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Successful Approaches for the Use of Unmanned Aerial Systems by Surface Transportation Agencies

Emanuel Banks

Steven J. Cook

Gregg Frederick

Shayne Gill

James S. Gray

See next page for additional authors

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Authors

Emanuel Banks, Steven J. Cook, Gregg Frederick, Shayne Gill, James S. Gray, Troy Larue, Jeff L. Milton, Amy Tootle, Paul Wheeler, Paul Snyder, and Zachary P. Waller



SCAN TEAM REPORT

NCHRP Project 20-68A, Scan 17-01

SUCCESSFUL APPROACHES FOR THE USE OF UNMANNED AERIAL SYSTEM BY SURFACE TRANSPORTATION AGENCIES

Supported by the
National Cooperative Highway Research Program

The information contained in this report was prepared as part of NCHRP Project 20-68A U.S. Domestic Scan, National Cooperative Highway Research Program.

SPECIAL NOTE: This report IS NOT an official publication of the National Cooperative Highway Research Program, Transportation Research Board, or the National Academies of Sciences, Engineering, and Medicine.



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The purpose of each scan, and of Project 20-68A as a whole, is to accelerate beneficial innovation by facilitating information sharing and technology exchange among the states and other transportation agencies, and identifying actionable items of common interest. Experience has shown that personal contact with new ideas and their application is a particularly valuable means for such sharing and exchange. A scan entails peer-to-peer discussions between practitioners who have implemented new practices and others who are able to disseminate knowledge of these new practices and their possible benefits to a broad audience of other users. Each scan addresses a single technical topic selected by AASHTO and the NCHRP 20-68A Project Panel. Further information on the NCHRP 20-68A U.S. Domestic Scan program is available at <http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1570>.

This report was prepared by the scan team for Scan 17-01, Successful Approaches for the Use of Unmanned Aerial Systems by Surface Transportation Agencies, whose members are listed below. Scan planning and logistics are managed by Arora and Associates, P.C.; Harry Capers is the Principal Investigator. NCHRP Project 20-68A is guided by a technical project panel and managed by Andrew C. Lemer, PhD, NCHRP Senior Program Officer.

Emanuel Banks, Arkansas DOT, AASHTO Chair

Steven J Cook, Michigan DOT

Gregg Frederick, Wyoming DOT

Shayne Gill, AASHTO Liaison

James S. Gray, FHWA

Troy Larue, Alaska DOT

Jeff L. Milton, Virginia DOT

Amy Tootle, Florida DOT

Paul Wheeler, Utah DOT

Paul R. Snyder, Dubuque-Snyder Aviation Consulting, Co-SME

Zach Waller, Dubuque-Snyder Aviation Consulting, Co-SME

Disclaimer

The information in this document was taken directly from the submission of the authors. The opinions and conclusions expressed or implied are those of the scan team and are not necessarily those of the Transportation Research Board or its sponsoring agencies. This report has not been reviewed by and is not a report of the Transportation Research Board or the National Academies of Sciences, Engineering, and Medicine.



Scan 17-01

Successful Approaches for the Use of Unmanned Aerial Systems by Surface Transportation Agencies

**REQUESTED BY THE
American Association
of State Highway and Transportation Officials**

PREPARED BY
Emanuel Banks, Arkansas DOT, AASHTO Chair
Steven J. Cook, Michigan DOT
Gregg Fredrick, Wyoming DOT
Shayne Gill, AASHTO Liaison
James S. Gray, FHWA
Troy Larue, Alaska DOT
Jeff L. Milton, Virginia DOT
Amy Tootle, Florida DOT
Paul Wheeler, Utah DOT
Paul R. Snyder, Dubuque-Snyder Aviation Consulting, Co-SME
Zach Waller, Dubuque-Snyder Aviation Consulting, Co-SME

SCAN MANAGEMENT
Arora and Associates, P.C.
Lawrenceville, NJ

July 2018

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ABBREVIATIONS AND ACRONYMS

Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ACUASI	Alaska Center of Unmanned Aircraft System Integration (University of Alaska Fairbanks)
AGL	Above Ground Level
AMA	Academy of Model Aeronautics
ASTM	American Society for Testing and Materials (ASTM International)
AUVSI	Association for Unmanned Vehicles Systems International
Caltrans	California Department of Transportation
CFR	Code of Federal Regulations
CDOT	Colorado Department of Transportation
COA	Certificate of Waiver or Authorization
DOT	Departments of Transportation
ERP	Emergency Response Plan
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRAT	Flight Risk Assessment Tool
GDOT	Georgia Department of Transportation
GIS	Geographic Information System
KYTC	Kentucky Transportation Cabinet
MDOT	Michigan Department of Transportation
MnDOT	Minnesota Department of Transportation
NAS	National Airspace System
NASAO	National Association of State Aviation Officials
NCDOT	North Carolina Department of Transportation
NCHRP	National Cooperative Highway Research Program
NJDOT	New Jersey Department of Transportation
NOTAM	Notice to Airmen
PIC	Pilot in Command
RFP	Request for Proposal
SfM	Structure from Motion
SME	Subject Matter Expert

ABBREVIATIONS AND ACRONYMS

SMS	Safety Management System
SMSVP	Safety Management System Voluntary Program
sUAS	Small Unmanned Aircraft System
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
UBIV	Under-Bridge Inspection Vehicle
UDOT	Utah Department of Transportation
VO	Visual Observer



Executive Summary

Overview

The past decade has seen ever-increasing attention and resources dedicated to the application and operation of unmanned aircraft systems (UASs). Beginning with issuance of special airworthiness certificates in the experimental category for unmanned aircraft in 2007, up to the Federal Aviation Administration's (FAA's) Modernization and Reform Act of 2012 and creation of Title 14 Code of Federal Regulations (CFR) §107 and §101, the complexity and breadth of applications for UAS technology have flourished.

Recognizing the interest and potential benefits to the surface transportation community the National Cooperative Highway Research Program (NCHRP) commissioned Scan 17-01 to accelerate beneficial innovation by facilitating information sharing and technology exchange among the states and other transportation agencies. Results from a desk scan, amplifying questions, and a peer exchange workshop produced conclusions and recommendations in seven topic areas for transportation agencies to consider when getting started using a UAS.

Key Findings and Observations

Executive Support

Top-down investment and support from executives emerged as one of the first elements transportation agencies interested in implementing a UAS need.

Findings and Conclusions

Successful programs:

- Have discerned the application and operation of a UAS based on one or more of the following:
 - Increased safety or reduced liability
 - Increased efficiency and productivity, or reduced impact on the public
 - Cost savings
 - Environmental protection
 - Higher quality end products
- Do not have to be high cost
- Recognize the importance of planning both the initial funding (i.e., for purchase) and continued use of UAS equipment (i.e., operations and maintenance)
- Agree that a UAS saves resources and increases efficiency. However, improvements could be made to support more comprehensive cost-benefit comparisons to traditional methods
- Emphasize the benefits of a UAS but understand negative connotations related to the technology

Organizational Structure

A clear organizational structure within transportation agencies will provide the framework for long-term success.

Findings and Conclusions

Successful programs:

- Have a centralized authority and top-down support
- Leverage existing aviation experience in their state
- Utilize a variety of funding models but have a dedicated source
- Recognize that a relationship with and understanding of the Federal Aviation Administration is critical
- Dedicate personnel to understanding and keeping up with federal, state, and local regulations
- Transfer knowledge across departments and encourage transparency through relationships
- Increase efficiency through fleet management and resource sharing

Policy and Regulation

Knowledge of federal statutes and regulations related to unmanned aircraft is an essential starting point. In addition, each agency must establish policy for acceptable use and operational guidelines for a UAS.

Findings and Conclusions

Successful programs:

- Align their policies and procedures to be consistent with federal statutes and regulations
- Have expertise in UAS regulations and have the ability to keep up with changes
- Understand how to obtain airspace authorization and work with local airports
- Promote existing regulations within the state to prevent unneeded regulations on a state and/or local level
- Develop or adopt a policies and procedures manual for UAS operations

Safety and Risk Management

Safety culture and risk-management processes are critical business practices for UAS operations.

Findings and Conclusions

Successful programs:

- Have a system to manage safety, which include a emergency response plans (ERP) and safety policies
- Have proper personnel and equipment for each mission
- Have flight risk-assessment tools and risk-acceptance procedures

-
- Adopt and promote an aviation safety culture
 - Ensure adequate insurance

Training and Crew Qualifications

Standardized practical training is needed to ensure safety and accurate data collection.

Findings and Conclusions

Successful programs:

- Understand that meeting Part 107 minimum requirements is not a guarantee of the UAS expertise needed for surface transportation UAS applications
- Establish and maintain initial and recurrent training needs for proficiency
- Tailor training needs to the varied applications of a UAS
- Identify expectations of UAS operations with management
- Use training to educate users on alternate methods of compliance for UAS operations, such as night operations, flight over people, or complex airspace

Public Relations

A thorough public relations plan, including elements such as community outreach and education, and a method for addressing public privacy concerns were prominent among invited states.

Findings and Conclusions

Successful programs:

- Have a plan that identifies and addresses target audiences, specifically:
 - Internal stakeholders (program, executive leadership, technical staff, state employees, and legislators)
 - External stakeholders (federal, state, local, university, vendors, the public, and airports)
- Identify existing regulations, rules, and policies and make positive use of social media, videos, and outreach to educate UAS users (both commercial user and hobbyists)
- Include the media in worksite setup, addressing privacy, safety, notice of operation, and on-site interaction during UAS flight.
- Include communication office in their ERP

Application and Operation

A comprehensive operational use plan emerged as essential for implementation of a UAS program.

Findings and Conclusions

Successful programs:

- Recognize that each state transportation agency is unique.
 - It is important to recognize that data needs vary and should be systems-requirements driven.

- Start small and grow with success
- Do not require a large investment to get started
- Justify UAS use with increased safety, reduced liability, greater cost savings, greater productivity, better end products, enhanced environmental protection, and reduced impact on the public
- Follow standard operating procedures
- Leverage the UAS across disciplines and share UAS assets throughout the state
- Leverage expertise in UAS operations
- Use post-processing software and hardware
- Have workflow processes for data collection, storage, usage, application development, and repurposed use of collected data

Recommendations

Considering the key findings above, the scan team settled on recommendations related to each of the seven topic areas. From executive support, the team encourages new programs to support initial plans by leveraging the successes of other state transportation agencies. Programs should plan to procure a system that is only as advanced as necessary for the operation. They should plan for a simple but impactful proof of concept, develop metrics by which executives can measure its success, and connect the metrics to a media plan.

In organizational structure, the scan team found that a centralized authority with top-down support, such as a UAS Steering Committee, was most effective. Such a committee can approve policies and procedures for implementing a UAS program and can build off the foundations set by scan team operations mentioned in Chapter 3.

New programs are advised to designate a single point of contact for managing authorizations with the FAA and stay up to date with federal and state regulatory changes. To date, implementation of unmanned aircraft brings a complex aviation component to surface transportation; traditional pilots and aviation experience and expertise must be available for programs to succeed.

The policies and regulation of UASs continue to develop and evolve on a near monthly basis. As they develop or adopt UAS-specific policies, new programs are encouraged to consider:

- Who is allowed to operate the UAS and prohibit work use of personal model aircraft
- Normal and emergency procedures, checklists, and aircraft operational manuals
- Personnel requirements for UAS operators as well as procedures for securing and utilizing airspace authorization
- Standards by which vendors may be contracted and data products will be accepted

In the topic of safety and risk management, programs are again encouraged to utilize internal aviation expertise as they adapt risk management processes and cultivate a culture of safety around their unmanned programs. Specific recommendations included developing a system to manage safety within the agency; ensure that insurance policies provide proper coverage for internal and external operators; and assess and document, safety, risk, and safety culture within the agency.

While 14 CFR §107 allows for the operation of a small UAS (sUAS) in the national airspace, the scan team recommends utilizing the associated operator certification as a foundation to build upon. In the training and crew qualifications topic area, programs are encouraged to consider a tiered system for initial and recurrent operator training. Beyond the 14 CFR §107 Remote Pilot's Certificate with an sUAS rating, such a system may consider flight training with an unmanned training platform, solo flight training specific to the proposed sUAS, and mission-specific training.

Invited participants and scan team members recognized that public relations are of particular importance to conducting unmanned operations. Stakeholders internal and external to a program's agency should be identified and engaged through diverse media channels. Each program should develop a public relations plan and should include media relations personnel in UAS site setup. An ERP must be established prior to flight operations and provide protocols for contacting key personnel and distributing quick media responses in the event of an emergency.

Finally, in the application and operations topic area the scan team recommended that stage transportation agencies should document and share use cases. This will encourage the agencies to leverage the experience and expertise of those who are currently conducting unmanned operations. As use cases are considered, workflow processes must consider how data will be collected, stored, and used. Whatever data is necessary for the application should also determine the type of sensor to be used, which will in turn determine the platform, equipment, and software acquired.

Overall, the invited and host state transportation agencies have collectively developed significant use cases for sUASs, which supplement their surface transportation efforts. Future sUAS programs among state transportation agencies should consider further validation of these applications with rigorous cost-benefit analysis and investigate whether sUAS data can be suitable for meeting industry standards.

Additional Information

Appendices in this report provide the following additional information:

- Appendix A Scan Team Biographical Sketches
- Appendix B Scan Team Contact Information
- Appendix C Amplifying Questions
- Appendix D Workshop Agenda and Invited Participants
- Appendix E Certificates of Waiver or Authorization
- Appendix F Section 333 Exemptions
- Appendix G 14 CFR §107.200(s) Waivers
- Appendix H Sample UAS Policies and Procedures
- Appendix I AMA sUAS Flight Safety Guide
- Appendix J Sample Safety Culture Survey

1 Introduction and Background

The past decade has seen ever-increasing attention and resources dedicated to the application and operation of unmanned aircraft systems (UASs). In 2005, the Federal Aviation Administration (FAA) began accepting applications for special airworthiness certificates in the experimental category for unmanned aircraft and issued some of its first interim operational approval guidance. By 2007, the FAA had issued four of these special airworthiness certificates for civil UASs, while interest in public UAS operations via Certificates of Waiver or Authorization (COA) began to accelerate. FAA approval of public COAs for unmanned aircraft increased steadily from 75 in 2007 to the issuance of more than 300 certificates in 2011.

In 2012, all efforts in the FAA related to unmanned aircraft were reorganized into a single division-level office—the newly created UAS Integration Office (known as AFS-80)—reporting directly to the FAA’s director of flight standards. During the same year, the FAA Modernization and Reform Act of 2012 (i.e., P.L. 112-095) was enacted. Amending title 49 of the United States Code and authorizing appropriations to the FAA for fiscal years 2011 through 2014, this seminal legislation slated a number of congressional mandates to the FAA with respect to the integration of unmanned aircraft into the National Airspace System (NAS).

Among the mandates, Congress established several statutory definitions for UASs and related technology, spurred development of a UAS Comprehensive Plan and five-year road map from the FAA, commissioned six UAS test sites, initiated several rulemaking processes, and provided a burgeoning number of businesses a method for operating certain unmanned aircraft commercially. This method was realized in the form of exemptions from the FAA for such operations on a case-by-case basis. The first commercial UAS operations via Section 333 exemption (i.e., exemption to Section 333 of Public Law 112-95) were authorized in September 2014 for closed-set filming. Only two years later, by 28 September 2016, the FAA had authorized over 5,500 such exemptions for applications ranging from aerial photography and real estate all the way to flare stack inspection.

In June 2016, the FAA published the final rule for civil operation of sUASs to the Federal Register. Initiated by congressional mandate in Public Law 112-95, these new regulations within Title 14 of the Code of Federal Regulations (CFR) §107 and §101 would become effective in August 2016 to “allow the operation of small unmanned aircraft systems in the National Airspace System, ... [and] prohibit model aircraft from endangering the safety of the [NAS].” 14 CFR §107 would also address the operation of sUASs and establish a process for issuing certificates to their remote pilots and waivers to a small subset of the new regulations. By the end of 2016, 22,000 remote pilot certificates with an sUAS rating had been issued, 1,400 waivers had been requested, and 200 waivers had been issued under 14 CFR §107.

Today, the policies and regulation of UASs continue to develop and evolve on a near monthly basis. Examples from 2017 include:

- The FAA’s establishment of airspace restrictions for unmanned aircraft over 133 military facilities in April
- The Federal Court of Appeals ruling to lift a regulatory requirement to register model aircraft in May
- A similar FAA airspace restriction for unmanned aircraft over 10 Department of the Interior sites in September
- The announcement of the UAS Integration Pilot Program in October

- The establishment of statutory authority for the FAA to require registration of model aircraft in December

With these developments, the complexity and breadth of FAA-sanctioned applications for UAS technology have also flourished.

Federal Operational Approvals

Certificates of Waiver or Authorization

A COA is an authorization that the FAA's Air Traffic Organization issues to a public operator for a specific UAS activity. The FAA conducts a technical review of COA applications. When necessary, provisions or limitations are imposed as part of the approval to ensure that the UAS can operate safely with other NAS users. As described in Overview of Programs, both the Ohio and Washington State Departments of Transportation (DOTs) were granted COAs, which were publicly released in response to a Freedom of Information Act request.

Section 333 Exemptions

All aircraft operations in the NAS require a certified and registered aircraft, a licensed pilot, and operational approval. Section 333 of Public Law 112-95 grants the Secretary of Transportation the authority to determine whether an airworthiness certificate is required for certain unmanned aircraft to operate in the NAS. Primarily between 2014 and 2016, this authority was exercised to grant case-by-case authorization for performing commercial UAS operations prior to the finalization of the sUAS Rule (i.e., 14 CFR §107).

Today, this method of operational approval is declining in the advent of the published sUAS Rule. At its inception, however, the process provided operators their first method to pursue safe and legal entry into the NAS as well as competitive advantage in the UAS marketplace. Detailed in Overview of Programs, the Kentucky Transportation Cabinet (KYTC) and California DOT (Caltrans) were both noted among those approved to operate under Section 333 exemptions in 2015.

14 CFR §107.200(a) Waivers

Waivers to 14 CFR §107 provide flexibility to the sUAS Rule commissioned by Public Law 11295 and have been effective since August 2016. Generally speaking, 14 CFR §107 requires remote pilots with an sUAS rating to fly under 400 feet above ground level (AGL), at groundspeeds less than 100 miles per hour, within visual line of sight, and during daylight hours only. Under 14 CFR §107.200(a), "The Administrator may issue a certificate of waiver authorizing a deviation from any regulation specified in §107.205 if the Administrator finds that a proposed sUAS operation can safely be conducted under the terms of that certificate of waiver."

Waivers under 14 CFR §107.200(a) are less burdensome than exemptions and are intended to accommodate new technologies and unique operational circumstances for sUAS operators. Among the most notable 14 CFR §107.200(a) waivers granted are those related to the FAA's Focus Area Pathfinder Programs. Exploring the incremental expansion of UAS operations in the NAS, CNN¹, PrecisionHawk², and BNSF Railway³ have been granted waivers under this regulation to operate in visual line-of-sight operations over

¹ CNN, Cable News Network, Turner Broadcasting System, Inc.
<https://www.cnn.com/>

² PrecisionHawk,
<https://www.precisionhawk.com/>

³ BNSF Railway, BNSF Railway Company,
<http://www.bnsf.com/>

people, extended visual line of sight operations in rural areas, and beyond visual line of sight operations in rural/isolated areas, respectively.

Applicants for these waivers are allowed to propose operations that deviate from the list of regulations⁴ below; however, it is the applicant's responsibility to propose means by which the operation may be conducted with at least an equivalent level of safety.

- §107.25 Operation from a moving vehicle or aircraft.
- §107.29 Daylight operation.
- §107.31 Visual line of sight aircraft operation.
- §107.33 Visual observer.
- §107.35 Operation of multiple small unmanned aircraft.
- §107.37(a) Yielding the right of way (Operation near aircraft; right-of-way rules.)
- §107.39 Operation over human beings.
- §107.41 Operation in certain airspace.
- §107.51 Operating limits for small unmanned aircraft.

Waivers issued under 14 CFR §107.200(a) apply specifically to the domestic operation of civil sUASs rather than to the operation of model aircraft or those conducted under exemptions issued via Section 333 of Public Law 11295. The North Carolina, Iowa, Georgia, and Ohio DOTs have been granted exemptions for either daylight operation (§107.29) or authorization to conduct operation in certain airspace (§107.41). While §107.29 and §107.41 are by far the most common of the waivers granted to date, they represent one of the most recent indicators of UAS activity and expertise in terms of operational approvals on public record.

UAS Integration Pilot Program

On 25 October 2017, a presidential memorandum for the Secretary of Transportation was released directing, "... the Secretary of Transportation, in consultation with the Administrator of the FAA, [to] establish a UAS Integration Pilot Program to test the further integration of UASs into the NAS in a select number of state, local, and tribal jurisdictions." Published in the Federal Register on 8 November 2017 and consistent with the presidential memorandum, the U.S. DOT and FAA announced the formation of the UAS Integration Pilot Program to:

"(1) ... accelerate the safe integration of UAS into the NAS by testing and validating new concepts of beyond visual line of sight operations in a controlled environment, focusing on detect and avoid technologies, command and control links, navigation, weather and human factors;

"(2) ... address ongoing concerns regarding the potential security and safety risks associated with UAS operating in close proximity to human beings and critical infrastructure by ensuring that operators communicate more effectively with Federal, State, local, and tribal law enforcement to enable law enforcement to determine if a UAS operation poses such a risk;

"(3) ... promote innovation in and development of the United States unmanned aviation industry, especially in sectors such as agriculture, emergency management, inspection services, and transportation safety, in which there are significant public benefits to be gained from the

⁴ Part 107 – Small Unmanned Aircraft Systems, Title 14: Aeronautics and Space, Electronic Code of Federal Regulations, Government Publishing Office, <https://www.ecfr.gov/cgi-bin/text-idx?SID=e331c2fe611df1717386d29eee38b000&mc=true&node=pt14.2.107&rgn=div5>

deployment of UAS; and

“(4) ... identify the most effective models of balancing local and national interests in UAS integration.”

On 9 May 2018, 10 state, local, and tribal governments were announced as participants in this program:

- Choctaw Nation of Oklahoma, Durant, OK
- City of San Diego, CA
- Innovation and Entrepreneurship Investment Authority, Herndon, VA
- Kansas DOT, Topeka, KS
- Lee County Mosquito Control District, Ft. Myers, FL
- Memphis-Shelby County Airport Authority, Memphis, TN
- North Carolina DOT, Raleigh, NC
- North Dakota DOT, Bismarck, ND
- City of Reno, NV
- University of Alaska Fairbanks, Fairbanks, AK

In its press release regarding the UAS Integration Pilot Program selectees, the National Association of State Aviation Officials (NASAO) announced that it was pleased to see that three of the 10 awardees went to state aviation departments or DOTs. NASOA President and CEO Mark Kimberling commended Secretary Elaine Chao and the U.S. DOT for recognizing, “... this important role states can play as laboratories for democracy so-to-speak, and we’re confident that the IPP will further illuminate the benefits of cooperative federalism to unleash the full potential of the drone industry.”



2 Overview of Scan Approach

Results of a recent American Association of State Highway and Transportation Officials (AASHTO) survey indicated that numerous state transportation agencies (e.g., Connecticut, Delaware, Florida, Idaho, Indiana, Kentucky, Michigan, Minnesota, Oregon, South Carolina, Vermont, and Washington State, among them) were exploring the operation and application of UASs. In response to this interest—as well as the challenges to implementation—Domestic Scan 17-01, *Successful Approaches for the Use of Unmanned Aerial Systems by Surface Transportation Agencies*, was commissioned. The purpose of this scan and of Project 20-68A as a whole is to accelerate beneficial innovation through:

- Facilitating information sharing and technology exchange among the states and other transportation agencies
- Identifying actionable items of common interest

Specifically, Scan 17-01 was intended to provide a better understanding of the proactive use of this technology as well as the return on investment and its benefits to the surface transportation community. The effort was intended to help accelerate national deployment of the technology by providing “getting started” guidance as well as case studies of successful UAS applications.

Initial Desk Scan

An initial desk scan indicated that several of the above-named state transportation agencies were actively researching the operation and application of UASs. This initial desk scan was delivered to the scan team in December 2017.

The Overview of Programs section of this report reflects these results, which were gathered primarily through internet searches for:

- Information regarding the broad development of the UAS industry within select states
- Publications, reports, presentations, media, and press releases describing UAS-related activities conducted by select DOTs
- Operational approvals (e.g., COAs, Section 333 exemptions, and §107.200(a) waivers) that the FAA granted to any state DOTs and open to the public.

The overview of program results, though limited to those activities that were readily identifiable through internet searches, expanded upon the programs identified in a AASHTO survey and are presented in this report alphabetically. The scan team gave particular attention to information relating strongly to the amplifying questions (see Appendix C).

Overview of Programs

California

AUVSI[®] UAS Industry Facts

- The FAA has given the University of California, Davis, and UC Merced multiple operational certificates of authorization to conduct research using UASs. The MESA lab at UC Merced has been performing research using UASs to understand crop growth dynamics, natural resource management, environmental monitoring, automated data surveillance-broadcast, airworthiness, and airspace integration.
- The Los Angeles Police Department and Ventura County Sheriff's Office have tested UASs to help law enforcement save lives and property by providing effective situational awareness in harsh conditions for rescue operations or other emergencies. Firefighters, public health experts, and Red Cross volunteers in Dunsmuir used UASs for aerial views of simulated training to prepare emergency responders.
- The University of California, Davis, and Yamaha have demonstrated spraying a vineyard with pesticides from an unmanned RMAX⁶ helicopter, a tactic that has been used extensively in Japan to save time, increase accuracy, and improve yields.

DOT Reports, Media, and Press Releases

- The California State Transportation Agency (Caltrans) created its UAS usage program in October 2016. According to the Caltrans website, "UAS acquisition or operation by California Department of Transportation (Department) staff or contractor for the delivery of any Department business activity is not currently authorized. Furthermore, all UAS flights over freeways, expressways, and state highways are prohibited unless it can be shown that these flights both comply with Federal Aviation Administration Regulation Part 107 Rule (PDF) and the Department encroachment permit guidelines (PDF) prior to conducting the operation(s)."
- On 14 August 2014 the Caltrans Division of Research, Innovation and System Information requested a preliminary investigation regarding the use of a UAS for steep terrain⁷. A summary of the report indicates that California maintains an interest in UAS operations but has had no significant research within Caltrans or other state agencies.
- Caltrans has developed guidelines for Caltrans permits⁸ for the film industry to obtain before using a UAS for filming over Caltrans property.

Federal Operational Approvals

- According to an AUVSI report, among the more than 5,500 commercial UAS exemptions granted by the FAA, California led the nation with 639 approved business operators, supporting industries such as agriculture, construction, filmmaking, and emergency management.
- Caltrans was issued a Section 333 exemption on July 2 2015 from 14 CFR §§ 61.23(a) and (c), 61.101(e)(4) and (5), 61.113(a), 61.315(a), 91.7(a), 91.119(c), 91.121, 91.151(a)(1), 91.405(a), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a) and (b). AerialZeus⁹ appears to have submitted the

⁵ Association for Unmanned Vehicles Systems International

⁶ Yamaha RMAX, Yamaha Motor Corporation, U.S.A.,
<https://www.yamahamotorsports.com/motorsports/pages/precision-agriculture-rmax>

⁷ The Use of Unmanned Aerial Systems for Steep Terrain Investigations, Preliminary Investigation, Caltrans Division of Research, Innovation and System Information, 14 August 2014,
http://www.dot.ca.gov/newtech/researchreports/preliminary_investigations/docs/unmanned_aerial_systems_preliminary_investigation_rev8-14-14.pdf

⁸ Guidelines for Caltrans Permits, California Film Commission, 24 June 2016, <http://www.dot.ca.gov/aeronaut/docs/Caltrans-EncroachmentPermitGuidelines.pdf>

exemption, requesting permission to operate the E384¹⁰ UAS to provide to Caltrans near infrared, infrared, and high-resolution aerial imagery.

Connecticut

AUVSI UAS Industry Facts

- Hartford-based insurance company Travelers received approval to use a UAS for aerial surveying. A UAS allows Travelers to obtain high-quality images of accident scenes or the sites of other insurance claims, providing key information in claims processing and management.
- Researchers at the University of Connecticut are using a UAS to map archaeological dig sites in the Middle East. The UAS is able to fly over critical sites and provide images that satellites cannot, providing the researchers with new information about Bronze Age graves.
- The West Haven Fire Department has begun to use a UAS in its emergency responses. In addition to flying over the scenes of fires and providing critical information about the size and scope of the blazes, West Haven Fire also plans to use its UAS in search and rescue operations, including water rescue operations off the state's coast.

DOT Reports, Media, and Press Releases

- 17 August 2016, Connecticut DOT announced its intent to test a UAS for bridge inspection¹¹. The agency will evaluate an unmanned aerial vehicle system (UAV) for bridge inspection. The agency will assess the effectiveness of UAS technology by comparing visual, full-routine bridge inspection tasks along an approximately one-mile structure, and process and analyze the data using a UAS. Upon completing the UAS inspections, the results will be compared to those obtained using conventional methods to identify the accuracy and feasibility of a UAS to replace partial current bridge inspection methods. No media have been identified to suggest that a final report has been submitted.

Federal Operational Approvals

- No additional information to report.

Delaware

AUVSI UAS Industry Facts

- Professor Arthur Trembanis at the University of Delaware uses a UAS to study coastal regions and erosion. Some areas may be too remote or dangerous for researchers to access. In these cases, a UAS can provide aerial images that can allow a closer look at how areas have been impacted by storm surge and other causes of erosion.
- Researchers from the University of Delaware have also partnered with Delaware State University researchers to track sand tiger sharks in the Delaware Bay. Unmanned systems allow the researchers to learn more about the habitats the sharks prefer and predict where they might migrate.

⁹ AerialZeus, LLC,
<https://aerialzeus.com/>

¹⁰ Event 38 Unmanned Systems,
<https://event38.com/>

¹¹ "CTDOT to Test Unmanned Aerial Vehicle System (UAV) for Bridge Inspection: UAV to Perform Limited Visual Under-Bridge Inspection on the Gold Star Memorial Bridge," News Release, Connecticut Department of Transportation, 17 August 2016,
<https://www.ct.gov/dot/cwp/view.asp?A=1373&Q=583894>

DOT Reports, Media, and Press Releases

- The University of Delaware developed “Autonomous Vehicles in Delaware: Analyzing the Impact and readiness for the First State”¹² in collaboration and with funding from the Delaware DOT. This document conducts a thorough overview of autonomy and operational considerations, Delaware’s readiness for UAS integration, and the factors needed to safely and effectively integrate UASs into the National Airspace

Federal Operational Approvals

- No additional information to report.

Florida

AUVSI UAS Industry Facts

- Niceville-based Pravia¹³ was the third company in the country to receive an exemption to fly UASs commercially. It uses a senseFly¹⁴ eBee Ag UAS to obtain aerial images, including thermal imaging and analysis, which allows its clients in the agriculture industry to improve crop yields.
- The University of Florida Unmanned Aircraft Systems Research Program¹⁵ is an interdisciplinary research group that seeks to use UASs in scientific research in areas where it may not be feasible to do ground or manned aerial surveys. The group has conducted ecological research in the Everglades and other locations across the state.
- Dozens of real-estate agents across the state have taken advantage of UAS technology to capture unique aerial perspectives of their listings. More real estate agents have received commercial UAS exemptions in Florida than in any other state.

DOT Reports, Media, and Press Releases

- In August 2015, Florida DOT announced proof of concept for using UASs in high mast pole and bridge inspections. This was an initial study to determine the feasibility of UASs for bridge inspections. This research set the stage for additional research to continue to validate the initial finding of reduced cost, decreased time, and increased quality of inspections.
- Florida Statute 934.50¹⁶ is state legislation regarding UAS technology. Highlights of the provision include:
 - Allowing businesses to use UAS technology for only the specific purpose for which the state has licensed the business
 - Allowing for aerial mapping
 - Prohibiting the capturing of images of privately owned property without written consent

¹² Barnes P and E Turkel, Autonomous Vehicles in Delaware: Analyzing the Impact and Readiness for the First State, Institute for Public Administration, School of Public Policy and Administration, University of Delaware, April 2017, <http://udspace.udel.edu/bitstream/handle/19716/21596/autonomous-vehicles-2017.pdf>

¹³ Pravia, LLC, <http://pravia.showitsite.com/pravia-uas-home>

¹⁴ senseFly, <https://www.sensefly.com/>

¹⁵ Unmanned Aircraft Systems Research Program, University of Florida, <https://uas.ifas.ufl.edu/>

¹⁶ Title XLVII Chapter 934, The 2018 Florida Statutes, The Florida Legislature, http://www.leg.state.fl.us/statutes/index.cfm?App_mode=Display_Statute&URL=0900-0999/0934/Sections/0934.50.html

(934.50[3][b])

- Prohibiting law enforcement from using a UAS to gather evidence or other information (934.50[3][a])
- Requiring users to follow FAA regulations
- The Florida DOT Aviation and Spaceports Office¹⁷ has developed an informational brochure to assist airports, UAS operators, the public, pilots, and law enforcement officials in increasing their knowledge of roles, responsibilities, and guidance related to UAS operations.
- The Florida DOT Surveying & Mapping¹⁸ website provides contact information and information regarding surveying and mapping using UAS assets. The website specifically states it leads, “statewide surveying and mapping efforts through spatial technology expertise in support of Florida’s transportation system. We support surveying and mapping activities statewide by providing policies, procedures, guidelines, and training. Our areas of expertise include: Aerial Surveying and Mapping, Location Surveying, Right-of-Way Mapping, and Geographic Mapping which includes distributing aerial photography, producing the Florida Official Transportation Map, and providing Geographic Information Systems (GIS) support for engineering and operations.”
- “UAS to Support Design Surveying Requirements”¹⁹ is an informational small-business-developed PowerPoint discussing strengths, weaknesses, challenges, the components of a UAS, and the regulatory climate.

Federal Operational Approvals

- No additional information to report.

Georgia

AUVSI UAS Industry Facts

- Georgia Tech has partnered with Atlanta-based CNN to explore the uses of UASs in newsgathering. As part of the FAA’s UAS Pathfinder program, the two organizations are working together to identify ways that a UAS can be used over crowds and in populated areas to give newscasters key aerial information.
- Decatur-based SkyFire Consulting²⁰ provides UAS platforms and training to emergency management agencies across the country and around the world. Its UASs, equipped with thermal cameras, are able to assist firefighting and search-and-rescue efforts. Using a UAS also allows first responders to get closer to hazardous materials and survey the situation while staying safe.
- The Atlantic Coastal Conservancy²¹, based in Jasper, uses its UAS to survey the Atlantic coastline, collecting key data about erosion and natural resources in the area. Its UAS also monitors areas that

¹⁷ Aviation and Spaceports Office, Florida Department of Transportation, <http://www.fdot.gov/aviation/>

¹⁸ Surveying & Mapping, Florida Department of Transportation, <http://www.fdot.gov/geospatial/>

¹⁹ Zoltek M, UAS to Support Design Surveying Requirements, 2017 Design Training Expo, <http://www.fdot.gov/design/training/DesignExpo/2017/Presentations/2017-MikeZoltek-UASoSupportDesignSurveyingRequirements.pdf>

²⁰ Skyfire Consulting, Atlanta Drone Group, Inc., <https://www.skyfireconsulting.com/>

²¹ Atlantic Coast Conservancy, <https://www.atlanticcoastconservancy.org/>

have been designated as conserved, ensuring that they remain protected from development.

DOT Reports, Media, and Press Releases

- Georgia DOT (GDOT) Research Project 12-38²² focused primarily on the agency, looking at the various divisions within GDOT and within each area and described how an sUAS could be economically and operationally feasible across a wide spectrum of applications.
- “A Comprehensive Matrix of Unmanned Aerial Systems Requirements for Potential Applications within a Department of Transportation”²³ is an overview of how UAS technology is being used within the various state DOTs as well as more specific use of sUASs within GDOT. This report provides a good overview of UAS potential within the various DOT segments.
- Contemplating drones for traffic control, GDOT commissioned a \$75,000 study²⁴ to see how sUAS could be used for areas of traffic management, including congestion monitoring, traffic signal inspection, vehicle-speed sampling, and nontraffic-related areas such as bridge inspection and monitoring of wildlife and airport flight paths.

Federal Operational Approvals

- GDOT was issued a §107.200(a) waiver on 13 March 2017 for 14 CFR §107.29 (Daylight operation), allowing for night sUAS operations.

Idaho

AUVSI UAS Industry Facts

- The Idaho Autonomous Systems Center of Excellence²⁵ is a joint project of the Idaho Department of Commerce, the Idaho National Laboratory, the Center for Advanced Energy Studies, Idaho universities, and industry leaders. The Center works on UAS research and development and fosters the growth of the UAS industry in Idaho.
- Hayden-based Empire Unmanned²⁶ was the first company to receive FAA approval to use a UAS for agricultural purposes, helping to survey fields and monitor plant health and growth. The company has since expanded to offices in Boise and Idaho Falls, ID, as well as in Colorado, California, and New Mexico.
- Researchers at Idaho State University and the University of Idaho have both used UASs to survey potato fields and detect areas of stress and disease. By equipping the UAS with special sensors, the researchers can quickly survey entire fields and pinpoint exact diseases that are afflicting the crops, as well as the areas that need to be treated.

²² Irizarry J and EN Johnson, Georgia DOT Research Project 12-38: Feasibility Study to Determine the Economic and Operational Benefits of Utilizing Unmanned Aerial Vehicles (UAVs), Georgia Institute of Technology Contract with Georgia Department of Transportation, 6 May 2014,
<https://smartech.gatech.edu/bitstream/handle/1853/52810/FHWA-GA-1H-12-38.pdf>

²³ Karan EP, HC Christmann, M Gheisar, J Irizarry, and EN Johnson, A Comprehensive Matrix of Unmanned Aerial Systems Requirements for Potential Applications within a Department of Transportation,
https://smartech.gatech.edu/bitstream/handle/1853/53645/paper173_camera_ready.pdf

²⁴ TRAFFIC MANAGEMENT: Georgia DOT contemplating drones for traffic control, Roads & Bridges, 11 June 2014,
<https://www.roadsbridges.com/traffic-management-georgia-dot-contemplating-drones-traffic-control>

²⁵ Idaho Autonomous Systems Center of Excellence, Idaho Commerce,
<https://commerce.idaho.gov/asce/>

²⁶ Empire Unmanned, <https://empireunmanned.com/>

DOT Reports, Media, and Press Releases

- Aeronautics Advisory Board member Rodger Sorensen reported on the use of UASs at the 2015-2017 Idaho Transportation Board’s annual meetings. Some of the projects planned for FY16 included a study of UAVs for bridge inspection.²⁷
- “UI, INL and Idaho Companies Partner to Expand Unmanned Aerial Systems Capabilities”²⁸ reported on a joint effort to identify the state’s UAS capabilities and improve technologies used with unmanned aircraft to improved data acquisition and processing. “Phase 1: Focus on unmanned technologies for acquiring and processing UAS data and distributing that data to its customers.” Funding was provided by Department of Commerce’s Idaho Global Entrepreneurial Mission.²⁹

Federal Operational Approvals

- No additional information to report

Indiana

AUVSI UAS Industry Facts

- Precision Drone, based in Noblesville, Indiana, manufactureed hexacopters for precision agriculture purposes. Its Pacesetter, Scout, and Onset UASs provided aerial imagery and data that could be used to improve crop yield, minimize run-off, and survey fields more cheaply and more quickly than other methods.
- The Wayne Township Fire Department has two UASs provided by consulting firm SkyFire. The UAS can be flown over fire scenes and transmit real-time information about the scope of the fire to first responders. A UAS is able to provide the firefighters with perspectives they are otherwise unable to obtain.
- Indiana State University has partnered with UAS company PrecisionHawk to conduct research with the company’s DataMapper aerial data software. According to Richard Baker, director of Indiana State University’s unmanned systems initiative, the collaboration will, “work to strategically address issues across the entire spectrum of data collection, analytics, and safety for unmanned aerial systems.”

DOT Reports, Media, and Press Releases

- At a regional summit hosted by the Greater Bloomington Chamber of Commerce, the Indiana DOT, using a UAS flown by a consultant group, showed a 13-minute video,^{30,31} to demonstrate how unmanned aircraft can help monitor construction progress.

Federal Operational Approvals

- No additional information to report.

²⁷ Regular Meeting of the Idaho Transportation Board, 18 November 2015, https://itd.idaho.gov/wp-content/uploads/Board_Minutes_2015-nov.pdf

²⁸ UI, INL and Idaho Companies Partner to Expand Unmanned Aerial Systems Capabilities, University of Idaho News, University of Idaho, 14 July 2016, <https://www.uidaho.edu/news/archive/news-releases/2016-july/071416-drones>

²⁹ Idaho Entrepreneurial Mission (IGEM), Idaho Commerce, <https://commerce.idaho.gov/idaho-business/idaho-global-entrepreneurial-mission-igem/>

³⁰ Drone Video Shows Sneak Peek of New I-69 Section 4, State of Indiana, 19 November 2015, <https://calendar.in.gov/site/indot/event/indot-drone-video-shows-sneak-peek-of-new-i-69-section-4/>

³¹ Section 4: Crane to Bloomington, I-69 Section 4, Indiana Department of Transportation, October 2015, <https://www.youtube.com/watch?v=41Pqh2DHsK4&feature=youtu.be>

Iowa

AUVSI UAS Industry Facts

- Simpson College, located in Indianola, has partnered with Stanford University and the FAA to research new uses for UASs in rural areas. This research, which includes exploring the feasibility of using rural airports as UAS hubs, will allow for more widespread agricultural UAS use in the future.
- Farmers across Iowa are adopting UAS technology. Not only can UASs survey whole fields much more quickly than can be done on the ground and more cheaply than if done by manned aircraft, UASs can also capture infrared images and other data that allow farmers to pinpoint areas of concern in their fields, such as areas affected by pests or crop disease.
- Ames-based Realtors Hunziker & Associates became the first company in Iowa to receive approval to fly UASs for real estate purposes. The company stated that the technology will be able to deliver amazing images and videos of our listings in real time.

DOT Reports, Media, and Press Releases

- In regard to the registration of UAS aircraft in Iowa³², Iowa DOT's Office of Aviation³³ indicated that this is a new area for it and that it will be monitoring how the FAA will address the concerns of flying sUASs in the future.
- Iowa DOT released a request for proposal to enter into an agreement with an sUAS company to acquire and process data to meet DOT objectives, including data for use by highway designers. (October 17, 2016)

Federal Operational Approvals

- Iowa DOT was issued 16 waivers between 23 Nov 2016 and 9 May 2017 for 14 CFR §107.41 Operations in certain airspace. Certificate 2017-ATO-P107-00057, for example, allows operations in accordance with Title 14 CFR §107.41, except "Operating limitations for small unmanned aircraft," and §107.51 b (2) are constrained to the Class D airspace in the vicinity of Waterloo Regional Airport at 400 feet AGL and below.

