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15. Supplementary Notes

The Federal Aviation Administration Modernization and Reform Act of 2012, section 47110 requires reporting on bird radar detection systems through publication of a final report after the conclusion of research activity. Since the FAA Bird Radar Research Program will continue for several years, this interim report has been produced to provide an update.

16. Abstract

The Federal Aviation Administration (FAA) initiated the Bird Radar Research Program in the 1990s when prototype systems for detecting birds at airfields were being introduced. Studies that focused on the performance of commercially available bird radar detection systems began in 2005. For nearly two decades, the FAA Airport Technology Research and Development Branch has directed research on an extensive and varied list of radar technologies. This interim report summarizes the Bird Radar Research Program to date and describes future planned bird radar research activities.

Bird radars have demonstrated valuable functionalities that support various end users in the aviation community. Currently, the primary role of bird radar is a tool to support wildlife hazard assessments at airports and control of hazardous wildlife at or near airport property. However, implementation and application of bird radar detection systems is continually evolving amidst accelerated technological improvements, systems integration, and robust data analysis capabilities. Bird radar manufacturers continue to develop improved equipment that can provide higher-fidelity data on target location, speed, and mass amounting to a potential role in civil air traffic control.

The FAA Bird Radar Research Program is expected to continue for a number of years with a focus on extending bird radar's role to support air traffic control on a local level and augmenting bird radar with other longer-range radar assets to provide coverage on a regional, and perhaps even a national, scale.

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TABLE OF CONTENTS

LIST OF ACRONYMS

AC	Advisory Circular
AHAS	Avian Hazard Advisory System
ATC	Air traffic control
CEAT	Center of Excellence for Airport Technology
DFW	Dallas/Fort Worth International Airport
DoD	U.S. Department of Defense
ESTCP	Environmental Security Technology Certification Program
FAA	Federal Aviation Administration
IVAR	Integration and Validation of Avian Radar
JFK	John F. Kennedy International Airport
MARS®	Mobile Avian Radar System
NASWI	Naval Air Station at Whidbey Island
NEXRAD	Next Generation Radar
ORD	Chicago O'Hare International Airport
SEA	Seattle-Tacoma International Airport
USAF	United States Air Force
USDA	United States Department of Agriculture

EXECUTIVE SUMMARY

The Federal Aviation Administration (FAA) Bird Radar Research Program began in the 1990s when prototype systems for detecting birds at airfields were being introduced. Studies that focused on the performance of commercially available bird radar detection systems started in 2005. For nearly two decades, the FAA Airport Technology Research and Development Branch has directed research on an extensive and varied list of radar technologies. This interim report summarizes the FAA Bird Radar Research Program to date and describes future planned bird radar research activities.

Over the course of the research program, bird radars have demonstrated valuable functionalities that support various end users in the aviation community. Currently, the primary role of bird radar is a tool to support wildlife hazard assessments at airports and control of hazardous wildlife at or near airport property. However, implementation and application of bird radar detection systems is continually evolving amidst accelerated technological improvements, systems integration, and robust data analysis capabilities. In recent years, bird radar manufacturers have developed improved equipment that can provide higher-fidelity data on target location, speed, and mass that could potentially support air traffic control.

Therefore, the FAA's research program on bird radar technology is expected to continue for a number of years with a focus on extending bird radar's role to support air traffic control on a local level and augmenting bird radar with other longer-range radar assets to provide coverage on a regional, and perhaps a national, scale.

1. INTRODUCTION.

The Federal Aviation Administration (FAA) Wildlife Hazard Mitigation Research Program works to mitigate wildlife collisions with aircraft. It provides practical wildlife management approaches, as well as real-time bird activity data to pilots and airport operators.

Wildlife hazards involve many different species of animals. Because birds are the most common hazard to aviation, they are the primary focus of the airport Wildlife Hazard Mitigation Research Program. Proper management of birds on and around airports reduces the bird strike risk. Radar-based bird detection systems support two critical and related efforts:

- To help airport operators identify daily and seasonal bird movements. Airport operators can then use this information to plan and carry out effective wildlife hazard management plans.

