U.S. Department
of Transportation

**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

November 21, 2016

The Honorable Harold Rogers
Chairman, Committee on Appropriations
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

In House Report 114-129 accompanying the Consolidated Appropriations Act, 2016,[1] Congress requested the Federal Aviation Administration (FAA) "to assess the feasibility of integrating proven UAS mitigation technology with airport operations in order to detect, identify, and track both the air vehicle and ground controller to explicitly identify the Unmanned Aircraft Systems (UAS) without interference to existing airport operations. This assessment should review techniques to defeat an errant or hostile UAS without causing any collateral damage to essential navigation systems, wireless communications, the general public or other airport operations ... provide a letter report on its findings no later than 180 days after enactment."

Furthermore, in the Joint Explanatory Statement the FAA is encouraged "to expand the program to include a commercial airport, in conjunction with the UAS center of excellence as evaluator. A letter report is requested on findings related to such expansion no later than 180 days after enactment."

The FAA has combined these two requests into this letter report.

Background:
Each month, on average, since the beginning of 2015, the FAA has recorded from pilots and others more than 100 reports of UAS sightings near manned aircraft, airports, or other critical infrastructure. These reported sightings raise serious safety concerns for the U.S. Department of Transportation, as well as a potential security concern for the U.S Department of Defense (DoD), U.S. Department of Homeland Security (DHS), and other law enforcement partners.

Due to this risk the U.S. Government is actively engaged in applied research to protect critical infrastructure. This operational research is currently being conducted through interagency partnerships.

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[1] Pub. Law No. 114-113.

Pathfinder Program:
To help further safe UAS integration, the FAA has taken steps to expand collaborative partnerships with specific entities within the private sector through the Pathfinder Program. A Pathfinder enables the FAA to work closely with industry to develop and validate operational concepts for certification, operations, and safety beyond those contained in established or proposed policies and procedures. The FAA has engaged in several Pathfinder Programs to explore:

- News Gathering In Populated Areas: CNN and the FAA are researching how UAS might be used safely for newsgathering in populated areas.

- Extended Visual Line of Sight: UAS manufacturer PrecisionHawk and the FAA are exploring how UAS can be employed in crop monitoring for precision agriculture operations in rural areas. This involves UAS flights outside the pilot's direct vision.

- Beyond Visual Line of Sight: BNSF Railroad and the FAA are studying the control challenges of using UAS to inspect rail system infrastructure in rural/isolated areas.

- UAS Detection at Airports: FAA in cooperation with its interagency partners is assessing "proven"[6] UAS detection capabilities. These assessments include:
  - Reviewing detection systems evaluations conducted by partner agencies for commercial airport applicability; and
  - Deploying detection systems to operational environments in order to develop minimum performance standards.

Interagency Collaboration:
The FAA and DHS are co-leading an Interagency UAS Detection at Airports Strategy Working Group. This interagency working group also includes the DoD, Federal Bureau of Investigation (FBI), U.S. Secret Service, U.S. Department of Energy, U.S. Department of Interior, National Aeronautics and Space Administration, and Federal Communications Commission. The working group focuses on the safety and security needs of airports against errant or hostile UAS by creating a safe, efficient, and flexible framework to assess the integration of UAS detection technologies. Results of these assessments will also inform partner agencies and stakeholders safeguarding critical infrastructure.

To formalize this partnership, the Memorandum of Understanding between DHS and FAA was signed on December 21, 2015. The purpose of this memorandum is to set forth terms by which DHS and the FAA will cooperate on various activities that support UAS integration into the National Airspace System (NAS) with an emphasis on enhancing both aviation safety and security through broad research and concept exploration projects.

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[6] House Report 114-129 accompanying the Consolidated Appropriations Act, 2016 "... to assess the feasibility of integrating proven UAS mitigation technology with airport operations in order to detect..."