Kentucky

AUVSI UAS Industry Facts

- Researchers at the University of Kentucky received a National Science Foundation grant to use UASs to collect atmospheric data. The project, known as Cloud Map, will be able to provide meteorologists with more accurate and detailed information, which will allow for more precise forecasting.
- Lexington-based Unmanned Services Inc. was the first Kentucky business to receive approval from the FAA to fly UASs commercially. It provides aerial photography services to clients across several industries, including the U.S. Geological Service, Lexington's NBC news affiliate, the Kentucky Fire Commission, and local real estate firms.
- Cadiz-based company Kentucky Windage UAV provides aerial mapping services to agricultural

³² Patane M, State requiring operators to register drones, Des Moines Register, 9 June 2015, <https://www.desmoinesregister.com/story/tech/2015/06/09/iowa-drone-operators-register-state/28734669/>

³³ Office of Aviation, Iowa Department of Transportation, <https://iowadot.gov/aviation>

clients. Its UASs are able to survey fields and use sensors to identify areas of stress such as disease or pests. In addition, it distributes the AgEagle³⁴ UAS to other farmers in the area who want to start using a UAS themselves.

DOT Reports, Media, and Press Releases

- “State DOTs Using Drones to Improve Safety, Collect Data and Cut Costs”³⁵ lists the KYTC as one of the 17 state DOTs that has studied or used UASs. <https://news.transportation.org/Pages/NewsReleaseDetail.aspx?NewsReleaseID=1466>

Federal Operational Approvals

- The KYTC was issued a Section 333 exemption (See Appendix F) on 28 October 2015 from 14 CFR §§ 61.23(a) and (c), 61.101(e)(4) and (5), 61.113(a), 61.315(a), 91.7(a), 91.119(c), 91.121, 91.151(a)(1), 91.405(a), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a) and (b). This exemption was requested to allow operation of the Arris M680-4 and Zeta FX-61 unmanned aircraft to conduct aerial mapping, surveying, monitoring, and inspections.

Michigan

AUVSI UAS Industry Facts

- Aerius Flight³⁶ located in South Lyon, uses UASs for data collection in agriculture, construction, mining, and disaster response. For precision agriculture, its UASs are able to provide data to farmers to help spot problems such as disease, weeds, or pests, as well as help increase crop yield.
- Grand Rapids-based Michigan Drone Pros³⁷ uses UASs to take high-quality aerial photography and video for purposes such as real estate listings, highway construction, accident investigations, future land development, and more. Currently, Michigan Drone Pros is developing the ability to use thermal imaging to further aid its clients.
- Ann Arbor-based SkySpecs³⁸, founded by students at the University of Michigan, developed software that can be attached to commercial UASs and help prevent them from colliding with obstacles in their path.

DOT Reports, Media, and Press Releases

- “Evaluating the Use of Unmanned Aerial Vehicles for Transportation Purposes”³⁹ reports on research conducted by Michigan DOT to evaluate five UAV platforms with various sensors. The report further shows the value this technology has to help DOT reduce cost and be more effective and efficient.
- Public Act 436 of 2016 established the Michigan Unmanned Aircraft Systems Task Force (Task Force). The task force was specifically charged with considering, “commercial and private uses of unmanned aircraft systems, landowner and privacy rights, as well as general rules and regulations

³⁴ AgEagle Aerial Systems, Inc., <https://www.ageagle.com/>

³⁵ State DOTs Using Drones to Improve Safety, Collect Data and Cut Costs, News Release, AASHTO News, American Association of State Highway and Transportation Officials, 27 March 2016, <https://news.transportation.org/Pages/NewsReleaseDetail.aspx?NewsReleaseID=1466>

³⁶ Aerius Flight, LLC, <http://www.aeriusflight.com/>

³⁷ Michigan Drone Pros, <http://www.michigandronepros.com/>

³⁸ SkySpecs, <https://skyspecs.com/>

³⁹ Brooks C, R Dobson, D Banach, D Dean, T Oommen, R Wolf, T Havens, T Ahlborn, and B Hart, Evaluating the Use of Unmanned Aerial Vehicles for Transportation Purposes, Michigan Department of Transportation, 7 April 2015, https://www.michigan.gov/documents/mdot/RC1616_Part_A_488515_7.pdf

for safe operation of unmanned aircraft systems, and prepare comprehensive recommendations for the safe and lawful operation of unmanned aircraft systems in this state.” The report further states, “The recommendations are to “include, but not be limited to, recommendations regarding the protection of public and private property interests and the use of unmanned aircraft systems over public property.”

- Listed below are three news or media examples discussing the task force’s findings:
 - Unmanned Aircraft Systems Task Force Final Report⁴⁰
 - Michigan Task Force Suggests Drone Use Limits to Lawmakers⁴¹
 - Spotlight: Changes Coming for Recreational Drone Use⁴²
- This effort⁴³ continued to test and evaluate five main UAV platforms with a combination of optical, thermal, and light detection and ranging (LiDAR) sensors to determine how to implement them into Michigan DOT (MDOT) workflows.

Federal Operational Approvals

- No additional information to report here.

Minnesota

AUVSI UAS Industry Facts

- The University of Minnesota has partnered with Richfield company Sentera⁴⁴ to develop an autopilot and flight control system for an unmanned aircraft. The university’s Aerospace Engineering and Mechanics Department⁴⁵ hosts a UAS laboratory working on this open-source system as well as other research into UAS navigation systems and how to make more fuel-efficient and safer UASs.
- Minneapolis-based Xcel Energy⁴⁶ uses UASs to inspect power lines, energy pipelines, and other infrastructure. In addition to receiving an exemption to conduct routine inspections, Xcel also received permission to begin testing beyond line of sight UAS operations in January 2016, allowing it to examine more efficiently more than 320,000 miles of infrastructure.
- Midwest Aerial Technologies, based in Willmar, provides aerial surveying services to industries such as agriculture, forestry, and real estate. It uses DJI⁴⁷ Vision 2 Plus+ and RF70 UASs to collect and analyze data, which can help farmers identify stressors on their crops.

⁴⁰ Unmanned Aircraft Systems Task Force Final Report, 20 November 2017,

https://www.michigan.gov/documents/aero/UASTF_Final_Report_v2_Full_606520_7.pdf,

⁴¹ Michigan task force suggests drone use limits to lawmakers, Detroit Free Press, 3 December 2017,

<https://www.freep.com/story/news/local/michigan/2017/12/03/drone-use-limits-michigan/917913001/>

⁴² Spotlight: Changes Coming for Recreational Drone Use, Aeronautics, Michigan Department of Transportation,

<https://www.michigan.gov/aero>

⁴³ Implementation of Unmanned Aerial Vehicles (UAVs) for Assessment of Transportation Infrastructure – Phase II, Michigan Tech Research Institute, 9 May 2018,

http://www.mtri.org/mdot_uav.html

⁴⁴ Sentera, Inc.,

<https://sentera.com/>

⁴⁵ Aerospace Engineering and Mechanics Department, University of Minnesota,

<https://www.aem.umn.edu/>

⁴⁶ Xcel Energy Inc.,

<https://www.xcelenergy.com/>

DOT Reports, Media, and Press Releases

- Phase 1 research titled “Unmanned Aerial Vehicle Bridge Inspection Demonstration Project”⁴⁸ was published in July 2015.
- In September 2015, the Minnesota DOT (MnDOT) released a technical summary titled “Unmanned Aerial Vehicles Enable Safe and Cost-Effective Bridge Inspection”⁴⁹. The effort was aimed at developing a field demonstration of UAVs for bridge inspection and evaluating the technology’s effectiveness and safety implications for routine bridge inspections and interim or special inspections.
- The MnDOT Office of Aeronautics and Aviation requires contractors to license their UAS and obtain a commercial operator’s license as required by Minnesota Statutes §360.521 through §360.675.⁵⁰
- MnDOT establishes Policy OP006 pertaining to UAS operations by MnDOT employees or by contractors working on behalf of MnDOT⁵¹. The policy requires MnDOT employees to obtain a blanket public COA that permits flights in Class G airspace at or below 400 feet or to perform operations that adhere to 14 CFR Part 107 (Part 107 operations). Policy established 18 June 2015 and most recently revised 16 March 2018.
- “Will drones transform bridge inspection?”⁵² describes continuing collaborative efforts between MnDOT and Collins Engineers to explore how drones can be used to reduce costs and minimize risk in bridge inspections for employees. Aside from identifying the benefits of UAS, the team is also developing best-practice guidelines that detail exactly when and how to best employ the technology.
- Unmanned Aircraft System Bridge Inspection Demonstration Project Phase II⁵³ was published 18 July 2017. The corresponding technical summary⁵⁴ was published in August 2017.

Federal Operational Approvals

- No additional information to report here.

New Jersey

AUVSI UAS Industry Facts

- The New Jersey Institute of Technology has run tests from the U.S. Coast Guard Training Center

⁴⁷ DJI,

<https://www.dji.com/>

⁴⁸ Zink J, B Lovelace, Unmanned Aerial Vehicle Bridge Inspection Demonstration Project, Minnesota Department of Transportation, July 2015, <http://www.dot.state.mn.us/research/TS/2015/201540.pdf>

⁴⁹ Unmanned Aerial Vehicles Enable Safe and Cost-Effective Bridge Inspection, Minnesota Department of Transportation, September 2015, <http://www.dot.state.mn.us/research/TS/2015/201540TS.pdf>

⁵⁰ Unmanned Aircraft Systems (UAS) or Drones, Aeronautics and Aviation, Minnesota Department of Transportation, <http://www.dot.state.mn.us/aero/drones/index.html>

⁵¹ Unmanned Aircraft System (UAS), MnDOT Policies, Minnesota Department of Transportation, <http://www.dot.state.mn.us/policy/operations/op006.html>

⁵² Zink J, Will drones transform bridge inspection?, Roads & Bridges, 6 September 2016, <https://www.roadsbridges.com/will-drones-transform-bridge-inspection>

⁵³ Research Project Final Report 2017-18: Unmanned Aircraft System Bridge Inspection Demonstration Project Phase II, Minnesota Department of Transportation, June 2017, <http://dot.state.mn.us/research/reports/2017/201718.pdf>

⁵⁴ MnDOT Improves on Award-Winning Use of Drones for Bridge Inspection, Minnesota Department of Transportation, August 2017, <http://dot.state.mn.us/research/TS/2017/201718TS.pdf>

in Cape May, New Jersey, to test the feasibility of safely integrating drones into national airspace and to assess the research and operational capabilities of communications and mapping sensors. The university has also assessed UAS technology that could be deployed in response to natural or manmade disasters to assist state and federal homeland security and emergency management agencies.

- Fovea Aero Systems in Medford⁵⁵, New Jersey, uses unmanned aircraft systems for a variety of applications, including power line and pipeline inspections, infrastructure assessment and maintenance, land mapping, and construction oversight. The technology used helps save New Jersey companies thousands of dollars and keeps workers out of potentially dangerous situations.
- Principia⁵⁶, in South Orange, New Jersey, uses UASs to film professional commercial services primarily for movie and TV productions. Principia is one of the few companies in the country approved to fly on film and TV sets.
- Unmanned Sensing Systems in Mount Laurel, New Jersey, provides aerial imagery that assists New Jersey farmers and crop owners in monitoring and optimizing their yields. The company's high-quality images go beyond what the human eye sees, using infrared data to calculate the health of the crops. With that data, the company can quickly identify for its clients crops that need attention for irrigation or insect problems, for example.

DOT Reports, Media, and Press Releases

- On 3 October 2017 the New Jersey DOT (NJDOT) Division of Multimodal Bureau of Aeronautics conducted a showcase that answered the question, “How do you start a brand new and innovative NJDOT drone program that has never been done before?”⁵⁷ As indicated in the presentation, the goal of the peer exchange between six DOTs was to discuss and share the following:
 - Best practices
 - Policies
 - Procedures
 - Current projects conducted by NJDOT
 - Research studies
 - Funding sources
 - State UAS legislation
 - Common challenges
- October 20, 2016 New Jersey Department of Transportation Bureau of Research released a request for proposal (RFP) with a closing date of 18 November 2016 regarding Drone/Unmanned Aircraft Systems (UAS) Regulations and Polices for Use in New Jersey Project No.: 2017-03. The RFP states,

⁵⁵ Fovea Aero Systems, LLC,
<https://www.foveaaero.com/>

⁵⁶ Principia, Inc.,
<http://www.principiainc.com/>

⁵⁷ Stott G, NJDOT Research ShowCase, NJDOT Division of Multimodal, Bureau of Aeronautics, New Jersey Department of Transportation,
<https://www.state.nj.us/transportation/refdata/research/pdf/presentations/NJDOTUASPeerExchangeandUASResearchProgram.pdf>

“The NJDOT Bureau of Aeronautics needs a comprehensive set of UAS (Unmanned Aircraft System or drone) regulations and policies.” The RFP included 38 areas these regulations and policies would need to address.

Federal Operational Approvals

- No additional information to report here.

North Carolina

AUVSI UAS Industry Facts

- PrecisionHawk, an international UAS company with headquarters in Raleigh, developed DataMapper software to allow users to upload data collected by UAS and apply algorithms to gain different insights for use in agriculture, oil and gas, mining, environmental monitoring, and emergency response.
- Flyboy Photo & Media⁵⁸, a Raleigh-based small business, uses UAS to capture images of large-scale commercial properties at both ground level and at altitudes up to 400 feet.
- Sky Pros Visual Marketing⁵⁹, a Charlotte-based company, uses UAS to provide video tours of real estate listings. Its founder, Terrice McClain, says that UAS allows interested individuals to see the whole property in a way that ground-level photography cannot.
- The NextGen Air Transportation⁶⁰ office at North Carolina State University is a state-funded consortium that works with partners to develop practical uses for UAS applications, such as surveying, infrastructure inspection, cargo delivery, insurance assessments, and agriculture imaging. The consortium work with state agencies to develop UAS implementation strategies and discuss ways UAS can be used in the future.

DOT Reports, Media, and Press Releases

- On 15 January 2016 NCDOT announced the creation of a permitting system for commercial and government UAS operators in North Carolina⁶¹. The system is designed to help UAS owners better understand restrictions on the use of their technology through a simple and efficient online process.
- NCDOT establishes best practices and recommended policies for agencies using UASs in first response, such as conducting search-and-rescue operations or surveying after a flood.⁶²

Federal Operational Approvals

- A §107.200(a) waiver was issued to NCDOT on June 19, 2017 for 14 CFR §107.29 (Daylight operation.) allowing for night sUAS operations⁶³. The department plans to use the waiver for a number of missions, including inspecting airport lighting and markings, responding to natural disasters like hurricanes, and mapping vehicle crashes on roadways. In addition, the department can

⁵⁸ Flyboy Photo & Media,
<https://www.flyboync.com/>

⁵⁹ Sky Pros Visual Marketing,
<http://www.sky-pros.com/>

⁶⁰ Institute for Transportation Research and Education, North Carolina State University,
<https://itre.ncsu.edu/focus/aviation/ngat/>

⁶¹ NCDOT Creates One-Stop Shop for NC Drone Operators, North Carolina Department of Transportation, 15 January 2016,
<https://www.ncdot.gov/news/press-releases/Pages/2016/NCDOT-Creates-OneStop-Shop-for-NC-Drone-.aspx>

⁶² Lillian B, North Carolina DOT Comes Up with Best Practices for UAS in First Response, Unmanned Aerial Online, 24 March 2017,
<https://unmanned-aerial.com/north-carolina-dot-comes-best-practices-uas-first-response>

respond to mission requests day or night.

Ohio

AUVSI UAS Industry Facts

- 3D Aerial⁶⁴, a Dayton-based small business, uses a senseFly eBee UAS in its precision agriculture work. The UAS allows them to not only conduct crop scouting and monitoring, but also to conduct more in-depth analyses of conditions such as plant stress, erosion, and the spread of invasive species.
- The Medina County Sheriff's Department has used UAS for nearly four years. According to Sheriff Tom Miller, the UAS is used primarily in search-and-rescue operations, specifically those involving children or Alzheimer's patients.
- The University of Akron has tested surveying, mapping and other imagery capabilities using UASs.
- Miamisburg-based Danis⁶⁵ uses a DJI Phantom to conduct a variety of inspections of its construction sites and existing buildings. By using a UAS in place of traditional manned inspections, Danis can keep its employees safe and out of potentially hazardous environments.

DOT Reports, Media, and Press Releases

- Ohio DOT agreed to a \$1.5 million contract with the Air Force Research Laboratory to work on a ground-based "sense-and-avoid system" for unmanned aircraft at the Springfield-Beckley Municipal Airport.⁶⁶
- Additional UAS news include:
 - Using drones to study traffic⁶⁷
 - Integrating drones in transportation infrastructure⁶⁸

Federal Operational Approvals

- Ohio DOT was issued a COA during 2012 to support operation of the Swinglet CAM in support of highway mapping, highway construction projects, and gathering photographic images over highway construction sites. Operations are to be conducted below 250 feet AGL, strictly within Class G airspace. Operations are to take place during daylight hours between 7:00 a.m. ET and 5:00 p.m. ET and last no longer than 25 minutes for each flight. Flights may be as frequent as two days per month during spring, summer, and fall.

Oregon

AUVSI UAS Industry Facts

⁶³ North Carolina DOT Gets Permission for Night UAS Flights, Aero News Network, 10 August 17,

<http://www.aero-news.net/emailarticle.cfm?do=main.textpost&id=49296232-cda5-4373-bd90-57de4bb22624>

⁶⁴ 3D Aerial Solutions, LLC,

<http://www.3daerial.com/>

⁶⁵ Danis,

<http://www.danis.com/>

⁶⁶ Ohio DOT Approves \$1.5 Million for Drone Research at Springfield Airport, Government Technology, 6 December 16,

<http://www.govtech.com/public-safety/Ohio-DOT-Approves-1-5-Million-for-Drone-Research-at-Springfield-Airport.html>

⁶⁷ UC researchers team up with ODOT to study traffic with drones, 9 WCPO Cincinnati, 10 July 18,

<https://www.wcpo.com/news/local-news/hamilton-county/cincinnati/uc-researchers-team-up-with-odot-to-study-traffic-with-drones>

⁶⁸ Ohio State pilots project to integrate drones in transportation infrastructure, College of Engineering, The Ohio University, 15 Jun 2018,

<https://engineering.osu.edu/news/2018/06/ohio-state-pilots-project-integrate-drones-transportation-infrastructure>

- Oregon State University's Aerial Information Systems Lab⁶⁹ has used UAS to detect the chlorophyll content at vineyards to gain valuable data that can improve wine quality.
- The Bureau of Land Management and the U.S. Geological Survey explored the use of UASs at the Horning Seed Orchard in Colton, Oregon, to increase the speed and accuracy of cone counts from above the trees, a process normally done from the ground by three full-time staff members.
- Business Oregon, the state's economic development arm, is contributing millions of dollars for the development of the Pendleton UAS Test Range as well as the Warm Springs and Tillamook test ranges, which are all part of one of the six Federal Aviation Administration-designated UAS test sites, and has developed SOAR Oregon, a business accelerator, to support Oregon's growing UAS industry.
- Oregon State University has conducted a number of UAS research projects, including successfully demonstrating search-and-rescue applications. UAS can safely reach higher vantage points over difficult terrain and survey a large search grid for a missing child, provide valuable data to help fight wildfires, and scan vast expanses of water where a boat might be adrift.
- Oregon State University also conducted a summer-long analysis of potato fields. The potato was chosen because it is a highly valued product yet expensive to raise. Farmers in the area spend about \$4,000 or more per acre, or about \$500,000 for the average-size field. Using a UAS will save farmers time and money and lead to improved safety over dangerous manned operations.
- The United States Geological Survey worked with the Bureau of Indian Affairs on projects in the Klamath River area of Oregon to study temperature dynamics on the river systems and assess the utility of thermal infrared remote sensing using a UAS.
- The Oregon Department of Fish and Wildlife plans to use a UAS to collect data on fish and bird populations. The UAS will count seabirds to assess their impact on migratory fish.

DOT Reports, Media, and Press Releases

- In 2013, the Oregon legislature enacted House Bill 2710, providing guidance and restrictions on the use of UASs within Oregon. On 29 March 2016, the Oregon legislature enacted House Bill 4066 to apply a prohibition on weaponizing UASs to all users and create a new violation for interfering with the flight of another aircraft. The measure also required public bodies that use UASs to develop policies and procedures for safeguarding the information gathered from UAS operations. Finally, the measure made allowances for flights over private property by FAA-authorized UASs and provided protections for critical infrastructure.
- Initiated on 10 July 2017, the Oregon DOT project SPR 787: Eyes in the Sky: Bridge Inspections with Unmanned Aerial Vehicles was completed in February 2018⁷⁰. This project investigated the capabilities and limitations of performing structural inspections with UAS. In addition to investigating bridges, UAS are also being evaluated for inspecting wireless communication towers.

Federal Operational Approvals

- No additional information to report here.

Vermont

⁶⁹ Aerial Information Systems Laboratory, College of Forestry, Oregon State University, <http://ais.forestry.oregonstate.edu/>

⁷⁰ SPR 787: Eyes in the Sky: Bridge Inspections with Unmanned Aerial Vehicles, Oregon Department of Transportation, February 2018, https://www.oregon.gov/ODOT/Programs/ResearchDocuments/SPR787_Eyes_in_the_Sky.pdf

AUVSI UAS Industry Facts

- The University of Vermont's Unmanned Aircraft Systems Team⁷¹ works with local and state stakeholders to provide UAS technology and capabilities in times of need. Its UASs have surveyed damages from severe storms and flooding and were used to collect high-resolution aerial images of an Amtrak derailment.
- AirShark⁷², based in Burlington, was the first Vermont business to receive approval from the FAA to fly UASs commercially. It conducts aerial inspections of infrastructure such as power lines, solar panels, and bridges and can also provide modeling services for its clients. By using a UAS, AirShark's clients are able to conduct inspections more cheaply and safely than can be achieved using more traditional methods.

DOT Reports, Media, and Press Releases

- The University of Vermont Transportation Research Center⁷³ and the Vermont Agency of Transportation⁷⁴ are supporting a U.S. DOT project titled Unmanned Aerial Systems for Transportation Decision Support. With the most recent quarterly report ending in June 2015, the project sought to apply proven UAS acquisition and analytical capabilities in four categories:
 - Geomorphic assessment
 - Construction management and phasing
 - Resource allocation during disaster response
 - Cost decision support

These activities pursued development of operational solutions to improve decision-making, reduce costs, increase life safety, and provide a measurable impact on existing decision processes, models and resource tasking.

Federal Operational Approvals

- No additional information to report here.

Organizational Meeting and Amplifying Questions

On 13 December 2017, the scan team convened in Washington, DC, to discuss the results presented in the initial desk scan. During this daylong meeting, team members were briefed on the goals and expectations of the domestic scan, reviewed and finalized the amplifying questions (see Appendix C), and were briefed on the subject matter experts' (SMEs') initial recommendations. Team members supplemented the discussion with their expertise and brought additional background information on the UAS activities of various state transportation agencies. The team members identified and agreed upon the following state agencies as having the highest priority for continued engagement in the scan:

⁷¹ Vermont Unmanned Aircraft Systems, University of Vermont, <http://www.uvm.edu/~uas/>

⁷² Airshark, <https://www.airshark.io/en/>; acquired by American Rail Engineers Corporation, <https://are-corp.com/>

⁷³ Transportation Research Center, College of Engineering and Mathematical Sciences, University of Vermont, <https://www.uvm.edu/cems/trc>

⁷⁴ Vermont Agency of Transportation, State of Vermont, <https://vtrans.vermont.gov/>

-
- Alaska
 - California
 - Colorado
 - Georgia
 - Iowa
 - Kentucky
 - Michigan
 - Minnesota
 - New Jersey
 - North Carolina
 - Ohio
 - Utah

State agencies that merited invitations to the peer exchange did so by several measures. First, many states were noted in a query of publicly available COAs, Section 333 exemptions, and §107.200(a) waivers granted by the FAA and U.S. DOT to state transportation agencies. MDOT was included for its implementation of the Unmanned Aircraft Systems Task Force. MnDOT was noted for its application of state-level legislation (i.e., Minnesota statutes §§360.521-360.675) requiring registration of unmanned aircraft, as well as its efforts to research the use of UAS technology for bridge inspections. NJDOT was included for its research related to unmanned aircraft and collaboration with the Cape May Airport as one of the FAA's seven test sites. Ultimately, the states illustrated in Figure 2.1 were invited to present at a peer exchange workshop, held between 9 and 13 April 2018.

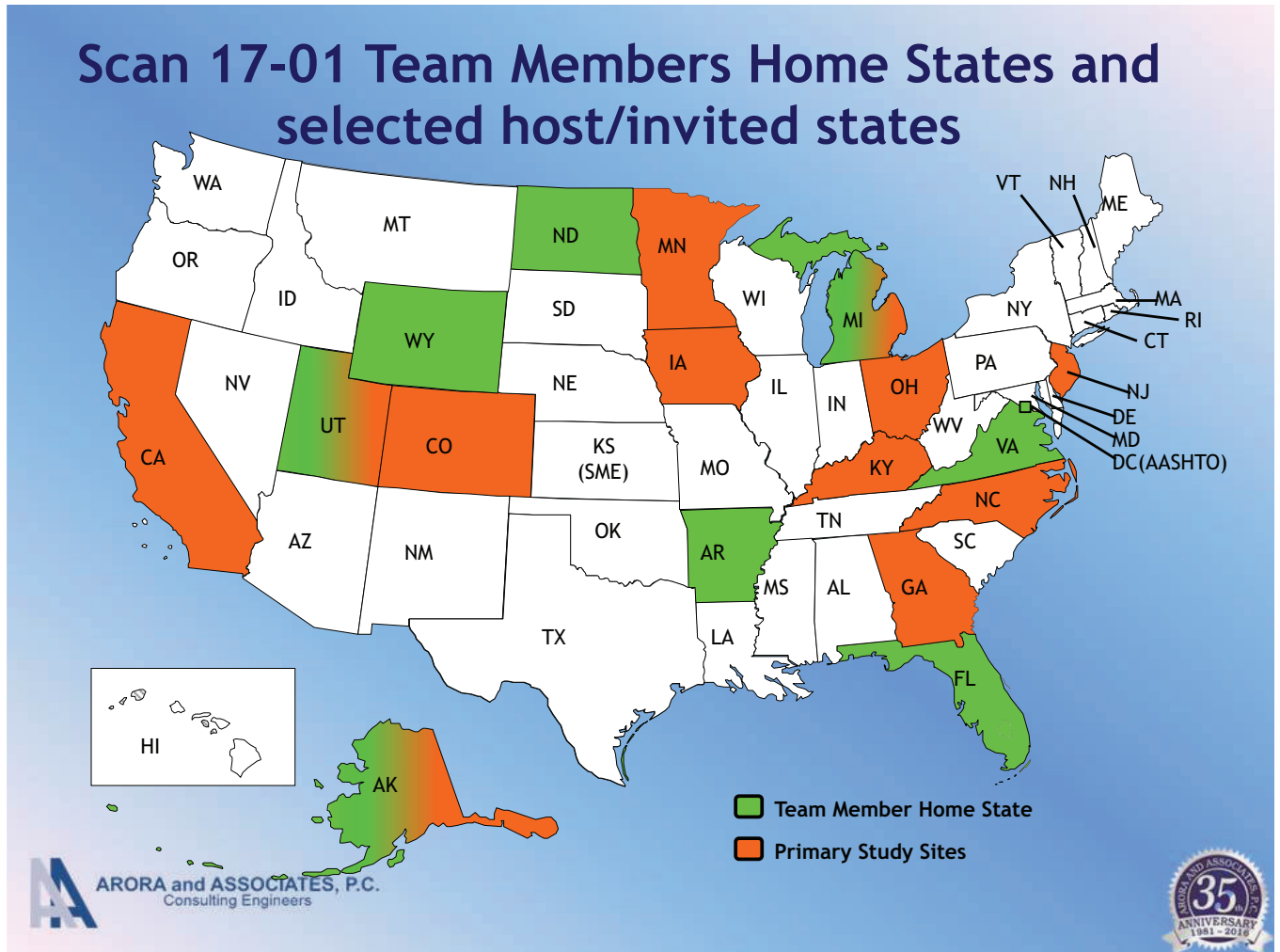


Figure 2.1 Scan team member home states and invited states



3 Key Findings and Observations

The Scan 17-01 peer exchange workshop was held in San Diego, CA. In preparation for the workshop, each invited state agency was prompted with a list of amplifying questions designed by the scan team (see Appendix C). One dozen state agencies were each granted a two-hour slot to present their UAS-application experiences to the scan team members and their peers. Federal Highway Administration (FHWA) and AASHTO representatives also made presentations during the workshop.

The following sections summarize information gathered during the five days of presentations and group discussions and from participant notes. Each day ended with a group discussion of the information shared by the day's presenters, which the two SMEs (i.e., Dubuque-Snyder Aviation Consulting) captured as noteworthy takeaways or significant findings. Before the invited presenters departed, the entire assembly was given a final opportunity to emphasize findings and takeaways from the week's presentations and discuss how these findings were related. During the final day of the exchange, the scan team and SMEs summarized the findings and organized them into major themes. The scan team settled on the seven themes below for this scan:

- Executive Support
- Organizational Structure
- Policy and Regulation
- Safety and Risk Management
- Training and Crew Qualifications
- Public Relations
- Application and Operation

After reviewing these themes, the scan team members agreed on a set of conclusions and recommendations for each. The themes were placed in a rough chronological order, beginning with those areas that transportation agencies should consider first when getting started using unmanned aircraft systems.

Executive Support

Incorporating unmanned aircraft into any complex organization requires executive buy-in and support. Successful implementation of an unmanned program will involve many stakeholders and a variety of interests. State transportation agencies considering a program of their own will want to start by demonstrating the value of this new technology to their executives as well as an understanding of the concerns that their stakeholders may have regarding unmanned operations (e.g., airspace violations, privacy infringement, and public perceptions).

To start the program, agencies are encouraged to choose an application that is simple and straightforward. Scan team participants found approval was more likely when an objective that the agency was already working toward could be accomplished less expensively, more safely, or more efficiently with an unmanned aircraft. Multiple-use cases have been demonstrated; however, new programs are encouraged not to tackle multiple-use cases all at once. Scan team members determined

agencies found success in starting with a single, low-risk use case (e.g., a slope failure survey or bridge failure inspection) that could document the value they were expecting to achieve.

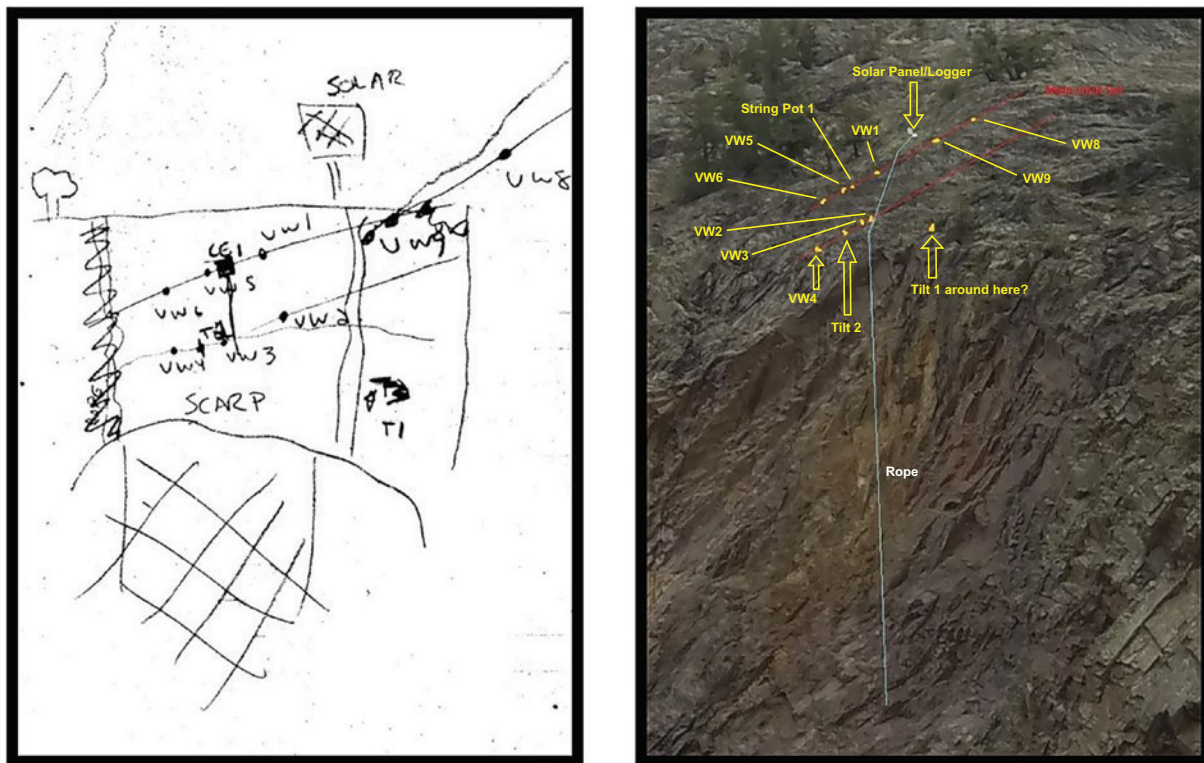


Figure 3.1 Colorado DOT sensor location recordings before and after unmanned aircraft implementation

From identifying an initial-use case and promoting its value, many scan participants reported that initial funding for their unmanned programs was found in an existing operating budget or in the office’s overhead budget. One agency was able to find funds to sevcure a platform and training with end-of-fiscal-year funds available at the state level. Many programs reported that initial operations involved collecting still images or video to better document a project or effort.

Whether it is time and expense saved or safety and data quality improved, metrics related to return on investment must be recorded. One cost-benefit analysis found that that unmanned thermal analysis techniques were able to detect more-precise areas of delamination distress across two bridges than the more traditional chain-dragging or hammer-sounding techniques. As these more-precise areas (i.e., 53.59 ft² versus 188.0 ft² and 92.73 ft² versus 313.28 ft², respectively) would require fewer repairs, projected cost savings were estimated at nearly 70%.

As the programs of scan participants demonstrated value, the scope and complexity of their unmanned aircraft use expanded. After years of demonstrated implementation, one program was allocated a large standing budget for UAS use. Another program was issued recurring state appropriations for development and administration of its unmanned efforts. Scan team members and participants alike agreed that UAS saves resources and increases efficiency. As the scope and frequency of UAS use allow for more comprehensive cost-benefit and return-on-investment metrics to be collected, more-informed executives will recognize their value in surface transportation and support on their implementation.

Key Findings and Observations

Top-down investment and support from executives emerged as one of the very first elements needed for transportation agencies interested in implementing UASs. Findings from the peer exchange workshop and the scan team's deliberations pointed to the following conclusions.

- Successful programs have discerned the application and operation of UASs based on one or more of the following:
 - Increased safety or reduced liability
 - Increased efficiency and productivity or reduced impact on the public
 - Cost savings
 - Environmental protection
 - Higher quality end products
- Successful programs do not have to be high cost.
- Successful programs recognize the importance of planning both the initial funding (i.e., for purchase) and continued use of UAS equipment (i.e., operations and maintenance).
- Successful programs agree that UAS saves resources and increases efficiency; however, improvements could be made to support more-comprehensive cost-benefit comparisons to traditional methods.
- Successful programs emphasize the benefits of UAS but understand negative connotations related to the technology.

Organizational Structure

Each state transportation agency has developed an organizational structure to facilitate safe and efficient operations. Many have found a place within a division of aeronautics or aviation and some have even grown into dedicated offices in their own right. In spite of the unique scopes of work and services provided, each agency has needed to leverage expertise and encourage collaboration across a diverse set of stakeholders to advance their unmanned operations.

In California, the Caltrans Division of Aeronautics develops and implements processes and procedures for operating UASs in a manner that is safe and consistent with applicable statutes and regulations. This division has been tasked with establishing a UAS technical advisory group and a steering committee. The technical advisory group:

- Establishes additional qualifications and guidelines for remote pilots over the FAA minimums
- Recommends changes to processes and procedures
- Acts as a resource for UAS trends, technology, law, and best practices

The chief of the Caltrans Division of Aeronautics chairs the Caltrans UAS Steering Committee, which:

- Reviews and approves changes to processes and procedures recommended by the technical advisory group
- Advocates for growing and improving the Caltrans UAS program
- Advocates for investments in UAS technology and training

Similarly, state legislation in Michigan established an Unmanned Aircraft Systems Task Force in 2017 to develop

statewide policy recommendations on the operation, use, and regulation of unmanned aircraft systems.

CDOT has a history of UAS use reaching back to 1994; however, it has been outsourcing the UAS services it needs since 2016. As other CDOT programs became interested in UASs, a request for proposal for UAS services was developed and opened to all CDOT programs. Currently, five contractors are active; three are structured as price agreements and the other two are price agreements with contracts. Organizing their operations in this way has allowed the vendors to maintain equipment liability and CDOT personnel to focus more on the data aspect rather than the latest UAS hardware and software.

Figure 3.2 is a rockslide change-detection workflow accomplished under a vendor arrangement. The first two models were captured two months apart. Overlaying these models allowed for the raw output composite model, which indicates the greatest areas of change in red. CDOT’s executive director issued Procedural Directive 70.1 “CDOT Use of UAS,” which became effective 4 November 2016. The document addresses internal use of UASs as well as contractor operations, dictating that the executive director be contacted prior to flights.

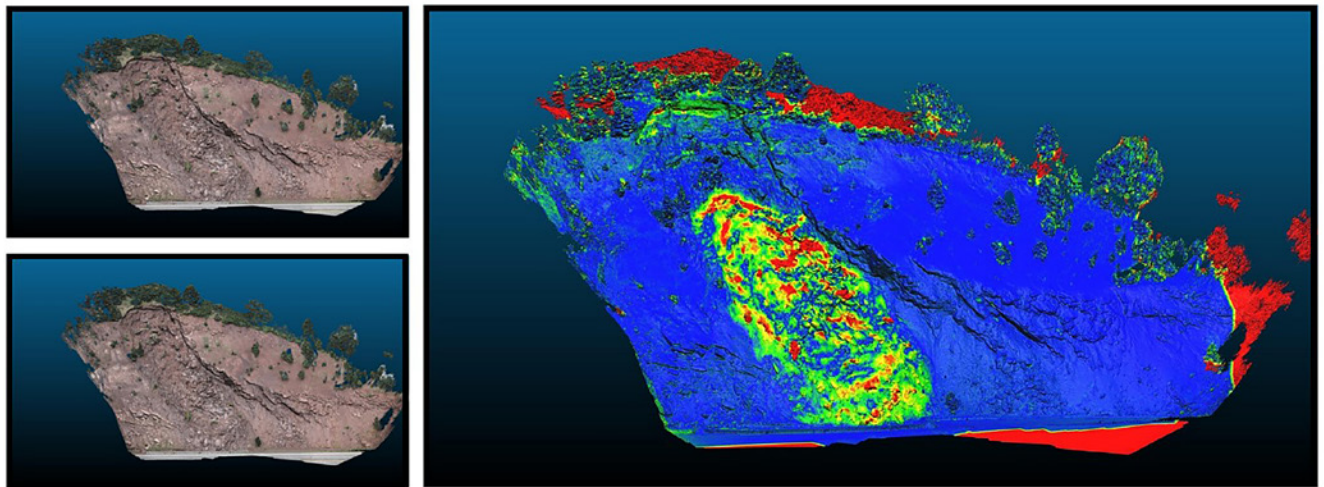


Figure 3.2 Colorado DOT rockslide change detection

In Iowa, the Office of Aviation acts as a resource for guidance on integrating UAS for the Iowa DOT. The office does not identify as a dedicated department for unmanned aircraft; however, it was the first department in the state to operate them and works on issues related to certification, regulation, and state legislation. The agency recommends designating a UAS champion and leveraging expertise in airspace, technology, and the FAA waiver process.

KYTC began its initial foray into unmanned aircraft by hiring a single survey coordinator in 2014 to begin using UASs. As the second public agency to acquire a Section 333 exemption (see Appendix F), the KYTC Department of Aviation completed several proof-of-concept flights (see Figure 3.3 for an example) and became the point of contact for questions from the public, hobbyists, entrepreneurs, and landowners. As operations have scaled, the agency recommends establishing a standing, interagency UAS user group, leveraging pilot expertise in the state, appointing a statewide lead agency for UAS use, and getting buy-in from surveyors and aeronautics



Figure 3.3 Kentucky Transportation Cabinet proof-of-concept product

As unmanned applications grew in its agency, MnDOT’s Office of Aeronautics recognized the need for a central policy that would govern UAS use by MnDOT and those working on behalf of the agency. The policy (Appendix H) establishes the Office of Aeronautics as a center point for the state and provides those who are not UAS experts a review process to ensure compliance with federal and state statutes and regulations. In addition to applications, the policy also provides information related to purchase and usage of unmanned technology. Prior to purchase, for example, Minnesota offices or districts are required to:

- Identify the mission and complete an analysis that identifies the benefits to MnDOT of using the UAS
- Specify the UAS intended for purchase
- Identify the personnel who will operate the UAS

Once a UAS is acquired but before it is operated, the office or district is required to provide an operation manual addressing common processes for the mission, crew training and certification procedures for the project and flight planning, maintenance and record-keeping for the UAS, and emergency procedures to follow in the event of a crash. If additional missions or the purchase of a new platform is sought, the Office of Aeronautics requires that it be reflected in updates to the operation manual. The Office of Aeronautics also assists in coordination between interested offices or districts and the FAA for federal approval of UAS applications.

In New Jersey, a UAS program coordinator position was created within the Bureau of Aeronautics to lead NJDOT’s UAS initiatives. This position was established to provide leadership, guidance, and coordination for division flight operations. Other responsibilities of the position include ensuring compliance with state and federal aviation regulations, coordinating FAA airspace waivers and authorizations, assisting RFP efforts when contracting consultants, and informing NJDOT of public perception and liability. In accepting requests for UAS application, the Bureau of Aeronautics found that 38 separate division requests could be consolidated into structural inspection, mapping and photogrammetry, or photo and video support.

The goal of the North Carolina DOT’s (NCDOT’s) Division of Aviation is to ensure that recreational, commercial, and government users are all operating unmanned aircraft safely and responsibly in the state. Several divisions within NCDOT have integrated unmanned aircraft. The Division of Aviation has seven unmanned aircraft and provides services to internal NCDOT customers such as the state’s Turnpike Authority, Ferry Division, Rail Division, and others. NCDOT Communications has two unmanned aircraft to capture video and photographs of NCDOT events and projects throughout the state. The NCDOT Photogrammetry, Roadside Environmental, and Geotechnical Engineering units each have a UAS to develop

photogrammetry standards, photograph job-site erosion-control measures, and respond to landslides, respectively. Finally, the NCDOT Environmental Analysis Unit has two UAS to apply herbicide to invasive species; the NCDOT Highway Division 1 Office uses one to assess post-storm damage. To guide these applications, the UAS Program Office in the Division of Aviation maintains a UAS operational procedures guide and a set of UAS standard operating procedures.

In Ohio, the UAS Center is a division of the Ohio DOT that performs and manages all UAS operations for the department and serves as a resource for other state agencies. As interest in implementing unmanned aircraft increased within the state, the center released a set of UAS operations and data usage guidance in October 2017 informing users of requirements to operate unmanned aircraft with the agency, services that the center can provide to Ohio DOT and state agencies, and due diligence requirements for data usage. When contractors, consultants, or suppliers anticipate use of a UAS within Ohio DOT right of way, the department has established Supplement 1132. This procedure requires agency contractors to submit operational information to the UAS Center for approval at least 30 days prior to any elected operation. The procedure also requires contractors to deliver the raw and processed data collected by the unmanned aircraft, flight planning information, and flight data logs to the UAS Center upon request.