- To survey the airspace to detect potential threats to the safe operation of aircraft.

The FAA Bird Radar Research Program, under the Wildlife Mitigation Research Program, began in the 1990s. Since the program's inception, radar systems specifically designed or adapted to detect birds have progressed from prototypes to commercially available products, which use technologies that continue to advance significantly.

In recent years, manufacturers of bird radars have developed equipment that provides better data on target location, speed, and mass than the radars that were the subject of the performance assessment program in 2005. The FAA will continue to focus on these radars through ongoing research that aims to achieve a data stream capability that can support aircraft movements in the national airspace. To this end, the Airport Technology Research and Development Branch is studying the feasibility of putting local bird radar displays in the civil air traffic control (ATC) environment.

1.1 IMPORTANT FINDINGS.

The following are some of the significant findings of the FAA Bird Radar Research Program to date.

- Existing commercial bird radars are suitable for detecting and tracking birds on and around an airport. Radar data is best suited for strategic wildlife hazard management and can support development of wildlife hazard assessments and wildlife hazard management plans.

- Bird radars can provide nearly real-time alerts of bird activity in operational areas around the airport that have a high risk of collisions.

- Some bird radar detection systems can detect bird movements on various scales—from the local airport property using local airport bird radars (such as the ones studied under this program) to regional airspace using fixed surveillance assets, such as the Next

Generation Weather Radar (NEXRAD). Full national airspace coverage is still many years away but may be possible with the right system integration developments.

1.2 RESEARCH SUMMARY.

The FAA Airport Technology Research and Development Branch, located at the William J. Hughes Technical Center in Atlantic City International Airport, New Jersey, launched an effort in 1999 to identify sensors that could detect and track birds in the critical airspace of airports (below 3000 feet above ground level for distances out to 6 nautical miles). Before this effort, many radar types had been used successfully for bird research, including the NEXRAD, modified military radars, and marine band radars with advanced digital processing. The FAA focused its research on using radar to increase airport safety from a wildlife hazard mitigation perspective. Bird radars were not a new technology, but their application at civil airports was new.

Through a grant to the University of Illinois Center of Excellence for Airport Technology (CEAT), a multiyear program was established to assess new safety technologies for commercial airports. In 2001, the FAA joined forces with radar experts in the U.S. Air Force's (USAF) Air Force Research Laboratory in a Dual Use Science and Technology Program to develop an avian radar system. In 2002, WaveBand Corporation was selected through a competitive process to develop a 94-GHz radar for this program. CEAT assessed the WaveBand radar throughout its development and in field tests in 2004 and 2005 at the Dallas/Fort Worth International Airport (DFW) and the Fermi National Accelerator Laboratory in Illinois. CEAT determined that the radar could effectively detect and track birds.

At the same time, other private companies were advancing radar technology for bird detection. As bird radars became commercially available, the FAA shifted its focus from developing a bird radar to assessing the performance of existing bird radars and their potential use at civil airports.

2. RADAR PERFORMANCE ASSESSMENT.

The FAA began a comprehensive Bird Radar Performance Assessment Research Program within the Wildlife Hazard Mitigation Research Program in 2005. As the principal investigating organization, CEAT first reviewed the USAF Avian Hazard Advisory System (AHAS). The AHAS used NEXRAD information to provide an assessment of the hazards posed by birds to USAF operations.

After reviewing the AHAS, CEAT selected Accipiter® avian radar systems for the FAA's first performance assessment tasks and deployed a system at Seattle-Tacoma International Airport (SEA) in 2007. By the end of 2009, CEAT also deployed Accipiter bird radars at Chicago O'Hare International (ORD) and John F. Kennedy (JFK) International Airports.