The FAA is focused on evaluating technology that can detect and track UAS and ensure safe airport operations. DHS has been tasked to lead the U.S. Government-wide efforts for research and development efforts for counter-UAS technology. The FAA is committed to working with government partners to support their research and development of mitigation methods by ensuring the proposed solutions do not impact the operational NAS. The responsibility for mitigation, such as disrupting or defeating a rogue UAS, is exclusive to law enforcement, DHS, or DoD.

Through DoD's extensive mitigation experience, it has concluded that more than one type of detection method may be required. This would be determined by the complexity of the operating environment. Detection capabilities include: Passive Radio Frequency (RF) — multiple sensors detect a UAS and the operator if broadcasting; Radar — detection of autonomous flight; Acoustics—signal detection, location, and classification; and Optical Observations — visible light and/or infra-red.

UAS Center of Excellence and Test Site Involvement:
The FAA's UAS Center of Excellence (COE), led by Mississippi State University, is assisting the Agency in reviewing detection capabilities. The COE will evaluate the technical readiness level of detection systems and applicability in different environments.

As mandated in the 2012 FAA Modernization and Reform Act, the FAA selected six UAS Test Sites: Griffiss International Airport, New York; Virginia Polytechnic Institute and State University; Texas A&M University - Corpus Christi; State of Nevada; North Dakota Department of Commerce; and the University of Alaska - Fairbanks.

The FAA engaged two UAS Test Sites to support evaluations of detection systems at commercial airports as discussed further in this report. Additional UAS Test Sites will support further evaluations.

Industry Collaboration:
In support of the UAS Detection at Airports Pathfinder the FAA executed four agreements with detection manufacturers to assess their systems at operational airports. Although these manufacturers have been engaged for this research, the FAA is not advocating any individual technical solution.

- CACI International Inc.: CACI's proof-of-concept "Skytracker" system employs RF sensors at strategic locations around an airport. When the sensors detect typical commercial UAS RF signals from their pre-established library, the system triangulates those signals and determines the location of both the unmanned aircraft and the operator.
- Gryphon Sensors Inc.: Solutions include radar, 3-dimensional target detection and tracking in large search volumes, all weather environments and day and night operations. Electronic support systems are employed to receive, locate, and exploit radio frequency signals from the UAS. The flexible tracking and classification architecture allows additional sensors such as slew-to-cue electro optic, infared cameras, and acoustic.

- Liteye Systems: Its AUDS system combines electronic scanning radar target detection and classification, electro optic tracking, and directional RF inhibition capability over three independent RF bands.

- Sensofusion: This RF-based system has a 10 kilometers range with its single AIRFENCE unit. The system also employs triangulation and is readily scalable.

Initial UAS Detection Evaluation:
CACI's detection system was installed at Atlantic City International Airport (ACY) in mid-January. This was after the FAA's William J. Hughes Technical Center's engineers planned logistics, supported deployment, and conducted non-interference evaluations to ensure the system would not disrupt airport safety and operations.

- The CACI system was evaluated at ACY from January 25 through February 2 and was the first UAS detection research in a commercial airport environment in Class C Airspace.

- A total of 141 operations were executed over 5 days, 72 with a UAS on the ground and 69 with differing small UAS in flight. All UAS were detected.

- The system had no impact to NAS operations.

- DHS participated by conducting the flight tests through its agreement with the University of Maryland, which is a member of the Virginia Polytechnic Institute and State University UAS Test Site.

All ground tests and flight tests were developed around the following characteristics of the CACI sensor system, some of which appear to be common in many RF sensor systems:

- Detection of UAS occurred as far away as 4.7 kilometers from a single sensor. Degradation of detection triangulation capabilities for the prototype system began at 2.2 kilometers from each individual sensor, which matched CACI's specifications for the assets deployed for this particular research effort. CACI states they have demonstrated for other federal agencies sensors with a greater range. The FAA plans to evaluate this capability at the next airport demonstration.

- To alleviate any privacy concerns for this specific evaluation, CACI's system was intentionally configured to detect only a small subset of commercially available UAS signals. CACI states they have demonstrated for other federal agencies that they have the ability to detect most or all known commercial UAS data links. The FAA plans to evaluate this capability at the next airport demonstration.

