The FAA's Center of Excellence for UAS Research

ASSURE

Alliance for System Safety of UAS through Research Excellence

Academic research within the FAA Center of Excellence: Assisting the FAA in the UAS rulemaking process

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Center of Excellence (COE)

- COEs are “entities with substantive ties to universities which advance the state of transportation knowledge within a particular aviation area.”
- The Federal Aviation Administration’s Center of Excellence for Unmanned Aerial Systems
  - ASSURE: The Alliance for System Safety of UAS Through Research Excellence
  - Announced May 2015
- $5 million to the UAS COE in FY15 & FY16
- Two funding vehicles
  - Grants (mandatory 1-to-1 cost share or “match”)
  - Indefinite delivery/Indefinite quantity (IDIQ) Contracts (cost share negotiable)

ASSURE University Team

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Detect & Avoid
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Currently Funded Research

A1-Certification Test Case to Validate sUAS Industry Consensus Standards

A2-Small UAS Detect and Avoid Requirements Necessary for Limited Beyond Visual Line of Sight (BVLOS) Operations

A3-UAS Airborne Collision Severity Evaluation

A4-UAS Ground Collision Severity Evaluation

A5-UAS Maintenance, Modification, Repair, Inspection, Training, and Certification Considerations

A6-Surveillance Criticality for Sense and Avoid (SAA)

A7-UAS Human Factors Control Station Design Standards

A8-Unmanned Aircraft Systems (UAS) Noise Certification

A1-Certification Test Case to Validate sUAS Industry Consensus Standards

- **Need**–No specific certification basis has been identified for sUAS. The ASTM F38 standards may serve as a foundation, but further research into the suitability of the standards and existing gaps is required to determine how they will apply.
- **Approach**–Build upon past research into the validation of the ASTM F38 standards, and expand to include issues relating to flight test. The research reviews compliance findings and explores the application of the F38 standards for flight test development. A flight test framework based upon the F38 requirements and existing flight test standards and practices will be developed. Compliance issues will be documented.
- **Benefit**-Inform flight test framework requirements for sUAS based upon the ASTM F38 standards and existing regulations

A1 Research Questions

- Are the ASTM F38 standards suitable for use as a certification basis for small UAS?
- With which ASTM F38 standard requirements is compliance difficult or overly burdensome?
- What are the gaps in the ASTM F38 standards with regards to assuring airworthiness and safe integration of sUAS into the NAS? Are safety-of-flight-critical hazards adequately addressed by the standard requirements?
- Is a flight test program feasible using the ASTM requirements as a framework?

ASTM F38 active standards evaluated

Designation	Title
ASTM F2908-14	Standard Specification for **Aircraft Flight Manual** (AFM) for a Small Unmanned Aircraft System
ASTM F2909-14	Standard Practice for **Maintenance** and Continued Airworthiness of Small Unmanned Aircraft Systems
ASTM F2910-14	Standard Specification for **Design and Construction** of a Small Unmanned Aircraft System
ASTM F2911-14e1	Standard Practice for **Production Acceptance** of Small Unmanned Aircraft System
ASTM F3002-14a	Standard Specification for Design of the **Command and Control System** for Small Unmanned Aircraft Systems
ASTM F3005-14a	Standard Specification for **Batteries** for Use in Small Unmanned Aircraft Systems

A2-Small UAS Detect and Avoid Requirements Necessary for Limited BVLOS Operations

Beyond Visual Line of Sight (BVLOS) Operations

- **Need**–To expand access for sUAS in limited portions of the NAS and still achieve a level of safety equivalent to manned aircraft operating in a similar manner.
- **Approach**–Define an operational framework and conduct a comparison of approaches that support development of standards for sUAS DAA systems and development of proposed operating rules, limitations, and guidelines for sUAS BVLOS operations.
- **Benefit**-Inform expanded safe operational access for sUAS by defining various potential operational frameworks that will allow safe BVLOS operations

A2 Research Questions

- What are the requirements for an airborne or ground based Detect and Avoid system compatible with sUAS operating in limited portions of the NAS in order for the sUAS pilot to comply with 14 CFR 91.113 in a manner that does not increase the risk to other aircraft, or persons on the ground, beyond that currently present in the NAS for similar manned aircraft operations?
- What are the requirements for a software algorithm(s), if any, to implement these requirements?
- What are the most feasible airborne or ground-based sensors that are capable of meeting these requirements and are compatible with sUAS size, weight, and power (SWaP) and level-of-certification constraints?

A3-UAS Airborne Collision Severity Evaluation

- **Need**–System safety thresholds for key UAS characteristics for identifying UAS as acceptably safe in credible encounter scenarios. Specifically to identify characteristics that relate to collision with other aircraft in the air.
- **Approach**–Utilize encounter scenarios with aircraft in the air to test UAS hazard severity characteristics. The research needs to recommend key UAS system safety characteristics for these encounters.
- **Benefit**-Inform operational approval restrictions for small UAS based on collision risk to manned aircraft and inform sUAS design requirements to reduce severity of collisions with manned aircraft

A3 Research Questions

- What are the hazard severity criteria for a UAS mid-air collision (weight, kinetic energy, etc.)?
- How can the design of a UAS minimize potential damage during a mid-air collision?
- What is the severity of a UAS collision with a manned aircraft?
- Can we classify a UAS impact similar to a bird strike?
- Will a UAS affect an engine similar to a bird engine ingestion?
- What particular characteristics of a UAS are required to avoid so it will not be a risk to a manned aircraft?
- Can we categorize the severity of a UAS mid-air collision with an aircraft based on the UAS and what would those categories look like?