In early 2010, changes to an existing Interagency Agreement with the U.S. Department of Agriculture (USDA)/Animal and Plant Health Inspection Service/Wildlife Services allowed USDA field wildlife biologists working at ORD to support the FAA's bird radar research activities. Their task was to develop a better understanding of how radar data could support wildlife hazard management best practices. By 2010, the USDA procured a MERLIN™ radar

system from DeTect, Inc., which effectively expanded the technological breadth of the overall assessment program.

2.1 APPROACH.

The FAA Bird Radar Research Program uses science-based assessment methods to assure that using new technologies at airports is justified based on proven performance, does not compromise safety, and is compatible with airport operations. The comprehensive study was designed with an approach to address the following four key areas:

1. Technical Evaluation—Addresses issues such as calibration, sensitivity, clutter interference, beam configurations, frequency, volume coverage, limiting environmental conditions, and reliability.

2. Deployment—Addresses site selection, equipment setup and initial operation, and integration into airport operations.

3. Validation——Considers whether the technology can detect birds and distinguish from other biological targets, provides a sense of mass/size, and helps identify species. Validation activities include:

    a. using dependent and independent observation tests; i.e., using field observers to independently identify targets using nationally accepted validation protocols;

    b. making regular observations during deployment;

    c. using known targets to challenge radar system detection; and

    d. assessing the capacity of the radar system to support ongoing wildlife management observation programs at airports.

4. Operations—Determine how airport personnel involved in wildlife safety management can effectively use radar data to supplement an airport's regular wildlife observation program.

2.2 TECHNOLOGIES.

The FAA Bird Radar Performance Assessment Program has studied an extensive and varied list of radar technologies. To date, the assessment has included multiple radars in the S-band and X-band frequencies, including magnetron and solid-state marine radars; multiple configurations of bird radar systems, including advanced L-band and frequency-modulated, continuous-wave radars; and issues of deployment, operations and maintenance, data management, and integration into airport operations.

2.2.1 Radar Systems.

The following commercial bird radars have been or are being evaluated as part of the FAA Bird Radar Performance Assessment Program. They are grouped into three categories according to their place in the evolution of the program.

1. Initial Commercial Bird Radar Detection Systems—The following systems were available at the beginning of the FAA Bird Radar Performance Assessment Program. Some components of these systems have been upgraded since 2005.

    a. Accipiter AR2 Radar System—The AR2 is a fully functioning, commercially available bird radar. It is deployed at several airport locations as part of the FAA Bird Radar Performance Assessment Program. The AR2 is configured with two radar antennas that can be either dish or array, or a mix of the two. The program has deployed and tested AR2s at SEA, ORD, JFK, and the Naval Air Station Whidbey Island (NASWI) in Oak Harbor, Washington.

    b. Accipiter AR1 Radar System—The AR1 is a fully functioning, commercially available bird radar. It is deployed as part of the FAA Bird Radar Performance Assessment Program at SEA, ORD, JFK, and NASWI. The AR1 system consists of a single antenna that can be either a dish or a slotted array.

    c. MARS® Mobile Avian Radar System—The Geo-Marine MARS is a fully functioning, commercially available bird radar. It is deployed at DFW. It is configured with two array antennas, one of which spins in a horizontal plane and the other in a vertical plane.

    d. MERLIN Avian Radar System—MERLIN is a fully functioning, commercially available bird radar. It is undergoing system evaluation and target detection validation as part of the FAA Bird Radar Performance Assessment Program. MERLIN is deployed at Terra Haute International-Hulman Field in Indiana.

2. Midstream Avian Radar Systems—The following systems were developed after the FAA Bird Radar Performance Assessment Program began. Their commercial availability and performance capabilities warranted inclusion in the program.

    a. SRC's BSTAR™—BSTAR is a fully functioning, commercially available bird radar system that was adapted from military applications. The system uses electronic phased array antennas as its primary detection mechanism. Phased array antennas, unlike other commercially available bird radar detection systems, do not involve moving parts; i.e., spinning antennas. BSTAR is deployed as part of the FAA Bird Radar Performance Assessment Program at DFW coincident with the MARS system.

    b. ROBIN—ROBIN Radar Systems offers commercial bird radar detection systems for civil airport and non-airport applications. Some ROBIN radar configurations use the same antennas as competitive U.S. systems. The FAA decided to assess

these products to identify the similarities and differences between ROBIN radar and the other systems.

