A1.02 Aviation Safety and Security: Fire, Icing and Propulsion-Safe and Secure CNS Aircraft Systems

NASA is concerned with the prevention of hazardous conditions and the mitigation of their effects when they do occur. One particular emphasis is on the prevention and suppression of in-flight fire and explosions, as well as fuel tank explosions and post-crash fires. Aircraft fires represent a small number of actual accident causes, but the number of fatalities due to in-flight, post-crash, and on-ground fires is large.

A second emphasis is on mitigating the safety risk and collateral damage due to unexpected failures of rotating components. Although the FAA mandates a blade containment and rotor unbalance requirement (FAR Part 33, Section 33.94) as part of the airworthiness standards for turbine aircraft engines, there are substantial potential (aircraft-engine) system benefits to be gained by enabling safety assured, lighter weight, lower cost, and more damage-tolerant designs for engine case/containment systems and associated (primary load path) structures.

A third emphasis for this subtopic is on propulsion system health management, in order to prevent or accommodate safety-significant malfunctions and damage. Past advances in this area have helped improve the reliability and safety of aircraft propulsion systems; however, propulsion system component failures are still a contributing factor in numerous aircraft accidents and incidents. Advances in technology are sought which help to further reduce the occurrence of and/or mitigate the effects of safety-significant propulsion system malfunctions and damage.

A fourth emphasis is to increase the level of safety for all aircraft flying in the atmospheric icing environment. To maximize the level of safety, aircraft must be capable of handling all possible icing conditions by either avoiding or tolerating the conditions. Proposals are invited that lead to innovative new approaches or significant improvements in existing technologies for in-flight icing conditions avoidance (icing weather information systems) or tolerance (airframe and engine ice protection systems and design tools).

A final emphasis for this subtopic is protection and hardening of the aircraft’s communication, navigation and surveillance (CNS) systems, as well as enabling new aviation security applications through improved air-to-ground data link communications. Technology is needed to harden the CNS systems, both onboard and air-to-ground, and to provide next-generation airborne, ground- and space-based surveillance systems.

With these emphases in mind, products and technologies that can be made affordable and retrofittable within the
current aviation system, as well as for use in the future, are sought:

- Technology for prevention and suppression of potential in-flight fires in fuel tanks, cargo bays, insulation, and other inaccessible locations due to accidents or deliberate acts.
- Technology to provide fuel tank vapor flammability reduction and onboard oxygen generation.
- Technology to minimize fire hazards in crashes and to prevent or delay fires.
- Advanced material or structural configuration concepts to prevent catastrophic failures of engine components, or to ensure fragment containment.
- Computational tools for analyzing blade-loss events and designing structural components and systems accordingly.
- Health management technologies such as instrumentation, ground and on-wing nondestructive inspection, health monitoring algorithms, and fault accommodating logic, which will predict, diagnose, prevent, assess, and allow recovery from propulsion system malfunctions or damage.
- Ground and airborne radome technologies for microwave wavelength radar and radiometers that remain clear of liquid water and ice in all weather situations.

In situ icing environment measurement systems that can provide practical, very low-cost validation data for emerging icing weather information systems and atmospheric modeling. Measured information must include location, altitude, cloud liquid water content, temperature, and ideally cloud particle sizing and phase information. Solutions envisioned would use radiosonde-based systems.

- Ice protection and detection technology submittal must provide significant improvements over current systems or address new design needs. Areas of improvement can be considered to be: efficient thermal protection systems, including composite wing or structures applications, wide area ice detection, detection that serves both ground and in-flight applications, and de-icing systems that operate at near anti-icing performance. Any submittal must be cost competitive to current technologies.
- Next generation capabilities for remote monitoring of onboard systems and the aircraft environment.
- Secure onboard information processing, computing and air/ground networking.
- Technologies to harden aircraft communication, navigation, and surveillance systems against abnormality and deliberate attack.