E. Langley Research Center (LaRC)

1. LaRC Small Unmanned Aerial System (sUAS) Facilities

The sUAS Range Safety Office's sUAS Operations Working Group, which began in 2011, continued to expand and develop during FY 2013. The genesis of the sUAS Operations Working Group was to implement and coordinate consolidation activities in terms of sharing common recourses, to provide pilot and observer training, and to integrate operations policy requirements from Headquarters, the Center, and other organizations including the FAA, DoD, and the Department of Homeland Security (DHS).

Range safety training was a major focus for the working group this fiscal year. The RSO developed and implemented a training plan to certify Designated Range Safety Officers (DRSOs), the personnel authorized by the NASA LaRC RSO to oversee the range safety of a specific UAS operation. Qualifications for DRSOs include demonstrated knowledge, experience, and decision making involving Center safety which may include the operation of various labs, projects, manned flight, simulators, and facilities (i.e., wind tunnels). Five DSROs completed this training.

In addition, the LaRC RSO attended the Range Safety Operations Course that was held at Wallops Flight Facility. Completion of this course complies with the continuous training requirement and certification for RSOs in accordance with NPR 8715.5.

2. LaRC Range Safety and sUAS Operation Oversight

During fiscal year 2013, the LaRC Range Safety Office provided oversight for sUAS fight operations in both the National Air Space (NAS) and in Restricted Air Space. NASA LaRC Range Safety continued to work closely with the FAA's UAS Program Office and with the respective organizations that manage Restricted Air Space. The primary goal of this effort was twofold: 1) to maintain safety of flight for the public, public property, and test personnel, and 2) to ensure that NASA Range Safety requirements were in alignment with NPR 8715.5, NASA Range Fight Safety Program. LaRC currently maintains COA to fly in the NAS at Allen C. Parkinson [Fort Pickett Army Airfield Blackstone (BKT)], 31VA Aberdeen, Smithfield, and at 42VA Virginia Beach, Military Aviation Museum, Virginia.

This year, an MOA was signed between NASA and FAA Headquarters providing a new COA notification process for obtaining streamlined access to class G uncontrolled airspace in the NAS for all NASA UASs that have a gross weight equal to or less than 55 pounds. Since this is a NASA Agency agreement, it is available to all NASA centers that currently have a flight operation. The MOA eliminates the requirement for obtaining a COA for every type of UAS flown by NASA in the 55 pound and under category. As identified in the implementation plan, the FAA named the Unmanned Aircraft System Integration Office as the office of primary responsibility. The Office of Strategic Infrastructure, Aircraft Management Division has the primary responsibility for NASA. It is important to note that policy and oversight for the self-certification of UAS airworthiness and the UAS pilots fall under the guidance of NASA Aircraft Operations Manual, NPR 7900.3, Chapter 5. This MOA will be reviewed annually and is effective until cancelled at any time by either party upon notification in writing. The agreement came about as a result of a working group made up of representatives from LaRC, ARC, DoD, DHS, and the FAA. This activity took place over the previous year culminating with signature approvals from both agencies in March 2013. LaRC is currently using the MOA for sUAS

operations at 31VA Aberdeen, Smithfield and at 42VA Virginia Beach, Military Aviation Museum, Virginia.

The Range Safety Office also supported several deployments to Finnegan UAS Air Field at Fort A. P. Hill, Virginia (operations in Restricted Air Space). A total of 23 deployment days were logged at LaRC range facilities during FY2013.

3. FY 2013 sUAS Flight Projects

a. AirSTAR

The Airborne Subscale Transport Aircraft Research (AirSTAR) project continued working on Phase V of the project (see Figure 29). Even though there were no flight tests during FY 2013, a COA was obtained for operations beyond line of sight at Allen C. Perkinson Army Airfield located in Blackstone, Virginia at Ft. Pickett. Take-off and landing will be in the NAS at Allen C. Perkinson. Once airborne, the BAT-4 (Figure 30) will transition into the Ft. Picket restricted airspace. Plans are also being made to make the first beyond line of sight flights at WFF. Similarly, a COA is currently in process of review by the FAA to allow take-off and landing from the WFF main base in the NAS and then immediately transition into the range or R6604 restricted airspace for flight research testing. Operational area is within 10 miles and 15,000 feet.

FIGURE 29: AIRSTAR PHASE V, REMOTE INTERNAL PILOT AND GLASS COCKPIT CONFIGURATION LOCATED INSIDE THE MOBILE OPERATIONS STATION WITH CONOPS BEYOND VISUAL RANGE.

FIGURE 30: AIRSTAR BAT-4 EXPERIMENTAL TEST-BED.

b. Flight Controls Testbeds (FLiC)

In April of 2013, the Automated Flight Controls Lab conducted UAS flight tests at Finnegan UAS Army Airfield at Ft. A. P. Hill, Virginia. The purpose of these tests was to validate a multiple UAS CONOPS to support optical identification strategies of collision avoidance research pertinent to UASs (Figure 31).