3. Emerging Avian Radar Systems—Manufacturers continue to enhance detection capabilities of radar systems not only through improved performance of the radar, but also through the integration of other sensors such as optical imaging sensors that provide additional levels of target validation and location. The Geo-Marine TITAN™ Radar has been identified as an emerging system that may offer benefits and performance capabilities beyond those currently included in the program. The TITAN™ offers a vertically scanning antenna system in which the axis of rotation shifts during rotation to generate a hemisphere of coverage.

4. The introduction of emerging bird radars are being monitored but have not yet been formally included in the FAA Bird Radar Performance Assessment Program.

2.2.2 Radar Components and Configurations.

Most recently, the FAA Bird Radar Performance Assessment Program has focused on entire systems, but such assessments require a deeper investigation into the individual components.

The major components of any bird radar system are a radar unit, an antenna, a digital radar processor, and a visual display. Manufacturers of commercially available radar systems often use the same components as their competitors. Sometimes, the only major distinctions between systems are the proprietary processing algorithms, displays, and operational configurations.

Even among a particular manufacturer's products, bird radars can be customized for different applications. These include environmental impact studies; bird strike prevention at civil airports, military airfields, and wind generation farms; ecological research; and wildlife management and planning.

The FAA Bird Radar Performance Assessment Program continues to evaluate various system configurations, which necessarily have an effect on the overall system performance. The following are common elements of radar systems that can be configured to suit the requirements of any particular operational environment:

· Platform—Radar antennas can be installed on trailers and vehicles to provide portability, or mounted on fixed structures, such as building or towers, or installed on the ground.

· Antennas—There are a wide variety of antennas in use, including slotted arrays, single- and dual-scanning dishes, multibeam antennas, and electronic phased arrays.

· Transceivers—Transceiver options include X-, S-, L-, and C-frequency bands; solid state; pulse Doppler; and frequency-modulated continuous wave.

3. RELATED STUDIES.

Between 2006 and 2009 [1 through 3], the FAA participated in and closely monitored the U.S. Department of Defense (DoD) Environmental Security Technology Certification Program (ESTCP) scientific validation of avian radar in a project referred to as Integration and Validation of Avian Radar (IVAR). The FAA's participation ensured that requirements and practices from both civil and military experience would contribute to the DoD validation effort. The objective of the 3-year, $1.3 million study was to use science-based methodologies to demonstrate and validate avian radar technology under real-world operational conditions at military airfields. Validation efforts were conducted at the Naval Air Station Patuxent River, Marine Corps Air Station Cherry Point, NASWI, and Elmendorf Air Force Base (now Joint Base Elmendorf-Richardson). The IVAR team developed a total of 38 performance metrics to evaluate avian radar technology against the project's six task objectives, i.e., Automatic Tracking, Sampling Protocols, Data Streaming, Data Integration, Data Fusion, and Additional.

Financial support for the IVAR project was provided by the Sustainable Infrastructure program area (now Resource Conservation and Climate Change) of the DoD ESTCP. The IVAR project and the activities being carried out by the CEAT performance assessment project shared equipment and other resources at those locations where both projects conducted studies.

4. REPORTS AND DOCUMENTATION.

The following publications document the findings of the FAA Bird Radar Performance Assessment Program. As indicated, some of these documents are still in production.

1. Advisory Circular 150/5220-25 [4]

   This advisory circular (AC) provides guidance on how airport operators can use data from avian radar systems to supplement an airport's Wildlife Hazard Management Plan and reduce the potential of collisions between birds and aircraft. The AC describes how the airport can select, purchase, install, and manage a bird radar. It also provides a generic set of performance specifications for bird radars. The FAA will update this AC as warranted by ongoing research under the Wildlife Hazard Mitigation Research Program.

