National Aeronautics and Space Administration

Headquarters
Washington, DC 20546-0001

April 25, 2013

The Honorable Paul Broun
Chairman
Subcommittee on Oversight
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, DC 20515

Dear Chairman Broun:

Enclosed are the responses to written questions submitted by you resulting from the February 15, 2013, hearing at which Dr. Waggoner testified regarding *"Operating Unmanned Aircraft System in the National Airspace System: Assessing Research and Development Efforts to Ensure Safety."* This material completes the information requested during that hearing.

Sincerely,
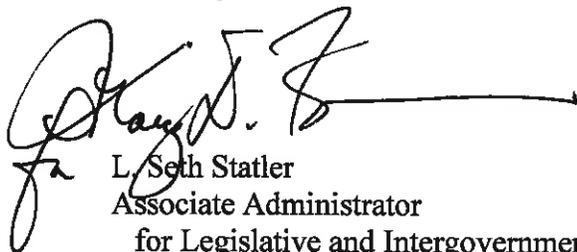
L. Seth Statler
Associate Administrator
   for Legislative and Intergovernmental Affairs

cc: Rep. Dan Maffei
     Ranking Member
     Subcommittee on Oversight

Enclosure

"Operating Unmanned Aircraft Systems in the National Airspace System: Assessing Research and Development Efforts to Ensure Safety"

Questions for the Record for Dr. Edgar G. Waggoner, Director, Integrated Systems Research Program Office, National Aeronautics and Space Administration

1. **Please explain how agencies such as the Federal Aviation Administration (FAA), Department of Homeland Security (DHS), National Aeronautics and Space Administration (NASA), and the Department of Defense (DoD) coordinate to identify R&D gaps.**
   a. **How do agencies decide who will fund projects to address these gaps?**

A: Several formal forums exist for coordination of agency efforts to address research gaps and to ensure no unnecessary duplication of effort. These include the Unmanned Aircraft System (UAS) Executive Committee and the Senior Steering Committee, RTCA Special Committee 203 and associated Working Groups, the Joint Planning and Development Office, and the UAS Aviation Rulemaking Committee. All of the subject Agencies are involved in each of these forums and each forum focuses on a particular aspect of UAS integration, e.g. the ExCom focuses on public UAS access. In addition, there are ad hoc on going dialogues among and between the various agencies focused on specific research activities.

In particular during FY 2011, the JPDO sponsored an effort to catalogue the UAS related activities of the subject agencies. The NextGen UAS Research, Development and Demonstration (RD&D) Roadmap was published in 2011. This report accomplished the following objectives:
- Documented an initial set of critical R&D challenges that need to be addressed to enable routine access for UAS in the NextGen NAS;
- Developed an approach to linking the R&D activities of the partner agencies with the R&D needs of the FAA to support integration of UAS in the NAS;
- Established an approach to coordinating R&D activities of the participating agencies in order to address those challenges;
- Identified relevant ongoing and planned R&D projects to serve as a baseline for the NextGen UAS RD&D Roadmap; and
- Set forth a series of next steps toward achieving a responsive, vetted Roadmap, monitoring progress, and identifying actions needed.

The UAS RDD Roadmap has assisted the JPDO partner agencies in sharing information to leverage the research investments of other agencies. Funding decisions to address UAS research gaps are made at the agency level based on priorities, capabilities and available resources.

2. **How often does the UAS Executive Committee meet to coordinate efforts?**
   a. **How many times has it met in the last year?**

A: The ExCom meets approximately quarterly. Since January 2012 the ExCom has met on the following dates: January 19, 2012, May 8, 2012, August 28, 2012, November 20, 2012, and January 9, 2013.

3. Are there any federal agencies or organizations that are not satisfactorily fulfilling their role in addressing UAS safety concerns?

A: The UAS RD&D Roadmap identifies responsibilities of federal agencies to conduct the R&D required to address UAS safety concerns associated with the enabling UAS routine access to the NAS. Federal agencies are fulfilling their respective roles as identified in the roadmap.

4. Are there any organizations that should be involved that currently are not?

A: The UAS RDD Roadmap is a comprehensive assessment of the roles of federal agencies in conducting related R&D. All agencies with a role in this effort are identified appropriately in the Roadmap.

5. RTCA's Special Committee 203 has been working on Minimum Aviation System Performance Standards (MASPS) and Minimum Operational Performance Standards (MOPS) for unmanned aircraft. How critical are these processes in advising us what research and development work is needed?
   a. When are these standards likely to be finalized?

A: The MASPS and eventually the MOPS being developed by RTCA Special Committee 203 will provide the minimum safety standards for the UAS system and two critical UAS technologies necessary for the safe introduction of UAS into the NAS for civil operations. These two critical areas for UAS civil standards are Sense and Avoid (SAA) and Control and Communications (C2). The MASPS and MOPS under development for the UAS system, SAA and C2 are very critical in advising what research and development work is needed. NASA's UAS Integration in the NAS Project continues to work closely with RTCA to support development of these standards and their associated data requirements to validate system-level performance recommendations.

The current plan within RTCA calls for the UAS System MASPS to be completed and released in May 2013. The date for the SAA and C2 MASPS is in flux.