Key Findings and Observations

A clear organizational structure within transportation agencies will provide the framework for long-term success. Findings from the peer exchange workshop and deliberations of the scan team pointed to the following conclusions. Successful programs:

- Have a centralized authority and top-down support
- Leverage existing aviation experience in their state
- Utilize a variety of funding models but have a dedicated source
- Recognize that a relationship with and understanding of the FAA is critical
- Dedicate personnel to understanding and keeping up with federal, state, and local regulations
- Transfer knowledge across departments and encourage transparency through relationships
- Increase efficiency through fleet management and resource sharing

Policy and Regulation

The past decade has demanded ever-increasing development of federal policy and regulation related to UAS. Influenced heavily by the FAA's reauthorizations and rulemaking, today's commercial certification for sUASs provides users with relatively easy, albeit limited, access to the NAS. The rules for sUASs (i.e., 14 CFR §107) prescribe methods for issuing a remote pilot certificate with an sUAS rating and generally limit flights to under 400 feet AGL, groundspeeds of less than 100 miles per hour, and operation within visual line of sight and during daylight hours only. The FAA accepts waiver applications related to several of these limitations for entities interested in more expanded operations.

Many state transportation agencies have taken advantage of operations under 14 CFR §107. However, several agencies have demonstrated a history of securing exemptions, waivers, or authorizations for their unmanned operations. Prior to 14 CFR §107 and waivers issued under that part, public COAs and Section 333 exemptions represent some of the most common modes of federal operational authorizations. The state transportation agencies represented by the scan team and invited participants have representation in each

of these areas. A few of these efforts are documented in the following paragraphs. Select approvals have been included in Appendix E, Appendix F, and Appendix G for reference.

Certificates of Waiver or Authorization

A COA is an authorization the FAA's Air Traffic Organization issues to a public operator for a specific UAS activity. Public COAs must adhere to the statutory terms of public aircraft operations; however, they enable public agencies to take the responsibility of self-certifying airworthiness for their unmanned platforms. Appendix E is an example statement from Ohio DOT.

In December 2012, Ohio DOT was issued a COA to operate the Swinglet CAM as a public aircraft. The certificate (2012-CSA-84) authorized operations in Class G airspace at or below 250 feet AGL in the vicinity of Williams County, OH. Operations were explicitly limited to a 3.3-acre rectangular area over U.S. Route 20A and the St. Joseph River. Flights were not to exceed 25 minutes and could only be as frequent as two days per month during the spring, summer, and fall. As a public aircraft, the operations were required to comply with the terms of 49 United States Code §40102(a)(41) and §40125, as well as the standard and special provisions of the COA. At the time of issuance, provisions required measures such as:

- Issuance of a Notice to Airmen (NOTAM) between 48 and 72 hours prior to the operation
- Monitoring of the TRACON⁷⁵ frequency during operations
- Minimum training requirements for visual observers (VOs)
- Monthly data reporting

MDOT recently secured a statewide COA authorizing the Aeryon⁷⁶ Scout for applications in emergency response such as oil spill responses and crash scene reconstruction. On 10 April 2018 NCDOT was also granted a blanket COA for public aircraft operations. This certificate (2018-ESA-1450-COA) authorizes operation of any sUAS weighing less than 55 pounds and operating at speeds less than 87 knots in Class G airspace at or below 400 feet AGL.

Section 333 Exemptions

As noted above, the Secretary of Transportation is able to utilize Section 333 exemptions to grant case-by-case authorizations for performing commercial UAS operations prior to finalization of the 14 CFR §107 rule set. While this method of approval was primarily leveraged between 2014 and 2016, involvement was still noted amongst the scan team members and participants.

AerialZeus, an engineering consulting company located in Sacramento, CA, was issued a Section 333 exemption on 30 June 2015. This exemption was requested to collect remote sensing data and conduct near-infrared, infrared, and high-resolution aerial imagery for Caltrans. AerialZeus was granted an exemption from 14 CFR §§61.23(a) and (c), 61.101(e)(4) and (5), 61.113(a), 61.315(a), 91.7(a), 91.119(c), 91.121, 91.151(a)(1), 91.405(a), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a) and (b) to the extent necessary to collect the aerial data. The exemption was aircraft-specific, required a VO for all operations, and the pilot in command (PIC) was required to hold either an airline transport, commercial, private, recreational, or sport pilot certificate, as well as a current FAA airman medical certificate or a valid U.S. driver's license. Furthermore, the PIC was also required to meet the flight review requirements specified in 14 CFR §61.56.

⁷⁵ Terminal radar approach control

⁷⁶ Aeryon Labs, <https://www.aeryon.com/>

Issued on 28 October 2015, the KYTC was granted a Section 333 exemption for conducting aerial mapping, surveying, monitoring, and inspections. Similar to the exemption above, the KYTC was exempted from 14 CFR §§61.23(a) and (c), 61.101(e)(4) and (5), 61.113(a), 61.315(a), 91.7(a), 91.119(c), 91.121, 91.151(a) (1), 91.405(a), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a) and (b). The accompanying conditions and limitations were also similar to the exemption associated with Caltrans but differed in that two aircraft (i.e., the Arris M680-4 and Zeta FX-61) were approved for operation.

Finally, the Ohio/Indiana UAS Center and Test Complex⁷⁷ was granted a Section 333 exemption on 16 November 2015. The exemption authorized operation of the senseFly eBee; Event 38 Unmanned Systems Inc. E384 UAS, Altavian⁷⁸ Nova F6500, Peregrine UAS, DJI Phantom, MLB Bat-3⁷⁹, and senseFly Swinglet. This exemption did not differ in respect to the regulatory relief granted.

14 CFR §107.200(a) Waivers

Waivers to 14 CFR §107 provide flexibility to the sUAS Rule. The FAA administrator has authority to issue a COA authorizing a deviation from any of the regulations specified in §107.205 provided the deviation can be conducted safely under the waiver's terms and conditions. Waivers to §107.29 and §107.41 are by far the most common waivers granted to date. State transportation agencies are again well-represented.

The Iowa DOT was issued 18 waivers between November 2016 and May 2017 for 14 CFR §107.41, Operations in Certain Airspace. These waivers collectively enable operation in all Class C, D, and E surface airspace in the state (examples of each are included in Appendix E). To ensure familiarity with airport surface area and traffic pattern operations while in the vicinity of airports, operational provisions of the waivers required that pilots, in addition to holding a valid remote pilot certificate, hold a private pilot or commercial pilot certificate. Furthermore, the remote PIC is required to monitor respective air traffic control frequencies and coordinate operations accordingly. Waiver 2017-ATO-P107-00057, for example, requires the PIC to "... monitor Waterloo Tower frequency 125.075 as required by ATC," and "... notify Waterloo Tower ... 30 minutes prior to commencing operations with a specific location and upon completion of UA operations." In the event of a lost link or lost communications emergency over an airport movement area, "... the UA's preprogrammed lost link procedure shall be programmed to return-to-home at an altitude of no less than 50 feet AGL to mitigate any potential interference with aircraft on taxiways and aprons." All such preprogrammed procedures are to return to land by moving away from any runway or extended centerline.

GDOT was issued a waiver for 14 CFR §107.29, Daylight Operation, effective 13 March 2017. The full waiver language can be found in Appendix E; however, some special provisions related to night sUAS operations include:

- All operations must use one or more VO.
- The remote PIC and VO must be trained to recognize and overcome visual illusions caused by darkness.
- The area of operations must be sufficiently illuminated to allow both the remote PIC and VO to identify people or obstacles on the ground.
- The small unmanned aircraft must be equipped with anticollision lighting visible from a distance of 3 statute miles.

⁷⁷ Ohio/Indiana Unmanned Aircraft Systems Center, Ohio Department of Transportation, <http://www.dot.state.oh.us/divisions/uas/Pages/default.aspx>

⁷⁸ Altavian, <https://www.altavian.com/>

⁷⁹ Northrop Grumman, <http://www.northropgrumman.com/>

NCDOT was issued a waiver for 14 CFR §107.29, Daylight Operation, effective 19 June 2017 (included in Appendix E). The waiver carried the same special provisions as the GDOT waiver related to night sUAS operations.

Agency Policies and Procedures

Development or adoption of internal policies and procedures related to unmanned aircraft use were observed and discussed among scan team members and participating agencies. Often utilized to define the use of the technology for a specific department, to document crew member roles and responsibilities, and/or to establish standard operating procedures, sample documents have been gathered into Appendix H. Sample documents were found establishing standards for initial and recurrent crew training, as well as procedures to be conducted before, during, and after a flight. Emergency procedures and accident reporting were noted, as well as recommendations for perimeter management around flight operations and nonparticipants.

Utah DOT's (UDOT's) procedures specifically note, "UAS procedures and department implementation will be reviewed annually to keep up with technology and respond to public concerns" and explicitly commit to conducting public education and outreach regarding the documents. In both documents, several pointers are found referencing 14 CFR §107, specifically the operating rules of Subpart B. On a similar note, CDOT's executive director issued a procedural directive (effective 4 November 2016) addressing internal use of UASs and contracted operations. The directive dictates that the executive director will be contacted prior to all flights.

MnDOT's UAS Policy (last revised 14 March 2018) pertains to UAS operations by both employees and contractors. MnDOT's Office of Aeronautics must approve UAS usage for both employees and third parties working on behalf of the agency. Several agencies utilized these documents to establish consequences for unauthorized use.

State Legislation

As attention has mounted for the development of policy and regulation at the federal level, several states have passed legislation related to unmanned aircraft. While some reported no legislative action to date, language related to unmanned aircraft was noted among the states represented by the scan participants regarding registration and licensing of unmanned aircraft, federal preemption, interference with police and emergency personnel operations, and prohibition of flight near confinement or correctional facilities. Specific state statutes are examined in the sections that follow.

In Michigan, the governor approved Public Act 436 of 2016, the Unmanned Aircraft Systems Act, in January 2017. Effective 4 April 2017, the act provides for the operation and regulation of UASs in Michigan and created an Unmanned Aircraft Systems Task Force. The excerpted provisions below address federal preemption, point to compliance with applicable federal regulations, discourage political subdivisions from regulating ownership or operations of UASs, and prohibit interference with public safety operations.

Sec. 5.

(1) Except as expressly authorized by statute, a political subdivision shall not enact or enforce an ordinance or resolution that regulates the ownership or operation of unmanned aircraft or otherwise engage in the regulation of the ownership or operation of unmanned aircraft.

(2) This act does not prohibit a political subdivision from promulgating rules, regulations, and ordinances for the use of unmanned aircraft systems by the political subdivision within the boundaries of the political subdivision.

(3) This act does not affect federal preemption of state law

Sec. 11

A person that is authorized by the Federal Aviation Administration to operate unmanned aircraft systems for commercial purposes may operate an unmanned aircraft system in this state if the unmanned aircraft system is operated in a manner consistent with federal law.

Sec. 13

A person may operate an unmanned aircraft system in this state for recreational purposes if the unmanned aircraft system is operated in a manner consistent with federal law for the operation of a model aircraft.

Sec. 21

An individual shall not knowingly and intentionally operate an unmanned aircraft system in a manner that interferes with the official duties of any of the following:

- (a) A police officer.
- (b) A firefighter.
- (c) A paramedic.
- (d) Search and rescue personnel.

In Minnesota, unmanned aircraft are not exempted from existing state statutes related to aircraft registration and taxation (§360.511 through §360.675). Particular attention is focused on aircraft registration, taxation, and licensing prior to commercial operations. All aircraft registered with the FAA, which includes all unmanned aircraft between 0.55 and 55 pounds, fixed-wing, helicopter, and balloons, are required to register with MnDOT as well as pay an annual registration fee on the rate and basis shown in §360.531 TAXATION.

Minnesota law further requires commercial operators to obtain a commercial operations license before they advertise, represent, or hold themselves out as giving or offering to provide commercial UAS services. Applicants are required to:

- Obtain approval from the airport they list on their application to operate on the field
- Submit proof of aircraft insurance coverage that meets or exceeds the minimum prescribed requirements in Chapter 8800 of the Minnesota Administrative Rules
- Make an agreement for maintenance of the aircraft
- Ensure current Minnesota registrations for any aircraft
- Submit the commercial operations license form with the \$30 annual license fee

MnDOT also attempts to track and post local ordinances passed in the state relating to UASs and their operation. These can be found on the MnDOT Aeronautics Drone webpage⁸⁰.

360.511 DEFINITIONS.

Subd. 16. Aircraft.

“Aircraft” means any contrivance, now known or hereafter invented, used or designed for navigation of or flight in the air.

360.531 TAXATION.

§Subdivision 1. In lieu tax.

All aircraft using the air space overlying the state of Minnesota or the airports thereof, except as set forth in section 360.55, shall be taxed in lieu of all other taxes thereon, on the basis and at the rate for the period January 1, 1966, to June 30, 1967, and for each fiscal year as follows.

Subd. 2. Rate.

The tax shall be as follows:

Base Price	Tax
Not over \$500,000	\$100
over \$500,000 but not over \$1,000,000	\$200
over \$1,000,000 but not over \$2,500,000	\$2,000
...	
over \$40,000,000	\$75,000

⁸⁰ Unmanned Aircraft Systems (UAS) or Drones, Aeronautics and Aviation, Minnesota Department of Transportation, <http://www.dot.state.mn.us/aero/drones/>

Subd. 4. Base price for taxation.

For the purpose of fixing a base price for taxation, the base price is defined as follows:

(a) The base price for taxation of an aircraft shall be the manufacturer's list price.

360.59 AIRCRAFT REGISTRATION AND LISTING FOR TAXATION.

Subd. 10. Certificate of insurance.

(a) Every owner of aircraft in this state when applying for registration, reregistration, or transfer of ownership shall supply any information the commissioner reasonably requires to determine that the aircraft during the period of its contemplated operation is covered by an insurance policy with limits of not less than \$100,000 per passenger seat liability both for passenger bodily injury or death and for property damage; not less than \$100,000 for bodily injury or death to each non-passenger in any one accident; and not less than \$300,000 per occurrence for bodily injury or death to non-passengers in any one accident.

North Carolina has included UAS provisions in its state statutes dating back to 2014 and Session Law 2014-100⁸¹. A number of revisions since have established language that regulates launch and recovery sites, prohibits surveillance of persons without consent, prohibits flight near confinement or correctional facilities, and establishes training and permit requirements for sUASs. The statute requires development of a knowledge test that “complies with all applicable state and federal regulations” for operating UASs and requires its completion prior to operation within the state. Furthermore, the general statutes require possession of a permit (issued by NCDOT’s Division of Aviation) to operate a UAS commercially. Several of these statutes point to federal regulations or dictate that the criteria and requirements mandated “... shall be no more restrictive than [those] adopted by the [FAA] ... under which a person may operate [UAS] for commercial purposes.”

North Carolina General Statutes Chapter 15A – Criminal Procedure

§ 15A-300.2. Regulation of launch and recovery sites.

(a) No unmanned aircraft system may be launched or recovered from any State or private property without consent.

(b) A unit of local government may adopt an ordinance to regulate the use of the local government’s property for the launch or recovery of unmanned aircraft systems.

§ 15A-300.1. Restrictions on use of unmanned aircraft systems.

(b) General Prohibitions. – Except as otherwise provided in this section, no person, entity, or State agency shall use an unmanned aircraft system to do any of the following:

(1) Conduct surveillance of:

a. A person or a dwelling occupied by a person and that dwelling’s curtilage without the person’s consent.

b. Private real property without the consent of the owner, easement holder, or lessee of the property.

(2) Photograph an individual, without the individual’s consent, for the purpose of publishing or otherwise publicly disseminating the photograph. This subdivision shall not apply to newsgathering, newsworthy events, or events or places to which the general public is invited.

§ 15A-300.3 Use of an unmanned aircraft system near a confinement or correctional facility prohibited

(a) Prohibition – No person, entity, or State agency shall use an unmanned aircraft system within a horizontal distance of 500 feet, or vertical distance of 250 feet from any local confinement facility, as defined in G.S. 153A-217, or State or federal correctional facility. For the purpose of this section, horizontal distance shall extend outward from the furthest exterior building walls, perimeter fences, and permanent fixed perimeter, or from another boundary clearly marked with posted notices. Posted notices shall be conspicuously posted not more than 100 yards apart along a marked boundary and comply with Department of Transportation guidelines.

North Carolina General Statutes Chapter 63 – Aeronautics

§ 63-95. Training required for operation of unmanned aircraft systems.

⁸¹ Senate Bill 744, Session Law 2014-100, Session 2013, General Assembly of North Carolina, <https://www.ncleg.net/EnactedLegislation/SessionLaws/HTML/2013-2014/SL2014-100.html>

(a) As used in this Article, the term “Division” means the Division of Aviation of the Department of Transportation.

(b) The Division shall develop a knowledge test for operating an unmanned aircraft system that complies with all applicable State and federal regulations and shall provide for administration of the test. The test shall ensure that the operator of an unmanned aircraft system is knowledgeable of the State statutes and regulations regarding the operation of unmanned aircraft systems. The Division may permit a person, including an agency of this State, an agency of a political subdivision of this State, an employer, or a private training facility, to administer the test developed pursuant to this subsection, provided the test is the same as that administered by the Division and complies with all applicable State and federal regulations.

(c) No agent or agency of the State, or agent or agency of a political subdivision of the State, may operate an unmanned aircraft system within the State without completion of the test set forth in subsection (b) of this section.

§ 63-96. Permit required for commercial operation of unmanned aircraft systems.

(a) No person shall operate an unmanned aircraft system, ... , in this State for commercial purposes unless the person is in possession of a permit issued by the Division valid for the unmanned aircraft system being operated. Application for the permit shall be made in the manner provided by the Division. Unless suspended or revoked, the license shall be effective for a period to be established by the Division not exceeding eight years.

(b) No person shall be issued a permit under this section unless all of the following apply:

(1) The person is at least the minimum age required by federal regulation for operation of an unmanned aircraft system.

(2) The person possesses a valid government-issued photographic identification acceptable to the Federal Aviation Administration for issuing authorization to operate an unmanned aircraft system.

(3) The person has passed the knowledge test for operating an unmanned aircraft system as prescribed in G.S. 63-95(b).

(4) The person has satisfied all other applicable requirements of this Article or federal regulation.

(c) A permit to operate an unmanned aircraft system for commercial purposes shall not be issued to a person while the person’s license or permit to operate an unmanned aircraft system is suspended, revoked, or cancelled in any state.

(d) The Division shall develop and administer a program that complies with all applicable federal regulations to issue permits to operators of unmanned aircraft systems for commercial purposes, including a fee structure for permits. Criteria and requirements established under the subdivisions set forth in this subsection shall be no more restrictive than the rules or regulations adopted by the Federal Aviation Administration setting forth the criteria and requirements under which a person may operate an unmanned aircraft system for commercial purposes.

Title 72, Chapter 14, of the Utah Code, Unmanned Aircraft – Drones, contains language that preempts local ordinances, establishes conditions under which a law enforcement agency may use data acquired by a UAS, and prohibits flight of an unmanned aircraft with weapons attached as well as near prison facilities. Title 72, Chapter 14, Part 4, allows those operating unmanned aircraft for recreational purposes in Utah to comply with either the state statutes or 14 CFR §101 Subpart E. In contrast to Minnesota state statutes, Title 72, Chapter 10, of the Utah Code (effective 9 May 2017) explicitly exempts unmanned aircraft from its state registration requirement.

72-10-109. Certificate of registration of aircraft required -- Exceptions.

(1) (a) A person may not operate, pilot, or navigate, or cause or authorize to be operated, piloted, or navigated within this state any civil aircraft located in this state unless the aircraft has a current certificate of registration issued by this state through the county in which the aircraft is located.

(b) This restriction does not apply to aircraft licensed by a foreign country with which the United States has a reciprocal agreement covering the operations of the registered aircraft or to a non-passenger-carrying flight solely for inspection or test purposes authorized by the Federal Aviation Administration to be made without the certificate of registration.

(2) Aircraft assessed by the State Tax Commission are exempt from the state registration requirement under Subsection (1).

(3) Unmanned aircraft as defined in Section 72-14-102 are exempt from the state registration requirement under Subsection (1).

72-14-103 Preemption of local ordinance.

(1) A political subdivision of the state, or an entity within a political subdivision of the state, may not enact a law, ordinance, or rule governing the private use of an unmanned aircraft unless:

- (a) authorized by this chapter; or
- (b) the political subdivision or entity is an airport operator that enacts the law, rule, or ordinance to govern:
 - (i) the operation of an unmanned aircraft within the geographic boundaries of the airport over which the airport operator has authority; or
 - (ii) the takeoff or landing of an unmanned aircraft at the airport over which the airport operator has authority.

(2) This chapter supersedes any law, ordinance, or rule enacted by a political subdivision of the state before July 1, 2017.

Enacted by Chapter 364, 2017 General Session

Key Findings and Observations

Knowledge of federal statutes and regulations related to unmanned aircraft is an essential starting point. In addition, each agency must establish policy for acceptable use and operational guidelines for UASs. Findings from the peer exchange workshop and deliberations of the scan team pointed to the following conclusions. Successful programs:

- Align their policies and procedures to be consistent with federal statutes and regulations
- Have expertise in UAS regulations and the ability to keep up with changes
- Understand how to obtain airspace authorization and work with local airports
- Promote existing regulation within the state to prevent unneeded regulations on a state or local level
- Develop or adopt policy and procedures manuals for UAS operations

Safety and Risk Management

The aviation industry, over decades of improvements and lessons learned, recognizes the tremendous value of having a positive safety culture and related risk management processes in place to reduce risk to the lowest practical level. As unmanned aircraft continue to integrate with the job functions of transportation agency personnel, it is critical to foster and develop these same principles when operating sUASs.

In March 2015, the FAA published Revision 1 of the Safety Management System Voluntary Program (SMSVP) Guide. This guide outlines the key components of a system that properly manages safety and meets FAA requirements and the International Civil Aviation Organization's standards for SMS compliance.

Safety Management System (SMS) is the formal, top-down business-like approach to managing safety risk, which includes a systemic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures. (SMSVP Edition 1 Rev. 1)

On a state and federal level, the transportation agencies must recognize their role in accident prevention. FAA Advisory Circular 120-92B states”

Using SMS principles provides both the organization and the Federal Aviation Administration the following:

- Structured means of safety risk management decision making.
 - A means of demonstrating safety management capability before system failures occur.
 - Increased confidence in risk controls through structured safety assurance processes.
 - An effective interface for knowledge sharing between regulator and organizations.
 - A safety promotion framework to support a sound safety culture.

An SMS focuses on the entire system of an organization. A framework is developed through a clear safety policy that, in part, establishes safety objectives, creates organizational structure, and communicates safety expectations for each employee. Processes are put into place to allow employees to report safety concerns or know what to do in the event of an emergency (i.e., an ERP). Once the safety policy is established, safety risk management and safety assurance processes are developed to manage safety on a daily basis. Safety risk management includes written processes for defining the system, how the organization identifies hazards within the various areas, analyzing or making sense of the data collected over time, determining the level of risk using tools such as risk matrix charts, and processes to mitigate and accept risk. Once risk is mitigated, safety assurance processes are engaged to ensure that the organization is “doing what it says it is doing” and that the mitigation strategies are actually working. The final part or component of SMS is safety promotion. Safety promotion requires initial and recurrent safety training commensurate with each person’s position; processes to communicate change, improvements, and concerns from various levels within the organization; and the creation of the safety culture, which is critical for the entire SMS to function properly.

A safety culture is critical in that, without it, all the processes and organizational clarity will have little effect. In his 1997 work, *Managing the Risk of Organizational Accidents*, James Reason addresses how a positive safety culture mitigates risk. A positive safety culture, in part, includes:

- An environment that encourages learning from mistakes
- An ability to adapt to change
- A willingness to share mistakes through safety reporting
- An informed culture where we understand why changes are being made and why we do what we do
- A just culture where all the stakeholders know their responsibilities and are confident that they will be treated fairly

The FAA and the International Civil Aviation Organization describe an SMS as having four major components. For SMS to work, all four must work in harmony with each other.

The Four SMS Components

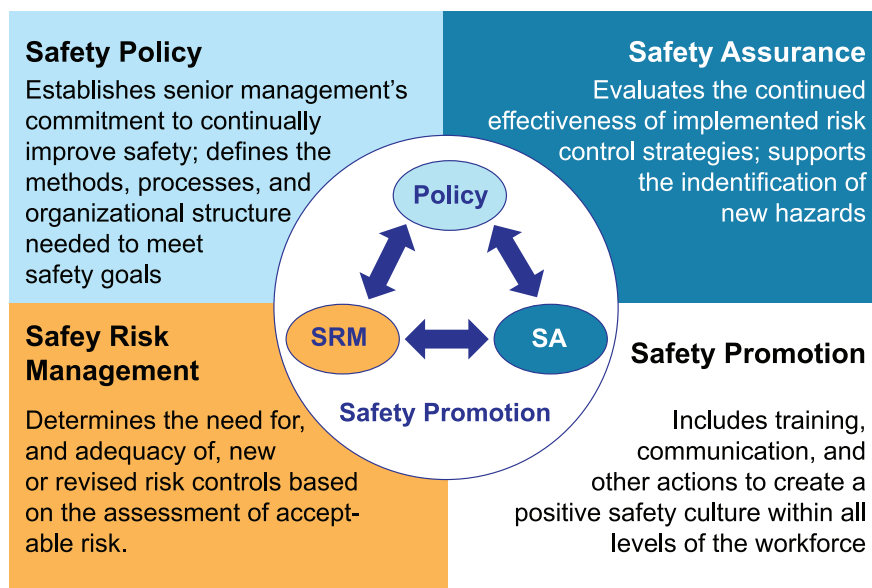


Figure 3.4 The four SMS components⁸²

⁸² Safety Management System Components, Federal Aviation Administration, <https://www.faa.gov/about/initiatives/sms/explained/components/>

Safety Policy

Safety policy means the certificate holder's documented commitment to safety, which defines its safety objectives and the accountabilities and responsibilities of its employees in regards to safety. (SMSVP Edition 1 Rev. 1)

The foundation of safety policy includes the organization's executive or executive leadership accountable for establishing the organization's commitment to providing the resources needed to implement and maintain an SMS. Organizational structure must be established with a safety policy that answers these questions:

- Who within the organization can accept risk for UAS operations?
- What levels of risk must be approved by the accountable executive?
- What levels of risk can be approved by the remote pilot operator?

It is important to answer these questions, which highlight the importance of properly training the executive leadership so they know how to make these decisions. Organizational structures between state transportation agencies vary; SMS identifies what must be done as part of an SMS but does not address how to accomplish the "what."

The transportation agencies that incorporate an existing aviation department or division for manned aircraft have a more smooth transition to safe UAS flight. Established safety procedures and organizational structure are normal in manned aviation. Once there is an organizational structure, much like business objectives, executive management can develop safety objectives that direct the organization's actions and help measure success. Safety policy is developed regarding how employees can submit nonpunitive safety reports to help the organization identify hazards or trends within the organization. Finally, a comprehensive emergency response plan is developed to establish responsibilities regarding how an accident or incident will be coordinated.

The Academy of Model Aeronautics (AMA) has developed an sUAS flight safety guide that can assist transportation agencies in developing their safety policy and basic safety principles when flying sUAS (see Appendix H). Helicopter Association International has created safety management tools⁸³ to assist organizations in creating an SMS, including the development of their organizational structure and emergency response plan.

It is important to note that the FAA intended SMS to be scalable. No two SMS programs are alike; each is tailored to the system in which it is functioning. A small organization of 10 people may do safety reporting using a comment box, while a 40-person organization may have electronic safety reporting. It is important to remember that SMS tells what must be done, not how it is done.

Safety Risk Management

Safety Risk Management means a process within the SMS composed of describing the system, identifying the hazards, and analyzing, assessing and controlling risk. (SMSVP Edition 1 Rev. 1)

Safety risk management consists of five main components: system/task analysis, hazard identification, risk analysis, risk assessment, and risk management. These five parts of safety risk management lay out a basic decision-making process to reduce and accept risk. The system/task analysis is the most misunderstood

⁸³ Safety Management System Toolkits, Helicopter Association International, <https://www.rotor.org/resource?PID=493&evl=0&CategoryID=22&CategoryName=Safety-Management-System-Toolkits>

component of the process. It is critical that we understand the system before we try to fix the program or reduce the risk. If we don't understand the system we will most likely misdiagnose the problem and mitigate the risk incorrectly. It is important to have the correct expertise participating in change and defining what the system is for a given scenario. State transportation agencies will need to establish how they will identify hazards within their organization. Using existing processes are most often used initially since they are already established. Nonpunitive safety reporting is a requirement; however, other methods may be used. For example, tracking damaged UAS parts, tracking the number of incident reports, and tracking injuries caused on the job site with a UAS operating are a few examples regarding what may be tracked; regardless, it should reflect the organization's safety objectives established by executive leadership.

UAS organizations must have processes to both collect and analyze the data. If no one ever looks at the pictures (or data) collected from a UAS, the information is useless. Who will collect the data, organize it, and make sense of it? What triggers will require the organization to identify the risk created by this hazard and determine if it is too high and must be addressed? As an organization decides to use a UAS for different purposes, who will identify the risk associated with that operation? Who will be allowed to accept the risk? If the risk is too high for approval, who will ensure that the risk-mitigation strategies are implemented and the new risk is calculated?

State transportation agencies will need a risk matrix chart tailored to and approved by the agency. Many variations are available but each organization needs to determine what makes something an unacceptable risk regarding severity and likelihood. Severity could be reputation, violation, injury level, environmental damage, and other factors. Severity is determined by what an organization would consider severe in its business and to its safety objectives. Likelihood would range from an event happening on every UAS flight to rarely, in which there is no known record of a situation ever occurring.

These steps not only apply organizationally but operationally as well. This is primarily what most state transportation agencies have focused on, the individual mission or operation. While we want system-wide processes for risk management, it is important that we conduct an operational risk assessment each time we fly a UAS. Many transportation agencies already have operational risk assessments; these have been used in manned aviation for decades. Caltrans, for example, has a hazard identification form that is used before each flight to help the remote pilot operator identify hazards for the flight.

Aviation has adopted the term flight risk assessment tool (FRAT). A UAS FRAT would identify high-risk factors for a given UAS operation. Often a numbering system gives value to each answer. For example, on assessing risk for pilot fatigue, a FRAT would ask if the pilot got 1–3 hours of sleep (4 points), 4–5 hours of sleep (3 points), 6–7 hours of sleep (2 points), or 7+ hours of sleep (1 point). After various questions to score, you would get a total score, which would rate your risk level, ranging from low to medium to high risk. Each level of risk would require authorization from a different level of management, who could accept that risk. If it was low, the remote pilot may accept the risk after trying to reduce it. For medium risk, it may be need a supervisor's approval. For high risk, the accountable executive may need to sign off and accept the risk.

Safety Assurance

Safety Assurance means processes within the SMS that function systematically to ensure the performance and effectiveness of safety risk controls and that the organization meets or exceeds its safety objectives through the collection, analysis, and assessment of information. (SMSVP Edition 1 Rev. 1)

Safety assurance is normally the SMS component most readily forgotten; however, it is critical for a fully functional SMS. Safety assurance gives the organization confidence that it is “doing what it says it is doing.” Safety reporting and tracking other selected UAS data is used to determine if risk-mitigation strategies are

working properly as well as to identify new hazards before an accident or incident occurs. Safety assurance is part of the overall plan to not only reduce risk, but keep risk low. Anytime we mitigate risk we also need to ask how we will measure this mitigation in three or six months to determine if it worked the way we intended or if there were any unintended circumstances.

Safety assurance is critical on an operational level in conjunction with a FRAT. The FRAT is a point in time before the flight when an organization tries to give numerical value to the perceived risk. UAS operations should also conclude each operation with a review of the flight. Were the predicted risks actually the high-risk items or did other unforeseen risks come up during the flight? This process of going back and reviewing what happened and whether it occurred as predicted is critical for continual improvement of an organization's safety.

Additional efforts within the UAS industry are being developed for operational risk assessments for sUASs. In 2018, ASTM International⁸⁴ developed the Standard Practice for Operational Risk Assessment of sUAS, which offers a standardized approach to identify, analyze, assess, and mitigate risk for sUASs. In 2018, Joint Authorities for Rulemaking of Unmanned Systems developed a guidance document for specific operations risk assessment. This document has developed a risk-assessment methodology for UASs and is widely accepted in the aviation community.

Safety Promotion

Safety Promotion means a combination of training and communication of safety information to support the implementation and operation of an SMS in an organization. (SMSVP Edition 1 Rev. 1)

The last component, safety promotion, has often been described as the wrapper that holds the SMS together. While the FAA cannot mandate a safety culture, the safety promotion component is the place where a strong positive safety culture will grow. This positive safety culture will grow by creating an environment where employees can feel free to report hazards, learn from their mistakes, and expect to be treated fairly. The organization must communicate safety objectives, changes, and other critical information and be willing to adapt and be flexible. As state transportation agencies implement safety promotion, the following questions will need to be answered to strengthen their SMS:

- How will the agency approach mistakes made when operating a UAS?
- How will the agency invest in employees through proper UAS safety training?
- How will the agency communicate new UAS policy and change within the organization?

Organizations that begin using UAS operations and desire to improve their safety management system and overall safety culture may consider taking the Transport Canada Score Your Safety Culture survey (see Appendix J). Surveys of this nature can give your organization a baseline regarding its safety culture. No score is unacceptable; instead, it is a first measurement of where an agency is and can help it to start improving its overall safety culture in a way that can be measured yearly, further identifying trends over time.

In summary, following are some key examples related to safety management systems that the participating state transportation agencies identified. This is not a complete, exhaustive list of all safety-related items done by each state agency but a sampling to show the extent of work accomplished and examples of best practices for those transportation agencies still developing their program.

⁸⁴ Formerly the American Society for Testing and Materials

Safety Practices

The Alaska Center of Unmanned Aircraft System Integration (ACUASI) is the UAS research program of the University of Alaska Fairbanks. It works in conjunction with Alaska DOT and Public Facilities and leads the FAA’s Alaska Test Site. ACUASI has established standard operating procedures and emergency procedures that are included within the following documents:

- Aircraft Services Directorate Safety Management Systems Policy
- UAS Center of Excellence Standard Operating Procedures
- University of Alaska at Fairbanks UA Operating Procedures
- Platform-specific operation and maintenance manual(s)
- Emergency response plans (mishap plans)

As part of ACUASI’s safety risk management, it has included risk assessments and mitigation strategies on all flights, including flight readiness reviews and safety review boards with a safety officer. ACUASI (Figure 3.5) and MnDOT (Figure 3.6) each developed a risk matrix chart to assess risk and help in the decision-making process. ACUASI also developed a risk analysis workbook to identify both initial risk and residual risk (Figure 3.7).

Risk Matrix (Pre/Post Treatment)

Hazard/Severity Matrix, Pre-Treatment									
Consequence					Increasing Likelihood				
Likelihood \ Severity	People	Assets (Property)	Environment	Reputation	Extremely Improbable E	Extremely Remote D	Remote C	Probable B	Frequent A
Catastrophic 1	Multiple fatalities (or fatality to all on board) usually with the loss of aircraft/vehicle	Greater than \$1 million	Severe	Severe					
Hazardous 2	Multiple serious injuries; fatal injury to a relatively small number of persons (one or two) or a hull loss without fatalities	\$200,000 to \$1 million	Major	Major					
Major 3	Physical distress or injuries to persons Substantial damage to aircraft/vehicle	\$10,000 to \$200,000	Minor	Minor					
Minor 4	Physical discomfort to persons Slight damage to aircraft/vehicle								
Minimal 5	Negligible safety effect	Less than \$10,000	Less than minor	Less than minor					

Figure 3.5 Alaska Center of Unmanned Aircraft System Integration risk matrix

Risk Assessment Matrix

		Consequence					
		No apparent affect to people, structures, or vehicles	Violation of FAR, unlikely to result in Civil Penalty	Violation of FAR, likely to result in Civil Penalty	Minor injury to persons and minor damage to property	Major injury to persons and major damage to property	Loss of life and property
		Insignificant 0	Minor 1	Moderate 2	Major 3	Severe 4	Catastrophic 5
Probability	Almost Certain (5)	5	6	7	8	9	10
	Likely (4)	4	5	6	7	8	9
	Possible (3)	3	4	5	6	7	8
	Unlikely (2)	2	3	4	5	6	7
	Rare (1)	1	2	3	4	5	6
	Extremely Rare (0)	0	1	2	3	4	5

	Numerical	Historical
< 1 in 10	Is expected to occur in most circumstances	
1 in 100 - 1000	Will probably occur	
1 in 1000 - 10,000	Might occur at some time in the future	
1 in 10000 - 100,000	Could occur but considered unlikely or doubtful	
1 in 100,000 - 1,000,000	May occur in exceptional circumstances	
> 1 in 1,000,000	Could only occur under specific conditions and extraordinary circumstances	

Figure 3.6 Minnesota DOT risk matrix

Project Risk Assessment Narrative:	Ops: LOW RISK	By: G. Foscue
The significant hazard with this project as well as most other UAS projects is the publicity/reputation hit that will occur in the event of an inflight collision with another aircraft. Hazard 9, Mid-Air Collision, cannot be mitigated to less than medium. The remaining medium hazard 3, Propulsion System Failure, is determined acceptable for this DOT infrastructure project. Flight operations will be conducted such that time spent over the pipeline will be minimized with flight routes programmed parallel to the pipeline unless it is part of a preplanned crossing.		

Hazard Analysis Workbook Summary		Initial Risk	Residual Risk
1	Loss of UAS Command and Control Link	C3	C5
2	Loss of navigational control	E2	E2
3	Propulsion System Failure	C3	D3
4	Observer loses visual contact with UA	D2	E2
5	UA Fly Away	E2	E2
6	Lost comms between UA PIC and ATC	#N/A	D5
7	Lost comms between PIC and observers	C4	E4
8	Loss of Link with Tracking Antenna	B2	C4
9	Mid-Air Collision	E1	E1
10	Unknown Winds Aloft	B3	E3
11	Low or bingo fuel prior to landing	E4	E4
12	Frequency Interference	D5	E5

	Likelihood	Extremely Improbable E	Extremely Remote D	Remote C	Probable B	Frequent A
Catastrophic 1	Severity	9	-			
Hazardous 2		2,4,5				
Major 3		10,14	3			
Minor 4		7,11,15	13	8		
Minimal 5		12	6,17	1	16	

Figure 3.7 Alaska Center of Unmanned Aircraft System Integration risk analysis workbook

The Caltrans organizational process shown in Figure 3.8 is in place for risk identification, analysis, assessment, and mitigation as part of the agency's safety policy for SMS and for UAS operations planning.

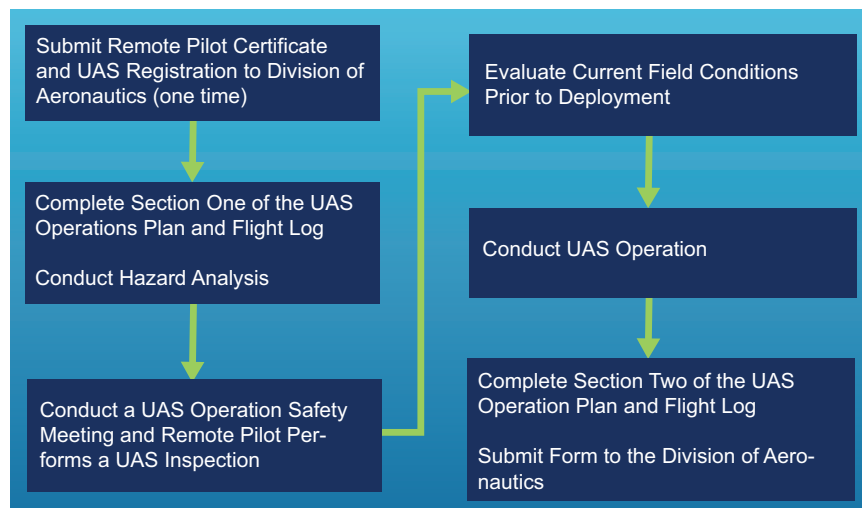


Figure 3.8 Caltrans safety organizational process

Caltrans includes a checklist of 21 items that identifies hazards and effectively reduces risk for UAS operations for each UAS operation. This ensures that all the critical elements that could increase risk are reviewed and considered. The following yes/no questions are included on the hazard analysis form.

- Have the forecasted weather conditions and wind speed been verified?
- Has the statutory three miles of visibility been verified?
- Is there a suitable takeoff and landing zone?
- Have state right-of-way boundaries been identified?
- Have nearby roadways, bridges, and properties been identified?

- Have permits to enter/encroachment permits been secured?
- Is the flight area free from pedestrians, bicyclists, and moving vehicles?
- Is the UAS crew adequately protected from roadway traffic and other hazards?
- Will a roadway closure be in effect for any anticipated or accidental overflight of the UAS over travel lanes or shoulders?

The Caltrans UAS Operations Handbook is used in conjunction with the UAS operational plan. The UAS operator must sign a statement saying, “I certify that I have read and will adhere to the Caltrans UAS Operations Handbook and all applicable federal, state, and local regulations.” A copy of this document is kept on file at the Division of Aeronautics after an operation is completed. The UAS Operations Handbook highlights UAS remote pilot and crew roles and responsibilities; UAS operation reporting requirements; the UAS acquisition process; and safety, traffic-closure, and right-of-way requirements and procedures (operational, reporting and insurance requirements) for construction contractors and encroachment permittees.

CDOT uses vendors to contract much of its UAS work. Under SMS principles, even though it is work performed by a vendor, it still falls on the organization to ensure that the vendor is using SMS principles when operating on the agency’s behalf. A procedural directive from CDOT’s executive director requires that all new UAS uses pass through the Division of Aeronautics for approval prior to operation. This procedural directive includes following rules and regulations set forth by the FAA and obtaining relevant certifications (e.g., Part 107).

CDOT has an emergency response plan that includes the following items if there is an incident involving a UAS. It also includes guidance for vendors if they are being used.

- Call 911 if there is a life-threatening or serious injury.
- Contact the Office of Risk Management.
- Notify upper management. (UAS accidents are currently higher profile than common vehicular accidents.)
- Treat accidents as a vehicular collision.
- Provide relevant insurance and other pertinent information.

GDOT has developed an operational form to be completed before flight. It is the department’s policy for the remote pilot operator to check the weather, airspace (controlled or uncontrolled), flight restrictions, NOTAMs, emergency procedures, and hazards before and after the launch and before landing the UAS. This includes any persons not identified as crew members, as well as completing a self-assessment. All pilots are required to complete this preflight form as well as a post-flight form. These documents then become their flight logs. Georgia’s information technology department is developing an application that will enable the pilots to complete the post-flight form online. It would include prepopulating the GPS locations and the local weather information.

At Ohio DOT, preflight planning is done a week or more ahead of time. Risks are identified based on several factors. Operational details include airspace, ground conditions, UAS (flight logs and maintenance), UAS pilot experience, operational description, altitude, date and time (frequency), weather, location of flight, local contact, NOTAMs, temporary flight restrictions, regulatory requirements, notifications, approvals (if required), flight logs, and planned patterns. Flight logs and

planned patterns are done just prior to flight. Preplanning is done but typically changes due to the dynamic environment/logistics at the time and location of flight. Overall hazards identified for the flight or operation include NAS, ground, nonparticipants, crew, and hazards to aircraft.