- The RF sensor system is impacted by the presence of impediments and relies on radio line of sight collection. A thorough site-survey and optimal placement of sensors minimized this impact.

- The system does require the UAS to have RF emission to detect.

From this evaluation, the FAA's preliminary findings identified processes and procedures for the deployment of a RF sensor system in an operational airport environment, as well as the initial minimum performance standards for UAS detection systems at airports. In the coming months, the FAA, DHS, CACI, and the University of Maryland will continue their collaborative efforts and develop a final report of the ACY research.

Additional UAS Detection Evaluations:
The FAA plans to assess Gryphon Sensors' detection capabilities at Dallas Fort Worth International Airport, Spring 2017. Specific research objectives are under development.

Furthermore, in cooperation with our interagency partners, the FAA is evaluating detection systems at the following locations:

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  Approximately 70 ground test scenarios were conducted, emulating flights, with 5 different UAS types. Scenarios included simultaneous concurrent operations with multiple UAS as well as a pilot conducting operations onboard a boat from a nearby waterway. Impediments of a RF system, deployment issues, and other logistical and communication challenges were documented.

- Denver International Airport (DEN): In October 2016 the FAA and DHS conducted a one-week operational evaluation at DEN. This included the deployment of systems from Liteye Systems, CACI Inc. and Sensofusion. In support of this effort, the North Dakota and Nevada UAS Test Sites flew nine dissimilar small UAS types. Activities included approximately 30 scenarios covering day and night operations in Class B airspace up to 1,000 feet. These operations did not impede, delay, or divert manned aircraft operations. Furthermore, the FAA hosted their intergacy partners at this operational evaluation to share methodologies of safely conducting UAS operations in civil airspace.

- Eglin Air Force Base (Duke Auxiliary Field Florida): The DoD annual Black Dart 2016 planning committee agreed to test an airport detection scenario to support FAA research. Black Dart is an annual joint U.S. military services exercise aimed at demonstrating and testing the latest countermeasure technologies for defense against unmanned aerial vehicles. Agencies evaluated both kinetic and non-kinetic mitigation technologies at Eglin, which is not possible in a civil airport environment. This event was held in

September 2016. To support the evaluations, FAA provided flight scenarios, air traffic controllers, and a mobile control tower.

Conclusion:
The FAA and partner agencies have assembled a complement of subject matter experts to determine a path forward. The draft research strategy considers that each airport poses unique user needs, engineering challenges, and cost-benefits. We will continue to work aggressively on UAS detection and coordinate closely with our interagency partners in evaluating the feasibility of integrating detection and mitigation technology at or around commercial airports. These assessments will be shared with our partner agencies managing critical infrastructure.

We have sent identical letters to Chairman Rogers, Vice Chairwoman Mikulski, and Congresswoman Lowey.

Sincerely,

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United States Senate
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The Honorable Nita Lowey
Ranking Member
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Conclusion:
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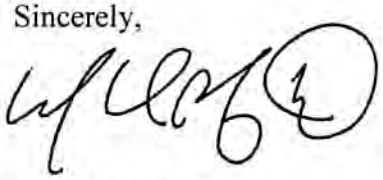
We have sent identical letters to Chairmen Cochran and Rogers and Congresswoman Lowey.

Sincerely,



Michael P. Huerta
Administrator

U.S. Department
of Transportation

**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

November 21, 2016

The Honorable Barbara Mikulski
Vice Chairwoman
Committee on Appropriations
United States Senate
Washington, DC 20510

Dear Vice Chairwoman Mikulski:

In House Report 114-129 accompanying the Consolidated Appropriations Act, 2016,[3] Congress requested the Federal Aviation Administration (FAA) "to assess the feasibility of integrating proven UAS mitigation technology with airport operations in order to detect, identify, and track both the air vehicle and ground controller to explicitly identify the Unmanned Aircraft Systems (UAS) without interference to existing airport operations. This assessment should review techniques to defeat an errant or hostile UAS without causing any collateral damage to essential navigation systems, wireless communications, the general public or other airport operations ... provide a letter report on its findings no later than 180 days after enactment."