2. DOT/FAA/AR-09/61 [5]

   This report describes how the CEAT deployed bird radar units as part of a multiyear FAA Airport Technology Research Project at SEA and NASWI. Deployment activities included identifying and selecting radar vendors and products, contracting for radar system deployment, selecting sites for radar placement, completing FAA obstruction and frequency applications, installing radars, and operating the radar systems.

3. DOT/FAA/TC-TN12/27 [6]

   Wildlife hazard assessments are regularly performed to support development of airport wildlife hazard management plans. Current assessments depend on visual observation of

wildlife. This technical note documents a study that demonstrated how a bird radar was used to supplement a year-long wildlife hazard assessment at Cedar City Regional Airport in Utah.

4. DOT/FAA/TC-TN12/60 [7]

   Magnetrons are a critical component of many current avian radar technologies. They provide avian radar systems with the radio energy that is transmitted and received to identify targets. This report examined the operational life of magnetrons in 12 avian radar systems deployed as a part of the FAA Bird Radar Performance Assessment Program. The findings indicate that magnetrons used in avian radar applications, under continuous operation, can be used effectively for nearly twice the manufacturer's typical recommended duration.

5. DOT/FAA/TC-TN/XX, "Avian Radar Maintenance: Magnetron Replacement," expected in early 2013 (Technical Note, in production)

   Magnetrons are a critical component of many current bird radar technologies. They provide bird radars with the radio energy that is transmitted and received to identify targets. This report examines the operational effectiveness of magnetrons with short and long operational histories. The report recommends replacing magnetrons based on performance criteria rather than on a fixed schedule or replacement period.

6. DOT/FAA/TC-TN/XX, "Avian Radar Systems Integration Identifying Shared Coverage Between Avian Radars and NEXRAD WSR-88D Weather Radar," expected in early 2013 (Technical Note, in production)

   Radar ornithologists have used the National Weather Service's NEXRAD Weather Surveillance Radar 1988 Doppler (WSR-88D) weather radar to track and measure bird movements on a regional scale. Local airport-based bird radars are used to detect and track birds on a local scale out to about 6 nautical miles. This report documents the development of a protocol for comparing target detections and combining data from two radar systems to create seamless coverage areas from the local airport area out to a regional perspective.

7. DOT/FAA/TC-TN/XX, "Avian Radar Operations: Radar Health Assessment," expected in early 2013 (Technical Note, in production)

   During the FAA Bird Radar Performance Assessment Program, several radar systems were operating at airports continuously for relatively long periods of time. Data from these radar systems suggest that when the radar systems fail, they fail rapidly. This report documents procedures for assessing the health of the radar system to ensure the radar sensors continue to operate within expected standards.

8. DOT/FAA/TC-TN/XX, "Avian Radar Deployment: Optimizing Avian Radar Location Using Clutter Mapping," expected in early 2013 (Technical Note, in production)

   Selecting the best location for bird radars is critical to their successful deployment at airports, as radar clutter can decrease the radar's ability to detect and track bird targets. This document provides a general protocol for clutter mapping and presents the results of clutter mapping at ORD, JFK, Portland International Airport, SEA, and NASWI.

9. DOT/FAA/TC-TN/XX, "Avian Radar Operations: Bird Threat System for Seattle-Tacoma International," expected in early 2013 (Technical Note, in production)

   In early 2011, the CEAT, in coordination with airport wildlife personnel at SEA, aided Accipiter Radar Technologies, Inc. in developing a bird threat alert system using real-time radar data. The objective was to provide near real-time alerts that would lead to action by airport operations staff. This report describes the bird threat alert system and explains how an improved and timelier understanding of bird hazards on an airport can lead to the use of bird radar information in ATC and specifically for hazard warnings put on the Automatic Terminal Information Service.

The DoD ESTCP IVAR project resulted in the following three reports.