MnDOT has used an aviation FRAT (see Figure 3.9) to assist in assessing risk before a flight. Depending on the scoring the flight is either cancelled or must be approved by someone who can accept higher risk. Generally, practice dictates that the remote pilot has the final say regarding whether the flight is cancelled or continued.

RISK CALCULATION SHEET			
Undesired Outcome	Consequence	Probability	Risk Factor
#1 <i>Members of the public encroaching area of operation</i>	1	4	5
Control Measure or comment on risk <i>MnDOT flaggers or observers will approach visitor before they reach the operator and ask them to tye back and hold questions until the flight is over.</i>	0	1	1
#2 <i>Other aircraft encroaching on airspace</i>	2	0	2
Control Measure or comment on risk <i>Observer will report to RPIC with proper notification if aircraft is spotted. Notifications include Aircraft Spotted: safe to proceed, hold and assess, or descend.</i>	0	0	0
#3 <i>Possibilities of UAS malfunction</i>	3	1	4
Control Measure or comment on risk <i>Proceed with fail safe functions. If all fails, deploy parachute or follow the UAS in a vehicle.</i>	0	1	2
#4 <i>Possibilities of weather related safety issues</i>	1	3	4
Control Measure or comment on risk <i>Cancel flight if less than visibility minimums, steady rain, or wind exceeds 20 mph.</i>	0	0	0


Figure 3.9 Minnesota DOT flight risk assessment tool

MnDOT requires contractors to submit a use application (see Figure 3.10) for each project, which contains the following information:

- Identify the office or district requesting to use the UAS.
- Detail the particular consultant, the purpose, time, manner, and location of use.
- Complete an analysis that identifies the benefit of using a UAS.
- Provide a safety and privacy plan that addresses the risks and outlines the risk mitigation processes.
- Include a list of landowners, bridge owners, airports, and other third parties involved in the operation.
- Prepare a communications plan to make the public aware of the operation.
- Provide proof of:
 - FAA UAS registration
 - MnDOT UAS registration

- Successful FAA UAS knowledge test or pilot’s license
- MnDOT commercial operations license
- E-mail the completed application to *DOT_UASRequest@state.mn.us.

MnDOT Unmanned Aircraft System (UAS) Use Application



Your Information	
Name	
Office/District	
Work Phone	
E-Mail Address	
Drone Information	
Are you purchasing a drone or using a contractor?	Purchasing <input type="checkbox"/> Using a Contractor <input type="checkbox"/>
What is your expected date of operation?	
Contractor Information	
If you are using a contractor please provide the following information	
Name of Contractor	
Street Address	
City ST ZIP Code	
Work Phone	
Email address	
FAA registration number	
Use Information	
How will you use the drone? Please describe:	
Does the use provide: Cost Efficiency <input type="checkbox"/> Improved Data Quality <input type="checkbox"/> Improved Personnel Safety <input type="checkbox"/>	
Will this operation fly over traffic? Yes <input type="checkbox"/> No <input type="checkbox"/>	
If yes, this operation will require lane closures. Please describe the lane closure locations and times:	

Figure 3.10 Minnesota DOT use application sample for UAS project

State transportation agencies have also played a role in safety by managing their fleet in the NAS through the development and use of various services. For example, AirMap⁸⁵ and Skyward⁸⁶ are two companies that are being contracted as software solutions to help with airspace management, access in low-altitude airspace, greater situational awareness, and airspace authorization regarding where UASs are flying.

Insurance Considerations

Insurance for UAS was extremely diverse among scan team members and participants. Regardless of the method, each agency must ensure that it understands what insurance coverage its state does or does not have. The type of insurance will affect how the UAS may be used.

If outside vendors were used, they were given requirements for insurance coverage. Many agencies were self-insured and had no additional insurance to cover UAS liability. Other agencies fell under existing insurance or insurance already held by the aviation department/division. Due to the extensive use cases for UAS, the risk associated varies depending on the event, platform, and participants.

Key Findings and Observations

Safety culture and risk management processes were recognized as critical business practices for UAS operations. Findings from the peer exchange workshop and deliberations of the scan team pointed to the following conclusions. Successful programs:

- Have a system to manage safety, which include a ERP and a safety policy

⁸⁵ AirMap, <https://www.airmap.com/>

⁸⁶ Skyward.io, <https://skyward.io/>

-
- Have proper personnel and equipment for each mission
 - Have flight risk assessment tools and risk acceptance procedures
 - Have adopted and promote an aviation safety culture
 - Ensure adequate insurance coverage

Training and Crew Qualifications

Standardized practical training is needed to ensure both safety and accurate data collection. While meeting Part 107 minimum requirements has developed a baseline for pilot knowledge and is still used by many state transportation agencies, it does not guarantee the UAS expertise needed in surface transportation UAS applications. Throughout the operations of state transportation agencies it became evident that initial, recurrent, and mission-specific training was needed to ensure the efficiency, effectiveness, and safety of UAS operations.

Regulatory Requirements for Certification

The following federal regulations provide the minimum knowledge requirement to obtain a UAS remote pilot certificate. Certification is knowledge-based and no demonstration of skill or record of experience is required under current rules. A Part 107-certified pilot for commercial operations could be an individual who has never flown an sUAS but has simply satisfactorily completed a written test qualifying them to fly an sUAS under 55 pounds, up to 100 mph, and under 400 ft AGL.

14 CFR §107.63 states, in part, the following for issuance of a remote pilot certificate with a small UAS rating:

“An applicant for a remote pilot certificate with a small UAS rating under this subpart must make the application in a form and manner acceptable to the Administrator.

- (a) The application must include either:
 - (1) Evidence showing that the applicant passed an initial aeronautical knowledge test. If applying using a paper application, this evidence must be an airman knowledge test report showing passage of the knowledge test; or
 - (2) If a person holds a pilot certificate (other than a student pilot certificate) issued under part 61 of this chapter and meets the flight review requirements specified in §61.56, a certificate of completion of a Part 107 initial training course.
- (b) If the application is being made pursuant to paragraph (a)(2) of this section:
 - (1) The application must be submitted to the responsible Flight Standards office, a designated pilot examiner, an airman certification representative for a pilot school, a certificated flight instructor, or other person authorized by the Administrator;
 - (2) The person accepting the application submission must verify the identity of the applicant in a manner acceptable to the Administrator; and
 - (3) The person making the application must, by logbook endorsement or other manner acceptable to the Administrator, show the applicant meets the flight review requirements specified in §61.56 of this chapter.”

Training Program Development

To address the level of skill and experience for UAS operators, scan team members and participants have established various flight-specific training requirements for their UAS operators to ensure safe and successful outcomes. This includes such training programs that require demonstration of skill and

experience showing:

- Tier 1 – Meet Part 107 requirements
- Tier 2 – Complete flight with a UAS trainer
- Tier 3 – Conduct solo flight with a UAS aircraft
- Tier 4 – Conduct UAS mission-specific training

Some agencies have developed a training group to maintain proficiency and provide the initial, recurrent, and mission-specific training. Other transportation agencies are contracting outside training professionals to help maintain proficiency and remain current with new technology. Depending on the supplier, some of the districts/offices purchase a training package when they order their UAS. These training packages could range from online training to prepare for the Part 107 remote pilot test to full hands-on training. The training office is able to pay for the study materials to take the FAA Part 107 written test and hands-on training.

The most robust initial and recurrent training programs are at those agencies that have UAS pilots who are also commercial pilots in manned aircraft. Often these pilots are part of the aviation division/department and are aware of standard training practices that have been developed over decades of manned flight. A central location, such as an aviation department within the agency, can give approvals for specific-use cases, ensure FAA compliance, and provide consulting for various divisions or departments within the agency desiring to utilize UASs.

For agencies that have contracted out their UAS flight operations, it is beneficial to be aware of the training requirements for their contractors. Use of outside commercial UAS operators requires oversight to ensure that their pilots are qualified, experienced, and competent to obtain the data that is needed. Often the most effective surface transportation contractors are retired surveyors or photogrammetrists who are now employed by or own an sUAS business. For those contractors with less experience or no significant references, some agencies will initially hire the contractors for small, low-risk jobs and/or require demonstration in safe areas as a way to evaluate proficiency if nothing is known about the vendor's reputation.

In Ohio, there are contractors that are on agency projects using UASs but are not specifically contracted to use these systems. Agencies may put out specifications for data and leave it up to the contractors or vendors on the method they use to complete the requirements. UAS contractor or vendor performance is evaluated using criteria such as:

- Safety on the job
- Data quality
- Cost
- Professionalism
- Quality of operation (e.g., how many “hiccups” there were during data collection)
- Availability
- UAS maintenance plan

Under MnDOT, the following items are required for UAS operations by internal personnel:

- Operators demonstrate their ability to perform the tasks required for the mission in a safe

environment, including exercising the emergency recovery capabilities.

- Pilots are required to fly three flights per quarter to maintain their currency. A qualified and current pilot must supervise pilots that are not current until they meet currency requirements.
- Pilots must be certificated by the FAA. In addition to FAA certification, pilots must demonstrate the ability to fly a UAS of similar design to the UAS they will operate in the field.
- Pilots must complete a mission-qualification flight every two years in addition to any requirements established by the FAA.

Under Ohio DOT, the following are UAS training requirements or considerations:

- Part 107 remote pilot certification with an sUAS rating
- Experience with manually piloting rotorcraft and fixed-wing UAS platforms
- Experience with infrastructure inspections or operations in confined spaces or within close proximity of the intended subject matter
- Experience with crew resource management
- Knowledge of industry formats to support Ohio DOT business functions (i.e., standard industry geographic information system [GIS] data formats, video formats and compression, and thermal data formats)
- Knowledge of industry data processing to support Ohio DOT business functions (i.e., PIX4D⁸⁷, ContextCapture⁸⁸, and AGI Photoscan⁸⁹)
- Experience with GIS software applications (i.e., Google Earth⁹⁰, Esri⁹¹ software, and feature manipulation engines)
- Knowledge of video and 3D software packages (i.e., Blender and Adobe Premiere Pro CC⁹²/Adobe After Effects CC⁹³)
- Knowledge of reading and interpreting thermal data
- Experience with flight planning with software like Mission Planner⁹⁴, DJI GO 4, DJI Ground Station, and senseFly's eMotion

Many scan team members or participants interviewed have similar procedures; some are more mature while others are still at the development stages. NCDOT has additional regulations under training required for operations of UASs (knowledge testing) that require its Division of Aviation to develop and administer a UAS knowledge test for both government and commercial operators that operate in North Carolina (see Figure 3.11 for the NC UAS permit prompt). The test is online and is the first part of the permitting process for commercial operations in North Carolina. The North Carolina commercial operations permit further requires the

⁸⁷ Pix4D SA, <https://www.pix4d.com/>

⁸⁸ SContextCapture, Bentley Systems Incorporated, <https://www.bentley.com/en/products/product-line/reality-modeling-software/contextcapture>

⁸⁹ PhotoScan, Agisoft, <http://www.agisoft.com/>

⁹⁰ Google Earth, Google, <https://www.google.com/earth/>

⁹¹ Esri™, <https://www.esri.com/en-us/home>

⁹² Adobe Premiere Pro CC, Adobe, <https://www.adobe.com/products/premiere.html>

⁹³ Adobe After Effects CC, Adobe, <https://www.adobe.com/products/aftereffects.html>

⁹⁴ Mission Planner, ArduPilot Dev Team, <http://ardupilot.org/planner/>

operator to be 16 years of age, have a valid driver's license, and meet the FAA requirements for a remote pilot operator.



Figure 3.11 NC UAS permit prompt

Standards and Scenario-Based Training

Additional efforts within the UAS industry are being developed. In 2018, ASTM developed the Standard Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement⁹⁵ to help develop training curricula and help individuals raise their knowledge levels for operating sUASs. Others' standards are more mission-specific and include:

- ASTM F3262-17, Standard Classification System for Small Unmanned Aircraft Systems (sUASs) for Land Search and Rescue⁹⁶
- ASTM F3196-18, Standard Practice for Seeking Approval for Beyond Visual Line of Sight (BVLOS) Small Unmanned Aircraft System (sUAS) Operations⁹⁷

Another standards organization, the National Institute of Science and Technology⁹⁸, is developing obstacle avoidance criteria for sUAS skills-based training.

As mentioned previously, mission-based training is also called scenario-based training, which is a training system that uses a structured script of real-world scenarios to address flight-training objectives in an operational environment. Such training can include initial training, transition training, upgrade training, recurrent training, and special training.⁹⁹

Scenario-based instruction is a training method that experienced instructors have used for decades. The variables involved with every UAS flight cannot be predicted; therefore, training must include a wide range of experiences to develop higher order thinking and decision-making skills that include analysis, synthesis,

⁹⁵ ASTM F3266-18: Standard Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement, ASTM International, <https://www.astm.org/Standards/F3266.htm>

⁹⁶ ASTM F3262-17, Standard Classification System for Small Unmanned Aircraft Systems (sUASs) for Land Search and Rescue, ASTM International, <https://www.astm.org/Standards/F3262.htm>

⁹⁷ ASTM F3196-18, Standard Practice for Seeking Approval for Beyond Visual Line of Sight (BVLOS) Small Unmanned Aircraft System (sUAS) Operations, ASTM International, <https://www.astm.org/Standards/F3196.htm>

⁹⁸ National Institute of Standards and Technology, U.S. Department of Commerce, <https://www.nist.gov/>

⁹⁹ Aviation Instructor's Handbook, FAA-H8083-9A, pp 2-6, Federal Aviation Administration, U.S. Department of Transportation, https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/aviation_instructors_handbook/media/FAA-H-8083-9A.pdf

and evaluation (see Figure 3.12). Successful scenario-based training must include the type of operations an sUAS should expect to encounter, such as night operations, flight over people, or complex airspace.

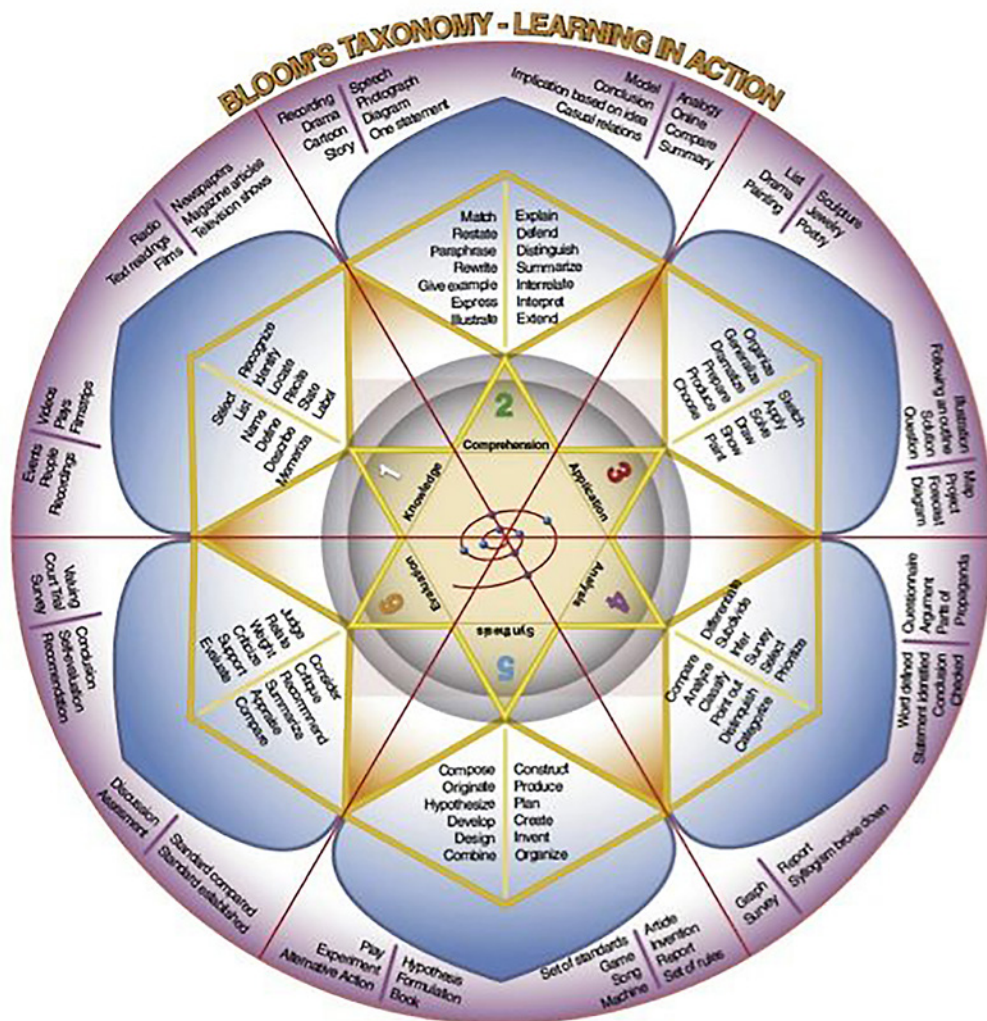


Figure 2-4. Bloom's Taxonomy of the Cognitive Domain.

Figure 3.12 Bloom's Taxonomy - Learning in Action

Key Findings and Observations

Standardized practical training is needed to ensure safety and accurate data collection. Findings from the peer exchange workshop and deliberations of the scan team pointed to the following conclusions.

- Meeting Part 107 minimum requirements is not a guarantee of the UAS expertise needed in surface transportation UAS applications.
- Successful programs:
 - Establish and maintain initial and recurrent training needs for proficiency
 - Tailor training needs to the varied applications of UAS
 - Identify expectations of UAS operations with management

- Use training to educate users on alternate methods of compliance for UAS operations, such as night operations, flight over people, or complex airspace

Public Relations

Outreach programs and education efforts were methods that state transportation agencies utilized when addressing stakeholder and public concerns. The use of sUASs within state transportation agencies intersects with a large variety of people and organizations that are internal and external to the agency. As sUASs are used, the importance of communicating with various stakeholders was of high value and importance. Internal stakeholders included executive leadership, technical staff, state employees, and legislators, while external stakeholders included federal, state, and local entities that could include airports, vendors, and other operators. In California, stakeholders involved with or requesting use of UAS include areas such as public affairs/graphic services, construction, maintenance, environmental, legal, emergency services, and other state agencies.

It was important to have educational and outreach efforts to clearly establish the agency's intentions and help improve the public understanding of UAS activity. These efforts reduce the negative perceptions of those stakeholders who didn't initially support UASs or understand their utility. This educational process included all individuals utilizing the technology as well as public relations personnel communicating to the proper stakeholders the purpose of each flight, safety considerations, and how privacy and compliance with existing laws will be addressed. When interested members of the public approach a research team operating a UAS with the MDOT, a team member not involved with operating the sUAS engages to help explain the project.

Outreach Efforts

Outreach efforts vary between states but were effective when made part of each on-site survey and planned UAS activity. To assist in the outreach effort, the following are examples of questions that would need to be answered by agencies developing their own outreach plan:

- Who might be affected by the UAS operation?
- How will the surrounding community be informed?
- What is the communication or emergency response plan if there is an incident where a person is injured or property damaged?
- How long will the operation be?
- Will there be sufficient noise to distract non-participants or draw attention to the sUAS operation?
- How will the agency ensure that the sUAS operator is not distracted during flight operations?
- What efforts should be made to minimize UAS disruption/concerns?
- Must any permissions be obtained from land owners?
- Do any noise laws, local ordinances, or zoning rules regarding the use of sUASs need to be complied with?
- Who will be the contact point for any the media?
- How will areas be sectioned off to communicate with people that an sUAS is flying?
- How are the images going to be used and protected?
- How long will the images be kept?

UAS informational seminars have been conducted to help the public become more aware. Depending on the visibility of the UAS flights, for smaller rural operations, state transportation agencies may decide to keep a low profile and do less public outreach. When agencies have gone to property owners, it is helpful for personnel to arrive in marked vehicles and be dressed in uniform with proper identification. This professional approach places the public at ease and helps to legitimize activities.

It should be noted that some states have started to use sUASs but have done little to no work on public relations or addressing privacy issues. Collectively this is an area where state transportation agencies can work together to develop the standard operating procedures necessary to affect public perception and reduce risk for any sUAS operation. As a starting point, the FAA and states like North Carolina have developed tools to use to help others to communicate with the public (see Figure 3.13 for an example). As acceptance of sUASs and the number of certified sUAS pilots grow, it is likely greater understanding will develop within the entire community.



Figure 3.13 FAA Know Before You Fly infographic

The North Carolina Division of Aviation set out with a goal to ensure that sUASs flying within the state were flown safely and responsibly. With this goal, North Carolina developed various public relation tools to help to communicate to the UAS community and those impacted by it. Following are resources NCDOT developed; they are useable as is or can be used as a model by other DOTs.

North Carolina Department of Transportation Resources

- UAS Resources
<https://connect.ncdot.gov/resources/Pages/Aviation-Division-Resources.aspx>
- Drone Education Video Compilation
<https://www.youtube.com/watch?v=w1uK-GbrHxY&feature=youtu.be>
- Drone Hobbyist Rules Videos
<https://www.youtube.com/watch?v=npCRgyWdTkM&feature=youtu.be>

- Holiday Hobbyist Video
<https://www.youtube.com/watch?v=2XE-KeHnj5kNCDOT>
- UAS Events
<https://connect.ncdot.gov/resources/Pages/UAS-Events.aspx>
- Permitting Page
<https://www.ncdot.gov/divisions/aviation/uas/Pages/default.aspx>
- Summary of NC UAS Regulations
https://connect.ncdot.gov/resources/Aviation%20Resources%20Documents/UAS_Memo.pdf

Addressing Privacy Concerns

Included in the public's perception of sUASs was a guarantee that their privacy would be maintained. To address privacy concerns, programs included media into work site setup, safety, notice for operation, and on-site interaction during UAS flight.

AMA privacy policy states that, "The use of imaging technology for aerial surveillance with radio control model aircraft having the capability of obtaining high-resolution photographs and/or video, or using any types of sensors, for the collection, retention, or dissemination of surveillance data or information on individuals, homes, businesses, or property at locations where there is a reasonable expectation of privacy is strictly prohibited by the AMA unless written expressed permission is obtained from the individual property owners or managers."

On the Alaska Drones website¹⁰⁰, Alaska provides a public education resource created by Alaska's Unmanned Aircraft Systems Legislative Task Force to raise public awareness of the laws applicable to sUASs. The document explains information operators should "know before you fly," safety guidelines, and current laws that relate to UAS operation; it also provides a set of frequently asked questions addressing the private citizen's rights as well as a common-sense approach for the UAS operator. Frequently asked questions and issues include:

- When does a flying drone breach privacy?
- My neighbor is sunbathing on her deck and my son is flying his drone.
- What if a drone is photographing through my window or hovering around my house?
- The neighbor is chasing my dog with his drone!
- What can I do if the drone's "buzzing" is annoying me?
- I understand why it's not safe to fly a drone near heavy traffic but what about privacy?
- What privacy concerns can there be when you're in a crowd?
- What safety concerns are most prevalent around crowds?
- How will the photos or video be stored or used?
- What happens if a drone captures inadvertent images?

Ohio DOT issues press releases to local media to help disseminate pertinent information. Interested parties can make inquiries by e-mail or telephone; the agency's UAS division has a staff dedicated to addressing these concerns. Ohio DOT's new website (to be rolled out in 2018) will enhance user performance with a public comments section where stakeholders, the public, and other interested parties can sign up to receive

¹⁰⁰ Alaska Drones, Alaska's Unmanned Aircraft Systems Legislative Task Force, <http://www.alaskadrones.org/>

information and to convey concerns, comments, or ideas.

Key Findings and Observations

A thorough public relations plan, including elements such as community outreach and education, as well as a method for addressing public privacy concerns were prominent among invited states. Findings from the peer exchange workshop and scan team deliberations pointed to the following conclusions. Successful programs:

- Have a plan that identifies and addresses target audiences:
 - Internal stakeholders (executive leadership, technical staff, state employees, and legislators)
 - External stakeholders (federal, state, local, university, vendors, public, and airports)
- Identify existing regulations, rules, and policies and positive use of social media, videos, and outreach to educate UAS users (commercial use and hobbyists)
- Include media in worksite setup, addressing privacy, safety, notice for operation, and onsite interaction during UAS flight
- Include the communication office in their ERP

Application and Operation

Scan team members and participants identified various examples of how sUAS were being used to replace or supplement the approved methods of conducting standard operations by surface transportation personnel. Through analysis of these various examples, several key findings were identified as critical elements to be realized or addressed in order to create and sustain a successful program using sUASs. The following section expands on these key findings and concludes by validating the realized usefulness of sUASs by providing several case studies. These case studies were developed by the agency conducting the actual operation. It is our intent to use these findings and case studies to provide a framework that will help:

- All state transportation agencies properly establish their need and justification before purchasing equipment
- In the development of RFP materials when purchasing a UAS, platforms, sensors, and associated software for workflow processes and data analysis
- Provide real-world examples validating the significant benefits of using sUASs within the state transportation agencies

Case studies referencing successful sUAS operations conducted by scan team members and participants include traffic monitoring, traffic flow, visual inspection, job site volumetric documentation, work zone safety, surveying and mapping, environmental studies, bridge inspections, photography, public relations, airport inspections, river channel assessments, confined spaces assessment, and vegetation management. No state transportation agency initially conducted all the case studies listed; each state transportation agency was unique in how it decided to establish its first-use case using sUASs. To begin, identify what is needed and what beneficial information could be obtained by using an sUAS. Successful agencies started small, showing success, documenting processes used and benefits gained, and then used initial-use case successes to grow the utilization of sUAS.

When starting, agencies were able to purchase an sUAS such as the DJI Phantom 4 with standard high-quality imagery and HD video for as little as \$1,500 to \$2,500. Being able to obtain an sUAS at a reasonable entry price point allowed many agencies to justify greater use and expansion by showing the benefits, such as those listed in Figure 3.14. Other programs partnered with universities and other entities conducting research to obtain grants to

purchase an sUAS and sensors to demonstrate their benefits.

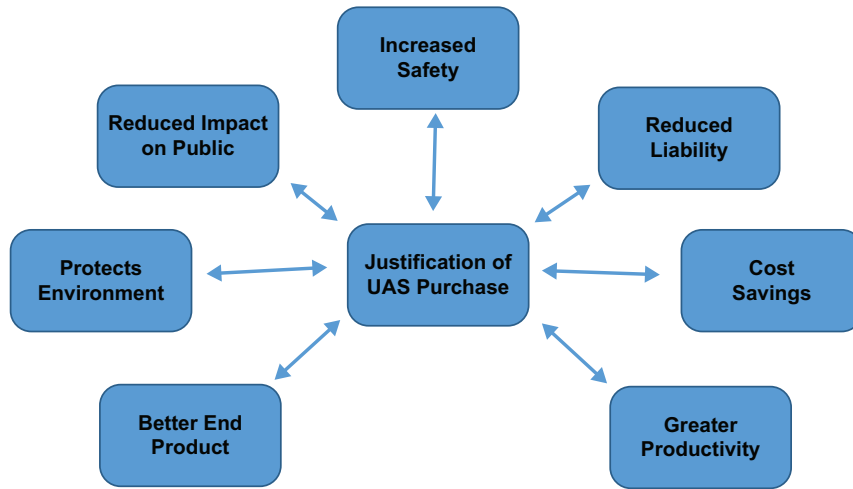


Figure 3.14 Justification of sUAS purchase

The development of initial-use cases from state transportation agencies highlights the need for standard operating procedures, purchased equipment, and measured success resulting in other partner agencies or divisions within the state agencies themselves to seek further use and validation. This creates an environment for success as other agencies desire to share knowledge, skill, and/or equipment, further validating the usefulness of the technology. Successful agencies have begun to develop processes for sharing resources, which is commonly done for larger equipment and areas that require specialized technical skills not related to sUAS operations. Also noteworthy, existing technical experts in transportation agencies, such as land surveyors, photogrammetrists, and aviation specialists have specialized skills that contribute significantly to the successful use of sUASs. These technical experts are already well-trained and experienced in workflow processes for data collection, storage, usage, application development, repurposed use of data collected, safety risk assessments, airspace management, and human factors.

Centralizing technical experts as well as sUAS platforms and sensors provides state transportation agencies with greater cross-utilization, reducing cost and helping standardize the use of UAS technology. Successful programs recognized the importance of purchasing equipment based on systems requirements, as shown in Figure 3.15. The methodology for purchasing included the following rationale: the data or need determined which sensors; the sensors determined the platform.

Decision Process for Acquisition

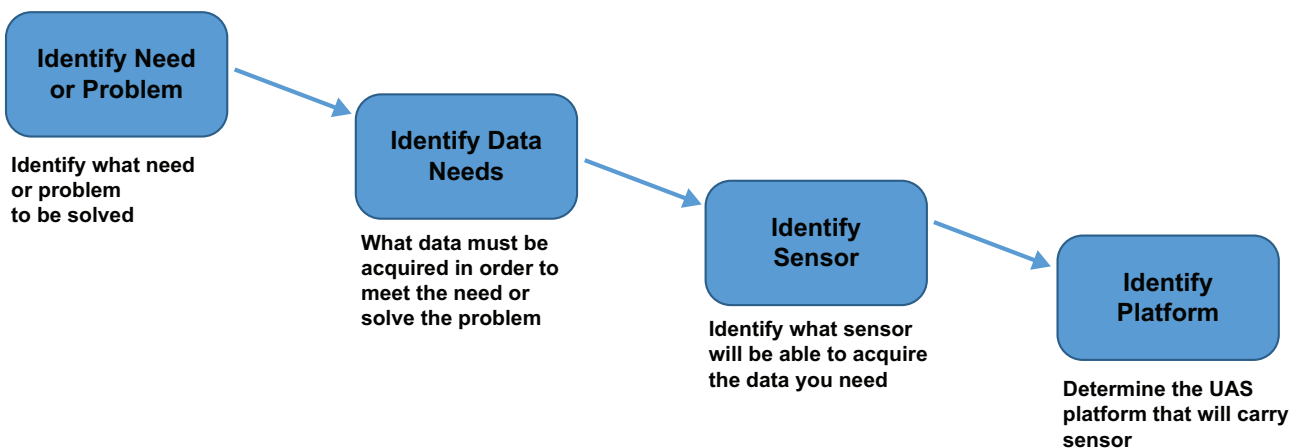


Figure 3.15 Decision process for sUAS acquisition

The graphic illustration Ohio DOT created can further assist transportation agencies in processing various use cases depending on need (see Figure 3.16). This illustration is one example; it should be noted that technology and platforms continue to advance in performance and capability.

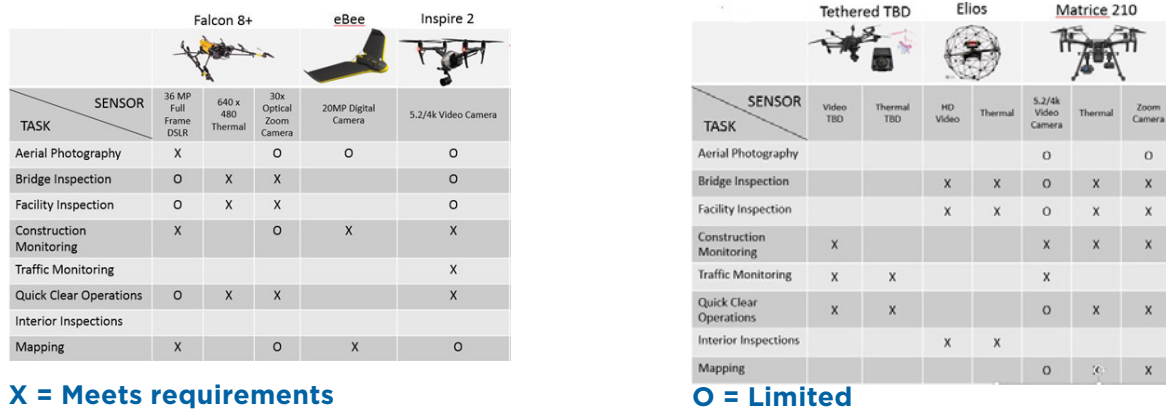


Figure 3.16 Ohio DOT platform and use cases

As previously stated, these case studies were developed by those conducting the actual operation. It is our intent use these findings and case studies to:

- Provide a framework that will help all state transportation agencies properly establish their need and justification before purchasing equipment
- Assist in the development of RFP materials when purchasing a UAS, platforms, sensors, and associated software for workflow processes and data analysis
- Provide real-world examples that validate the significant benefits of using sUASs among state transportation agencies

The following case studies are organized by identifying the need or providing a problem statement, which includes justification on the benefit of UAS use; what was required of the UAS to meet that need; which sensor and platform was selected; and a collection of successes and lessons learned from the case study. Key factors considered when purchasing a UAS were the level of autonomy, safety, ease of use, data transferability, platform capability, recommendations from others, specific features, training, cost, operating cost, post-processing software, familiarity, and customer service.

Key Findings and Observations

A comprehensive operational use plan emerged as essential for implementation of a UAS program. Findings from the peer exchange workshop and scan team deliberations pointed to the following conclusions.

- Each state transportation agency is unique.
 - It is important to recognize data needs vary and should be driven by systems requirements.
- Successful programs:
 - Start small and grow with success
 - Did not require a large investment to get started

- Start small and grow with success
- Did not require a large investment to get started
- Justified UAS use with increased safety, reduced liability, decreased expenditures, greater productivity, better end product, greater protection of the environment, and reduced impact on public
- Followed standard operating procedures
- Leveraged UASs across disciplines and shared UAS assets throughout the state
- Leveraged expertise in UAS operations, including hardware and post-processing software
- Had workflow processes for data collection storage, usage, and application development and repurposed use of the data collected

Case Studies

sUAS Case Study 1: Structure-from-Motion Bridge Inspection



Figure 3.17 Alaska Center of Unmanned Aircraft System Integration point cloud reconstruction (dense structure-from-motion [SfM] techniques)

Need Statement

At 280 feet long, the remote Placer River Bridge in Alaska is the longest clear span, glued-laminated, timber-truss pedestrian bridge in North America. This bridge is only accessible via Alaska Railroad and visual inspections were normally required, forcing inspectors to climb up and rappel under the structure. High-quality imagery with 2 to 3 mm accuracy was needed to properly inspect the bridge. Bridge plans were available to be used for points of reference and to assist with autopilot navigation.

Justification

The risk assessment showed that an sUAS with the proper sensor could conduct the inspection with greater productivity and much more safely than workers on suspended ropes.

Sensor Package

The sensor package included a gyrostabilized Sony NEX-7¹⁰¹ and GoPro¹⁰², which had approximately 20

¹⁰¹ Sony, <https://www.sony.com/electronics/cameras>

¹⁰² GoPro, Inc., <https://gopro.com/>

¹⁰³ FARO Technologies, Inc., <https://www.faro.com/products/construction-bim-cim/faro-focus/>

minutes of flight capability with a live video feed. A FARO¹⁰³ Focus laser scanner was set up in 12 locations.

Platform

ACUASI chose to build a hexacopter called the Ptarmigan based on a COTS DJI S800 aircraft.

Success and Lessons Learned

- An sUAS minimized the time spent on site and increased safety by removing potential points of failure (e.g., suspended platforms, ladders, and harnesses) and potentially dangerous situations from the conventional inspection equation.
- Proposed FAA rules accommodate 90% of U.S. Forest Service sUAS operations across multiple disciplines.
- The cost of using sUAS for project work, such as structure inspections, will decrease as Forest Service sUAS policy evolves and methods mature.
- An sUAS is a higher order data-collection tool that needs to be more effectively utilized by the Forest Service. Data collected included 90 gigabytes and 5000 images, video and laser scans over four hours of total flight time.

Table 1 Summary of Data Acquisition Mission

Type of Data	Sensor Type	No. of Images/Scans	Size (GB)	Note
Imaging	Nikon D800E	2222	34.9	Ground-based imagery
	Sony Alpha NEX-7	2626	24.7	UAS-based imagery
Video	GoPro	10	7.57	-
Laser scanning	FARO Focus ^{3D}	24	4.26	-
3D Point Clouds		5	13.71	-

Figure 3.18 Summary of data capture mission

sUAS Case Study 2: Alaska Avalanche Assessment

Case History

The agency’s sUAS was deployed on two separate occasions over the past winter season. On 9 March 2018 a report was received of a fast moving avalanche at MP 3 Portage Valley Road (Figure 3.19). It was reported within a few hundred feet of the road, which was likely dusted from the air blast. From a safe location, it was estimated—from the photos of the sUAS camera and gimbal—that the slide had stopped between 150 and 200 feet from the road by the trees with no snow on them. The sUAS allows for a reduction in risk by providing an eye in the sky. Without it, good, reliable, real-time information could not have been collected without some risk of further avalanches by going in on skis or snowshoes to investigate.

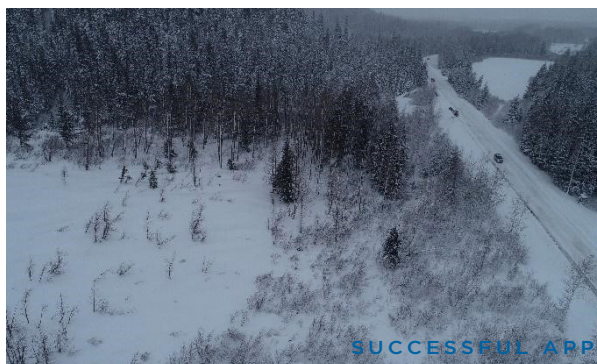


Figure 3.19 Five Sisters avalanche path, Portage Road MP 3

A second occurrence (Figure 3.19) was 19 March 2018, on Marmot Gully 2, Hatcher Pass Road MP 14.9 and 15.1. The sUAS was instrumental in initially investigating the two avalanches that had crossed the road; the investigation was done without exposing personnel to further avalanche hazard. An initial scene size-up was collected and used to determine if anyone or any vehicles were visible from the air.



Figure 3.20 Marmot Gully 2, Hatcher Pass Road MP 14.9 and 15.1

Platform

DJI Phantom 4 Pro

Justification

The sUAS reduced risk and increased safety for the agency’s avalanche crews and equipment operators by getting a bird’s eye view, providing good-quality photos and video to assist in the assessments of many different avalanche-related situations that can arise on the Seward Highway.

Future

The agency is researching the possibility of using sUASs and mapping software with photogrammetry and GIS mapping for their avalanche paths, determining the snow depth in the starting zones, tracks, and run outs during the winter. There are also plans to utilize the sUAS for dud recovery and assist in rescue operations should they arise.

sUAS Case Study 3: Michigan Bridge Inspection

Need Statement

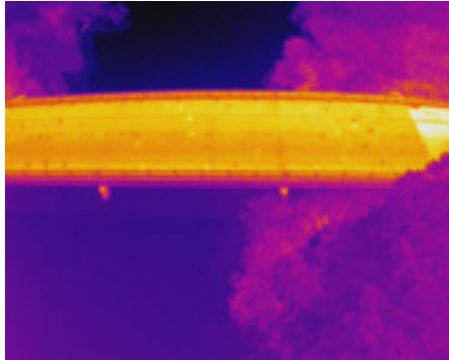
sUAS data were collected along a road corridor of US-31, 14 miles north of Muskegon, MI, including a bridge over the White River. By providing a right-of-way along a road corridor and a bridge, this site helped combine a demonstration of longer-distance monitoring with a bridge survey. The bridge is 169 feet long and 43 feet wide. A 2014 detailed MDOT bridge scoping report indicates that 13.6% of the bridge had delaminations and approximately 300 square feet of concrete patching, for a bridge deck rating of 4 (Poor Condition).

For this site, imagery were collected using the Nikon¹⁰⁴ D810, DJI Phantom 3A, DJI Mavic, FLIR¹⁰⁵ Vue Pro, FLIR Vue Pro R, FLIR Duo, and GoPro Hero3, including traffic video. sUAS data-collection capabilities were deployed

¹⁰⁴ Nikon, Nikon Corporation, <https://www.nikon.com/>

¹⁰⁵ FLIR® Systems, Inc., <https://www.flir.com/>

to demonstrate the efficiencies of rapid, high-quality data sets using these sensory technologies. GIS-based layers created included an optical orthophoto, a digital elevation model, and hillshade were created in post-processing. Thermal orthophotos with both relative temperature values and radiometrically calibrated per-pixel values and an orthomosaic of the underside of the bridge were also created.



**Figure 3.21 Thermal image
FLIR Vue Pro R sensor**



**Figure 3.22 Bergen Hexacopter
shortly after take-off**

Justification

Demonstrated how implementing UAV technologies into MDOT workflows can provide many benefits to the agency and to the motoring public, such as improved safety, cost-effectiveness, operational management, and timely maintenance of the transportation infrastructure.

Sensor Package

A thermal image of the US-31 northbound bridge in Muskegon, MI, was collected with the FLIR Vue Pro R sensor, with different temperatures on the bridge deck potentially indicating defects. Brighter yellow colors are warmer, while darker purple colors are cooler. With the Pro R version, these colors can be turned into per-pixel temperature values, identifying bridge deck spalling and delamination. Data collection was done using thermal imagery of the US-31 road corridor with dual FLIR cameras.

Platform

Bergen¹⁰⁶ Hexacopter Unmanned Aerial Platform, DJI Mavic, and DJI Phantom 3A

Success and Lessons Learned

¹⁰⁶ Bergen R/C Helicopters, <http://www.bergenrc.com/>

Data collection from these sensory technologies have shown the potential benefits of implementing UAV into MDOT workflows. These technologies will help with many transportation management and operations data needs, including providing MDOT with updated methods to collect needed bridge element inspection data, including identifying spalls with optical images and likely delaminations with thermal data.

sUAS Case Study 4: Minnesota Confined Spaces Inspection

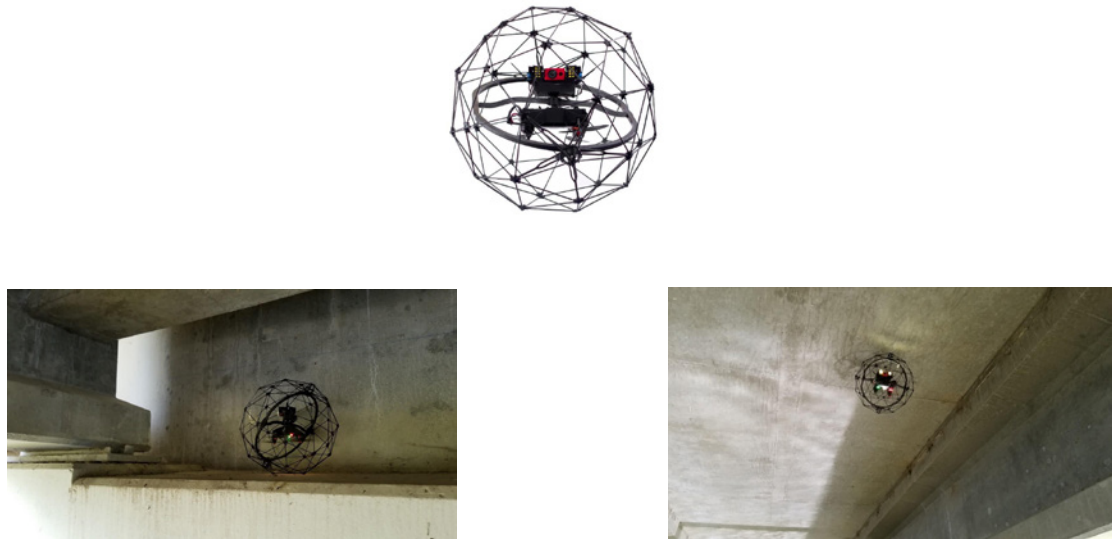


Figure 3.23 Flyability Elios conducting inspections

Need Statement

An opportunity identified during previous MnDOT research was the ability to inspect very tight areas and confined spaces. An important focus of this next phase of research was identification of an sUAS capable of this challenging task. The Flyability¹⁰⁷ Elios was identified and tested extensively on a wide variety of bridges. This collision-tolerant platform solves the issue of accessing those difficult-to-reach areas by employing a cage that tolerates contact with the structure and uses the structure itself to fly and navigate. One case that emerged as valuable to bridge inspection was the ability to fly between beams and through diaphragms. The majority of bridge superstructures are composed of multiple beam lines. These bridges have redundant load paths, making them lower risk compared to other bridge types. Since under-bridge inspection vehicles and traffic control are expensive and tend to be highly restrictive in metropolitan areas, many of these bridges do not get a regular close-up inspection.