Furthermore, in the Joint Explanatory Statement the FAA is encouraged "to expand the program to include a commercial airport, in conjunction with the UAS center of excellence as evaluator. A letter report is requested on findings related to such expansion no later than 180 days after enactment."

The FAA has combined these two requests into this letter report.

Background:
Each month, on average, since the beginning of 2015, the FAA has recorded from pilots and others more than 100 reports of UAS sightings near manned aircraft, airports, or other critical infrastructure. These reported sightings raise serious safety concerns for the U.S. Department of Transportation, as well as a potential security concern for the U.S Department of Defense (DoD), U.S. Department of Homeland Security (DHS), and other law enforcement partners.

[3] Pub. Law No. 114-113.

Pathfinder Program:
To help further safe UAS integration, the FAA has taken steps to expand collaborative partnerships with specific entities within the private sector through the Pathfinder Program. A Pathfinder enables the FAA to work closely with industry to develop and validate operational concepts for certification, operations, and safety beyond those contained in established or proposed policies and procedures. The FAA has engaged in several Pathfinder Programs to explore:

- News Gathering In Populated Areas: CNN and the FAA are researching how UAS might be used safely for newsgathering in populated areas.

- Extended Visual Line of Sight: UAS manufacturer PrecisionHawk and the FAA are exploring how UAS can be employed in crop monitoring for precision agriculture operations in rural areas. This involves UAS flights outside the pilot's direct vision.

- Beyond Visual Line of Sight: BNSF Railroad and the FAA are studying the control challenges of using UAS to inspect rail system infrastructure in rural/isolated areas.

- UAS Detection at Airports: FAA in cooperation with its interagency partners is assessing "proven"[2] UAS detection capabilities. These assessments include:
  - Reviewing detection systems evaluations conducted by partner agencies for commercial airport applicability; and
  - Deploying detection systems to operational environments in order to develop minimum performance standards.

Interagency Collaboration:
The FAA and DHS are co-leading an Interagency UAS Detection at Airports Strategy Working Group. This interagency working group also includes the DoD, Federal Bureau of Investigation (FBI), U.S. Secret Service, U.S. Department of Energy, U.S. Department of Interior, National Aeronautics and Space Administration, and Federal Communications Commission. The working group focuses on the safety and security needs of airports against errant or hostile UAS by creating a safe, efficient, and flexible framework to assess the integration of UAS detection technologies. Results of these assessments will also inform partner agencies and stakeholders safeguarding critical infrastructure.

To formalize this partnership, the Memorandum of Understanding between DHS and FAA was signed on December 21, 2015. The purpose of this memorandum is to set forth terms by which DHS and the FAA will cooperate on various activities that support UAS integration into the National Airspace System (NAS) with an emphasis on enhancing both aviation safety and security through broad research and concept exploration projects.

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[2] House Report 114-129 accompanying the Consolidated Appropriations Act, 2016 "... to assess the feasibility of integrating proven UAS mitigation technology with airport operations in order to detect..."

The FAA is focused on evaluating technology that can detect and track UAS and ensure safe airport operations. DHS has been tasked to lead the U.S. Government-wide efforts for research and development efforts for counter-UAS technology. The FAA is committed to working with government partners to support their research and development of mitigation methods by ensuring the proposed solutions do not impact the operational NAS. The responsibility for mitigation, such as disrupting or defeating a rogue UAS, is exclusive to law enforcement, DHS, or DoD.

Through DoD's extensive mitigation experience, it has concluded that more than one type of detection method may be required. This would be determined by the complexity of the operating environment. Detection capabilities include: Passive Radio Frequency (RF) — multiple sensors detect a UAS and the operator if broadcasting; Radar — detection of autonomous flight; Acoustics—signal detection, location, and classification; and Optical Observations — visible light and/or infra-red.

UAS Center of Excellence and Test Site Involvement:
The FAA's UAS Center of Excellence (COE), led by Mississippi State University, is assisting the Agency in reviewing detection capabilities. The COE will evaluate the technical readiness level of detection systems and applicability in different environments.