10. Final Report: Project RC-200723 [1]

    This 380-page document details the objectives, methods, testing design, results, and conclusions of the IVAR study, together with an analysis of potential costs and implementation issues.

11. ESTCP Cost and Performance Report: Project RC-200723 [2]

    A 60-page distillation of the Final Report, reformatted and oriented toward air operations, Bird/Animal Aircraft Strike Hazard (BASH) management, and natural resources management personnel who might be considering the purchase, installation, and operation of avian radar systems.

12. Functional Requirements and Performance Specifications: Project RC-200723 [3]

    Based on the results of the IVAR study, this report identifies a vendor-neutral set of functions that any modern bird radar system should be able to perform, and a quantitative or qualitative level at which those systems should be able to perform those functions. This document was intended for use in support of a contract's statement of work, setting out a baseline for the performance requirements of a bird radar. Because bird radar was, and still is, a rapidly advancing technology, the Functional Specifications document was intended as only a baseline to which additional functions, or better performance of existing functions, could be added from other bird radar systems or new systems that came on the market.

5. BIRD RADAR UTILITY.

Bird radars support various end users in the aviation community. To be useful, information produced by the bird radar system must consider each user's intended application and each application's information requirements.

5.1 HISTORICALLY BASED WILDIFE HAZARD ASSESSMENTS.

The FAA provides guidance for managing wildlife hazards at U.S. civil airports through several documents, particularly AC 150/5200-33B [8]. Additionally, the FAA provides guidance to airports certificated under Title 14 Code of Federal Regulations, Part 139, Certification of Airports [9], on conducting wildlife hazard assessments and developing detailed wildlife hazard management plans for addressing assessment findings.

Today's commercial bird radar detection systems have proven their ability to support wildlife hazard management. Wildlife hazard assessments rely on visual observation of wildlife and mainly on bird activity. Bird radar detection systems strengthen a process that historically has been performed by observers with binoculars. Bird radar detection systems deployed at airports during a wildlife hazard assessment can provide 24-hour, 360-degree observation at ranges beyond what human observers can see, even with the aid of binoculars and spotting scopes. Bird radar detection systems also provide data management features that allow users to visually review historical data on a computer screen. The display can show a geographic information systems map interface like Google Earth™ mapping system overlaid with bird activity. The bird radar system can allow the user to watch video playback of bird movement patterns and pinpoint land features that may be attracting the birds. Ultimately, bird radar detection systems enable wildlife management personnel to efficiently prioritize abatement procedures to the areas of highest hazard level and risk to operating aircraft. In practical terms, airport operations personnel can use customized, periodic (e.g., hourly, daily, monthly, seasonal) historical data to verify how birds use the airport property. For example, the senior wildlife biologist at SEA used the airport's bird radar to see exactly what times of the day large flocks of European starlings approached the airport and where their roosts were located. This allowed the coordination of effective harassment techniques before the flocks reached the airport.

5.2 NEAR REAL-TIME WILDIFE HAZARD CONTROL.

Current bird radar detection systems provide continuous situational awareness to airport operations personnel and wildlife managers. Bird radars can be optimized to provide threat assessments for particular airport areas considered to be high risk for bird aircraft collisions, such as the approach and departure corridors extending out from the end of runways. As the radar detects birds, the system can display their movements as tracks, indicating heading, speed, and to some extent, amount of bio mass and number of targets. Near real-time bird tracks can appear on displays in the airport operations center and airport operations vehicles. When activity in a high-risk area exceeds a preset level, the system can send an alert. This allows operations personnel or the wildlife manager to pinpoint the location of the activity, harass the subject birds, and notify the ATC tower of continuing activity.

6. FUTURE RESEARCH ON BIRD RADARS IN THE ATC ENVIRONMENT.

The FAA Bird Radar Performance Assessment Program has demonstrated the value of bird radars for wildlife management on the airport. The next logical step is to explore the possibility of using these bird radars to support strategic and tactical ATC functions.