Justification

The collision-tolerant UAS provides an effective, safe, and cost-effective way to inspect these bridges. The use of these types of platforms may also reduce the need for expensive access methods and traffic control. Combined with typical inspection-specific drones, such as the senseFly Albris, we can now achieve nearly 100% inspection coverage of a bridge.

Payload/Sensor Package

The payload on the Elios contains an uncooled FLIR thermal camera core (1600x120 at 9 feet per second)

¹⁰⁷ Flyability SA, <https://www.flyability.com/>

with vertical and horizontal degree range of 42 and 56 degrees, respectively, autopilot, system management, wireless communication, Full High Definition (FHD) main camera (1920x1080 at 30 feet per second) with vertical and horizontal degree range of 75 and 130 degrees, respectively, and five arrays of high-efficiency LED lighting. The carbon fiber cage is made of soft coating, modular components and thermoplastic elastomer suspensions for ease of maintenance. The Elios is collision-tolerant, uniform all around up to 3 meters per second on sharp objects and up to 4 m/s on flat objects, and contains a 3-axis gimbal system for stability.

Platform

Flyability Elios

Success and Lessons Learned



Figure 3.24 Elios conducting an inspection inside a steel box beam

Collision Tolerant/Confined Spaces

One of the main objectives in this case was to identify and test a technology that would allow for the inspection of very tight and confined spaces. The team identified and extensively tested the Flyability Elios collision-tolerant sUAS. Multiple applications included several confined-space inspections in steel and concrete box beams and pier towers. Another application that proved very effective was the sUAS's ability to inspect between beams on multibeam bridges. Beam bridges are low risk due to their load path redundancy, so many do not receive a hands-on inspection. In addition, lane closures are undesirable and may be difficult to obtain permission for, especially in busy urban areas. This sUAS may not quite attain the quality of a hands-on inspection since the inspection is by viewing video along with the required visual observer nearby, but the overall effect is a much-improved inspection for a low cost when compared to an inspection that is performed from the ground.

Cost

Bridge inspection costs can be reduced with the use of sUASs. Under-bridge inspection vehicles (UBIVs) cost anywhere from \$500,000 to \$1,000,000 to purchase; rental costs per day range from \$2,000 to \$3,500 with an operator. Inspection-specific platforms equipped with state-of-the-art imaging devices cost anywhere from \$15,000 to \$40,000. Bridge owners should consider the use of this technology where costs can be reduced without a reduction in inspection quality. Traffic control is also expensive and can range from \$500 to \$2,500 per day, which can be reduced or eliminated with sUAS integration.

The overall average cost savings was 40% during this case using both the albris and Elios. Where no cost savings were exhibited, the quality of the deliverables was greatly improved. More difficult to quantify is the cost savings realized where improved data leads to more informed decisions on investments in bridge maintenance, repair, and rehabilitation. While difficult to compute, these cost savings are likely greater than realized with the reduction of expensive access methods and traffic control.

Improved Deliverables/Reality Modeling

Traditional bridge inspection results are typically compiled in a tabular format supplemented with images by low-resolution hand-held cameras. UASs and related processing software give engineers the ability to collect large amounts of data and process it into actionable information. The tabular data consists of bridge inventory items, bridge elements and their quantities, and bridge defects. Utilizing this technology allows inspectors to communicate bridge inspection results in a more graphical manner, which can be easily reviewed and understood by bridge owners and engineers. The tabular data is important and will remain an important part of the inspection deliverables. Communicating the results in a 3D manner allows inspectors to generate better data and gives the inspector the ability to generate more-accurate quantities.

Safety

With over 60 bridges inspected to date and hundreds of flights in Minnesota, this case has demonstrated that the use of sUASs for bridge inspection can reduce safety risks. This is accomplished in two ways. First is the ability to reduce risk by removing or reducing the need for traditional access methods, such as UBIVs, rope access, ladders, and scaffolding. These traditional access methods will still be necessary, but the use of unmanned aircraft can reduce their use to the short term, which reduces risk to bridge inspectors. The second opportunity to reduce risk is the elimination or reduction of traffic control. There is a significant risk to both the public and bridge inspectors when lane and shoulder closures are needed to complete a bridge inspection with traditional access methods such as UBIVs. Compounding this issue is the rise of distracted driving, which increases this risk.

Recommendations

Based on the research work of this phase, the following recommendations are as follows:

- Collision-tolerant sUASs should be considered for confined-space inspections where access and safety can be improved without a reduction in inspection quality.
- Collision-tolerant sUASs should be considered for the inspection of multi-beam bridges, especially when a hands-on inspection is cost-prohibitive and may be prohibited entirely due to access restrictions.
- Unmanned aircraft use should be considered as part of a risk-based approach to bridge inspection where safety, cost, and quality improvements can be realized.
- Reality modeling of bridges is revolutionizing the ways we document and communicate inspection results. Bridge owners should take advantage of this technology to improve their bridge inspection programs.
- Safety risks can be reduced for both inspectors and the public. Much of the focus has been on the safety of flying an sUAS; however, the emphasis should be on reducing the risk of the overall inspection.
- Although related technology has advanced rapidly, the benefits of using sUASs are not being realized due to underutilization. Bridge owners should consider their use when considering

inspection quality, cost savings, and safety.

sUAS Case Study 5: Utah Model-Based Design and Construction

Need Statement

UDOT seeks to find ways to be better stewards of the transportation system by improving its construction processes. Recently these processes have changed to test utilizing model-based design and construction to help eliminate paper plan sets in favor of an intelligent 3D model that can be better utilized for construction. With these changes, new tools were needed to facilitate the change and ensure quality during the construction process.

Justification

As part of this process, sUASs were used to help with inspection, quantities, the as-built model, quality control and assurance to augment existing tools. For the final as-built, the sUAS point cloud was combined with static LiDAR (light detection and ranging) of the roadway surface to provide the highly detailed hybrid 3D model shown in Figure 3.25.

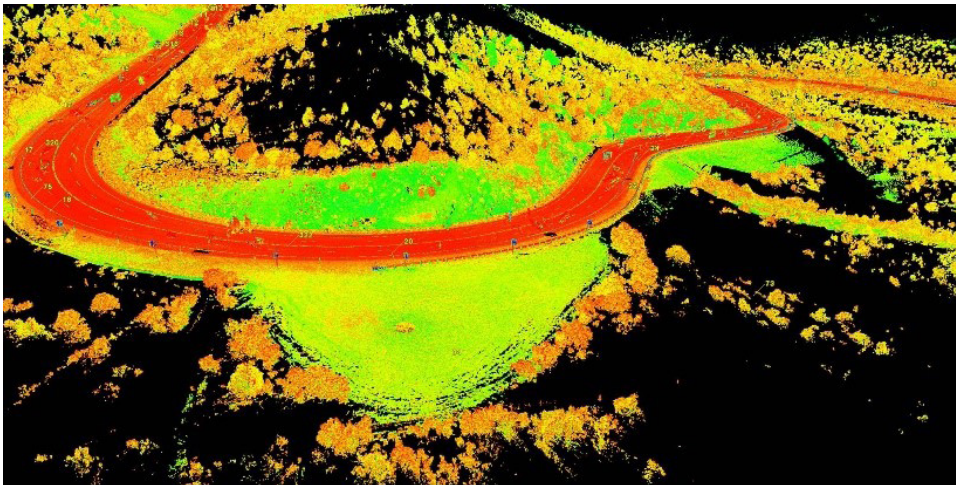


Figure 3.25 Hybrid 3D point cloud SR-20

The ability to get high-resolution imagery and a highly detailed point cloud using UAS technology has allowed for improved data collection at a lower cost. Utilizing model-based design and construction, e-Construction, and UAS technology on the SR-20 project had a direct impact on the project being completed 25 days ahead of schedule, which reduced the impact on the public. In addition, the project had an overall cost savings of \$82,672 (2.58%) and the workforce was 45% more productive than it would have been using conventional tools.

Sensor Package

The senseFly Ebee Plus is equipped with a senseFly S.O.D.A camera. The camera has a 1-inch 20-megapixel RGB (red, green, blue) sensor with a global shutter that can achieve a 2.9-cm/pixel ground-sampling distance flying at 122 meters (400 feet) AGL.

Platform

- senseFly Ebee Plus RTK fixed-wing UAS

- Pix4D software for processing imagery from UAS

Success and Lessons Learned

By utilizing UASs as part of its processes, UDOT was able to gather more-detailed data that enabled it to verify quantities and the project's overall quality. The Ebee was often used because of its ease of use, the low cost, and the speed at which it was able to capture data. This provided a rich data set at a frequency and quality that had never before been achieved on projects. The cost of an sUAS is minimal and can see full return on investment within the first few flights compared with the cost of traditional photogrammetry.

sUAS Case Study 6: Utah point cloud Surveying

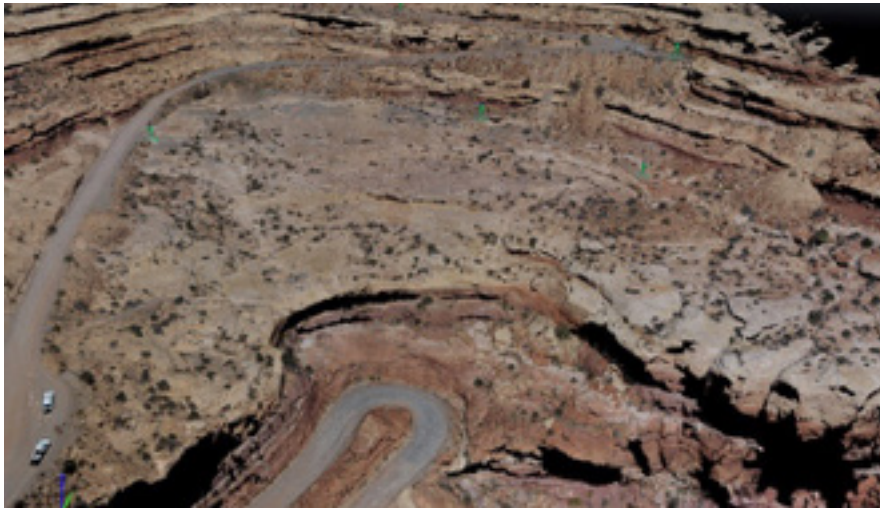


Figure 3.26 3D point cloud of Moki Dugway

Need Statement

Each year an estimated average of 60 employees of state DOTs lose their lives in the line of duty¹⁰⁸. Unfortunately, surveyors have been 38% of in-the-line-of-duty deaths at UDOT. A tool was needed to help supplement the existing tools that surveyors use to allow them to increase their productivity while minimizing their exposure to dangerous situations.

Justification

By utilizing sUASs, UDOT was able to collect high-quality survey data and minimize the time surveyors spent in dangerous situations. sUASs can be used to collect data where it is dangerous or extremely difficult for a person to access, such as in active roadways, riverbeds, unstable landslide areas, steep terrain, and the cliffs such as those shown in Figure 3.26.

Sensor Package

- DJI Phantom 4 -12 megapixel camera
- senseFly Albris TripleView head (HD video, 38MP still, thermal)
- Wingtra¹⁰⁹ One - Sony RX1RII / 35-mm lens, full-frame sensor, 42 MP, RGB

¹⁰⁸ Mendez V, FHWA-HRT-14-005: Guest Editorial: Improving Safety and Mobility for Pedestrians and Bicyclists, Vol 78 No 1, July/August 2014, <https://www.fhwa.dot.gov/publications/publicroads/14julaug/editorsnotes.cfm>

¹⁰⁹ Wingtra, <https://wingtra.com/>

Platform

- DJI Phantom 4
- senseFly Albris
- Wingtra One VTOL fixed-wing UAS

Success and Lessons Learned

Unmanned aircraft can fly lower than traditional aircraft and achieve the same, if not better, quality data at lower cost for small to medium size surveys. Much of the mapping can be completed with automated software to help ensure quality control with minimal training. This produces high-resolution imagery along with high-quality point cloud data that can be used in design to supplement conventional survey tools. By utilizing ground control points, real-time kinematics, or post-processing kinematics it is possible to achieve survey-grade accuracy for deliverables.

Powerful computing hardware is required to process projects larger than 2000 images and is recommended for all processing to increase productivity. A productivity increase of 40% can be seen on areas with steep terrain and low vegetation over conventional survey methods.

4 Recommendations

Examining the preceding key findings and observations, the scan team settled on the following recommendations for new agencies to consider as they pursue unmanned programs of their own. These recommendations are grouped according to the seven major themes introduced earlier in this report.

Executive Support

Several recommendations revolved around ways to cultivate the executive support necessary when proposing a UAS program or application. Programs should only plan to procure a system that is as advanced as necessary for the operation, should show the value of the assets across a variety of disciplines, and “develop a plan for an early win.” Programs should develop metrics by which executives can measure and demonstrate their success and connect these with a media plan to educate stakeholders and the public. Other recommendations included:

- Leverage other state transportation agency successes to promote your initial plans.
- Establish funded projects that directly compare traditional processes with the long-term application of a UAS.
- Develop comprehensive cost-benefit tracking as your UAS assets are utilized.
- Establish industry standard for insurance rates.

Organizational Structure

Each transportation agency should develop a centralized organizational structure for UAS, identifying who is the lead and who has authority to make decisions. Designation of an engaged leader to represent the entire state—and stakeholders—as well as the formation of a UAS steering committee was recommended. The role of such a steering committee might include appropriate stakeholder representation and creation of a strategic plan and policies that are in alignment with the state’s overall plans.

While the applications and geographical locations of UAS operations presented at the workshop varied widely, a centralized authority with top-down support was found to be most effective. The implementation of UASs brings a complex aviation component to surface transportation; traditional pilots and aviation experience and expertise must be available for programs to succeed. Scan team members further recommend that those interested in getting started in unmanned aircraft always have a procurement process prepared to expense out last-minute end-of-year funds should they become available. Other recommendations include:

- Charter a UAS steering committee with appropriate representation and written support from leadership.
- Designate a primary point of contact for managing authorizations with the FAA, keeping up with regulatory changes, and providing consistent communication of changes.
- Establish an organizational structure to centralize all UAS operations.
- Document the benefit of UAS operations to secure funding.

Policy and Regulation

In 2016 the FAA published new regulations within title 14 of CFR §107 and §101. These regulations allow for “... the operation of small unmanned aircraft systems [sUAS] in the National Airspace System ... [and] prohibit model aircraft from endangering the safety of the [NAS].” 14 CFR §107 addressed the operation of sUASs, established a process for issuing certificates to their pilots, and offered waivers to a small subset of the new regulations. By the end of the 2016 calendar year, 22,000 remote pilot certificates with an sUAS rating had been issued, 1,400 waivers had been requested, and 200 waivers had been issued under 14 CFR §107.

Today, the policy and regulation of UAS continue to develop and evolve nearly monthly. Examples within 2017 include:

- April – The FAA’s establishment of airspace restrictions for unmanned aircraft over 133 military facilities
- May – The Federal Court of Appeals ruling to lift a regulatory requirement to register model aircraft
- September – A similar airspace restriction by the FAA for unmanned aircraft over 10 Department of the Interior sites
- October – Announcement of the UAS Integration Pilot Program
- December – Establishment of statutory authority for the FAA to require registration of model aircraft

In addition to knowledge of the federal statutes and regulations above, the scan team recognizes the need for departmental policies on the topic of unmanned aircraft. It has been recommended that transportation agencies develop or adopt policies that include the following:

- Identify who is allowed to fly unmanned assets
- Specifically prohibit work-related use of personal model aircraft
- Identify personnel requirements for UAS operations as well as procedures for securing and utilizing federal airspace authorizations
- Establish normal and emergency procedures, checklists, and aircraft operational manuals
- Establish allowances for delivered data (based on industry standards) and standards by which vendors may be contracted to provide flight or post-processing services

Safety and Risk Management

Over decades of improvements and lessons learned, the aviation industry has recognized the tremendous value of having a positive safety culture and related risk-management processes in place to reduce risk to the lowest practical level. As unmanned aircraft continue to integrate with the job functions of DOT surface transportation personnel, it is critical that these same principles are fostered and developed with the UAS surface transportation personnel operating the sUAS. It is the team’s recommendation that each state utilize key aviation personnel with aviation experience within the DOT to effectively assist in completing the following:

- Develop a system to manage safety within the organization that integrates UAS operations. In this development, consider assigning a UAS steering committee member who has aviation experience to address these concerns.

-
- Promote the use of UAS in surface transportation to reduce risk and improve safety.
 - Confirm that the insurance policy is reviewed to ensure proper UAS coverage for internal and external operators.
 - Ensure DOT policies adequately assess safety and risk for the pilot and public when operating unmanned aircraft.
 - Conduct a safety culture survey to measure the current safety culture and use the survey's results to develop a plan to create or improve the safety culture.

Training and Crew Qualifications

The primary purpose of using an unmanned aircraft is to collect data. The collection of this data requires knowledge, skill, and aeronautical decision-making. Operators of unmanned aircraft must be proficient and be expected to maintain that proficiency. The following recommendations are critical to maintain proper training and crew qualifications:

- Establish flight-specific training requirements for all UAS operators to ensure safe and successful outcomes. This includes developing tiered initial and recurrent training for proficiency, which may include the following tiers:
 - Tier 1 – Meet Part 107 requirements
 - Tier 2 – Complete flight with a UAS trainer
 - Tier 3 – Conduct solo flight with a UAS aircraft
 - Tier 4 – Conduct UAS mission-specific training
- Harness the expertise of DOTs that have successfully developed training programs.
- Conduct regular training and refresher training programs to ensure compliance with regulations and policy.

Public Relations

Public relations is critical to the success of your program. You must identify your internal and external audiences and determine how your organization will communicate and respond. Key recommendations to assist your organization in getting started include:

- Have an ERP that includes quick media response. During an emergency, the ERP will establish proper protocols for contacting key personnel to disseminate information and react to the event.
- Engage your community of users through diverse media channels.
- Develop a public relations plan considering your target audience(s).
- Include media relations personnel in UAS site setup. Be consistent in your level of visibility (low or high) and the message you want to deliver.
- Promote existing privacy regulations as sufficient to protect the public; no new UAS privacy laws are needed.

Application and Operations

As previously stated, a comprehensive operational use plan is essential for implementing a UAS program. An effective operation identifies use cases to begin operations and develops operational procedures specific to each organization's UAS mission. Operational recommendations to get started include:

- Harness the expertise of DOTs that have successfully acquired alternative methods for UAS operations (i.e., waivers, exceptions, and authorizations).
- Purchase equipment based on systems requirements. The data determines which sensors; the sensors determine the platform.
- Develop workflow processes for data collection, storage, usage, and application development.
- Document and share use cases among state agencies. Use cases shared included:
 - Traffic monitoring
 - Traffic flow
 - Visual inspection
 - Job site volumetric documentation
 - Work zone safety
 - Surveying and mapping
 - Environmental
 - Bridge inspection
 - Photography
 - Public relations
 - Airport inspection
 - River channel assessments
 - Confined spaces assessment
 - Vegetation management

Overall, the invited and host state DOT agencies have collectively developed significant use cases for sUASs, which supplement their surface transportation efforts. Future sUAS programs among state transportation agencies should consider further validation of these applications with rigorous cost-benefit analysis as well as investigation of whether sUAS data can be suitable for meeting industry standards.



5 Implementation Strategies

Several approaches are being utilized to disseminate the information accumulated as part of this scan's peer exchange workshop; this is being done in coordination with CTC & Associates¹¹⁰. These approaches include possible presentations at meetings and events sponsored by potential stakeholders, such as AASHTO, the Intelligent Transportation Society of America¹¹¹, InterDrone, and the National Association of State Aviation Officials¹¹². In addition to these presentations, peer to peer workshops, webinars, articles, training, and research are anticipated.

¹¹⁰ CTC & Associates LLC, <https://ctcandassociates.com/>

¹¹¹ Intelligent Transportation Society of America (ITS America), <https://www.itsa.org/>

¹¹² National Association of State Aviation Officials, <http://www.nasao.org/>

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Appendix A: Scan Team Biographical Sketches

EMANUEL BANKS (AASHTO Chair) is the deputy director and chief engineer of the Arkansas Department of Transportation. His current responsibilities consist of overseeing all engineering activities for the department, which includes the administrative oversight for the three engineering branches—planning, design, and operations—and providing assistance in public and intergovernmental activities. He began his full-time career with the agency in December 1987 as a civil engineer and has held various positions over his 30-year career. Banks has a bachelor's degree in civil engineering from the University of Arkansas at Fayetteville and is a registered professional engineer.

STEVEN J. COOK is the engineer of operations and maintenance for the Michigan Department of Transportation at the Operations Field Services Division in Lansing. He has 35 years of infrastructure engineering-related experience, including design; construction; maintenance; operations; and ITS/connected vehicle research, development, and deployment. He directs and manages the Systems Operations and Maintenance Field Services Section, which has statewide responsibilities for maintenance operations, transportation systems operations strategic planning and deployment, incident management, congestion and mobility modeling, the traffic signal program, ITS/connected vehicle programs, and related operations/maintenance and mobility research needs. He is the agency's project manager for the UAS research/deployment and provides technical assistance and statewide policy regarding the use of UAS. Cook is a member of both the AASHTO Committee on Transportation System Operations and the AASHTO Committee on Maintenance; he has participated on several NCHRP projects throughout his career. He is a graduate of Michigan State University, where he earned a bachelor's degree in civil engineering, and he holds a master's degree in business administration from Northwood University. He is a licensed professional engineer in Michigan.

GREGG FREDRICK is the chief engineer for the Wyoming Department of Transportation. He oversees the planning, engineering, and construction programs responsible for the delivery of the state's transportation improvement program. He also oversees the operational aspects (i.e., safety, maintenance, traffic, facilities, and equipment) of the state's assets. He is a member of the AASHTO Transportation Policy Forum, the Council on Highways and Streets, and he is the chairman of the Committee on Bridges and Structures, a position he has held since 2012. Frederick earned his bachelor's degree in civil engineering with a structural emphasis from the University of Wyoming, is a licensed professional engineer in Wyoming, and is a private pilot.

SHAYNE GILL (AASHTO Liaison) is the program director for multimodal transportation at AASHTO. He is the liaison for the organization's Council on Aviation, which has primary jurisdiction as lead on coordination of state departments of transportation use of unmanned aerial systems. Gill's work in policy and government relations includes almost 12 years of legislative experience as Congressional staff on Capitol Hill.

JAMES S. GRAY currently serves as the UAS and construction technology engineer on the Construction Management Team within the Office of Infrastructure for the Federal Highway Administration. Since joining FHWA in 2006, Gray has held positions as a project engineer and a construction operations engineer with the Eastern Federal Lands Division. Prior to working with FHWA, he worked for the Michigan Department of Transportation. Gray holds a master's degree in business administration from Pennsylvania State University and a bachelor's degree in civil engineering from Michigan State University. He is a licensed professional engineer in Michigan.

TROY LARUE is the statewide Aviation Division operations manager for the Alaska Department of Transportation and Public Facilities. He started his career with the department in 1997 as an equipment operator at the Dutch Harbor airport. LaRue has worked as an equipment operator, airport manager, and district superintendent, before assuming his current position as division operations manager. He supervises

three aviation sections that manage the airport capital improvement program for 240 airports, airport property management, aviation policy, aviation system planning, and airport operations and security. LaRue has also been tasked with forming a UAS steering committee to establish operating standards for the department. He is a certified member of AAAE and has over two decades of airport experience.

JEFF L. MILTON serves as the bridge preservation specialist for the Structure and Bridge Division of the Virginia Department of Transportation. He has over 43 years of experience with the agency and his work has included the program areas of bridge design, bridge construction support, bridge load rating, bridge safety inspection, bridge maintenance and preservation, and project and program management. In his current position, Milton serves as a Structure and Bridge Division program manager for the division's bridge maintenance and preservation programs. He has a bachelor's degree in civil engineering technology from the Central Virginia Community College. Jeff holds the qualification as a program manager under the requirements of the National Bridge Inspection Standards. He was one of the authors of the Domestic Scan proposal titled, "Defining State DOT Needs for Unmanned Aerial Systems for Bridge Condition Assessment." Jeff is also a member of the Society for Protective Coatings and the American Society of Highway Engineers.

AMY TOOTLE is the state construction engineer at the Florida Department of Transportation. In this position she oversees a technical staff of 11 specialists and engineers who develop construction policies and procedures for the department. For the past five years she has been leveraging technology to not only become paperless statewide on construction projects but advancing new technologies to increase efficiency and make our work zones a safer environment for all who enter them. She began her career in the private sector, working as both a design consultant and field engineer. Since joining the Florida Department of Transportation in the fall of 2010, she has held various positions in central office. She is a member of the AASHTO Committee on Construction and is vice chair of its Integrated Construction Technology Technical Subcommittee. She is also a member of the TRB Standing Committee on Construction Management. Tootle is a registered civil professional engineer and a 1999 graduate of the University of Florida.

PAUL WHEELER is part of the Technology Advancement Team, serving as the lead unmanned aerial systems coordinator at the Utah Department of Transportation. He has worked in many capacities within the agency for the past 20 years as a survey technology advisor, lead of the 3D visualization group, computer-aided design and drafting support specialist, and construction surveyor. He is an instrument-rated private pilot and is working on fostering innovation through the use of unmanned aircraft systems.

PAUL R. SNYDER (CO-SUBJECT MATTER EXPERT) is an active partner of Dubuque-Snyder Aviation Consulting, established in 2006. The company specializes in fleet aircraft acquisition, overall program evaluation, and safety management systems. At the University of North Dakota, he is an assistant professor, the chief flight instructor, and the director of the UAS program for the Aviation Department. Snyder holds a bachelor's degree in aeronautical studies, and a master's degree in educational leadership. He teaches courses in Introduction to UAS, Advanced UAS Operations, Safety Management Systems, and various advanced flight-instructor courses. Snyder is a member of the Association for Unmanned Vehicle Systems International, ASTM International, and the University Aviation Association. He is currently supporting several state and federal research projects related to unmanned aircraft systems, which includes safety risk management, detect and avoid, beyond visual line of sight, power line inspections, and human factors.

ZACHARY P. WALLER (CO-SUBJECT MATTER EXPERT) is an assistant professor at the University of North Dakota and director of research for the university's Aviation Department. Holding a bachelor's degree in aeronautics and a master's degree in aviation, Waller currently teaches a number of courses related to unmanned aircraft at the undergraduate level. He maintains a commercial pilot certificate with instrument and multiengine ratings and has developed unmanned curriculum with the Air Force Research Lab as well as CAE Inc. Waller is a member of the publishing board for the Journal of Unmanned Aerial

APPENDIX A : SCAN TEAM BIOGRAPHICAL SKETCHES

Systems and an active reviewer for the International Journal of Aviation, Aeronautics, and Aerospace. He is a member of the Great Plains AUVSI Chapter and supports several state and federal research efforts examining the unmanned aircraft industry, policy, and regulation. He contributed to proposal efforts resulting in the award of both the Northern Plains UAS Test Site to the North Dakota Department of Commerce in 2013 and the Alliance for System Safety of UAS through Research Excellence as the FAA UAS Center of Excellence in 2015. Waller is currently involved in research regarding beyond visual line of sight with UAS, power line component inspection using UAS, and UAS use by surface transportation agencies and is pursuing a PhD in education foundations and research.



APPENDIX B : SCAN TEAM CONTACT INFORMATION

Appendix B: Scan Team Contact Information

APPENDIX B : SCAN TEAM CONTACT INFORMATION

Emanuel Banks, AASHTO Chair

Deputy Director/ Chief Engineer
Arkansas Department of Transportation
10324 I-30
Little Rock, AR 72209
Phone: (501) 569-2214
E-mail: emanuel.banks@ardot.gov

Steven J. Cook, P.E.

Engineer of Operations & Maintenance
Michigan Department of Transportation
6333 Lansing Road
Lansing, MI 48917
Phone: (517) 636-4094
E-mail: cooks9@michigan.gov

Gregg Fredrick

Chief Engineer
Wyoming Department of Transportation
5300 Bishop Blvd.
Cheyenne, WY 82009-3340
Phone: (307) 777-4484
E-mail: gregg.fredrick@wyo.gov

Shayne Gill (AASHTO Liaison)

Program Director for Multimodal Transportation
American Association of State Highway and Transportation Officials
444 N. Capitol Street, NW, Suite 249
Washington, DC 20001
Phone: (202) 624-3630
E-mail: sgill@aaashto.org

James Gray

UAS and Construction Technology Engineer
FHWA Office of Infrastructure
Construction Management Team
Federal Highway Administration
Phone: (703) 509-3464
E-mail: james.gray@dot.gov

Troy Larue

Division Operations Manager
Alaska Department of Transportation
Phone: (907) 269-0730
E-mail: troy.larue@alaska.gov

Jeff L. Milton

Bridge Preservation Specialist
Structure and Bridge Division
Virginia Department of Transportation
4219 Campbell Avenue
Lynchburg, VA 24501
Phone: (434) 856-8278
E-mail: jeffrey.milton@vdot.virginia.gov

Amy Tootle

State Construction Engineer
Florida Department of Transportation
605 Suwannee Street
Tallahassee, FL 32399-0450
Phone: (850) 414-4364
E-mail: amy.tootle@dot.state.fl.us

Paul Wheeler

Lead UAS Coordinator
Technology Advancement
Utah Department of Transportation
4501 South 2700 West
Salt Lake City, UT 84129
PO Box 148470,
Salt Lake City, UT 84114-8470
Phone: (801) 965-4700
Phone: (801) 633-9998
E-mail: pwheeler@utah.gov

Paul R. Snyder (Co-Subject Matter Expert)

Director of UAS Program
Dubuque-Snyder Aviation Consulting
Assistant Professor
University of North Dakota
1811 17th Street NE
Grand Forks, ND 58203
Phone: (218) 791-4161
E-mail: prsnyder08@gmail.com

Zachary Waller (Co-Subject Matter Expert)

Director of Research for the Aviation Department
Dubuque-Snyder Aviation Consulting
Assistant Professor
University of North Dakota
1811 17th Street NE
Grand Forks, ND 58203
Phone: (218) 205-0722,
E-mail: zwaller@aero.und.edu

Appendix C: Amplifying Questions

UAS Platform and Features Selection

1. **Describe the UAS and related features (i.e. sensors, software, attached devices) your Agency is using.**
 - a. Are the sensors interchangeable between any or all of your UAS platforms?
 - b. Explain how you chose each platform and related features.
 - c. Did you purchase all UAS platforms and features at once or over time?
2. **Describe how each UAS platform and features are being utilized within your Agency. If utilized within multiple disciplines, please explain individually.**
 - a. What about the current platform or features is meeting your expectations?
 - i. What current practice did the UAS platform or features replace or supplement?
 - b. What about the current platform or features is not meeting your expectations?
 - c. What lessons have you learned regarding the choice of a platform or features?
 - d. What lessons have you learned regarding actual deployment of UAS?
 - i. Barriers?
 - ii. Opportunities?
 - e. Are you considering the purchase of any new, emerging technology related to UAS?
 - i. If yes, what is preventing you from purchasing?
3. **What factors made you purchase the UAS platform(s) and features you are currently using?**
 - a. Level of autonomy?
 - b. Data transfer ability?
 - c. Availability of features for particular need?
 - d. Platform capability?
 - e. Familiarity?
 - f. Training availability?
 - g. Ease of use?
 - h. Recommendation from other agency?
 - i. Cost?
 - j. Other?

Funding

1. **If your agency owns the UAS platform:**
 - a. How did you budget for initial use and each year thereafter?
 - i. Fixed costs
 1. Insurance?
 2. Depreciation
 2. Depreciation?
 3. Hardware (initial and maintenance)?
 4. Training?
 5. Licenses?
 6. Other
 - ii. Variable costs
 7. Battery
 8. Fuel
 9. Mx
 10. Software/hardware upgrades
 11. Data storage
 12. Other

-
- b. What was your initial funding source to get UAS started?
 - i. Expense
 - ii. Work program
 - iii. Legislative budget request
 - iv. Grants
 - v. Other
 - c. What is the ongoing funding source?
 - i. Expense
 - ii. Work Program
 - iii. Legislative Budget Request
 - iv. Grants
 - v. Other
 - d. Why did you choose these funding sources?
 - e. How flexible are the funds?

Operations of UAS

1. **Who owns the UAS platform(s) and features you are using? Who flies/operates the UAS you are using?**
 - a. If you are contracting the UAS resource:
 - i. Could we possibly have a copy of the agreement?
 - ii. How did you choose the contractor?
 - iii. What is the cost structure for use of UAS resources?
2. **What is your flight completion rate? (i.e., how often are flights Mx or Wx)**
3. **How is the data collected by the UAS being stored short term and long term?**
 - a. What reporting is being done? Who is it shared with? How?
4. **How has real-time data been coordinated, processed and communicated?**
5. **With limited funding, how is project selection and sequencing prioritized for optimal benefit to users?**
6. **What up front preparation needs to be accomplished before each flight?**
 - a. Notifications?
 - b. Flight patterns?
7. **How long does your UAS Platform remain airborne before needing fuel/charging?**
8. **Was your UAS used for improving bridge element condition state assessment within the agency? If so,**
 - a. How is data collected?
 - b. How is data stored?
 - c. How is data processed and used?
 - i. Once data collected is there any information regarding comparison of results to currently accepted practices?

Quality Assurance and Quality Control

1. **What training or certification is required and preferred to qualify individuals in the use of UAS resources?**
2. **What training is provided by non-pilots on how to best utilize platforms and sensors?**
3. **How do your operators maintain currency/proficiency regarding UAS? What are the standards?**
4. **How are your UAS operators evaluated on their performance?**

5. Do you have standard operating procedures for use of UAS (internal and external)?
6. What is your emergency response plan should you encounter an accident or incident with the UAS?
7. What maintenance requirements are maintained for your UAS to consider it in an airworthy condition?
8. What insurance requirements must you have for the operator? Aircraft?
9. How is your aircraft insured?

Public Relations

1. How do you inform and engage political and business leaders regarding your efforts? What are the risks and opportunities based on their perceptions?
2. What are the challenges with public outreach and engagement for using a UAS? How have these challenges been met?
3. How do you engage with those who live or work near where your UAS is being operated?
4. How do intermodal planning and projects result in cost savings? To whom? Why?

Legislation and Policy

1. What are individual states and local governments doing from a legislative standpoint?
 - a. Policies/procedures and regulations
 - b. Are they aligned with FAA laws/policies?
2. How is use of UAS being policed in your state?
 - a. Active work zones with traffic and workers
3. What governmental partnerships/collaborations have been formed to help coordinate the use of UAS?
4. Are you aware of any type of task forces regarding how they are used with public property?

Performance Measures/Lessons Learned

1. What are the significant benefits you are seeing by using UAS in agency?
2. What are the negative effects of using UAS in the agency?
3. How does your organization assess the viability or success of using the UAS resources?
4. What metrics do you use to measure a successful UAS program?
5. What metrics does your supervisors use to measure a successful use of UAS?
6. What performance measures are in place?
7. Who has ownership or responsibility for performance measures? What tools, forecasting models or programs do you use to estimate performance benefits? Are after-measurements conducted? If so, how close are the results to the forecasts?
8. What advice do you have for others in selecting and implementing a UAS or multiple UAS?
9. How long did it take until you saw results for your efforts?
10. What has gone well?
11. What do you see as your greatest success to date?
12. What would you do differently next time?
13. Is there anything else that you would like to tell us that is not cover in your answers the above questions?



Appendix D: Workshop Agenda and Invited Participants

APPENDIX D : WORKSHOP AGENDA AND INVITED PARTICIPANTS

	Monday 9-Apr	Tuesday 10-Apr	Wednesday 11-Apr	Thursday 12-Apr	Friday 13-Apr
8 am – 12 noon	Introduction	Georgia Presentation	Minnesota Presentation	Utah Presentation	Scan team final meeting (scan team only)
	FHWA UAS efforts Alaska Presentation	Iowa Presentation	New Jersey Presentation	AASHTO – The Survey and Transportation TV story Group discussion	
1 pm – 6 pm	California Presentation	Kentucky Presentation	North Carolina Presentation	Group discussion	
	Colorado Presentation	Michigan Presentation	Ohio Presentation		
	Daily Wrap up	Daily Wrap up	Daily Wrap up	Daily up	


State	Contact Info
Alaska	Catherine F. Cahill, Ph.D. Director Alaska Center for UAS Integration Geophysical Institute University of Alaska Fairbanks Fairbanks, AK 99775 Phone: 907-474-6905 Email: cfcahill@alaska.edu
California	Gary Cathey Chief, Division of Aeronautics California Department of Transportation Phone: (916) 654-5183 Email: gary.cathey@dot.ca.gov
California	Samer Momani Certified Remote Pilot –D7 Environmental California Department of Transportation Phone: 213-897-2777 Email: samer.momani@dot.ca.gov
California	Kourosh Langari Certified Remote Pilot –D4 Surveys California Department of Transportation Phone: (510) 286-5313 Email: kourosh.langari@dot.ca.gov
California	Patrick Piacentini Structures Maintenance and Investigations California Department of Transportation Phone: 916-227-9769 Email: patrick.piacentini@dot.ca.gov
Colorado	Beau Taylor Geologist/Physical Scientist II Geohazards and Geotechnical Programs 4670 Holly St., Unit A, Denver, CO 80216 Colorado DOT Phone: 303.398.6588 Fax: 303.398.6504 Email: Beau.Taylor@state.co.us
Georgia	Robert P. Maguire, ASC UAS Program Manager Georgia Department of Transportation 600 W. Peachtree St. NW, 2nd Floor, Atlanta, GA 30308 Phone: (404) 631-1311 Fax: (404) 631-1935 Email: bomaguire@dot.ga.gov
Iowa	Tim McClung Planning and Outreach Manager Office of Aviation Iowa DOT 800 Lincoln Way Ames, IA 50010 Phone: 515-239-1689 Email: tim.mcclung@iowadot.us

APPENDIX D : WORKSHOP AGENDA AND INVITED PARTICIPANTS

State	Contact Info
Kentucky	Glenn Anderson, PE UAS Engineer Kentucky Department of Aviation 90 Airport Road Frankfort, KY 40601 Phone: 502-564-3389 Email: Glenn.Anderson@ky.gov
Kentucky	Robert Cammack Environmental and Energy Cabinet Abandoned Mine Lands Division Kentucky Department of Aviation Phone: 502-782-6334 Email: Robert.Cammack@ky.gov
Michigan	Colin Brooks Michigan Tech Research Institute 3600 Green Court, Suite 100 Ann Arbor, Michigan 48105 Phone: 734-913-6858 Emails: cnbrooks@mtu.edu
Michigan	Rick Dobson Michigan Tech Research Institute 3600 Green Court, Suite 100 Ann Arbor, Michigan 48105 Phone: 734-913-6872 Emails: rjdobson@mtu.edu
Minnesota	Rick Braunig UAS, Aviation Safety and Enforcement Transportation Program Supervisor Minnesota Department of Transportation Phone: 651-234-7230 Email: rick.braunig@state.mn.us
Minnesota	Jennifer L. Wells, P.E. Metro Bridge Programming/Inspection (Mobility) Minnesota Department of Transportation Phone: 651-470-6832 Email: jennifer.wells@state.mn.us
Minnesota	Adam Smith, CP, GISP Project Manager Photogrammetrics Unit Minnesota Department of Transportation 395 John Ireland Blvd, MS 640 St. Paul, MN 55155 Phone: 951-366-3479 Email: adam.smith@state.mn.us
New Jersey	Glenn Stott, ATP UAS Program Manager New Jersey Department of Transportation Multi Modal, Bureau of Aeronautics 1035 Parkway Avenue, PO Box 600 Trenton, NJ 08625-0600 Phone: (609) 530-2900 Email: glenn.stott@dot.nj.gov

State	Contact Info
North Carolina	Basil Yap UAS Program Manager Division of Aviation North Carolina Department of Transportation 1050 Meridian Drive Morrisville, NC, 27560 Phone: 919-814-0572 Email: bkyap@ncdot.gov
North Carolina	Thomas M Walls Data Analyst North Carolina Department of Transportation Email: tmwalls@ncdot.gov
North Carolina	Darshan Divakaran UAS Program Engineer Division of Aviation North Carolina Department of Transportation 1050 Meridian Drive, Morrisville, NC, 27560 Phone: 919-814-0584 Email: ddivakaran@ncdot.gov
Ohio	Fred Judson, GISP UAS Director of Programs Ohio DOT UAS Center 4170 Allium Ct., Springfield, Ohio 45505 Phone: 419.373.4497 Email: fred.judson@dot.state.oh.us
Utah	Riley Lindsay Land Surveyor Utah DOT Phone: 435 893-4732 Email: rlindsay@utah.gov

Appendix E: Certificates of Waiver or Authorization

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION	
CERTIFICATE OF WAIVER OR AUTHORIZATION	
ISSUED TO Ohio Department of Transportation	
Attn: Fred Judson 317 E. Poe Rd. Bowling Green, OH 43402	
This certificate is issued for the operations specifically described hereinafter. No person shall conduct any operation pursuant to the authority of this certificate except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.	
OPERATIONS AUTHORIZED Operation of the Swinglet CAM Unmanned Aircraft System (UAS) in Class G airspace, at or below 250 feet Above Ground Level (AGL), in the vicinity of Williams County, OH, as depicted in Attachment 1, under the jurisdiction of Toledo Terminal Radar Approach Control (TRACON). See Special Provisions.	
LIST OF WAIVED REGULATIONS BY SECTION AND TITLE N/A	
STANDARD PROVISIONS	
1. A copy of the application made for this certificate shall be attached and become a part hereof. 2. This certificate shall be presented for inspection upon the request of any authorized representative of the Federal Aviation Administration, or of any State or municipal official charged with the duty of enforcing local laws or regulations. 3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein. 4. This certificate is nontransferable.	
Note-This certificate constitutes a waiver of those Federal rules or regulations specifically referred to above. It does not constitute a waiver of any State law or local ordinance.	
SPECIAL PROVISIONS	
Special Provisions are set forth and attached.	
This certificate 2012-CSA-84 effective from December 21, 2012 through December 20, 2014 and is subject to cancellation at any time upon notice by the Administrator or his/her authorized representative.	
BY DIRECTION OF THE ADMINISTRATOR	
<u>FAA Headquarters, AJV-115</u> <small>(Region)</small>	 <u>Douglas Gould</u> <small>(Signature)</small>
<u>December 19, 2012</u> <small>(Date)</small>	<u>Air Traffic Manager, Unmanned Aircraft Systems</u> <small>(Title)</small>

COA Number: 2012-CSA-84

Issued To: Ohio Department of Transportation, referred herein as the “proponent”

Address: Attn: Fred Judson
317 E. Poe Rd.
Bowling Green, OH 43402

Activity: Operation of the Swinglet CAM Unmanned Aircraft System (UAS) in Class G airspace, at or below 250 feet Above Ground Level (AGL), in the vicinity of Williams County, OH, as depicted in Attachment 1, under the jurisdiction of Toledo Terminal Radar Approach Control (TRACON).