As mandated in the 2012 FAA Modernization and Reform Act, the FAA selected six UAS Test Sites: Griffiss International Airport, New York; Virginia Polytechnic Institute and State University; Texas A&M University - Corpus Christi; State of Nevada; North Dakota Department of Commerce; and the University of Alaska - Fairbanks.

The FAA engaged two UAS Test Sites to support evaluations of detection systems at commercial airports as discussed further in this report. Additional UAS Test Sites will support further evaluations.

Industry Collaboration:
In support of the UAS Detection at Airports Pathfinder the FAA executed four agreements with detection manufacturers to assess their systems at operational airports. Although these manufacturers have been engaged for this research, the FAA is not advocating any individual technical solution.

- CACI International Inc.: CACI's proof-of-concept "Skytracker" system employs RF sensors at strategic locations around an airport. When the sensors detect typical commercial UAS RF signals from their pre-established library, the system triangulates those signals and determines the location of both the unmanned aircraft and the operator.
- Gryphon Sensors Inc.: Solutions include radar, 3-dimensional target detection and tracking in large search volumes, all weather environments and day and night operations. Electronic support systems are employed to receive, locate, and exploit radio frequency signals from the UAS. The flexible tracking and classification architecture allows additional sensors such as slew-to-cue electro optic, infared cameras, and acoustic.

- Liteye Systems: Its AUDS system combines electronic scanning radar target detection and classification, electro optic tracking, and directional RF inhibition capability over three independent RF bands.

- Sensofusion: This RF-based system has a 10 kilometers range with its single AIRFENCE unit. The system also employs triangulation and is readily scalable.

Initial UAS Detection Evaluation:
CACI's detection system was installed at Atlantic City International Airport (ACY) in mid-January. This was after the FAA's William J. Hughes Technical Center's engineers planned logistics, supported deployment, and conducted non-interference evaluations to ensure the system would not disrupt airport safety and operations.

- The CACI system was evaluated at ACY from January 25 through February 2 and was the first UAS detection research in a commercial airport environment in Class C Airspace.

- A total of 141 operations were executed over 5 days, 72 with a UAS on the ground and 69 with differing small UAS in flight. All UAS were detected.

- The system had no impact to NAS operations.

- DHS participated by conducting the flight tests through its agreement with the University of Maryland, which is a member of the Virginia Polytechnic Institute and State University UAS Test Site.

All ground tests and flight tests were developed around the following characteristics of the CACI sensor system, some of which appear to be common in many RF sensor systems:

- Detection of UAS occurred as far away as 4.7 kilometers from a single sensor. Degradation of detection triangulation capabilities for the prototype system began at 2.2 kilometers from each individual sensor, which matched CACI's specifications for the assets deployed for this particular research effort. CACI states they have demonstrated for other federal agencies sensors with a greater range. The FAA plans to evaluate this capability at the next airport demonstration.

- To alleviate any privacy concerns for this specific evaluation, CACI's system was intentionally configured to detect only a small subset of commercially available UAS signals. CACI states they have demonstrated for other federal agencies that they have the ability to detect most or all known commercial UAS data links. The FAA plans to evaluate this capability at the next airport demonstration.

- The RF sensor system is impacted by the presence of impediments and relies on radio line of sight collection. A thorough site-survey and optimal placement of sensors minimized this impact.

- The system does require the UAS to have RF emission to detect.

From this evaluation, the FAA's preliminary findings identified processes and procedures for the deployment of a RF sensor system in an operational airport environment, as well as the initial minimum performance standards for UAS detection systems at airports. In the coming months, the FAA, DHS, CACI, and the University of Maryland will continue their collaborative efforts and develop a final report of the ACY research.

Additional UAS Detection Evaluations:
The FAA plans to assess Gryphon Sensors' detection capabilities at Dallas Fort Worth International Airport, Spring 2017. Specific research objectives are under development.

Furthermore, in cooperation with our interagency partners, the FAA is evaluating detection systems at the following locations:

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