FIGURE 31: MULTIPLE UAS CONOPS USING TWO FLIC TESTBEDS

Even at modest relative speeds of 40 to 60 knots, it is challenging for UASs to fly in close proximity using camera-based, autonomous collision avoidance which requires the detection of a possible collision and execution of an appropriate maneuver to avoid it within a few seconds or less. The Automated Flight Laboratory here at LaRC and Boston University is currently engaged in a collaborative effort to design biologically-inspired, neuromorphic optic flow algorithms to avoid collisions and embed these algorithms in small-sized, low-weight, and low-power customized hardware solutions in UAS.

Data obtained from these multiple operation flight tests are also being used in the preparation of an FAA “safety case” for obtaining a COA to operate multiple UAS in the NASA for the purpose of extending UAS collision avoidance activities as part of the UAS in the NAS integration project.

c. NASA UAS Challenge

The LaRC Flight Operation and Range Safety Office provided guidance and support for the NASA Challenge which took place at Kennedy Space Center in September 2013. LaRC provided review and approval during the development of operating procedures, approving pilot training, analysis of range safety/system hazards, and the review and approval for the airworthiness of an AERO-M hexacopter unmanned aerial vehicle (UAV) owned by Marshall Space Flight Center (Figure 32). The inter-center challenge, a competition between NASA space flight centers, KSC, MSFC, and JSC highlighted hands-on learning and practical experience for project/system engineers to apply the NASA systems engineering process and requirements described in NPR 7123.1. Since the project selected for the challenge involved flying UAVs, additional requirements needed to be met. In preparation for the challenge, the project team at MSFC completed flight testing with their AERO-M hexacopter in restricted airspace managed by the Redstone Army Airfield Flight Operations Huntsville in Madison County, Alabama.

FIGURE 32: AERO-M HEXACOPTER UAV OWNED BY MSFC

d. REC Lab

The Rapid Evaluation Concept (REC) Lab continues to utilize a fleet of all-electric Edge 540T 33% subscale vehicles as a sUAS research vehicle test-bed (Figure 33). The research flights test automation algorithms which perform separation assurance and traffic conflict resolution, in situ resource aware mission re-planning, and onboard resource and systems health monitoring and prognostics. Many of these research algorithms have been tested in pure simulation environments, and fielding these algorithms in realistic environments allows testing to account for assumptions made in the various simulation environments. It should be noted that the automated conflict detection systems and resolution software under study are totally separate from the main flight control software and systems that are required for the PIC to operate the UAS safely in the NAS defined for “nominal operational conditions.” Efforts are underway to transition from a single Edge 540T operation with simulated traffic to a multi-UAV

operation in the NAS (Figure 34). An FAA “safety case” is being drafted as an attachment to the COA application for multi-UAV operation testing.

FIGURE 33: EDGE 540T 33% SUBSCALE VEHICLE BEING OPERATED AT 31VA ABERDEEN AIRFIELD, SMITHFIELD, VIRGINIA.

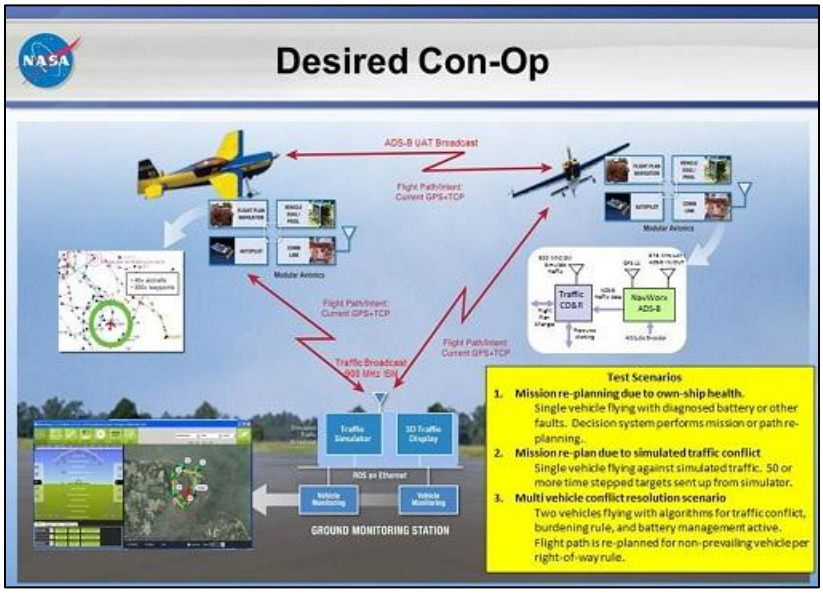

FIGURE 34: EDGE 540T 33% SUBSCALE VEHICLE DESIRED CON-OP