Purpose: To prescribe UAS operating requirements in the National Airspace System (NAS) for the purpose of operational flights.

Dates of Use: This COA is valid from December 21, 2012 through December 20, 2014. Should a renewal become necessary, the proponent shall advise the Federal Aviation Administration (FAA), in writing, no later than 60 business days prior to the requested effective date.

Public Aircraft

1. A public aircraft operation is determined by statute, 49 USC §40102(a)(41) and §40125.
2. All public aircraft flights conducted under a COA must comply with the terms of the statute.
3. All flights must be conducted per the declarations submitted on COA on-line.

STANDARD PROVISIONS

A. General.

The review of this activity is based upon current understanding of UAS operations and their impact in the NAS. This COA will not be considered a precedent for future operations. (As changes in or understanding of the UAS industry occur, limitations and conditions for operations will be adjusted.)

All personnel connected with the UAS operation must read and comply with the contents of this authorization and its provisions.

A copy of the COA including the special limitations must be immediately available to all operational personnel at each operating location whenever UAS operations are being conducted.

This authorization may be canceled at any time by the Administrator, the person authorized to grant the authorization, or the representative designated to monitor a specific operation. As a general rule, this authorization may be canceled when it is no longer required, there is an abuse of its provisions, or when unforeseen safety factors develop. Failure to comply with the authorization is cause for cancellation. The proponent will receive written notice of cancellation.

During the time this COA is approved and active, a site safety evaluation/visit may be accomplished to ensure COA compliance, assess any adverse impact on ATC or airspace, and ensure this COA is not burdensome or ineffective. Deviations, accidents/incidents/mishaps, complaints, etc will prompt a COA review or site visit to address the issue. Refusal to allow a site safety evaluation/visit may result in cancellation of the COA. Note: This section does not pertain to agencies that have other existing agreements in place with the FAA.

B. Airworthiness Certification.

The unmanned aircraft must be shown to be airworthy to conduct flight operations in the NAS. The Ohio Department of Transportation has made its own determination that the Swinglet CAM unmanned aircraft is airworthy. The Swinglet CAM must be operated in strict compliance with all provisions and conditions contained in the Airworthiness Safety Release, including all documents and provisions referenced in the COA application.

1. A configuration control program must be in place for hardware and/or software changes made to the UAS to ensure continued airworthiness. If a new or revised Airworthiness Release is generated as a result of changes in the hardware or software affecting the operating characteristics of the UAS, notify the UAS Integration Office of the changes as soon as practical.

- a. Software and hardware changes should be documented as part of the normal maintenance procedures. Software changes to the aircraft and control station as well as hardware system changes are classified as major changes unless the agency has a formal process, accepted by the FAA. These changes should be provided to the UAS Integration office in summary form at the time of incorporation.
 - b. Major modifications or changes, performed under the COA, or other authorizations that could potentially affect the safe operation of the system must be documented and provided to the FAA in the form of a new AWR, unless the agency has a formal process, accepted by the FAA.
 - c. All previously flight proven systems to include payloads, may be installed or removed as required, and that activity recorded in the unmanned aircraft and ground control stations logbooks by persons authorized to conduct UAS maintenance Describe any payload equipment configurations in the UAS logbook that will result in a weight and balance change, electrical loads, and or flight dynamics, unless the agency has a formal process, accepted by the FAA.
 - d. For unmanned aircraft system discrepancies, a record entry should be made by an appropriately rated person to document the finding in the logbook. No flights may be conducted following major changes, modifications or new installations unless the party responsible for certifying airworthiness has determined the system is safe to operate in the NAS and a new AWR is generated, unless the agency has a formal process, accepted by the FAA. The successful completion of these tests must be recorded in the appropriate logbook, unless the agency has a formal process, accepted by the FAA.
2. The Swinglet CAM must be operated in strict compliance with all provisions and conditions contained within the spectrum analysis assigned and authorized for use within the defined operations area.
 3. All items contained in the application for equipment frequency allocation must be adhered to, including the assigned frequencies and antenna equipment characteristics. A ground operational check to verify the control station can communicate with the aircraft (frequency integration check) must be conducted prior to the launch of the unmanned aircraft to ensure any electromagnetic interference does not adversely affect control of the aircraft.
 4. The use of a Traffic Collision Avoidance System (TCAS) in any mode while operating an unmanned aircraft is prohibited.

C. Operations.

1. Unless otherwise authorized as a special provision, a maximum of one unmanned aircraft will be controlled:
 - a. In any defined operating area,

- b. From a single control station, and
 - c. By one pilot at a time.
2. A Pilot-in-Command (PIC) is the person who has final authority and responsibility for the operation and safety of flight, has been designated as PIC before or during the flight, and holds the appropriate category, class, and type rating, if appropriate, for the conduct of the flight. The responsibility and authority of the PIC as described by 14 CFR 91.3, Responsibility and Authority of the Pilot-in-Command, apply to the unmanned aircraft PIC. The PIC position may rotate duties as necessary with equally qualified pilots. The individual designated as PIC may change during flight. **Note:** The PIC can only be the PIC for one aircraft at a time. For Optionally Piloted Aircraft (OPA), PIC must meet UAS guidance requirements for training, pilot licensing, and medical requirements when operating OPA as a UAS.
3. The PIC must conduct a pre-takeoff briefing as applicable prior to each launch. The briefing should include but is not limited to the
- a. Contents of the COA,
 - b. Altitudes to be flown,
 - c. Mission overview including handoff procedures,
 - d. Frequencies to be used,
 - e. Flight time, including reserve fuel requirements,
 - f. Contingency procedures to include lost link, divert, and flight termination, and
 - g. Hazards unique to the flight being flown.

Note: Flight Crew Member (UAS). In addition to the flight crew members identified in 14 CFR Part 1, Definitions and Abbreviations, an Unmanned Aircraft System flight crew members include pilots, sensor/payload operators, and visual observers and may include other persons as appropriate or required to ensure safe operation of the aircraft.

4. All operations will be conducted in compliance with Title 14 CFR Part 91. Special attention should be given to:
- a. § 91.3 Responsibility and authority of the pilot in command
 - b. § 91.13 Careless or reckless operation
 - c. § 91.17 Alcohol or drugs
 - d. § 91.103 Preflight Actions
 - e. § 91.111 Operating near other aircraft.
 - f. § 91.113 Right-of-way rules: Except water operations
 - g. § 91.115 Right-of-way rules: Water operations
 - h. § 91.119 Minimum safe altitudes: General
 - i. § 91.123 Compliance with ATC clearances and instructions.

- j. § 91.133 Restricted and prohibited areas
 - k. § 91.137 Temporary flight restrictions in the vicinity of disaster/hazard areas
 - l. § 91.145 Management of aircraft operations in the vicinity of aerial demonstrations and major sporting events
 - m. § 91.151 Fuel requirements for flight in VFR conditions
 - n. § 91.155 Basic VFR weather minimums
 - o. § 91.159 VFR cruising altitude or flight level
 - p. § 91.209 Aircraft Lights
 - q. § 91.213 Inoperative instruments and equipment
 - r. § 91.215 ATC transponder and altitude reporting equipment and use
 - s. Appendix D to Part 91 — Airports/Locations: Special Operating Restrictions
5. Unless otherwise authorized as a special provision, all operations must be conducted in visual meteorological conditions (VMC) during daylight hours in compliance with Title 14 of the Code of Federal Regulations (CFR) Part 91 §91.155 and the following:
6. Special Visual Flight Rules (VFR) operations are not authorized.
- a. VFR cloud clearances specified in 14 CFR Part 91 §91.155, must be maintained, except in Class G airspace where Class E airspace visibility requirements must be applied, but not less than 3 statute miles (SM) flight visibility and 1000' ceiling.
 - b. Flights conducted under Instrument Flight Rules (IFR) in Class A airspace shall remain clear of clouds. NOTE: Deviations from IFR clearance necessary to comply with this provision must have prior ATC approval.
 - c. Chase aircraft must maintain 5 NM flight visibility.
7. Night operations are prohibited unless otherwise authorized as a special provision.
8. Operations (including lost link procedures) must not be conducted over populated areas, heavily trafficked roads, or an open-air assembly of people.

D. Air Traffic Control (ATC) Communications.

- 1. The pilot and/or PIC will maintain direct, two-way communication with ATC and have the ability to maneuver the unmanned aircraft in response to ATC instructions, unless addressed in the Special Provision Section.
 - a. When required, ATC will assign a radio frequency for air traffic control during flight. The use of land-line and/or cellular telephones is prohibited as the primary means for in-flight communication with ATC.

2. The PIC must not accept an ATC clearance requiring the use of visual separation, sequencing, or visual approach.
3. When necessary, transit of airways and routes must be conducted as expeditiously as possible. The unmanned aircraft must not loiter on Victor airways, jet routes, Q and T routes, IR routes, or VR routes.
4. For flights operating on an IFR clearance at or above 18,000 feet mean sea level (MSL), the PIC must ensure positional information in reference to established National Airspace System (NAS) fixes, NAVAIDs, and/or waypoints is provided to ATC. The use of latitude/longitude positions is not authorized, except oceanic flight operations.
5. If equipped, the unmanned aircraft must operate with
 - a. An operational mode 3/A transponder with altitude encoding, or mode S transponder (preferred) set to an ATC assigned squawk
 - b. Position/navigation and anti-collision lights on at all times during flight unless stipulated in the special provisions or the proponent has a specific exemption from 14 CFR Part 91.209.
6. Operations that use a Global Positioning System (GPS) for navigation must check Receiver Autonomous Integrity Monitoring (RAIM) notices prior to flight operations. Flight into a GPS test area or degraded RAIM is prohibited for those aircraft that use GPS as their sole means for navigation.

E. Safety of Flight.

1. The proponent or delegated representative is responsible for halting or canceling activity in the COA area if, at any time, the safety of persons or property on the ground or in the air is in jeopardy, or if there is a failure to comply with the terms or conditions of this authorization.
2. ATC must be immediately notified in the event of any emergency, loss and subsequent restoration of command link, loss of PIC or observer visual contact, or any other malfunction or occurrence that would impact safety or operations.
3. Sterile Cockpit Procedures.
 - a. Critical phases of flight include all ground operations involving
 - (1) Taxi (movement of an aircraft under its own power on the surface of an airport)
 - (2) Take-off and landing (launch or recovery)
 - (3) All other flight operations in which safety or mission accomplishment might be compromised by distractions
 - b. No crewmember may perform any duties during a critical phase of flight not required for the safe operation of the aircraft.

- c. No crewmember may engage in, nor may any PIC permit, any activity during a critical phase of flight which could
 - (1) Distract any crewmember from the performance of his/her duties or
 - (2) Interfere in any way with the proper conduct of those duties.
 - d. The pilot and/or the PIC must not engage in any activity not directly related to the operation of the aircraft. Activities include, but are not limited to, operating UAS sensors or other payload systems.
 - e. The use of cell phones or other electronic devices is restricted to communications pertinent to the operational control of the unmanned aircraft and any required communications with Air Traffic Control.
4. See-and-Avoid.
- Unmanned aircraft have no on-board pilot to perform see-and-avoid responsibilities; therefore, when operating outside of active restricted and warning areas approved for aviation activities, provisions must be made to ensure an equivalent level of safety exists for unmanned operations. Adherence to 14 CFR Part 91 §91.111, §91.113 and §91.115, is required.
- a. The proponent and/or delegated representatives are responsible at all times for collision avoidance with all aviation activities and the safety of persons or property on the surface with respect to the UAS.
 - b. UAS pilots will ensure there is a safe operating distance between aviation activities and unmanned aircraft at all times.
 - c. Any crew member responsible for performing see-and-avoid requirements for the UA must have and maintain instantaneous communication with the PIC.
 - d. UA operations will only be conducted within Reduced Vertical Separation Minimum (RVSM) altitudes, when appropriately equipped or having received a clearance under an FAA deviation. **NOTE:** UA operations should not plan on an en-route clearance in RVSM altitudes, without being RVSM equipped.
 - e. Visual observers must be used at all times except in Class A, airspace, active Restricted Areas, and Warning areas designated for aviation activities.
 - (1) Observers may either be ground-based or in a chase plane.
 - (2) If the chase aircraft is operating more than 100 feet above/below and/or more than ½ NM laterally of the unmanned aircraft, the chase aircraft PIC will advise the controlling ATC facility.
 - f. The PIC is responsible to ensure visual observers are;
 - (1) Able to see the aircraft and the surrounding airspace throughout the entire flight, and

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- (2) Able to provide the PIC with the UA's flight path, and proximity to all aviation activities and other hazards (e.g., terrain, weather, structures) sufficiently to exercise effective control of the UA to:
 - (a) Comply with CFR Parts 91.111, 91.113 and 91.115, and
 - (b) Prevent the UA from creating a collision hazard.
5. Observers must be able to communicate clearly to the pilot any instructions required to remain clear of conflicting traffic, using standard phraseology as listed in the Aeronautical Information Manual when practical.
6. A PIC may rotate duties as necessary to fulfill operational requirements; a PIC must be designated at all times.
7. Pilots flying chase aircraft must not concurrently perform observer or UA pilot duties.
8. Pilot and observers must not assume concurrent duties as both pilot and observer.
9. The required number of ground observers will be in place during flight operations.
10. The use of multiple successive observers (daisy chaining) is prohibited unless otherwise authorized as a special provision.
11. The dropping or spraying of aircraft stores, or carrying of hazardous materials (including ordnance) outside of active Restricted, Prohibited, or Warning Areas approved for aviation activities is prohibited unless specifically authorized as a special provision.

F. Crewmember Requirements.

1. All crewmembers associated with the operation of the unmanned aircraft, including chase operations, must be qualified or must be receiving formal training under the direct supervision of a qualified instructor, who has at all times, responsibility for the operation of the unmanned aircraft.
2. Pilots and observers must have an understanding of, and comply with, Title 14 Code of Federal Regulations, and/or agency directives and regulations, applicable to the airspace where the unmanned aircraft will operate.
3. Pilots, supplemental pilots, and observers must maintain a current second class (or higher) airman medical certificate that has been issued under 14 CFR Part 67, or an FAA accepted agency equivalent based on the application.
4. At a minimum, the use of alcohol and/or drugs in violation of 14 CFR Part 91 §91.17 applies to UA pilots and observers.

5. At a minimum, observers must receive training on rules and responsibilities described in 14 CFR Part 91 §91.111, §91.113 and §91.115, regarding cloud clearance, flight visibility, and the pilot controller glossary, including standard ATC phraseology and communication.
6. Recent Pilot Experience (Currency). The proponent must provide documentation, upon request, showing the pilot/supplemental pilot/PIC maintains an appropriate level of recent pilot experience in either the UAS being operated or in a certified simulator. At a minimum, he/she must conduct three takeoffs (launch) and three landings (recovery) in the specific UAS within the previous 90 days (excluding pilots who do not conduct launch/recovery during normal/emergency operations). If a supplemental pilot assumes the role of PIC, he/she must comply with PIC rating requirements.
7. A PIC and/or supplemental pilot have the ability to assume the duties of an internal or an external UAS pilot at any point during the flight.
8. A PIC may be augmented by supplemental pilots.
9. PIC Ratings.

Rating requirements for the UAS PIC depend on the type of operation conducted. The requirement for the PIC to hold, at a minimum, a current FAA private pilot certificate or the FAA accepted agency equivalent, based on the application of 14 CFR Part 61, is predicated on various factors including the location of the planned operations, mission profile, size of the unmanned aircraft, and whether or not the operation is conducted within or beyond visual line-of-sight.

 - a. The PIC must hold, at a minimum, a current FAA private pilot certificate or the FAA accepted agency equivalent, based on the application or 14 CFR Part 61.under all operations:
 - (1) Approved for flight in Class A, B, C, D, E, and G (more than 400 feet above ground level (AGL)) airspace
 - (2) Conducted under IFR (FAA instrument rating required, or the FAA accepted agency equivalent, based on the application or 14 CFR Part 61
 - (3) Approved for night operations
 - (4) Conducted at or within 5 NM of a joint use or public airfields
 - (5) Requiring a chase aircraft
 - (6) At any time the FAA has determined the need based on the UAS characteristics, mission profile, or other operational parameters
 - b. Operations without a pilot certificate may be allowed when all of the following conditions are met:
 - (1) The PIC has successfully completed, at a minimum, FAA private pilot ground instruction and passed the written examination, or the FAA accepted agency equivalent, based on the application. Airman Test reports are valid for the 24-

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calendar month period preceding the month the exam was completed, at which time the instruction and written examination must be repeated.

- (2) Operations are during daylight hours.
 - (3) The operation is conducted in a sparsely populated location.
 - (4) The operation is conducted from a privately owned airfield, military installation, or off-airport location.
 - (5) Operations are approved and conducted solely within visual line-of-sight in Class G airspace.
 - (6) Visual line-of-sight operations are conducted at an altitude of no more than 400 feet Above Ground Level (AGL) in class G airspace at all times.
- c. The FAA may require specific aircraft category and class ratings in manned aircraft depending on the UAS seeking approval and the characteristics of its flight controls interface.

10. PIC Recent Flight Experience (Currency).

- a. For those operations that require a certificated pilot or FAA accepted agency equivalent, based on the application, the PIC must have flight reviews 14 CFR Part 61.56, and if the pilot conducts takeoff, launch, landing or recovery the PIC must maintain recent pilot experience in manned aircraft per 14 CFR Part 61.57,; Recent Flight Experience: Pilot in Command. .
- b. For operations approved for night or IFR through special provisions, the PIC must maintain minimum recent pilot experience per 14 CFR Part 61.57, Recent Flight Experience: Pilot in Command, as applicable.

11. Supplemental Pilot Ratings.

- a. Supplemental pilots must have, at a minimum, successfully completed private pilot ground school and passed the written test or the FAA accepted agency equivalent, based on the application. The ground school written test results are valid for two years from the date of completion, at which time the instruction and written examination must be repeated. If a supplemental pilot assumes the role of PIC, he/she must comply with PIC rating, currency, medical, and training requirements listed in this document.

12. Ancillary personnel such as systems operators or mission specialists must be thoroughly familiar with and possess operational experience of the equipment being used. If the systems being used are for observation and detection of other aircraft for collision avoidance purposes, personnel must be thoroughly trained on collision avoidance procedures and techniques and have direct communication with the UAS pilot, observer, and other crewmembers.

13. The Agency will ensure that Crew Resource Management (CRM) training is current for all crew members before flying operational or training missions. The CRM program

must consist of initial training, as well as CRM recurrent training during every recurrent training cycle, not to exceed a 12 month interval between initial training and recurrent training or between subsequent recurrent training sessions.

G. Notice to Airmen (NOTAM).

1. A distance (D) NOTAM must be issued when unmanned aircraft operations are being conducted. This requirement may be accomplished
 - a. Through the proponent's local base operations or NOTAM issuing authority, or
 - b. By contacting the NOTAM Flight Service Station at 1-877-4-US-NTMS (1-877-487-6867) not more than 72 hours in advance, but not less than 48 hours prior to the operation, unless otherwise authorized as a special provision. The issuing agency will require the:
 - (1) Name and address of the pilot filing the NOTAM request
 - (2) Location, altitude, or operating area
 - (3) Time and nature of the activity.
2. For proponents filing their NOTAM with the Department of Defense: The requirement to file with an Automated Flight Service Station (AFSS) is in addition to any local procedures/requirements for filing through the Defense Internet NOTAM Service (DINS).

H. Data Reporting.

1. Documentation of all operations associated with UAS activities is required regardless of the airspace in which the UAS operates. This requirement includes COA operations within Special Use airspace. NOTE: Negative (zero flights) reports are required.
2. The proponent must submit the following information through UAS COA On-Line on a monthly basis:
 - a. The number of flights conducted under this COA. (A flight during which any portion is conducted in the NAS must be counted only once, regardless of how many times it may enter and leave Special Use airspace between takeoff and landing)
 - b. Aircraft operational hours per flight
 - c. Ground control station operational hours in support of each flight, to include Launch and Recovery Element (LRE) operations
 - d. Pilot duty time per flight
 - e. Equipment malfunctions (hardware/software) affecting either the aircraft or ground control station
 - f. Deviations from ATC instructions and/or Letters of Agreement/Procedures
 - g. Operational/coordination issues

- h. The number and duration of lost link events (control, vehicle performance and health monitoring, or communications) per aircraft per flight.

I. Incident/Accident/Mishap Reporting.

Immediately after an incident or accident, and before additional flight under this COA, the proponent must provide initial notification of the following to the FAA via the UAS COA On-Line forms (Incident/Accident).

1. All accidents/mishaps involving UAS operations where any of the following occurs:
 - a. Fatal injury, where the operation of a UAS results in a death occurring within 30 days of the accident/mishap
 - b. Serious injury, where the operation of a UAS results in a hospitalization of more than 48 hours, the fracture of any bone (except for simple fractures of fingers, toes, or nose), severe hemorrhage or tissue damage, internal injuries, or second or third-degree burns
 - c. Total unmanned aircraft loss
 - d. Substantial damage to the unmanned aircraft system where there is damage to the airframe, power plant, or onboard systems that must be repaired prior to further flight
 - e. Damage to property, other than the unmanned aircraft.
2. Any incident/mishap that results in an unsafe/abnormal operation including but not limited to
 - a. A malfunction or failure of the unmanned aircraft's on-board flight control system (including navigation)
 - b. A malfunction or failure of ground control station flight control hardware or software (other than loss of control link)
 - c. A power plant failure or malfunction
 - d. An in-flight fire
 - e. An aircraft collision
 - f. Any in-flight failure of the unmanned aircraft's electrical system requiring use of alternate or emergency power to complete the flight
 - g. A deviation from any provision contained in the COA
 - h. A deviation from an ATC clearance and/or Letter(s) of Agreement/Procedures
 - i. A lost control link event resulting in
 - (1) Fly-away, or
 - (2) Execution of a pre-planned/unplanned lost link procedure.

3. Initial reports must contain the information identified in the COA On-Line Accident/Incident Report.
4. Follow-on reports describing the accident/incident/mishap(s) must be submitted by providing copies of proponent aviation accident/incident reports upon completion of safety investigations. Such reports must be limited to factual information only where privileged safety or law enforcement information is included in the final report.
5. Public-use agencies other than those which are part of the Department of Defense are advised that the above procedures are not a substitute for separate accident/incident reporting required by the National Transportation Safety Board under 49 CFR Part 830 §830.5.
6. This COA is issued with the provision that the FAA be permitted involvement in the proponent's incident/accident/mishap investigation as prescribed by FAA Order 8020.11, Aircraft Accident and Incident Notification, Investigation, and Reporting.

FLIGHT STANDARDS SPECIAL PROVISIONS

A. Contingency Planning

1. **Point Identification.** The proponent must submit contingency plans that address emergency recovery or flight termination of the unmanned aircraft (UA) in the event of unrecoverable system failure. These procedures will normally include Lost Link Points (LLP), Divert/Contingency Points (DCP) and Flight Termination Points (FTP) for each operation. LLPs and DCPs must be submitted in latitude/longitude (Lat/Long) format along with a graphic representation plotted on an aviation sectional chart (or similar format). FTPs or other accepted contingency planning measures must also be submitted in latitude/longitude (Lat/Long) format along with a graphic representation plotted on an aviation sectional chart, or other graphic representation acceptable to the FAA. The FAA accepts the LLPs, DCPs, FTPs, and other contingency planning measures, submitted by the proponent but does not approve them. When conditions preclude the use of FTPs, the proponent must submit other contingency planning options for consideration and approval. At least one LLP, DCP, and FTP (or an acceptable alternative contingency planning measure) is required for each operation. The proponent must furnish this data with the initial COA application. Any subsequent changes or modifications to this data must be provided to AJV-13 for review and consideration no later than 30 days prior to proposed flight operations.
2. **Risk Mitigation Plans.** For all operations, the proponent must develop detailed plans to mitigate the risk of collision with other aircraft and the risk posed to persons and property on the ground in the event the UAS encounters a lost link, needs to divert, or the flight needs to be terminated. The proponent must take into consideration all airspace constructs and minimize risk to other aircraft by avoiding published airways, military training routes, NAVAIDs, and congested areas. In the event of a contingency divert or flight termination, the use of a chase aircraft is preferred when the UAS is operated

outside of Restricted or Warning Areas. If time permits, the proponent should make every attempt to utilize a chase aircraft to monitor the aircraft to a DCP or to the FTP. In the event of a contingency divert or flight termination, the proponent will operate in Class A airspace and Special Use airspace to the maximum extent possible to reduce the risk of collision with non-participating air traffic.

a. LLP Procedures.

- (1) LLPs are defined as a point, or sequence of points where the aircraft will proceed and hold at a specified altitude, for a specified period of time, in the event the command and control link to the aircraft is lost. The aircraft will autonomously hold, or loiter, at the LLP until the communication link with the aircraft is restored or the specified time elapses. If the time period elapses, the aircraft may autoland, proceed to another LLP in an attempt to regain the communication link, or proceed to an FTP for flight termination. LLPs may be used as FTPs. In this case, the aircraft may loiter at the LLP/FTP until link is re-established or fuel exhaustion occurs.
- (2) For areas where multiple or concurrent UAS operations are authorized in the same operational area, a segregation plan must be in place in the event of a simultaneous lost link scenario. The segregation plan may include altitude offsets and horizontal separation by using independent LLPs whenever possible.

b. DCP Procedures.

- (1) A DCP is defined as an alternate landing/recovery site to be used in the event of an abnormal condition that requires a precautionary landing. Each DCP must incorporate the means of communication with ATC throughout the descent and landing (unless otherwise specified in the Special Provisions) as well as a plan for ground operations and securing/parking the aircraft on the ground. This includes the availability of ground control stations capable of launch/recovery, communication equipment, and an adequate power source to operate all required equipment.
- (2) For local operations, the DCP specified will normally be the airport/facility used for launch and recovery; however, the proponent may specify additional DCPs as alternates.
- (3) For transit and/or mission operations that are being conducted in Class A airspace or Class E airspace above flight level (FL)-600, DCPs will be identified during the flight to be no further than one hour of flight time at any given time, taking into consideration altitude, winds, fuel consumption, and other factors. If it is not possible to define DCPs along the entire flight plan route, the proponent must identify qualified FTPs along the entire route and be prepared to execute flight termination at one of the specified FTPs if a return to base (RTB) is not possible.
- (4) It is preferred that specified DCPs are non-joint use military airfields, other government-owned airfields, or private-use airfields. However, the proponent may designate any suitable airfield for review and consideration.

c. Flight Termination Procedures.

- (1) Flight termination is the intentional and deliberate process of performing controlled flight into terrain (CFIT). Flight termination must be executed in the event that all contingencies have been exhausted and further flight of the aircraft cannot be safely achieved or other potential hazards exist that require immediate discontinuation of flight. FTPs or alternative contingency planning measures must be located within power off glide distance of the aircraft during all phases of flight and must be submitted for review and acceptance. The proponent must ensure sufficient FTPs or other contingency plan measures are defined to accommodate flight termination at any given point along the route of flight. The location of these points is based on the assumption of an unrecoverable system failure and must take into consideration altitude, winds, and other factors.
- (2) Unless otherwise authorized, FTPs must be located in sparsely populated areas. Except for on- or near-airport operations, FTPs will be located no closer than five nautical miles from any airport, heliport, airfield, NAVAID, airway, populated area, major roadway, oil rig, power plant, or any other infrastructure. For offshore locations, the proponent must refer to appropriate United States Coast Guard (USCG) charts and other publications to avoid maritime obstructions, shipping lanes, and other hazards. Populated areas are defined as those areas depicted in yellow on a VFR sectional chart or as determined from other sources.
 - (a) It is preferred that flight termination occurs in Restricted or Warning Areas, government-owned land, or offshore locations that are restricted from routine civil use. However, the proponent may designate any suitable location for review and consideration.
 - (b) The proponent is required to survey all designated areas prior to their use as an FTP. All FTPs will be reviewed for suitability on a routine and periodic basis, not to exceed six months. The proponent assumes full risk and all liability associated with the selection and use of any designated FTP.
 - (c) It is desirable that the proponent receive prior permission from the land owner or using agency prior to the use of this area as an FTP. The proponent should clearly communicate the purpose and intent of the FTP.
 - (d) For each FTP, plans must incorporate the means of communication with ATC throughout the descent as well as a plan for retrieval/recovery of the aircraft.
 - (e) Contingency planning must take into consideration all airspace constructs and minimize risk to other aircraft by avoiding published airways, military training routes, NAVAIDs, and congested areas to the maximum extent possible.
 - (f) In the event of a contingency divert or flight termination, if time permits, the use of a chase aircraft is preferred when the UA is operated outside of Restricted or Warning Areas.
 - (g) In the event of a contingency divert or flight termination or other approved contingency measures, the proponent will operate in Class A airspace and Special Use airspace to the maximum extent possible to reduce the risk of collision with non-participating air traffic.

B. Night Operation Limitations.

UAS night operations are those operations that occur between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time. (Note: this is equal to approximately 30 minutes after sunset until 30 minutes before sunrise).

1. Night operations are not authorized.

AIR TRAFFIC CONTROL SPECIAL PROVISIONS**A. Coordination Requirements.**

PIC will send flight schedule to Toledo TRACON at 419-865-6686, 24 hours prior to flight.

B. Communication Requirements.

Proponent must monitor Toledo TRACON on 134.35 MHz during UA flight operations.

C. Flight Planning Requirements.

Coordination as described to Toledo TRACON.

D. Procedural Requirements.

PIC will coordinate operation and adhere to needs as described by Toledo TRACON during 24 hour notice communication.

E. Emergency/Contingency Procedures.

1. Lost Link Procedures:

In the event of a lost link, the UAS pilot will immediately notify Toledo TRACON at 419-865-6686, state pilot intentions, and comply with the following provisions:

- a. If the aircraft continues to have GPS link but loses data communication with either or both the ground station and the remote control, the Swinglet will return to the rally point (or other pre-designation landing area) and initiate an "auto-landing".
- b. If the aircraft loses communication to the GPS satellites, the PIC will manually pilot the sUAS either to its landing point or to a pre-designated safe landing area. A landing order can be given at any time it reaches a designated landing area where the Swinglet will perform an auto land sequence.
- c. If the aircraft loses all communication from the GPS satellites, ground station and remote control it will perform an auto land sequence at its current location.

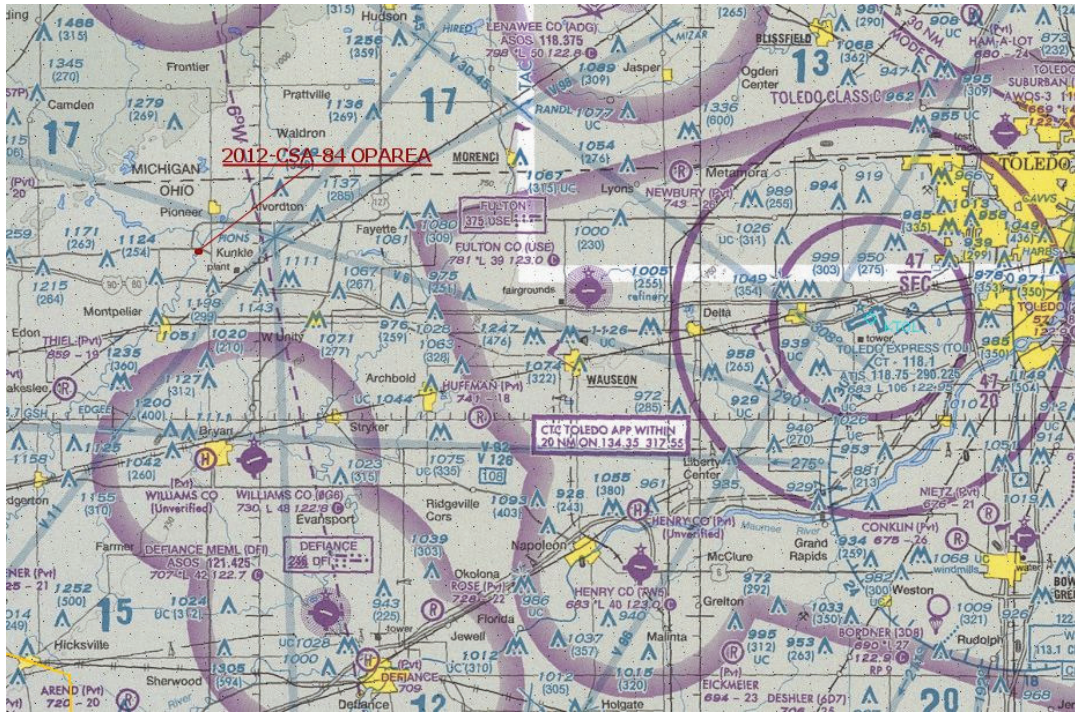
- d. If lost link occurs within a restricted or warning area, or the lost link procedure above takes the UA into the restricted or warning area – the aircraft will not exit the restricted or warning areas until the link is re-established.
- e. The unmanned aircraft lost link mission will not transit or orbit over populated areas.
- f. Lost link programmed procedures will avoid unexpected turn-around and/or altitude changes and will provide sufficient time to communicate and coordinate with ATC.
- g. Lost link orbit points shall not coincide with the centerline of Victor airways.

F. Operations Area – See Attachment 1

AUTHORIZATION

This Certificate of Waiver or Authorization does not, in itself, waive any Title 14 Code of Federal Regulations, nor any state law or local ordinance. Should the proposed operation conflict with any state law or local ordinance, or require permission of local authorities or property owners, it is the responsibility of the Ohio Department of Transportation to resolve the matter. This COA does not authorize flight within Special Use airspace without approval from the using agency. The Ohio Department of Transportation is hereby authorized to operate the Swinglet CAM Unmanned Aircraft System in the operations area depicted in the Activity section of this attachment.

Version 2.1: June 2012





2012-CSA-84 OPAREA:

N 41°38'38.24\" / W 084°34'16.60\" to
N 41°38'37.93\" / W 084°34'08.59\" to
N 41°38'35.62\" / W 084°34'08.75\" to
N 41°38'35.93\" / W 084°34'16.76\" to the point of beginning.

Altitude: At or below 250 feet AGL (Above Ground Level)

Version 2.1: June 2012



OHIO DEPARTMENT OF TRANSPORTATION

DISTRICT 2 + 317 EAST POE RD. + BOWLING GREEN, OHIO 43402 + (419) 353-8131
JOHN R. KASICH, GOVERNOR + JERRY WRAY, DIRECTOR + TODD AUDET, P.E., DISTRICT DEPUTY DIRECTOR

3/9/2012

• • •

Fred Judson, GISP
317 E. Poe Rd.
Bowling Green, Ohio 43402

Federal Aviation Administration
Unmanned Aircraft Program Office, AFS407
490 L'Enfant Plaza SW, Suite 3200
Washington, DC 20024

Ohio Department of Transportation's Public Aircraft Airworthiness Declaration

The Ohio Department of Transportation declares the small Unmanned Aircraft System (sUAS) from, sensefly LLC, model swinglet CAM, to be owned and operated by the Ohio Department of Transportation.

The Ohio Department of Transportation assumes all responsibility to insure the airworthiness of the aircraft.

The Ohio Department of Transportation declares the aircraft to be airworthy when used in accordance with the manufacturer's recommendations and specifications in the swinglet CAM User Manual and the maintenance program titled "senseFly Swinglet CAM INSPECTION AND LOG PROCEDURES FOR THE OHIO DEPARTMENT OF TRANSPORTATION" for safe operations conducted during daylight hours, within line of sight and below 400 ft. height above ground level.

Thank You

A handwritten signature in black ink, appearing to read "Fred Judson".

Fred Judson, GISP
GIS Information Systems Coordinator
Ohio Department of Transportation



MIKE DEWINE

★ OHIO ATTORNEY GENERAL ★

Transportation Section
Office 614-466-5932
Fax 614-466-1756

150 E. Gay St., 22nd Floor
Columbus, OH 43215
www.OhioAttorneyGeneral.gov

September 17, 2012

Randy Willis Acting Manager, UAS
Federal Aviation Administration
Unmanned Aircraft Program Office, AFS-407
490 L'Enfant Plaza SW, Suite 3200
Washington, DC 20024

Re: Ohio Department of Transportation Application for
Certificate of Waiver or Authorization (COA)

Dear Mr. Willis:

This office has been informed that the Ohio Department of Transportation (ODOT) has applied for a "Certificate of Waiver or Authorization" in order to operate an unmanned aircraft system. In support of that application, this letter is to certify that ODOT is a political subdivision of the government of the State of Ohio, as described in 49 USC § 40102 (a)(41)(C).


Ohio Revised Code §121.02(D) establishes the Department of Transportation, under the administration of the Director of Transportation, as an administrative department of Ohio government. The powers and duties of the Director of Transportation and the Department of Transportation are set forth in Ohio Revised Code Chapter 55.

Based upon the forgoing, there can be no question that the Ohio Department of Transportation is an administrative department of the government of the State of Ohio, duly established by the Ohio General Assembly, and existing under and in accordance with the laws of this State.

If you have any questions or require additional information, please contact me.

Very truly yours,

MIKE DEWINE
Ohio Attorney General



STEPHEN H. JOHNSON
Chief, Transportation Section



Appendix F:

Section 333 Exemptions



U.S. Department
of Transportation

**Federal Aviation
Administration**

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

October 28, 2015

Exemption No. 13383
Regulatory Docket No. FAA-2015-2509

Dan Farrell
Kentucky Transportation Cabinet
Department of Highways
200 Mero Street
Frankfort, KY 40622

Dear Mr. Farrell:

This letter is to inform you that we have granted your request for exemption. It transmits our decision, explains its basis, and gives you the conditions and limitations of the exemption, including the date it ends.

By letter dated April 2, 2015, you petitioned the Federal Aviation Administration (FAA) on behalf of Kentucky Transportation Cabinet (hereinafter petitioner or operator) for an exemption. The petitioner requested to operate an unmanned aircraft system (UAS) to conduct aerial mapping, surveying, monitoring, and inspections,.

See the docket, at www.regulations.gov, for the petition submitted to the FAA describing the proposed operations and the regulations that the petitioner seeks an exemption.

The FAA has determined that good cause exists for not publishing a summary of the petition in the Federal Register because the requested exemption would not set a precedent, and any delay in acting on this petition would be detrimental to the petitioner.

Airworthiness Certification

The UAS proposed by the petitioner are the Arris M680-4 and Zeta FX-61.

In accordance with the statutory criteria provided in Section 333 of Public Law 112 95 in reference to 49 U.S.C. § 44704, and in consideration of the size, weight, speed, and limited operating area associated with the aircraft and its operation, the Secretary of Transportation

has determined that this aircraft meets the conditions of Section 333. Therefore, the FAA finds that relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*, and any associated noise certification and testing requirements of part 36, is not necessary.

The Basis for Our Decision

You have requested to use a UAS for aerial data collection¹. The FAA has issued grants of exemption in circumstances similar in all material respects to those presented in your petition. In Grants of Exemption Nos. 11062 to Astraeus Aerial (*see* Docket No. FAA–2014–0352), 11109 to Clayco, Inc. (*see* Docket No. FAA–2014–0507), 11112 to VDOS Global, LLC (*see* Docket No. FAA–2014–0382), and 11213 to Aeryon Labs, Inc. (*see* Docket No. FAA–2014–0642), the FAA found that the enhanced safety achieved using an unmanned aircraft (UA) with the specifications described by the petitioner and carrying no passengers or crew, rather than a manned aircraft of significantly greater proportions, carrying crew in addition to flammable fuel, gives the FAA good cause to find that the UAS operation enabled by this exemption is in the public interest.

Having reviewed your reasons for requesting an exemption, I find that—

- They are similar in all material respects to relief previously requested in Grant of Exemption Nos. 11062, 11109, 11112, and 11213;
- The reasons stated by the FAA for granting Exemption Nos. 11062, 11109, 11112, and 11213 also apply to the situation you present; and
- A grant of exemption is in the public interest.

Our Decision

In consideration of the foregoing, I find that a grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. 106(f), 40113, and 44701, delegated to me by the Administrator, Kentucky Transportation Cabinet is granted an exemption from 14 CFR §§ 61.23(a) and (c), 61.101(e)(4) and (5), 61.113(a), 61.315(a), 91.7(a), 91.119(c), 91.121, 91.151(a)(1), 91.405(a), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a) and (b), to the extent necessary to allow the petitioner to operate a UAS to perform aerial data collection. This exemption is subject to the conditions and limitations listed below.

¹ Aerial data collection includes any remote sensing and measuring by an instrument(s) aboard the UA. Examples include imagery (photography, video, infrared, etc.), electronic measurement (precision surveying, RF analysis, etc.), chemical measurement (particulate measurement, etc.), or any other gathering of data by instruments aboard the UA.

Conditions and Limitations

In this grant of exemption, Kentucky Transportation Cabinet is hereafter referred to as the operator.

Failure to comply with any of the conditions and limitations of this grant of exemption will be grounds for the immediate suspension or rescission of this exemption.

1. Operations authorized by this grant of exemption are limited to the Arris M680-4 and Zeta FX-61 when weighing less than 55 pounds including payload. Proposed operations of any other aircraft will require a new petition or a petition to amend this exemption.
2. Operations for the purpose of closed-set motion picture and television filming are not permitted.
3. The UA may not be operated at a speed exceeding 87 knots (100 miles per hour). The exemption holder may use either groundspeed or calibrated airspeed to determine compliance with the 87 knot speed restriction. In no case will the UA be operated at airspeeds greater than the maximum UA operating airspeed recommended by the aircraft manufacturer.
4. The UA must be operated at an altitude of no more than 400 feet above ground level (AGL). Altitude must be reported in feet AGL.
5. The UA must be operated within visual line of sight (VLOS) of the PIC at all times. This requires the PIC to be able to use human vision unaided by any device other than corrective lenses, as specified on the PIC's FAA-issued airman medical certificate or U.S. driver's license.
6. All operations must utilize a visual observer (VO). The UA must be operated within the visual line of sight (VLOS) of the PIC and VO at all times. The VO may be used to satisfy the VLOS requirement as long as the PIC always maintains VLOS capability. The VO and PIC must be able to communicate verbally at all times; electronic messaging or texting is not permitted during flight operations. The PIC must be designated before the flight and cannot transfer his or her designation for the duration of the flight. The PIC must ensure that the VO can perform the duties required of the VO.
7. This exemption and all documents needed to operate the UAS and conduct its operations in accordance with the conditions and limitations stated in this grant of exemption, are hereinafter referred to as the operating documents. The operating documents must be accessible during UAS operations and made available to the Administrator upon request. If a discrepancy exists between the conditions and

limitations in this exemption and the procedures outlined in the operating documents, the conditions and limitations herein take precedence and must be followed.