The FAA launched a study to determine if it is practicable, feasible, and cost-effective to use commercial bird radar system displays in FAA ATC towers. The displays will provide air traffic controllers with information about the presence of hazardous bird species and related bird strike risks.

The study is being conducted in three distinct phases:

- Phase 1, which evaluated the requirements for displays that are in use at ATC towers.

- Phase 2, which determined if the displays for commercial off-the-shelf bird radar detection systems comply with the requirements identified in Phase 1.

- Phase 3, which is underway and will confirm the display requirements and establish preliminary operational protocols for air traffic controllers using the displays. Phase 3 is expected to include both field evaluations in ATC towers, as well as laboratory evaluations where air traffic controllers will interact with simulated traffic and bird activity around airports. Phase 3 efforts will provide both procedural and human factors perspectives. Undoubtedly, coordination and collaboration with appropriate FAA Air Traffic Organization offices will increase as this effort continues and will impact plans for implementing bird radar detection systems in the ATC environment.

Phases 1 and 2 are nearly completed. Phase 3 is expected to be completed with results documented in a technical note by the end of 2013.

7. CONCLUSIONS.

The Federal Aviation Administration (FAA) initiated the Bird Radar Research Program in the 1990s. Since the program began, bird radar detection systems have gone from prototypes to commercially available products. The technologies used by these systems have advanced significantly since the beginning of the program.

Over the course of the research program, bird radar detection systems demonstrated valuable functionalities that support various end users in the aviation community, including support of wildlife hazard assessment development and control of hazardous wildlife at or near airport property.

As radar sensors and system technologies continue to improve at an accelerated pace, the implementation and application of bird radar detection systems will continue to broaden. The FAA maintains the hope of achieving a bird radar data stream capable of supporting aircraft movements in the national airspace. To this end, the FAA has initiated a study looking into the feasibility of putting local bird radar displays in the civil air traffic control (ATC) environment.

The FAA Bird Radar Research Program is expected to continue for a number of years with a focus on extending bird radar's capabilities through augmentation of other longer-range radar assets to provide ATC coverage on a regional and even a national scale.

8. REFERENCES.

1. Brand, M., Key, G., Herricks, E., King, R., et al., "Integration and Validation of Avian Radars, Final Report: Project RC-200723," July 28, 2011, ESTCP, Arlington, VA, http://www.serdp.org/content/download/12691/150867/file/RC-200723-FR_PI%20Update.pdf (last visited 01/11/2013).

2. "ESTCP Cost and Performance Report: Project RC-200723," August 2011, http://www.serdp.org/content/download/12597/150202/file/RC-200723-C&P.pdf (last visited 01/11/2013).

3. Brand, M., Key, G., Herricks, E., King, R., et al., "Final Report: Functional Requirements and Performance Specifications for Avian Radar Systems: Project RC-200723, Integration and Validation of Avian Radars (IVAR)," December 9, 2011, ESTCP, Arlington, VA, http://www.serdp.org/content/download/15546/176956/version/4/file/RC-200723-%20FR+FunSpec.pdf (last visited 01/11/2013).

4. Federal Aviation Administration, Advisory Circular (AC) 150/5220-25, "Airport Avian Radar Systems," November 23, 2010.

5. Herricks, E., Woodworth, E., and King, R., "Deployment of Avian Radars at Civil Airports," FAA report DOT/FAA/AR-09/61, February 2010.

6. Herricks, E., Bunch, W., Osmek, S., and Svoboda, F., "Using an Avian Radar to Supplement an Airport Wildlife Hazard Assessment," FAA report DOT/FAA/TC-TN12/27, July 2012.

7. Bunch, W. and Herricks, E., "Avian Radar Maintenance: Magnetron Life Assessment," FAA report DOT/FAA/TC-TN12/60, January 2013.

8. Federal Aviation Administration, AC 150/5200-33B, "Hazardous Wildlife Attractants On or Near Airports," August 28, 2007.

9. U.S. Federal Register, Title 14 Code of Federal Regulations, Part 139, "Certification of Airports," Government Printing Office, Washington, DC.