A4-UAS Ground Collision Severity Evaluation

- **Need**–It is necessary to determine hazard severity thresholds for UAS using safety characteristic factors that affect the potential severity of UAS in collisions with people and other aircraft on the ground or aircraft in the air. These severity thresholds will help determine acceptable corresponding system failure levels in accordance with the applicable 14 CFR requirements (for example 14 CFR 23.1309 and 14 CFR 25.1309).
- **Approach**–Utilize encounter scenarios with aircraft in the air to test UAS hazard severity characteristics. The research needs to recommend key UAS system safety characteristics for these encounters.
- **Benefit**-Inform how UAS might be designed as to minimize the potential damage done during a collision

A4 Research Questions

- What are the hazard severity criteria for a UAS collision (weight, kinetic energy, etc)?
- What is the severity of a UAS collision with aircraft on the ground?
- What is the severity of a UAS collision with property on the ground?
- What is the severity of a UAS collision with a person on the ground?
- What are the characteristics of a UAS where it will not be a risk to an aircraft or person/property on the ground?
- Can the severity of a UAS collision with an aircraft or person/property on the ground be characterized into categories based on the UAS and what would those categories look like?
- How can UAS be designed as to minimize the potential damage done during a collision?

A5-UAS Maintenance, Modification, Repair, Inspection, Training, and Certification Considerations

- **Need**–To develop standards for UAS maintenance, modification, repair, inspection, and technician training, and to identify requirements for approved certification standards for air vehicle and system maintenance providers and maintenance technicians.
- **Approach**–Determine differences in practices and standards between manned and unmanned aircraft related to maintenance, repair, record keeping, accident reporting, training, and technical documentation.
- **Benefit**-Recommendations for defining standards for maintenance, records and training for UAV including certification requirements for service providers and identify training standards for all Risk Classes of UAS and inform integration of these standards into existing training and certification requirements

A5 Research Questions

- What is the current state of UAS maintenance practices and training and how does it compare to manned aviation practices?
- What are the elements that comprise UAS maintenance for all types/sizes of UAS?
- What are the unique elements of UAS maintenance that differ from manned aircraft maintenance and what is their implication on training and certification?
- What are the unique considerations for composite material structures of UAS?
- Is there a need to delineate between different risk classes of UAS when determining maintenance and training requirements?
- What are the consequences of maintenance-induced failures in UAS?
- What standards exist, or need to be developed, for determining requirements and capabilities of entities that modify and/or repair UAS?

A6-Surveillance Criticality for Sense and Avoid (SAA)

- **Need**–Research must determine the sufficiency of existing airborne surveillance equipment for manned aircraft (e.g. transponders and/or ADS-B) for providing separation provision and collision avoidance functions for UAS.
- **Approach**–To develop a methodology and toolset for evaluating SAA technologies using available analysis processes, simulation environments, and equipment characterizations.
- **Benefit**-Inputs to standards (RTCA and ASTM F38) and ADS-B spectrum management analysis

A6 Research Questions

- For a cooperative DAA solution based on ADS-B and/or transponders, how should the current operational or technical performance requirements for ADS-B Out and/or transponders be changed (if at all) for UAS Sense and Avoid functions?
- Do current surveillance equipment technologies meet the design assurance criteria to provide UAS Sense and Avoid functions?
- What is the criteria for evaluating “equivalent level of safety” of UAS against piloted-aircraft for SAA functions?

A7-UAS Human Factors Control Station Design Standards

Need–This research addresses human factors safety concerns that are unique to UAS to support development of standards, regulations, and guidance for civil UAS. This research addresses four synergistic areas:

1. Function Allocation (FA) between UAS Pilot and System Automation;
2. Control Station Standards and Guidelines;
3. Crewmember Training and Certification; and
4. Visual Observer (VO) Requirements.

Approach–The FA research will inform the control station recommendations which will in turn inform crew member training and certification recommendations. Empirical studies will inform the VO requirements

Benefit–Inform control station standards and guidelines; crew member training and certification; VO requirements

A7 Research Questions

- What are the recommended function allocation strategies for UAS human-machine functions?
- What measures should be used for making strategy tradeoffs?
- What are alternative conceptual approaches for allocation of pre-flight and enroute contingency planning and management tasks to different people?
- What are the recommended minimum standards and design guidelines for UAS control stations?
- What are the function allocation strategies that support those standards and guidelines?
- What are the recommended crewmember training and certification requirements, to include pilots and other crewmembers?
- What are the recommended visual observer training and certification requirements?

A8-Unmanned Aircraft Systems (UAS) Noise Certification

Need–The primary control over UAS source noise is the noise certification process, and this requires a detailed analysis of the noise signature radiating from different systems.

Approach–Conduct acoustic measurements of noise radiating from several typical UAS's, and establish a well-documented archive of acoustical data that will assist FAA in developing standards, procedures, and regulatory products related to UAS.

Benefits–Support noise certification requirements