Otherwise, the operator must follow the procedures as outlined in its operating documents. The operator may update or revise its operating documents. It is the operator's responsibility to track such revisions and present updated and revised documents to the Administrator or any law enforcement official upon request. The operator must also present updated and revised documents if it petitions for extension or amendment to this grant of exemption. If the operator determines that any update or revision would affect the basis upon which the FAA granted this exemption, then the operator must petition for an amendment to its grant of exemption. The FAA's UAS Integration Office (AFS-80) may be contacted if questions arise regarding updates or revisions to the operating documents.

8. Any UAS that has undergone maintenance or alterations that affect the UAS operation or flight characteristics, e.g., replacement of a flight critical component, must undergo a functional test flight prior to conducting further operations under this exemption. Functional test flights may only be conducted by a PIC with a VO and must remain at least 500 feet from other people. The functional test flight must be conducted in such a manner so as to not pose an undue hazard to persons and property.
9. The operator is responsible for maintaining and inspecting the UAS to ensure that it is in a condition for safe operation.
10. Prior to each flight, the PIC must conduct a pre-flight inspection and determine the UAS is in a condition for safe flight. The pre-flight inspection must account for all potential discrepancies, e.g., inoperable components, items, or equipment. If the inspection reveals a condition that affects the safe operation of the UAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the UAS is found to be in a condition for safe flight.
11. The operator must follow the UAS manufacturer's maintenance, overhaul, replacement, inspection, and life limit requirements for the aircraft and aircraft components.
12. Each UAS operated under this exemption must comply with all manufacturer safety bulletins.
13. Under this grant of exemption, a PIC must hold either an airline transport, commercial, private, recreational, or sport pilot certificate. The PIC must also hold a current FAA airman medical certificate or a valid U.S. driver's license issued by a state, the District of Columbia, Puerto Rico, a territory, a possession, or the Federal government. The PIC must also meet the flight review requirements specified in 14 CFR § 61.56 in an aircraft in which the PIC is rated on his or her pilot certificate.

14. The operator may not permit any PIC to operate unless the PIC demonstrates the ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption, including evasive and emergency maneuvers and maintaining appropriate distances from persons, vessels, vehicles and structures. PIC qualification flight hours and currency must be logged in a manner consistent with 14 CFR § 61.51(b). Flights for the purposes of training the operator's PICs and VOs (training, proficiency, and experience-building) and determining the PIC's ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption are permitted under the terms of this exemption. However, training operations may only be conducted during dedicated training sessions. During training, proficiency, and experience-building flights, all persons not essential for flight operations are considered nonparticipants, and the PIC must operate the UA with appropriate distance from nonparticipants in accordance with 14 CFR § 91.119.
15. UAS operations may not be conducted during night, as defined in 14 CFR § 1.1. All operations must be conducted under visual meteorological conditions (VMC). Flights under special visual flight rules (SVFR) are not authorized.
16. The UA may not operate within 5 nautical miles of an airport reference point (ARP) as denoted in the current FAA Airport/Facility Directory (AFD) or for airports not denoted with an ARP, the center of the airport symbol as denoted on the current FAA-published aeronautical chart, unless a letter of agreement with that airport's management is obtained or otherwise permitted by a COA issued to the exemption holder. The letter of agreement with the airport management must be made available to the Administrator or any law enforcement official upon request.
17. The UA may not be operated less than 500 feet below or less than 2,000 feet horizontally from a cloud or when visibility is less than 3 statute miles from the PIC.
18. For tethered UAS operations, the tether line must have colored pennants or streamers attached at not more than 50 foot intervals beginning at 150 feet above the surface of the earth and visible from at least one mile. This requirement for pennants or streamers is not applicable when operating exclusively below the top of and within 250 feet of any structure, so long as the UA operation does not obscure the lighting of the structure.
19. If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the private or controlled-access property.
20. The PIC must abort the flight in the event of unpredicted obstacles or emergencies.
21. The PIC is prohibited from beginning a flight unless (considering wind and forecast weather conditions) there is enough available power for the UA to conduct the

intended operation and to operate after that for at least five minutes or with the reserve power recommended by the manufacturer if greater.

22. Air Traffic Organization (ATO) Certificate of Waiver or Authorization (COA). All operations shall be conducted in accordance with an ATO-issued COA. The exemption holder may apply for a new or amended COA if it intends to conduct operations that cannot be conducted under the terms of the attached COA.
23. All aircraft operated in accordance with this exemption must be identified by serial number, registered in accordance with 14 CFR part 47, and have identification (N-Number) markings in accordance with 14 CFR part 45, Subpart C. Markings must be as large as practicable.
24. Documents used by the operator to ensure the safe operation and flight of the UAS and any documents required under 14 CFR §§ 91.9 and 91.203 must be available to the PIC at the Ground Control Station of the UAS any time the aircraft is operating. These documents must be made available to the Administrator or any law enforcement official upon request.
25. The UA must remain clear and give way to all manned aviation operations and activities at all times.
26. The UAS may not be operated by the PIC from any moving device or vehicle.
27. All Flight operations must be conducted at least 500 feet from all nonparticipating persons, vessels, vehicles, and structures unless:
 - a. Barriers or structures are present that sufficiently protect nonparticipating persons from the UA and/or debris in the event of an accident. The operator must ensure that nonparticipating persons remain under such protection. If a situation arises where nonparticipating persons leave such protection and are within 500 feet of the UA, flight operations must cease immediately in a manner ensuring the safety of nonparticipating persons; and
 - b. The owner/controller of any vessels, vehicles or structures has granted permission for operating closer to those objects and the PIC has made a safety assessment of the risk of operating closer to those objects and determined that it does not present an undue hazard.

The PIC, VO, operator trainees or essential persons are not considered nonparticipating persons under this exemption.

28. All operations shall be conducted over private or controlled-access property with permission from the property owner/controller or authorized representative. Permission from property owner/controller or authorized representative will be obtained for each flight to be conducted.

29. Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable COA must be reported to the FAA's UAS Integration Office (AFS-80) within 24 hours. Accidents must be reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: www.nts.gov.

If this exemption permits operations for the purpose of closed-set motion picture and television filming and production, the following additional conditions and limitations apply.

30. The operator must have a motion picture and television operations manual (MPTOM) as documented in this grant of exemption.
31. At least 3 days before aerial filming, the operator of the UAS affected by this exemption must submit a written Plan of Activities to the local Flight Standards District Office (FSDO) with jurisdiction over the area of proposed filming. The 3-day notification may be waived with the concurrence of the FSDO. The plan of activities must include at least the following:
 - a. Dates and times for all flights;
 - b. Name and phone number of the operator for the UAS aerial filming conducted under this grant of exemption;
 - c. Name and phone number of the person responsible for the on-scene operation of the UAS;
 - d. Make, model, and serial or N-Number of UAS to be used;
 - e. Name and certificate number of UAS PICs involved in the aerial filming;
 - f. A statement that the operator has obtained permission from property owners and/or local officials to conduct the filming production event; the list of those who gave permission must be made available to the inspector upon request;
 - g. Signature of exemption holder or representative; and
 - h. A description of the flight activity, including maps or diagrams of any area, city, town, county, and/or state over which filming will be conducted and the altitudes essential to accomplish the operation.
32. Flight operations may be conducted closer than 500 feet from participating persons consenting to be involved and necessary for the filming production, as specified in the exemption holder's MPTOM.

Unless otherwise specified in this grant of exemption, the UAS, the UAS PIC, and the UAS operations must comply with all applicable parts of 14 CFR including, but not limited to, parts 45, 47, 61, and 91.

This exemption terminates on October 31, 2017, unless sooner superseded or rescinded.

Sincerely,

/s/

John S. Duncan

Director, Flight Standards Service

Enclosures



U.S. Department
of Transportation

**Federal Aviation
Administration**

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

November 16, 2015

Exemption No. 13593
Regulatory Docket No. FAA-2015-3437

Mr. Richard Honneywell
Executive Director
Ohio/Indiana UAS Center & Test Complex
4170 Allium Court
Springfield, OH 45505

Dear Mr. Honneywell:

This letter is to inform you that we have granted your request for exemption. It transmits our decision, explains its basis, and gives you the conditions and limitations of the exemption, including the date it ends.

By letter dated June 26, 2015, you petitioned the Federal Aviation Administration (FAA) on behalf of Ohio/Indiana UAS Center & Test Complex (hereinafter petitioner or operator) for an exemption. The petitioner requested to operate an unmanned aircraft system (UAS) to conduct precision agriculture; education; environmental, wildlife, and forestry monitoring; infrastructure inspection; survey and mapping; and research and development.

See the docket, at www.regulations.gov, for the petition submitted to the FAA describing the proposed operations and the regulations that the petitioner seeks an exemption.

The FAA has determined that good cause exists for not publishing a summary of the petition in the Federal Register because the requested exemption would not set a precedent, and any delay in acting on this petition would be detrimental to the petitioner.

Airworthiness Certification

The UAS proposed by the petitioner are the SenseFly eBee; Event 38 Unmanned Systems Inc., E384 UAS, Altavian Nova F6500, Peregrine UAS, DJI Phantom, MLB Bat-3, and SenseFly Swinglet.

In accordance with the statutory criteria provided in Section 333 of Public Law 112–95 in reference to 49 U.S.C. § 44704, and in consideration of the size, weight, speed, and limited operating area associated with the aircraft and its operation, the Secretary of Transportation has determined that this aircraft meets the conditions of Section 333. Therefore, the FAA finds that relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*, and any associated noise certification and testing requirements of part 36, is not necessary.

The Basis for Our Decision

You have requested to use a UAS for aerial data collection¹. The FAA has issued grants of exemption in circumstances similar in all material respects to those presented in your petition. In Grants of Exemption Nos. 11062 to Astraeus Aerial (*see* Docket No. FAA–2014–0352), 11109 to Clayco, Inc. (*see* Docket No. FAA–2014–0507), 11112 to VDOS Global, LLC (*see* Docket No. FAA–2014–0382), 11213 to Aeryon Labs, Inc. (*see* Docket No. FAA–2014–0642), and 12645 to Allied Drones (*see* Docket No. FAA–2014–0804), the FAA found that the enhanced safety achieved using an unmanned aircraft (UA) with the specifications described by the petitioner and carrying no passengers or crew, rather than a manned aircraft of significantly greater proportions, carrying crew in addition to flammable fuel, gives the FAA good cause to find that the UAS operation enabled by this exemption is in the public interest.

Having reviewed your reasons for requesting an exemption, I find that—

- They are similar in all material respects to relief previously requested in Grant of Exemption Nos. 11062, 11109, 11112, 11213, and 12645;
- The reasons stated by the FAA for granting Exemption Nos. 11062, 11109, 11112, 11213, and 12645 also apply to the situation you present; and
- A grant of exemption is in the public interest.

Our Decision

In consideration of the foregoing, I find that a grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. 106(f), 40113, and 44701, delegated to me by the Administrator, Ohio/Indiana UAS Center & Test Complex is granted an exemption from 14 CFR §§ 61.23(a) and (c), 61.101(e)(4) and (5), 61.113(a), 61.315(a), 91.7(a), 91.119(c), 91.121, 91.151(a)(1), 91.405(a), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a) and (b), to the extent necessary to allow the petitioner to operate a UAS to perform

¹ Aerial data collection includes any remote sensing and measuring by an instrument(s) aboard the UA. Examples include imagery (photography, video, infrared, etc.), electronic measurement (precision surveying, RF analysis, etc.), chemical measurement (particulate measurement, etc.), or any other gathering of data by instruments aboard the UA.

aerial data collection. This exemption is subject to the conditions and limitations listed below.

Conditions and Limitations

In this grant of exemption, Ohio/Indiana UAS Center & Test Complex is hereafter referred to as the operator.

Failure to comply with any of the conditions and limitations of this grant of exemption will be grounds for the immediate suspension or rescission of this exemption.

1. Operations authorized by this grant of exemption are limited to the SenseFly eBee; Event 38 Unmanned Systems Inc., E384 UAS, Altavian Nova F6500, Peregrine UAS, DJI Phantom, MLB Bat-3, and SenseFly Swinglet when weighing less than 55 pounds including payload. Proposed operations of any other aircraft will require a new petition or a petition to amend this exemption.
2. Operations for the purpose of closed-set motion picture and television filming are not permitted.
3. The UA may not be operated at a speed exceeding 87 knots (100 miles per hour). The exemption holder may use either groundspeed or calibrated airspeed to determine compliance with the 87 knot speed restriction. In no case will the UA be operated at airspeeds greater than the maximum UA operating airspeed recommended by the aircraft manufacturer.
4. The UA must be operated at an altitude of no more than 400 feet above ground level (AGL). Altitude must be reported in feet AGL.
5. The UA must be operated within visual line of sight (VLOS) of the PIC at all times. This requires the PIC to be able to use human vision unaided by any device other than corrective lenses, as specified on the PIC's FAA-issued airman medical certificate or U.S. driver's license.
6. All operations must utilize a visual observer (VO). The UA must be operated within the visual line of sight (VLOS) of the PIC and VO at all times. The VO may be used to satisfy the VLOS requirement as long as the PIC always maintains VLOS capability. The VO and PIC must be able to communicate verbally at all times; electronic messaging or texting is not permitted during flight operations. The PIC must be designated before the flight and cannot transfer his or her designation for the duration of the flight. The PIC must ensure that the VO can perform the duties required of the VO.

7. This exemption and all documents needed to operate the UAS and conduct its operations in accordance with the conditions and limitations stated in this grant of exemption, are hereinafter referred to as the operating documents. The operating documents must be accessible during UAS operations and made available to the Administrator upon request. If a discrepancy exists between the conditions and limitations in this exemption and the procedures outlined in the operating documents, the conditions and limitations herein take precedence and must be followed. Otherwise, the operator must follow the procedures as outlined in its operating documents. The operator may update or revise its operating documents. It is the operator's responsibility to track such revisions and present updated and revised documents to the Administrator or any law enforcement official upon request. The operator must also present updated and revised documents if it petitions for extension or amendment to this grant of exemption. If the operator determines that any update or revision would affect the basis upon which the FAA granted this exemption, then the operator must petition for an amendment to its grant of exemption. The FAA's UAS Integration Office (AFS-80) may be contacted if questions arise regarding updates or revisions to the operating documents.
8. Any UAS that has undergone maintenance or alterations that affect the UAS operation or flight characteristics, e.g., replacement of a flight critical component, must undergo a functional test flight prior to conducting further operations under this exemption. Functional test flights may only be conducted by a PIC with a VO and must remain at least 500 feet from other people. The functional test flight must be conducted in such a manner so as to not pose an undue hazard to persons and property.
9. The operator is responsible for maintaining and inspecting the UAS to ensure that it is in a condition for safe operation.
10. Prior to each flight, the PIC must conduct a pre-flight inspection and determine the UAS is in a condition for safe flight. The pre-flight inspection must account for all potential discrepancies, e.g., inoperable components, items, or equipment. If the inspection reveals a condition that affects the safe operation of the UAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the UAS is found to be in a condition for safe flight.
11. The operator must follow the UAS manufacturer's maintenance, overhaul, replacement, inspection, and life limit requirements for the aircraft and aircraft components.
12. Each UAS operated under this exemption must comply with all manufacturer safety bulletins.
13. Under this grant of exemption, a PIC must hold either an airline transport, commercial, private, recreational, or sport pilot certificate. The PIC must also hold a

current FAA airman medical certificate or a valid U.S. driver's license issued by a state, the District of Columbia, Puerto Rico, a territory, a possession, or the Federal government. The PIC must also meet the flight review requirements specified in 14 CFR § 61.56 in an aircraft in which the PIC is rated on his or her pilot certificate.

14. The operator may not permit any PIC to operate unless the PIC demonstrates the ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption, including evasive and emergency maneuvers and maintaining appropriate distances from persons, vessels, vehicles and structures. PIC qualification flight hours and currency must be logged in a manner consistent with 14 CFR § 61.51(b). Flights for the purposes of training the operator's PICs and VOs (training, proficiency, and experience-building) and determining the PIC's ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption are permitted under the terms of this exemption. However, training operations may only be conducted during dedicated training sessions. During training, proficiency, and experience-building flights, all persons not essential for flight operations are considered nonparticipants, and the PIC must operate the UA with appropriate distance from nonparticipants in accordance with 14 CFR § 91.119.
15. UAS operations may not be conducted during night, as defined in 14 CFR § 1.1. All operations must be conducted under visual meteorological conditions (VMC). Flights under special visual flight rules (SVFR) are not authorized.
16. The UA may not operate within 5 nautical miles of an airport reference point (ARP) as denoted in the current FAA Airport/Facility Directory (AFD) or for airports not denoted with an ARP, the center of the airport symbol as denoted on the current FAA-published aeronautical chart, unless a letter of agreement with that airport's management is obtained or otherwise permitted by a COA issued to the exemption holder. The letter of agreement with the airport management must be made available to the Administrator or any law enforcement official upon request.
17. The UA may not be operated less than 500 feet below or less than 2,000 feet horizontally from a cloud or when visibility is less than 3 statute miles from the PIC.
18. For tethered UAS operations, the tether line must have colored pennants or streamers attached at not more than 50 foot intervals beginning at 150 feet above the surface of the earth and visible from at least one mile. This requirement for pennants or streamers is not applicable when operating exclusively below the top of and within 250 feet of any structure, so long as the UA operation does not obscure the lighting of the structure.
19. If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the private or controlled-access property.

20. The PIC must abort the flight in the event of unpredicted obstacles or emergencies.
21. The PIC is prohibited from beginning a flight unless (considering wind and forecast weather conditions) there is enough available power for the UA to conduct the intended operation and to operate after that for at least 5 minutes or with the reserve power recommended by the manufacturer if greater.
22. Air Traffic Organization (ATO) Certificate of Waiver or Authorization (COA). All operations shall be conducted in accordance with an ATO-issued COA. The exemption holder may apply for a new or amended COA if it intends to conduct operations that cannot be conducted under the terms of the enclosed COA.
23. All aircraft operated in accordance with this exemption must be identified by serial number, registered in accordance with 14 CFR part 47, and have identification (N-Number) markings in accordance with 14 CFR part 45, Subpart C. Markings must be as large as practicable.
24. Documents used by the operator to ensure the safe operation and flight of the UAS and any documents required under 14 CFR §§ 91.9 and 91.203 must be available to the PIC at the Ground Control Station of the UAS any time the aircraft is operating. These documents must be made available to the Administrator or any law enforcement official upon request.
25. The UA must remain clear and give way to all manned aviation operations and activities at all times.
26. The UAS may not be operated by the PIC from any moving device or vehicle.
27. All Flight operations must be conducted at least 500 feet from all nonparticipating persons, vessels, vehicles, and structures unless:
 - a. Barriers or structures are present that sufficiently protect nonparticipating persons from the UA and/or debris in the event of an accident. The operator must ensure that nonparticipating persons remain under such protection. If a situation arises where nonparticipating persons leave such protection and are within 500 feet of the UA, flight operations must cease immediately in a manner ensuring the safety of nonparticipating persons; and
 - b. The owner/controller of any vessels, vehicles or structures has granted permission for operating closer to those objects and the PIC has made a safety assessment of the risk of operating closer to those objects and determined that it does not present an undue hazard.

The PIC, VO, operator trainees or essential persons are not considered nonparticipating persons under this exemption.

28. All operations shall be conducted over private or controlled-access property with permission from the property owner/controller or authorized representative. Permission from property owner/controller or authorized representative will be obtained for each flight to be conducted.
29. Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable COA must be reported to the FAA's UAS Integration Office (AFS-80) within 24 hours. Accidents must be reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: www.nts.gov.

If this exemption permits operations for the purpose of closed-set motion picture and television filming and production, the following additional conditions and limitations apply.

30. The operator must have a motion picture and television operations manual (MPTOM) as documented in this grant of exemption.
31. At least 3 days before aerial filming, the operator of the UAS affected by this exemption must submit a written Plan of Activities to the local Flight Standards District Office (FSDO) with jurisdiction over the area of proposed filming. The 3-day notification may be waived with the concurrence of the FSDO. The plan of activities must include at least the following:
 - a. Dates and times for all flights;
 - b. Name and phone number of the operator for the UAS aerial filming conducted under this grant of exemption;
 - c. Name and phone number of the person responsible for the on-scene operation of the UAS;
 - d. Make, model, and serial or N-Number of UAS to be used;
 - e. Name and certificate number of UAS PICs involved in the aerial filming;
 - f. A statement that the operator has obtained permission from property owners and/or local officials to conduct the filming production event; the list of those who gave permission must be made available to the inspector upon request;
 - g. Signature of exemption holder or representative; and
 - h. A description of the flight activity, including maps or diagrams of any area, city, town, county, and/or state over which filming will be conducted and the altitudes essential to accomplish the operation.
32. Flight operations may be conducted closer than 500 feet from participating persons consenting to be involved and necessary for the filming production, as specified in the exemption holder's MPTOM.

Unless otherwise specified in this grant of exemption, the UAS, the UAS PIC, and the UAS operations must comply with all applicable parts of 14 CFR including, but not limited to, parts 45, 47, 61, and 91.

This exemption terminates on November 30, 2017, unless sooner superseded or rescinded.

Sincerely,

/s/

John S. Duncan


Director, Flight Standards Service

Enclosure

Appendix G

14 CFR §107.200(a) Waivers

FAA FORM 7711-1 UAS PART 107 WAIVER
2016-ATO-P107-00043

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION	
CERTIFICATE OF WAIVER OR AUTHORIZATION	
ISSUED TO Tim McClung Iowa Department of Transportation	POC Phone Number (515) 239-1689
ADDRESS 800 Lincoln Way, Ames, IA 50010	
This certificate is issued for the operations specifically described hereinafter. No person shall conduct any operation pursuant to the authority of this certificate except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.	
OPERATIONS AUTHORIZED Unmanned Aircraft Systems operations in accordance with Title 14 CFR Part 107.41, except "Operating limitations for small unmanned aircraft" Part 107.51 b (2) are limited to the altitude listed below. Class of Airspace: E surface areas in the vicinity of DVN, CWI and MUT At or below 400 feet above ground level (AGL) Under the jurisdiction of: Quad City TRACON Iowa state aviation office would like to inspect and record assets at airports in coordination with airport management, and other transportation assets in the areas of airports, with UAS.	
LIST OF WAIVED REGULATIONS BY SECTION AND TITLE 107.41 Operations in certain airspace	
STANDARD PROVISIONS	
1. A copy of the application made for this certificate shall be attached and become a part hereof. 2. This certificate shall be presented for inspection upon the request of any authorized representative of the Federal Aviation Administration, or of any State or municipal official charged with the duty of enforcing local laws or regulations. 3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein. 4. This certificate is nontransferable.	
Note-This certificate constitutes a waiver of those Federal rules or regulations specifically referred to above. It does not constitute a waiver of any State law or local ordinance.	
SPECIAL PROVISIONS	
Special Provisions 1 thru 4 inclusive, are set forth on page 2 of this authorization.	
This certificate 2016-ATO-P107-00043 is effective from December 4, 2016, to December 3, 2018, inclusive, and is subject to cancellation at any time upon notice by the Administrator or his/her authorized representative.	
BY DIRECTION OF THE ADMINISTRATOR	
<u>FAA Headquarters, AJV-115</u> <small>(Region)</small>	 <u>Randy Willis</u> <small>(Signature)</small>
<u>December 2, 2016</u> <small>(Date)</small>	<u>Manager, Emerging Technologies Team (AJV-115)</u> <small>(Title)</small>

SPECIAL PROVISIONS

1. CONTACT INFORMATION:

Tim McClung is the person designated as responsible for the overall safety of UAS operations under this Certificate of Waiver. During UAS operations for on-site communication/recall, the Pilot shall be continuously available for direct contact at (515) 239-1689 by Quad City TRACON or designated representative.

2. SCHEDULE:

This Certificate of Waiver and the Special Provisions shall be in effect from December 4, 2016, to December 3, 2018, between sunrise and sunset local time.

3. OPERATIONS:

- a. Operations will only be conducted in VFR conditions with greater than 5 miles visibility and 3,000 ft ceiling.
- b. The PIC will monitor CTAF and broadcast, as necessary, prior to commencing, during and upon completion of UAS operations.
- c. In addition to holding a valid Remote Pilot Certificate, pilots flying under this waiver will also hold a Private Pilot or Commercial Pilot Certificate to ensure familiarity with airport surface area and traffic pattern operations.
- d. Operations will be conducted in coordination with airport management.
- e. The PIC will notify Quad City TRACON at 309-799-7866 prior to commencing and upon completion of UA operations.

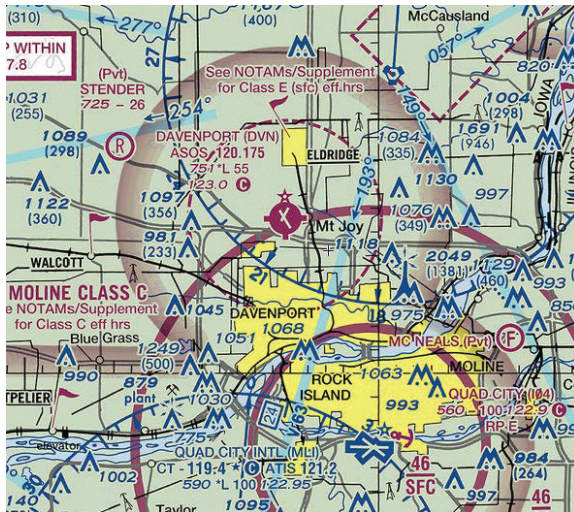
4. EMERGENCY/CONTINGENCY PROCEDURES:

- a. If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the operating area and land.
- b. If lost link occurs over an airport movement area, the UA's pre-programmed lost link procedure shall be programmed to return-to-home at an altitude of no less than 50 feet AGL to mitigate any potential interference with aircraft on taxiways and aprons. The UA will be launched from a position where, if a lost link situation occurs, the aircraft will return to its home point by moving away from any runway (or extended centerline) and crossing other airport operational areas at no less than 50 feet AGL.

ATTACHMENT 1

Operations Area

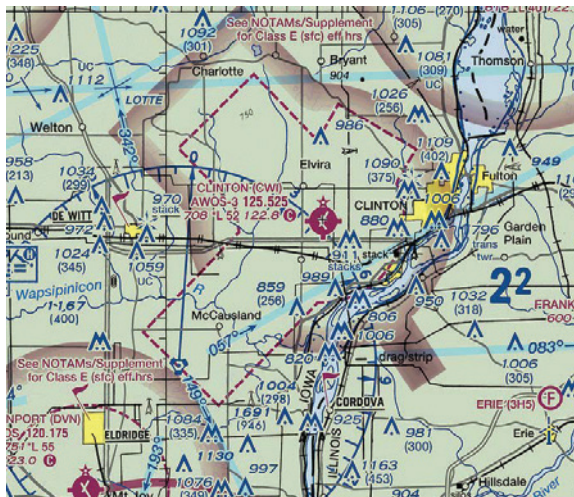
Class E surface Airspace
At or below 400 feet AGL




Davenport (DVN)



Muscatine (MUT)



Clinton (CWI)

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION	
CERTIFICATE OF WAIVER OR AUTHORIZATION	
ISSUED TO Iowa Department of Transportation/ ATTN: Brian Kuennen	POC Phone Number (515) 239-1689
ADDRESS 800 Lincoln Way, Ames, IA 50010	
This certificate is issued for the operations specifically described hereinafter. No person shall conduct any operation pursuant to the authority of this certificate except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.	
OPERATIONS AUTHORIZED Unmanned Aircraft Systems operations in accordance with Title 14 CFR Part 107.41, except "Operating limitations for small unmanned aircraft" Part 107.51 b (2) are limited to the altitude listed below. Class of Airspace: Class D airspace in the vicinity of Waterloo Regional Airport (KALO) Operating Altitude: 400 feet AGL and below Under the jurisdiction of: Waterloo ATCT	
LIST OF WAIVED REGULATIONS BY SECTION AND TITLE 107.41 Operations in certain airspace	
STANDARD PROVISIONS	
1. A copy of the application made for this certificate shall be attached and become a part hereof. 2. This certificate shall be presented for inspection upon the request of any authorized representative of the Federal Aviation Administration, or of any State or municipal official charged with the duty of enforcing local laws or regulations. 3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein. 4. This certificate is nontransferable.	
Note-This certificate constitutes a waiver of those Federal rules or regulations specifically referred to above. It does not constitute a waiver of any State law or local ordinance.	
SPECIAL PROVISIONS	
Special Provisions 1 thru 4 inclusive are set forth on page 2 of this authorization.	
This certificate 2017-ATO-P107-00057 is effective from May 10, 2017, to May 10, 2019, inclusive, and is subject to cancellation at any time upon notice by the Administrator or his/her authorized representative.	
BY DIRECTION OF THE ADMINISTRATOR	
<u>FAA Headquarters, AJV-115</u> (Region)	 <u>Randy Willis</u> (Signature)
<u>May 9, 2017</u> (Date)	<u>Manager, Emerging Technologies Team (AJV-115)</u> (Title)

FAA FORM 7711-1 UAS PART 107 WAIVER
2016-ATO-P107-00057**SPECIAL PROVISIONS****1. CONTACT INFORMATION:**

- a. The Responsible Person, Brian Kuennen, for Iowa Department of Transportation is directly responsible for safety of operations conducted under this Waiver and will ensure the remote PIC and VO comply with all provisions of this Waiver.
- b. This Waiver must not be combined with any other waiver(s), authorizations(s), or exemption(s) without specific authorization from the FAA.
- c. The FAA has the authority to cancel or delay any or all flight operations if the safety of persons or property on the ground or in the air, are in jeopardy or there is a violation of the terms of this Waiver.
- d. The Responsible Person listed on this Waiver must maintain a current list of pilots by name and remote pilot certificate number used in the Waiver holder's operations. This list must be presented for inspection upon request from the Administrator or an authorized representative.
- e. The Responsible Person listed on this Waiver must maintain a current list of small unmanned aircraft (sUA) by registration number(s) used in the Waiver holder's operations. This list must be presented for inspection upon request from the Administrator or an authorized representative.
- f. The Responsible Person shall ensure there is a means for immediate communication with the PIC during UAS operations if ATC deems necessary.

2. SCHEDULE OF FLIGHT OPERATIONS:

This Certificate of Waiver or Authorization and the Special Provisions shall be in effect from May 10, 2017 through May 10, 2019, **between sunrise and sunset local time.**

3. OPERATIONS:

- a. Operations will only be conducted in VFR conditions with greater than 5 miles visibility and 3,000 ft ceiling.
- b. The PIC will monitor Waterloo Tower frequency 125.075 as required by ATC
- c. In addition to holding a valid Remote Pilot Certificate, pilots flying under this waiver will also hold a Private Pilot or Commercial Pilot Certificate to ensure familiarity with airport surface area and traffic pattern operations.
- d. Operations will be conducted in coordination with Waterloo ATCT.

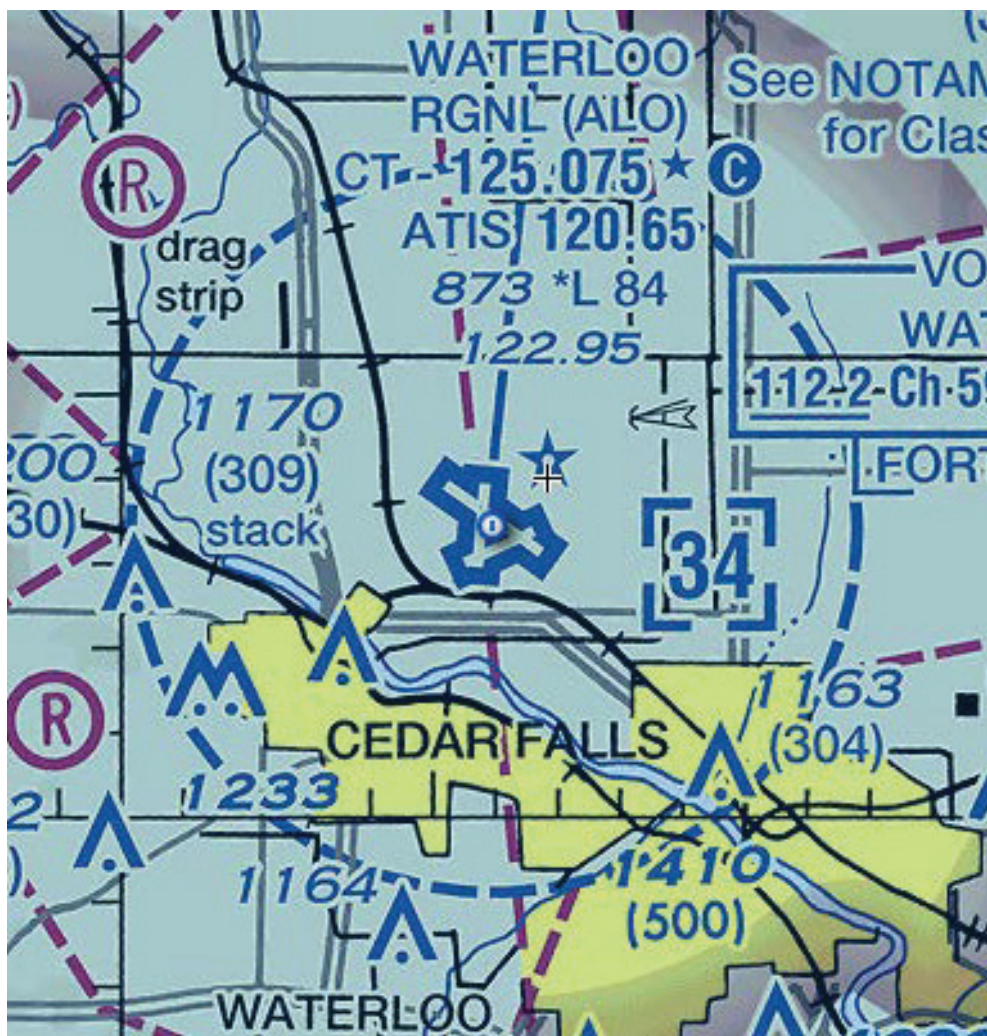
- e. The PIC will notify Waterloo Tower at (319) 233-4835 **30 minutes prior to commencing operations with a specific location** and upon completion of UA operations.


4. EMERGENCY/CONTINGENCY PROCEDURES - Lost Link/Lost Communications Procedures:

- a. If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the operating area and land.
- b. If lost link occurs over an airport movement area, the UA's pre-programmed lost link procedure shall be programmed to return-to-home at an altitude of no less than 50 feet AGL to mitigate any potential interference with aircraft on taxiways and aprons. The UA will return to its home point by moving away from any runway (or extended centerline) and crossing other airport operational areas at no less than 50 feet AGL..

ATTACHMENT 1

Operations Area
ALO Class D Airspace
At or below 400 feet AGL
42° 33' 24" N/ 92° 24' 01" W
Less than 3 NM Radius



DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION	
CERTIFICATE OF WAIVER OR AUTHORIZATION	
ISSUED TO Iowa Department of Transportation/ ATTN: Tim McClung	POC Phone Number (515) 239-1689
ADDRESS 800 Lincoln Way, Ames, IA 50010	
This certificate is issued for the operations specifically described hereinafter. No person shall conduct any operation pursuant to the authority of this certificate except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.	
OPERATIONS AUTHORIZED Unmanned Aircraft Systems operations in accordance with Title 14 CFR Part 107.41, except "Operating limitations for small unmanned aircraft" Part 107.51 b (2) are limited to the altitude listed below. Class of Airspace: Class C airspace in the vicinity of The Eastern Iowa Airport (CID) Operating Altitude: 400 feet AGL and below Under the jurisdiction of: Cedar Rapids Tower	
LIST OF WAIVED REGULATIONS BY SECTION AND TITLE 107.41 Operations in certain airspace	
STANDARD PROVISIONS	
1. A copy of the application made for this certificate shall be attached and become a part hereof. 2. This certificate shall be presented for inspection upon the request of any authorized representative of the Federal Aviation Administration, or of any State or municipal official charged with the duty of enforcing local laws or regulations. 3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein. 4. This certificate is nontransferable.	
Note-This certificate constitutes a waiver of those Federal rules or regulations specifically referred to above. It does not constitute a waiver of any State law or local ordinance.	
SPECIAL PROVISIONS	
Special Provisions 1 thru 4 inclusive are set forth on page 2 of this authorization.	
This certificate 2017-ATO-P107-00053 is effective from February 23, 2017, to February 28, 2017, inclusive, and is subject to cancellation at any time upon notice by the Administrator or his/her authorized representative.	
BY DIRECTION OF THE ADMINISTRATOR	
<u>FAA Headquarters, AJV-115</u> <small>(Region)</small>	 <u>Randy Willis</u> <small>(Signature)</small>
<u>February 21, 2017</u> <small>(Date)</small>	<u>Manager, Emerging Technologies Team (AJV-115)</u> <small>(Title)</small>

FAA FORM 7711-1 UAS PART 107 WAIVER
2016-ATO-P107-00053**SPECIAL PROVISIONS****1. CONTACT INFORMATION:**

- a. The Responsible Person, Tim McClung, for Iowa Department of Transportation is directly responsible for safety of operations conducted under this Waiver and will ensure the remote PIC and VO comply with all provisions of this Waiver.
- b. This Waiver must not be combined with any other waiver(s), authorizations(s), or exemption(s) without specific authorization from the FAA.
- c. The FAA has the authority to cancel or delay any or all flight operations if the safety of persons or property on the ground or in the air, are in jeopardy or there is a violation of the terms of this Waiver.
- d. The Responsible Person listed on this Waiver must maintain a current list of pilots by name and remote pilot certificate number used in the Waiver holder's operations. This list must be presented for inspection upon request from the Administrator or an authorized representative.
- e. The Responsible Person listed on this Waiver must maintain a current list of small unmanned aircraft (sUA) by registration number(s) used in the Waiver holder's operations. This list must be presented for inspection upon request from the Administrator or an authorized representative.
- f. The Responsible Person shall ensure there is a means for immediate communication with the PIC during UAS operations if ATC deems necessary.

2. SCHEDULE OF FLIGHT OPERATIONS:

This Certificate of Waiver or Authorization and the Special Provisions shall be in effect from February 8, 2017 through February 28, 2019, **between sunrise and sunset local time.**

3. OPERATIONS:

- a. Operations will only be conducted in VFR conditions with greater than 5 miles visibility and 3,000 ft ceiling.
- b. The PIC will monitor Cedar Rapids Tower frequency 118.7 as required by ATC
- c. In addition to holding a valid Remote Pilot Certificate, pilots flying under this waiver will also hold a Private Pilot or Commercial Pilot Certificate to ensure familiarity with airport surface area and traffic pattern operations.
- d. Operations will be conducted in coordination with Cedar Rapids ATCT.

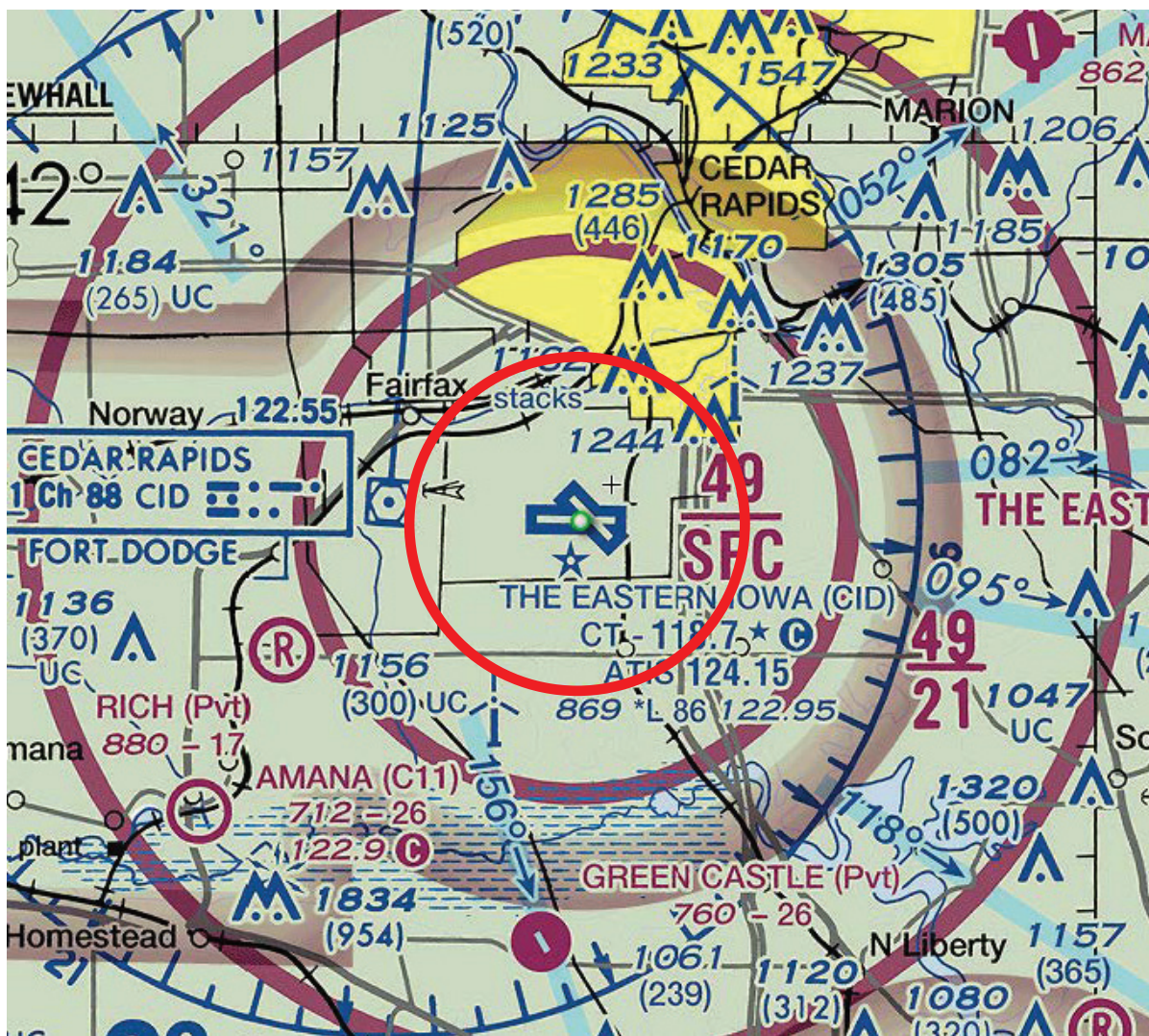
- e. The PIC will notify Cedar Rapids ATCT at (319) 366-0830 30 minutes prior to commencing operations with a specific location and upon completion of UA operations.

4. EMERGENCY/CONTINGENCY PROCEDURES - Lost Link/Lost Communications Procedures:

- a. If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the operating area and land.
- b. If lost link occurs over an airport movement area, the UA's pre-programmed lost link procedure shall be programmed to return-to-home at an altitude of no less than 50 feet AGL to mitigate any potential interference with aircraft on taxiways and aprons. The UA will return to its home point by moving away from any runway (or extended centerline) and crossing other airport operational areas at no less than 50 feet AGL..

ATTACHMENT 1

Operations Area
CID Class C Airspace
At or below 400 feet AGL
41° 53' 04" N/ 91° 42' 36" W
Less than 3 NM Radius



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
CERTIFICATE OF WAIVER OR AUTHORIZATION

ISSUED TO

Georgia Department of Transportation
Responsible Person: John Sibley
Waiver Number: 107W-2017-00355

ADDRESS –

515 Plasters Ave
Atlanta, GA 30324

This certificate is issued for the operations specifically described hereinafter. No person shall conduct any operation pursuant to the authority of this certificate except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.