6. Many who follow this issue argue that a "one-size-fits-all" approach to regulation will not be effective given the wide range of systems.
   a. What is your recommendation for categorizing the systems? By size (i.e. weight)? Payload? Capabilities? Mission? Complexity?

A: The categorization of the systems is the responsibility of the FAA. The UAS Integration in the NAS Project is currently evaluating the impact of size, payload, capabilities, mission, and complexity to support proposed categorization of UAS and associated operations. Research to date has identified numerous factors, including weight, complexity, and various operational capabilities that may have a significant

influence on categorizing UAS. Initial work designed to determine the scope of the issue was recently published in a NASA Technical Memorandum titled "Perspectives on Unmanned Aircraft Classification for Civil Airworthiness Standards", NASA/TM–2013–217969. The outcomes of NASA research will be shared with the FAA through the end of the Project in FY 2016 to assist them with their rulemaking responsibilities.

      b. How does this impact R&D investments? Do you see a greater need for R&D on smaller or larger systems?

A: NASA is conducting research on sense-and-avoid requirements applicable to UAS irrespective of size, since we do not see a difference in sense-and-avoid R&D needs in relation to large or small UAS.

With respect to airworthiness standards, the answer is not as clear. The classification research described in 6(a) indicates that further R&D investments are needed to address the unique aspects of unmanned systems that may introduce unacceptable risks, including the reliability and design assurance of equipment such as communication links for command and control, sense and avoid sensors, and ground control stations.

      c. What is the status of a final rule regarding the certification and operation of small (i.e., ultralight, low-speed, short-life) UAS?

A: The FAA has not released the final small UAS rule for public comment as of this writing.

7. **GAO's Dr. Dillingham testified that "(e)nsuring uninterrupted command and control for both small and large UAS remains a key obstacle for safe and routine integration into the national airspace." Dr. Dillingham's testimony also states that "UAS currently use unprotected radio spectrum and, like any other wireless technology, remain vulnerable to unintentional or intentional interference. This remains a key security and safety vulnerability..."**
      a. Who is responsible for ensuring the command and control and navigational links are secure, reliable, and robust?

A: In the United States, it is the responsibility of the FAA to establish the civil certification requirements for secure, reliable, and robust UAS communications. For integration in the NAS, civil UAS will need to utilize FAA certified communications equipment operating in protected safety spectrum for control communications.

To address security of the UAS control communication system, NASA is working in partnership with the FAA to analyze and develop mitigations to potential C2 security vulnerabilities to inform related FAA security requirements for civil UAS. Reliability and robustness are being addressed during the development of control communication performance requirements in RTCA SC-203, leading to control communication MASPS and MOPS. NASA has partnered with Rockwell Collins to develop a prototype UAS control communication system and perform a series of flight tests to evaluate the

prototype in relevant flight environments. Results of these evaluations will be shared with the FAA.

8. Dr. Toner's statement mentioned "perception and acceptance." There are a lot of misconceptions and associated fears with regard to unmanned systems. What can be done to change that?

A: NASA's research to develop technical solutions to real challenges related to safety and security can contribute to public confidence that UAS will be at least as safe and secure as manned aircraft before they can access the National Airspace on a routine basis.

9. Please identify any projects jointly funded by FAA and NASA with any other agency, as well as the FY 2013 funding level for those projects.

A: Relative to research and development associated with integrating UAS into the NAS, NASA is cooperating on various activities across several stakeholder agencies. The majority of these cooperative activities do not require any exchange of funds. However, there are two activities where NASA is supporting the funding of specific, focused integration efforts.

The UAS Integration in the NAS Project is working closely with the FAA UAS Integration Office to deliver relevant data. The Project is currently planning to augment the FAA's contracted effort to develop the National Airspace System Enterprise Architecture (EA) at the FY 2013 funding amount of $500K. The NASA contribution will focus on integration of essential source materials (FAA UAS ConOps, FAA Roadmap for Integration of Civil UAS in the NAS, Aviation Rulemaking Committee (ARC) Implementation Plan Working Group (IPWG) Implementation plan, and JPDO Comprehensive Plan) to reflect unique aspects of UAS operations in the NAS in the NextGen Architecture.

In addition, the UAS Integration in the NAS Project is working closely with the Air Force Research Lab (AFRL) at Wright Patterson Air Force Base to coordinate on Human Factors guidelines for ground control stations (GCS). The Project is jointly funding a contract with approximately $150K to acquire software support and maintenance from the AFRL contractor for common software that both NASA and AFRL are using in our respective UAS research efforts.

10. Is it important for the FAA to regularly update its report titled "NextGen UAS Research, Development and Demonstration Roadmap?" How often would you recommend this roadmap be updated? Do you believe this document is sufficient to coordinate R&D investments? How does this document influence R&D investments at NASA?

A: As discussed previously, the NextGen UAS RD&D Roadmap is an important document that catalogued JPDO partner agency activities as they were defined in FY 2011. Additional work is ongoing through the various coordination mechanisms described above to identify gaps between current plans and assess additional R&D needs. This includes the FAA's Comprehensive Plan and

the UAS Concept of Operations. Products resulting from the ongoing work need to be thoroughly assessed to understand how current investments toward UAS integration are aligned with the implementation strategy for UAS integration.