) software systems for analyzing and aggregating HFDM data used to proactively address outside of envelope" flight and encourage voluntary compliance with best practices. *(ESPN-R, EASA Safety Roadmap and HSE-82)*

Optionally Piloted Aircraft (OPA) and Unmanned Aircraft Systems (UAS) used for high risk surveillance, inspection and data collection operations such as power line patrol and structural inspections. *(HSE-90)*

Note: Cost-Effective IFR Certification" in the list describes a synthesis of technologies and is added due to the recent certification progress in the United States (Bell and Leonardo) and the safety advantages of IFR operations that are inferred by all organizations; EASA, FAA, ESPN-R and IHFS. For example, here is an excerpt from Section III.10 of EASA s 2018 Rotorcraft Safety Roadmap:

> Losses of control due to inadvertent entry into IMC: Create a more proportionate training path for pilots to gain instrument flying qualifications. With better access to IFR flying, GA pilots would be able to perform flights with more confidence in safely completing them. Before the publication of the Opinion on Easier access for general aviation pilots to instrument flight rules flying (RMT.0677), or as a follow-up task, EASA should evaluate and extend the scope of its application to rotorcraft. This task is currently limited to pilots that fly typical single- and multi-engine piston GA aeroplanes in non-commercial operations."

A joint FAA and EASA IFR STC for existing Class I (2 seat trainer) and Class II (Bell 206 size) helicopters will help facilitate the needed cultural shift and ongoing IFR advocacy work being carried out in the helicopter industry. This could potentially be further supported by EASA s Basic Instrument Rating (BIR) initiative if extended to helicopters (currently a fixed-wing initiative)