OPERATIONS AUTHORIZED

Night small unmanned aircraft system (sUAS) operations.

LIST OF WAIVED REGULATIONS BY SECTION AND TITLE

14 CFR § 107.29 Daylight operation

STANDARD PROVISIONS

1. A copy of the application made for this certificate shall be attached to and become a part hereof.
2. This certificate shall be presented for inspection upon the request of any authorized representative of the Administrator of the Federal Aviation Administration, or of any State or municipal official charged with the duty of enforcing local laws or regulations.
3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein.
4. This certificate is nontransferable.

NOTE—This certificate constitutes a waiver of those Federal rules or regulations specifically referred to above. It does not constitute a waiver of any State law or local ordinance.

SPECIAL PROVISIONS

Special Provisions Nos. 1 to 11, inclusive, are set forth on the attached pages.

This Certificate of Waiver is effective from March 13, 2017 to March 31, 2021 and is subject to cancellation at any time upon notice by the Administrator or an authorized representative.

BY DIRECTION OF THE ADMINISTRATOR

General Aviation and Commercial Division, AFS-800

SPECIAL PROVISIONS ISSUED TO
Georgia Department of Transportation

General.

The FAA's Flight Standards Service has reviewed your application to ensure compliance with the requirements of 14 CFR § 107.200. The Administrator finds that the proposed sUAS operation can be conducted safely under the provisions of this Certificate of Waiver (Waiver) as listed below, because you have established adequate mitigations for risks involved with operating your sUAS in the manner you described. Adherence to the provisions of this Waiver establishes the required level of safety within the national airspace system.

This Waiver may be canceled at any time by the Administrator, the person authorized to grant the Waiver, or the representative designated to monitor a specific operation. As a general rule, this Waiver may be canceled when it is no longer required, there is an abuse of its provisions, or when unforeseen safety factors develop. Failure to comply with any provision listed below is a violation of the terms of this Waiver and may serve as justification for cancellation.

List of Regulations Waived by Section and Title. The following regulations are waived:

14 CFR § 107.29, Daylight operation, is waived to allow sUAS operations during night.

Common Provisions. The Responsible Person is directly responsible for safety of operations conducted under this Waiver and will ensure the remote Pilot in Command (PIC), manipulator of the controls, and Visual Observer (VO) complies with all provisions of this Waiver.

1. The Responsible Person listed on the Waiver is responsible to the FAA for the safe conduct of the operations. Prior to conducting operations that are the subject of this Waiver, the responsible person:
 - a. Must ensure the remote PIC, manipulators of the controls, and VO are informed on the terms and provisions of this waiver and the strict observance of the terms and provisions herein;
 - b. Must ensure the remote PIC, manipulators of the controls, and VO are informed and familiar with part 107 regulations not waived; and
 - c. The above must be documented and must be presented for inspection upon request from the Administrator or an authorized representative.
2. This Waiver must not be combined with any other waiver(s), authorizations(s), or exemption(s) without specific authorization from the FAA;
3. The FAA has the authority to cancel or delay any or all flight operations if the safety of persons or property on the ground or in the air, are in jeopardy or there is a violation of the terms of this Waiver;
4. Operations under this Waiver are to be conducted in Class G airspace only unless specific airspace authorization or Waiver is received from the FAA in accordance with § 107.41;
5. A copy of this Waiver must be available during sUAS operations that are the subject of this Waiver;
6. The Responsible Person listed on this Waiver must maintain a current list of pilots by name and remote pilot certificate number used in the Waiver holder's operations. This list must be presented for inspection upon request from the Administrator or an authorized representative;

Certificate of Waiver Number 107W-2017-00355

-
7. The Responsible Person listed on this Waiver must maintain a current list of small unmanned aircraft (sUA) by registration number(s) used in the Waiver holder's operations. This list must be presented for inspection upon request from the Administrator or an authorized representative;

Night sUAS Operations Special Provisions. sUAS operations may be conducted at night, as defined in 14 CFR § 1.1, provided:

8. All operations under this Waiver must use one or more VO;
9. Prior to conducting operations that are the subject of this Waiver, the remote PIC and VO must be trained, as described in the Waiver application, to recognize and overcome visual illusions caused by darkness, and understand physiological conditions which may degrade night vision. This training must be documented and must be presented for inspection upon request from the Administrator or an authorized representative;
10. The area of operation must be sufficiently illuminated to allow both the remote PIC and VO to identify people or obstacles on the ground, or a daytime site assessment must be performed prior to conducting operations that are the subject of this Waiver, noting any hazards or obstructions; and
11. The sUA must be equipped with lighted anti-collision lighting visible from a distance of no less than 3 statute miles. The intensity of the anti-collision lighting may be reduced if, because of operating conditions, it would be in the interest of safety to do so.

Certificate of Waiver Number 107W-2017-00355

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION CERTIFICATE OF WAIVER OR AUTHORIZATION	
ISSUED TO	NCDOT Responsible Person: Basil Yap Waiver Number: 107W-2017-02055
ADDRESS—	1560 Mail Service Center Raleigh, NC 27699
This certificate is issued for the operations specifically described hereinafter. No person shall conduct any operation pursuant to the authority of this certificate except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.	
OPERATIONS AUTHORIZED	Night small unmanned aircraft system (sUAS) operations.
LIST OF WAIVED REGULATIONS BY SECTION AND TITLE 14 CFR § 107.29 Daylight operation	
STANDARD PROVISIONS	
1. A copy of the application made for this certificate shall be attached to and become a part hereof. 2. This certificate shall be presented for inspection upon the request of any authorized representative of the Administrator of the Federal Aviation Administration, or of any State or municipal official charged with the duty of enforcing local laws or regulations. 3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein. 4. This certificate is nontransferable.	
NOTE—This certificate constitutes a waiver of those Federal rules or regulations specifically referred to above. It does not constitute a waiver of any State law or local ordinance.	
SPECIAL PROVISIONS	
Special Provisions Nos. 1 to 11, inclusive, are set forth on the attached pages.	
This Certificate of Waiver is effective from June 19, 2017 to June 30, 2021 and is subject to cancellation at any time upon notice by the Administrator or an authorized representative.	
BY DIRECTION OF THE ADMINISTRATOR General Aviation and Commercial Division, AFS-800	

FAA Form 7711-1 (7-74) CC

SPECIAL PROVISIONS ISSUED TO NCDOT

General.

The FAA's Flight Standards Service has reviewed your application to ensure compliance with the requirements of 14 CFR § 107.200. The Administrator finds that the proposed sUAS operation can be conducted safely under the provisions of this Certificate of Waiver (Waiver) as listed below, because you have established adequate mitigations for risks involved with operating your sUAS in the manner you described. Adherence to the provisions of this Waiver establishes the required level of safety within the national airspace system.

This Waiver may be canceled at any time by the Administrator, the person authorized to grant the Waiver, or the representative designated to monitor a specific operation. As a general rule, this Waiver may be canceled when it is no longer required, there is an abuse of its provisions, or when unforeseen safety factors develop. Failure to comply with any provision listed below is a violation of the terms of this Waiver and may serve as justification for cancellation.

List of Regulations Waived by Section and Title. The following regulations are waived:

14 CFR § 107.29, Daylight operation, is waived to allow sUAS operations during night.

Common Special Provisions. The Responsible Person is directly responsible for safety of operations conducted under this Waiver and will ensure the remote Pilot in Command (PIC), manipulator of the controls, and Visual Observer (VO) complies with all provisions of this Waiver.

1. The Responsible Person listed on the Waiver is responsible to the FAA for the safe conduct of the operations. Prior to conducting operations that are the subject of this Waiver, the responsible person:
 - a. Must ensure the remote PIC, manipulators of the controls, and VO are informed on the terms and provisions of this Waiver and the strict observance of the terms and provisions herein;
 - b. Must ensure the remote PIC, manipulators of the controls, and VO are informed and familiar with part 107 regulations not waived; and
 - c. The above must be documented and must be presented for inspection upon request from the Administrator or an authorized representative.
2. This Waiver must not be combined with any other waiver(s), authorizations(s), or exemption(s) without specific authorization from the FAA;
3. The FAA has the authority to cancel or delay any or all flight operations if the safety of persons or property on the ground or in the air, are in jeopardy or there is a violation of the terms of this Waiver;
4. Operations under this Waiver may only be conducted in Class G airspace unless a separate airspace Certificate of Waiver or Authorization specifically stating that night operations may be conducted in controlled airspace is received from the FAA, in accordance with § 107.41. The airspace Certificate of Waiver or Authorization to operate at night must be requested separately, and is not part of this Waiver;
5. A copy of this Waiver must be available during sUAS operations that are the subject of this Waiver;
6. The Responsible Person listed on this Waiver must maintain a current list of pilots by name and remote pilot certificate number used in the Waiver holder's operations. This list must be presented for inspection upon request from the Administrator or an authorized representative;

Certificate of Waiver Number 107W-2017-02055

7. The Responsible Person listed on this Waiver must maintain a current list of small unmanned aircraft (sUA) by registration number(s) used in the Waiver holder's operations. This list must be presented for inspection upon request from the Administrator or an authorized representative;

Night sUAS Operations Special Provisions. sUAS operations may be conducted at night, as defined in 14 CFR § 1.1, provided:

8. All operations under this Waiver must use one or more VO;
9. Prior to conducting operations that are the subject of this Waiver, the remote PIC and VO must be trained, as described in the Waiver application, to recognize and overcome visual illusions caused by darkness, and understand physiological conditions which may degrade night vision. This training must be documented and must be presented for inspection upon request from the Administrator or an authorized representative;
10. The area of operation must be sufficiently illuminated to allow both the remote PIC and VO to identify people or obstacles on the ground, or a daytime site assessment must be performed prior to conducting operations that are the subject of this Waiver, noting any hazards or obstructions; and
11. The sUA must be equipped with lighted anti-collision lighting visible from a distance of no less than 3 statute miles. The intensity of the anti-collision lighting may be reduced if, because of operating conditions, it would be in the interest of safety to do so.





Appendix H: Sample UAS Policies and Procedures



UNMANNED AIRCRAFT SYSTEM (UAS)

POLICY NO. OP006, EFFECTIVE DATE 3-14-2018

Policy Owner: Director, Office of Aeronautics

Policy Contact: Manager, Aviation Safety & Enforcement, Office of Aeronautics

Policy History: 06-18-2015, Established
 07-29-2016, Revision 1
 03-14-2018, Revision 2

Policy Statement

The Minnesota Department of Transportation (MnDOT) will permit the use of an Unmanned Aircraft System (UAS) for the purposes of conducting the business of the agency. The *MnDOT Unmanned Aircraft Systems policy* pertains to operations by MnDOT employees or by contractors and consultants working on behalf of MnDOT. The Office of Aeronautics *must* approve UAS usage by MnDOT or third parties conducting business for MnDOT.

For UAS operation MnDOT employees *must*:

- Comply with the requirements of the Federal Aviation Administration (FAA).
- Create a safety and operations plan that addresses all aspects of the intended mission.

When contracting for UAS services, the contractor *must* adhere to federal regulations under which they are operating.

MnDOT-owned UAS and UAS owned by contractors are required to license the aircraft as required by [Minnesota Statutes §360.511](#) through [Minnesota Statutes §360.62](#). Contractors are required to obtain a commercial operator's license from the MnDOT Office of Aeronautics as required by [Minnesota Statutes §360.521](#) - [Minnesota Statutes §360.675](#).

The Office of Aeronautics provides assistance to districts and offices that are pursuing or contracting for UAS services.

Reason for Policy

- Provide clear and concise information on the UAS application, purchase and usage procedures
- Identify roles and responsibilities
- Ensure compliance with state and federal laws and regulations

Check out [MnDOT's Policy Website](#).

Who Needs to Know this Policy?

- Office of the Commissioner
- District Engineers and Assistant District Engineers
- Office Directors
- Division Business Managers
- Project Managers
- Office of Communications
- Employees and third parties, including consultants and contractors, seeking or obtaining approval to use UAS for MnDOT activities

Definitions

Flight

A flight is an individual operation of the UAS from takeoff to landing. Each flight should have defined parameters for area of operation, altitudes, flight path and length of flight.

Mission

The mission includes the specific details and justification for the particular use of a particular aircraft. Examples of missions include bridge inspections, aerial photography, salt pile measurements, etc.

Pilot

UAS pilots must meet the FAA requirements for the type of operation they are conducting. Pilots flying under the Part 107 small UAS rule **must be certificated** as remote pilots with a small UAS rating. If the operation is being conducted under a Certificate of Authorization (COA), then the pilot must meet the requirements as required by the COA. All MnDOT staff piloting small UAS are required to have a remote pilot certificate with small UAS rating issued by the FAA. Additional training will be required to comply with a COA or Operations Manual.

Project

A project is a specific task. A project will have a specific purpose, timeframe and defined location. A project may require multiple flights.

Unmanned Aircraft System (UAS)

A UAS is an unmanned aircraft vehicle (UAV) and all the associated support equipment, control station, data links, telemetry, communications and navigation equipment necessary to operate the unmanned craft. The UAV is the flying portion of the system, flown by a qualified pilot via a ground control system, or autonomously through use of an on-board computer, communication links and any additional equipment that is necessary for the UAV to operate safely.

Small UAS

Small UAS (sUAS) is a UAS that weighs less than 55 pounds including everything that is on-board or otherwise attached to the aircraft.

Unmanned Aircraft Vehicle (UAV)

A UAV is an aircraft flown without direct human intervention from within or on the aircraft.

Small UAV

A small UAV is an aircraft that weighs less than 55 pounds including everything on-board or otherwise attached to the aircraft. UAVs are normally either fixed wing aircraft or multi-rotor aircraft.

Procedures

MnDOT contracting process for UAS approval

Offices or districts contracting for UAS use *must* complete a **MnDOT Unmanned Aircraft System Use (UAS) application**. The information captured in this document *must* represent a comprehensive view of the issues surrounding the decision and incorporate feedback from all parties directly impacted.

- Identify the office or district requesting to use the UAS
- Detail the particular consultant, the purpose, time, manner, and location of use
- Complete an analysis that identifies the benefit of using a UAS
- Provide a safety and privacy plan that addresses the risks and outlines the risk mitigation processes
- Prepare a communications plan to make the public aware of the operation
- Email the completed application to ***DOT_UASRequest@state.mn.us**

The Office of Aeronautics must review and approve all applications prior to contracting for services. The Office of Aeronautics will consult with the Office of Chief Counsel, as needed, to determine if the content of the application complies with federal

APPENDIX H : SAMPLE UAS POLICIES AND PROCEDURES

and state regulations. The funding plan is the responsibility of the requestor and not subject to the review and approval by the Office of Aeronautics.

UAS purchase process and FAA approval

Offices or districts preparing for the purchase of a UAS *must* complete a **MnDOT Unmanned Aircraft System Use (UAS) application**. The information captured in this document *must* represent a comprehensive view of the issues surrounding the decision and incorporate feedback from all parties directly impacted.

Prior to purchase, the office or district *must*:

- Identify the mission and complete an analysis that identifies the MnDOT benefits of using the UAS
- Specify the UAS intended for purchase
- Identify the personnel that will operate the UAS

Prior to operating the UAS, the office or district *must*:

- Provide an operation manual that addresses common processes for the mission, crew training and certification procedures for project and flight planning, UAS maintenance, record-keeping, and emergency procedures to follow in the event of a crash.
- Additional missions for an existing UAS require an update of the operations manual to cover the new missions.
- Purchase of a new UAS requires an update of the operations manual to cover the maintenance and operation of the new UAS.
- On approval of the purchase, the Office of Aeronautics will coordinate federal approval with the requesting MnDOT office or district for UAS use.

While FAA approval may not be required for UAS operations that comply with **CFR Title 14, Part 107**, “*Operation and Certification of sUAS*,” offices or districts may find the need for exceptions to the Part 107 rules. Currently there are two means to get an exception to Part 107:

- Request a specific exemption for a specific restriction on a specific project, like flights in Class B Airspace or,
- Obtain a Certificate of Waiver or Authorization (COA) from the FAA, which takes longer to get initial approval, but allows the operator more latitude in the scope of the exception. Offices or districts anticipating short notice waivers for flights in support of disaster operations should work towards obtaining a COA.

UAS operations by MnDOT personnel

In addition to regular field safety policies MnDOT operators must comply with the following requirements:

- All operators must meet the current FAA requirements.
- MnDOT further requires that operators demonstrate their ability to perform the tasks required for the mission in a safe environment including exercising the emergency recovery capabilities.
- An Office of Aeronautics pilot or a mission-qualified pilot will supervise newly certified pilots on their first project flight in the field.
- Pilots are required to fly three flights per quarter to maintain their currency. A qualified and current pilot must supervise pilots that are not current until they meet currency requirements.
- Pilots must be certificated by the FAA. In addition to FAA certification, pilots must demonstrate the ability to fly a UAS of similar design to the UAS they will operate in the field. Offices or districts should take advantage of training available from the UAS manufacturer to gain skills in operating the particular UAS they will fly in the field, as an efficient and effective means of financial management.
 - Pilots must complete a mission-qualification flight every two years in addition to any requirements established by the FAA.
 - Contact the Emergency Management & Safety Manager for general safety questions.
 - Contact the Office of Aeronautics, 651-234-7200 (office) or 1-800-657-3922 (toll free) for aviation safety and training, **MnDOT Office of Aeronautics and Aviation**
 - **MnDOT Employee Safety Handbook** (for employees only) and the **MnDOT Safety Resources** website provide information such as **Eye and Face Protection**, **Head Protection**, **Foot Protection**, **High Visibility Protection** and other workplace safety material.

UAS operations on MnDOT projects or Right of Way by parties who are not MnDOT personnel or consultants and contractors hired by MnDOT

MnDOT will not authorize the use of a UAS on MnDOT projects or right of way by persons unaffiliated with MnDOT. UAS operators flying in accordance with 14 CFR, Part 107 generally do not require MnDOT authorization. If special circumstance seems to indicate the need for MnDOT authorization, contact the Office of Aeronautics prior to proceeding.

A contractor or consultant of MnDOT may want to fly over a project or MnDOT right of way. MnDOT personnel must complete a MnDOT Unmanned Aircraft System Use (UAS) application prior to the UAS operation and email the completed application to *DOT_UASRequest@state.mn.us. The Office of Aeronautics will consult with the Office of Chief Counsel, as needed, to determine if the operation can be safely completed and complies with federal and state regulations.

Responsibilities

Office of Aeronautics

- Review proposed UAS use requests for contractor use of UAS.
- Approve the UAS Use Request and the operations manual for UAS missions flown by MnDOT staff.
- Jointly coordinate COA applications with the requesting MnDOT office or district
- Assist in registering the UAS and contractors to ensure compliance with state statutes and rules, as necessary
- Conduct spot checks of UAS operations to ensure compliance and to identify opportunities for improvement of UAS operations.
- Assist the district or office in working with the FAA on waivers and airspace authorizations. If issues with the FAA arise, the district or office should contact the Office of Aeronautics for assistance.

Office of Communications/District Public Affairs Coordinators

- Provide media coordination for projects to ensure clear, consistent messages about MnDOT use of UAS

Office of Government Affairs

- Provide timely updates on MnDOT UAS usage to the Governor and legislature, as requested

Districts and Offices (program managers and contractors)

- Prepare and provide the UAS Use Application to the Office of Aeronautics for review and approval
- Prepare an operations manual for the MnDOT ownership and use of UAS
- Monitor the operations of MnDOT-owned UAS to ensure that flights are being conducted in accordance with the operations manual
- Prepare the funding plan supporting the UAS (purchase or contract)
- Notify the Office of Communications or District Public Affairs Coordinator on each project
- Ensure employees authorized to use a UAS read, understand and follow this policy
- Provide necessary coordination with multiple parties to mitigate risk exposure for employees, contractors and the public
- Involve the Office of Aeronautics when working with the FAA on waivers and airspace authorizations. If issues with the FAA arise, the district or office should contact the Office of Aeronautics.

Employees using Unmanned Aircraft Systems

- Read, understand and follow this policy and the operations manual, all FAA regulations and the instructions provided by the UAS manufacturer
- When operating the UAS always err on the side of safety.

Contractors or Consultants using Unmanned Aircraft Systems on MnDOT projects or right of way

- Follow the restrictions laid out in the UAS Use Application and supporting documentation
- Operate the UAS within the restrictions imposed by the FAA, State of Minnesota and the instructions provided by the UAS manufacturer.

Forms and Instructions

[MnDOT Unmanned Aircraft System Use \(UAS\) application](#)

Related Information

[Minnesota Statutes §360.511](#) through [Minnesota Statutes §360.62](#) *Aircraft Registration*

[Minnesota Administrative Rules 8800.3100](#) through [Minnesota Administrative Rules 8800.3950](#) *Commercial Operations*

[FAA Fly for Work/Business](#)

[FAA Unmanned Aircraft Systems \(UAS\) Regulations & Policies](#)

[FAA Unmanned Aircraft Systems](#)

- The Small UAS Rule (14 CFR Part 107), including all pilot and operating rules, is effective on August 29, 2016. For more detailed information, please see:
 - [Summary of the Small UAS Rule \(pdf\)](#)
 - [Small UAS Advisory Circular - How to Use the Rule \(pdf\)](#)
 - [Complete Text of the Small UAS Rule](#)

[MnDOT Contract Management Policy](#)

[MnDOT Media Relations Policy](#)

[MnDOT Office of Aeronautics and Aviation](#)

[MnDOT Employee Safety Handbook](#) (*employee use*)

Policy Ownership and Authorization

Policy Owner: Director, Office of Aeronautics

Signature: Cassandra Tsackson

Print Name: CASSANDRA TSACKSON

Date: MARCH 16, 2018

Internal Control & Accountability Governance Board has reviewed this policy and recommends approval:

Signature: Janet Cherney

Print Name: Janet Cherney

Date: 3/30/18

Responsible Senior Officer: Deputy Commissioner

Signature: Susan M. Mulvihill

Print Name: SUSAN M. MULVIHILL

Date: 4/3/18



UAS STANDARD OPERATING PROCEDURES

FLIGHT OPERATIONS



UAS PROGRAM OFFICE

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
1050 Meridian Drive, Morrisville, NC, 27560

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1. INTRODUCTION

The standard operational procedures will serve as a guide for flight operations planning and execution. The operational procedures document best practices and internal processes for safe and effective flight operations. This includes roles and responsibilities, mission phases, and emergency procedures. The aim is to document everything that needs to be done during a mission, so it can act as a reference point for team members. Flight operations should be conducted under the 14 CFR Part 107/Certificate of Airworthiness. However, not all of these guidelines will apply to all situations. Therefore, use your best judgment and error to the side of safety.

2. PERSONNEL

The UAS Coordinator or Remote Pilot-in-command (RPIC) is responsible for the overall safety during UAS operations.

UAS COORDINATOR:

- The UAS Coordinator shall maintain a file for each operator and airframe. The file shall include copies of training records, flight incidents, maintenance records, etc.
- It is the responsibility of the UAS Coordinator to be current and to update the RPIC and observer with all federal and state regulations as they change;
- The UAS Coordinator shall ensure that the RPIC has all documents required as per FAA, state and department guidelines.
- The UAS Coordinator should ensure that the RPIC is current with the training and knowledge.
- It is the responsibility of the UAS Coordinator to ensure all UAS are registered and in airworthy condition.

REMOTE PILOT-IN-COMMAND (RPIC):

- To be considered for selection as an operator, applicants must meet the requirements for and successfully pass the FAA Remote Pilot Certification and the North Carolina UAS Operator permit administered by NC Division of Aviation in order to be accepted into the UAS crew.
- Operators interacting with Air Traffic Control (ATC) or Terminal Radar Approach Control Facilities (TRACON) shall have sufficient expertise to perform that task readily. Operators must have an understanding of, and comply with FAA Regulations applicable to the airspace where the UAS operates.
- An operator's primary duty is the safe and effective operation of the UAS in accordance with the manufacturers' approved flight manual, FAA regulations, NC General Statutes and department policy and procedures. Operators must remain knowledgeable of all FAA regulations; UAS manufacturer's flight manual and bulletins and department policy and procedures.
- Operators may be temporarily removed from flight status at any time by the UAS Coordinator, for reasons including performance, proficiency, physical condition, etc. Should this become

necessary, the operator will be notified verbally and in writing of the reason, further action to be taken and expected duration of such removal.

- It is the responsibility of the RPIC to ensure all UAS are registered and in airworthy condition prior to UAS operations.

OBSERVERS (OPTIONAL)

- Observers must have been provided with sufficient training to communicate clearly to the operator any turning instructions required to stay clear of conflicting traffic and obstacles.
- An observer's primary duty is to operate the UAS's equipment including cameras, radio communications with RPIC , as well as be an observer for anything that may affect the RPIC's primary duty (see and avoid).

3. TRAINING

The key to continued safe operations is by maintaining a professional level of competency. The first step in this process is establishing minimum qualifications for selecting operators, and the second step involves training those personnel.

TRAINING PLANS

1. All operators have a training plan on file that outlines training objectives. This training plan will be held in conjunction with the member's normal training file per department policy.
2. The approved training plan is developed by the UAS coordinator.
3. All deployments or exercises are documented and count toward an operators training.
4. It is the UAS Coordinators/ RPIC responsibility to verify the training file contains all pertinent information.

INITIAL TRAINING

1. Operators must obtain the FAA Remote Pilot Certification and the North Carolina UAS Operator Permit. In addition the operator should, at a minimum, have knowledge of the rules and responsibilities described in 14 CFR 91.111, Operating Near Other Aircraft; 14 CFR 91.113, Right-of-Way Rules: Except Water Operations; and 14 CFR 91.155, Basic VFR Weather Minimums; knowledge of air traffic and radio communications, including the use of approved ATC/pilot phraseology; and knowledge of appropriate sections of the Aeronautical Information Manual.
2. In conjunction with fulfilling all training requirements for RPICs duties, the new operator must also become familiar with UAS operations, the aircraft and its equipment.
3. Any new operator who fails to successfully complete the initial training may be denied as a PIC of the UAS operation.
4. Before an operator can fly as RPIC, he/she must complete at least two hours of flight training with the department assigned UAS Coordinator to show proficiency of the flight training exercises and the airframe. This must be accomplished to show their ability and knowledge of the UAS.

RECURRENT TRAINING

1. All operators shall maintain proficiency in their RPIC abilities. Operators who do not have any documented training or flight time within a span of 60 days will have to show proficiency before being a RPIC during an UAS operation or exercise.
2. Recurrent training is not limited to actual operating skills but includes knowledge of all pertinent UAS/aviation matters.
3. Failure to prove proficiency can result in removal from UAS responsibilities.

4. PRE-FLIGHT OPERATIONS

Preflight activities are the duty of the RPIC before the start of the flight operation. Activities include inspection of the aircraft, assessment of the operating location, briefing crew members involved in the operation, and equipment checkouts. All flight operations should be conducted in accordance with the provision of 14 CFR Part 107, state and local regulations, and the operator's manual for the subject aircraft.

PLANNING

1. The flight crew should be familiarized with all available information pertaining to the flight such as; take-off/landing, including but not limited to the operational limitations of Part 107, weather conditions, hazards, no fly zones, etc.
2. North Carolina state statues require land-owner approval before operations take place.
3. RPIC will ensure the location for take-off and emergency landing is adequate upon arrival at the location. At least one emergency landing area should be identified before the start of operations.
4. RPIC should be aware of all surroundings in the event that an emergency landing is necessary. This includes the ability to recover the UAS.

INSPECTION

1. Before the first flight of the day, verify all batteries are fully charged.
2. Check the airframe for signs of damage, and its overall condition.
3. Check the entire aircraft per the pre-flight inspection instructions in the manual for the specific aircraft to make sure it is in good structural condition and no parts are damaged, loose, or missing.
4. Check the propeller or rotor blades for chips, cracks, looseness and any deformation.
5. Check that camera(s) and mounting systems are secure and operational.
6. Perform an overall visual check of the aircraft prior to arming any power systems.
7. Repair or replace any part found to be unsuitable to fly during the pre-flight procedures prior to takeoff.

WEATHER

1. Before each flight the RPIC and observer should ensure that he/she gathers enough information about the existing and anticipated near-term weather conditions throughout the entire mission environment. As a best practice he/she should utilize FAA approved weather resources such as; Meteorological Terminal Aviation Weather Reports (METARS), Terminal Area Forecasts (TAF), etc. to obtain the best information. In order to obtain the latest and most current weather conditions, Notices to Airmen (NOTAMs), and Temporary Flight Restrictions (TFRs) the RPIC should obtain a local aviation briefing at; 1-800-WXBRIEF or www.1800WXBRIEF.com.
2. Wind direction plays a major factor in flight operations. Operators should take precautions to ensure that wind conditions do not exceed the aircraft limits stated in the aircraft operations manual/specifications. An anemometer (pocket anemometers are available from a variety of sources) is a low-cost and simple to use tool that can be utilized in order to better estimate the wind speed and determine if it is within the necessary limits of the UAS being flown. Use of an anemometer is highly recommended, in particular in cases where wind conditions and whether they are within limits may be questionable.
3. The RPIC should ensure that the flight will occur within the weather requirements specified in Part 107.51 (c-d), 3 statute miles, the UA must be kept at least 500 ft. below a cloud and at least 2,000 ft. horizontally from a cloud. While the FAA can obtain waivers under Part 107 for certain types of operations in particular locations for night-time or beyond line of sight operations, the vast majority of authorizations are for FAA VFR conditions and require Visual Line of Sight (VLOS) between the aircraft and the UAS Operator as well as between the aircraft and the Visual Observer at all times.

CHECKLIST

Preflight inspection is required under Part 107.49; the RPIC is required to develop a preflight inspection checklist if the manufacture has not developed one.

The checklist is usually integrated into the UAS flight software or can be obtained from the UAS vendor. In case that is not available, a standard Flight Checklist (Figure 1) should be made and followed by the flight crew. RPIC should utilize the checklist to ensure the highest level of safety. At a minimum, this pre-flight checklist should contain the following:

-
1. Required documentation, Pilots Certificate, NC State Operators Permit, Aircraft Registration, UAS Flight Manual, Proof of Insurance.
 2. Weather conditions suitable.
 3. Check air frame for cracks and check all screws are tight.
 4. Propeller(s)/Rotor(s) not damaged and tightly fixed.
 5. Propulsion system mounting(s) secure.
 6. Batteries fully charged and securely mounted.
 7. Communications (datalink) check.
 8. Ensure the GPS module (if any) has GPS “fix.”
 9. Check mission flight plan.
 10. “Return Home” and/or “Emergency Landing” locations (if supported by the particular UAS) are selected, located appropriately, and loaded to the GCS and aircraft.
 11. Ensure sensors are calibrated and that the right setting is loaded.
 12. Complete flight crew briefing.
 13. Ensure the launch site is free of obstacles.
 14. Recheck wind direction before launch.
 15. Confirm phone number for nearest Air Traffic Control facility in event of emergency.

FLIGHT CHECKLIST		
PRE FLIGHT	DURING FLIGHT	POST FLIGHT
<p>At office</p> <ul style="list-style-type: none"> <input type="checkbox"/> Aircraft Documentation <input type="checkbox"/> NOTAM <input type="checkbox"/> Local regulations and permissions. <input type="checkbox"/> Proximity to the airport. <input type="checkbox"/> Weather condition permits flying. <input type="checkbox"/> All Batteries Charged <input type="checkbox"/> Flight Gear check <p>In the field</p> <ul style="list-style-type: none"> <input type="checkbox"/> Scan area for obstacles, e.g. take-off and landing area. <input type="checkbox"/> Wind check <input type="checkbox"/> Daily Flight Report filled. <input type="checkbox"/> Assemble UAV, ensure screws are tight and propeller check <input type="checkbox"/> Sensor/ Camera setting check <input type="checkbox"/> Batteries securely mounted <input type="checkbox"/> Ensure GPS fix <input type="checkbox"/> Confirm Mission flight plan <input type="checkbox"/> Operators checklist (Integrated) <input type="checkbox"/> RC remote check (if used) <input type="checkbox"/> Final airframe inspection <input type="checkbox"/> Flight Crew briefings, e.g. flight mission and safety <input type="checkbox"/> Wind check again for launch. 	<p>After launch</p> <ul style="list-style-type: none"> <input type="checkbox"/> Aircraft reached safe altitude. <input type="checkbox"/> Confirm observer has the aircraft in sight. <input type="checkbox"/> All systems green <input type="checkbox"/> Satellite and GPS check <input type="checkbox"/> Check Battery remaining <p>Before Landing</p> <ul style="list-style-type: none"> <input type="checkbox"/> Ensure UAV flight done according to mission plan. <input type="checkbox"/> Scan landing area for obstacles. <input type="checkbox"/> Wind check <input type="checkbox"/> Observer briefing for landing <input type="checkbox"/> All systems green 	<p>After landing</p> <ul style="list-style-type: none"> <input type="checkbox"/> Power down UAV <input type="checkbox"/> Remove and safely store batteries <input type="checkbox"/> Airframe inspection <input type="checkbox"/> Check camera/ sensor to ensure data collected <input type="checkbox"/> Transfer data and flight log <input type="checkbox"/> Make logbook entry <p>Back at office</p> <ul style="list-style-type: none"> <input type="checkbox"/> Flight and Maintenance Report <input type="checkbox"/> Charge Batteries <input type="checkbox"/> SD card cleaned and ready to use <input type="checkbox"/> Airframe checked <input type="checkbox"/> Data processed

Figure 1: Example of a Flight Checklist*

* This checklist is considered a guide and not definitive checklist for all UAS's. Use common sense when operating UAS's. Consult local UAS agency or vendors to ensure your checklist is appropriate.

DOCUMENTATION

Once the RPIC confirms the location is safe to fly and becomes familiarized with the surroundings, it is recommended that he/she document all the details in a Pre Flight Report. The Pre Flight Report can often be filled out prior to arrival at the site as a part of mission planning and then signed off by the RPIC once on site and the RPIC has confirmed that the operation can be conducted safely at the site. Furthermore, it is recommended that such a report be completed for each mission regardless of whether it is completed prior to or after the flight as the report serves as an essential piece of documentation associated with the UAS operation.

1. An example of what the report should contain is:
2. Altitudes to be flown
3. Mission overview
4. Frequencies to be used
5. Planned flight time, including reserve fuel requirements

6. Contingency procedures
7. Pilot Name
8. Observer(s) name(s)
9. Date & Time

PRE FLIGHT REPORT

Documents	
Land Owner Permission	XXXXXX
Aircraft Registration	XXXXXX
Plan	
Call signs & Phraseology	Loiter, RTL
Altitude to be flown	100 meters
Mission Overview	Crop data
Frequencies	2.4 ghz
Planned Flight time, including reserve	30 mins
Contingency procedure: lost link, divert, etc.	Return to land
Hazards unique to the flight being flown	Variable winds
Closest Airport	KRDU
Emergency Contact	
Law Enforcement	911
Closest Tower Frequency	127.450
Site Manager	James B.
Roles	
Pilot	Marc A.
Observer 1	Rachel J.
Observer 2	none
Data Analyst	Peter S.

*Figure 2: Example of a Pre-Flight Report**

** This report is considered a guide and not definitive report for all UAS's. Use common sense when operating UAS's. Consult local UAS agency or vendors to ensure your checklist is appropriate.*

5. DURING FLIGHT OPERATIONS

1. The UAS RPIC should launch, operate, and recover from preset locations so that the aircraft will fly according to the mission plan.
2. After the UAS is launched, the flight crew should have a clear view of the aircraft at all times, called Visual Line of Sight (VLOS). Observation locations should be selected for the maximum line of sight throughout the planned flight operations area (Part 107.31).
3. All flight operations must be conducted using a minimum of a RP and PMC per Part 107.31. However it is advisable to utilize one or more VO's, as outlined in Part 107.33, depending on the complexity of the flight mission to perform general safety, visual observation, hazard and traffic avoidance (Part 107.37).
4. To ensure the flight is going according to the flight plan, the RP, PMC and VO (if used) must be able to maintain effective communication with each other at all times (Part 107.33).
5. The visual observer should be informed on what the aircraft is supposed to be doing and the altitude of the aircraft above ground level.
6. Part 107.39 does not permit UAS flights over persons not directly involved in the operations. Flights taking place over populated areas, heavily trafficked roads, or an open-air assembly of people is not allowed under regulation (unless through waiver). If the mission dictates that flight operations be conducted in such areas, the RPIC will need to obtain a waiver before conducting a flight.
7. The observer should make the pilot aware of any possible flight hazards during the flight.
8. Upon any failure during the flight or any loss of visual contact with the UAS, the RPIC should command the aircraft back to the recovery location or utilize the built-in fail-safe features to recover the aircraft. Emergency procedures as defined in the specific UAS operator's manual should be followed.

6. POST FLIGHT OPERATIONS

1. RPIC should scan the landing area for potential obstruction hazards and recheck weather conditions.
2. RPIC should announce to the observer and any other people around that the aircraft is on final approach and inbound to land.
3. RPIC should always be prepared to reject or abort a take-off or landing, called a “go-around,” if the PMC becomes aware that such an operation cannot be safely made due to an unexpected weather situation, emergency, hazard or miscalculation.
4. Carefully land the aircraft away from any obstructions and people.
5. After landing:
 - Shut down the UAS and disconnect the batteries.
 - Power down the camera or sensors.
 - Visually check aircraft for signs of damage and/or excessive wear.
 - Verify that mission objectives have been met.
 - If imagery or other data are recorded onboard the aircraft during flight, transfer the data as necessary to the Ground Control Station (GCS) or a backup storage device. If all data and imagery is transmitted to the GCS and recorded on the GCS during the flight, then operators may wish to consider backing up the data prior conducting additional flight operations.
 - Enter logbook entries recording flight time and other flight details.
 - In case there are multiple flights to be conducted, repeat checklist steps to prepare the aircraft for launch again.

7. EMERGENCY PROCEDURES

Emergency procedures are specific to each UAS type as designed by the manufacturer. It is the responsibility of the flight crew to be proficient with the aircraft operational manual provided by the vendor before any flight operations are conducted. It is also a best and safe practice to prepare an Emergency Checklist (Figure 3) in case of emergencies. The RPIC should always be prepared to execute an emergency procedure in instances where there is a lost link, loss of GPS, or there are other aircraft or obstructions in the flight path. He/she should brief the flight crew before the start of the flight operations about emergency procedures and have a mission abort site for landing in the case of an emergency. After the aircraft has safely landed, it should be documented for maintenance purposes.

Some possible emergencies due to system failures are as follows:

- Loss of Datalink communications
- Loss of GPS
- Autopilot Software error/failure
- Loss of Engine power
- Ground Control System failure
- Intrusion of another aircraft into the UAS mission airspace

This is not meant to be a comprehensive list as the types of failures and associated emergency conditions vary for different UAS, airspace events, and crew performance.

Many UAS have a number of failsafe options in case of failures or emergency situations. These include using methods of stabilization and an automated Return to Land (RTL) or Loiter mode. Other features include fail-recovery software. The specific failsafe options available for each type of UAS should be outlined in the UAS documentation (Operator's Manual, Checklists, etc.). These fail-safe mechanisms should be tested during training and currency flights. Flying without these fail-safe mechanisms in place is not recommended.

An emergency avoidance procedure should be determined before landing. Options include land immediately, move to a predetermined location and altitude, or another approach. All possible incursions must be assessed for risk mitigation.

In the event of a lost link or fly away, the RPIC should evaluate the airspace affected and contact the appropriate controlling agency (i.e. control tower, airport manager, Center, Restricted Area agency, etc.)

immediately with details of the flight such as; location, direction of flight and approximate altitude, speed and flight time remaining (remaining battery life) .

In the event of an emergency the RPIC should be prepared to submit a written statement on any deviations upon the request of the Administrator (FAA) as outline in Part 107.21. Best practices suggest that the RPIC fill out a NASA Aviation Safety Reporting System (ASRS), Electronic Report Submission (ERS). More information can be found at: <https://asrs.arc.nasa.gov/overview/summary.html>.

Note: The NASA ARRS system was developed to encourage pilots, aviation maintenance technicians and other personnel to disclose mistakes in a non-punitive format in an effort to advance safety. In exchange for volunteering information the person reporting the infraction may receive a reduced penalty if the FAA pursues certificate action.

Emergency Checklist		
Loss of Data link/ Ground Control System (GCS) Failure Result of both datalinks lost (no heartbeats) or GCS laptop and radio links fail for more than 10 seconds.	Autopilot software failure Result if the autopilot software crashes during flight mode	Battery Warnings Result of main GCS laptop and radio links fail for more than 10 seconds.
<ul style="list-style-type: none"> → UAV will loiter for 2 minutes (check operators manual for exact time) → If datalink not re-established within this time, flight will terminate and return to land (fail safe setting) 	<ul style="list-style-type: none"> → Try reconnecting from GCS laptop → RC control should be established and the UAV should be landed. If no RC then flight will terminate and return to land (fail safe setting) 	<ul style="list-style-type: none"> → If Battery low warning or battery percentage 35% then landing is advised. Use landing zone or alternate landing area. → If Battery percentage 10% for more than 5 seconds then lading or abort sequence is advised. → If 0% then engine shuts down.
Loss of GPS Result when UAV loses GPS signal in the flight mode	Loss of engine power Result of airspeed and altitude drop, engine most likely stopped working.	Intruding Aircraft Result of another aircraft entering the UAS mission airspace (refer to FAR 91.113)
<ul style="list-style-type: none"> → UAV will automatically loiter around point of GPS lock loss for 20 seconds (check operators manual for exact time) → UAV will navigate to Home waypoint → RC control should be established and the UAV should be landed. If no RC then flight will terminate and return to land (fail safe setting) 	<ul style="list-style-type: none"> → The UAV will attempt to glide to airfield home (fail safe) → Make sure the UAV is in line of sight at all times. 	<ul style="list-style-type: none"> → If approaching head-on both aircrafts alter their heading to the right. Same applies to UAVs too → Use FLY here option if available. → Immediately descend the UAV to safe altitude

Figure 3: Example of an Emergency Checklist*

* This checklist is considered a guide and not definitive checklist for all UAS's. Use common sense when operating UAS's. Consult local UAS agency or vendors to ensure your checklist is appropriate.

8. FLIGHT AREA / PERIMETER MANAGEMENT

The selection of launch and landing sites is based first and foremost on safety. It is the job of the RPIC to ensure that all flight operations are within the FAA-issued airspace authorization parameters and UAS flight limits. Flight boundaries, including any restrictions imposed by FAA approvals, nearby airport locations, restricted areas, TFRs, etc. should be reviewed prior to commencing flight operations. In addition, the RPIC should identify the following:

1. Primary Take-off and Landing site - Typically the primary landing shall be the same as the launch site but they can be separate locations. The RPIC has final authority for any approaches to the primary site and elect to reject an approach deemed unsafe.
2. Alternate landing sites - The RPIC shall designate at least one alternate landing site. In the event that a landing is not possible and the primary landing site is deemed unsafe, procedures to utilize the back-up site will be invoked.
3. Mission Abort Sites - The RPIC may optionally designate an alternate landing site whereby the aircraft may be landed in directly in an emergency situation. The alternate landing site should be located so as to provide absolute minimal risk if the aircraft is required to vacate airspace in an emergency. If the RPIC deems it necessary, the UAS may be flown to this site and landed without regard to the risk to the flight equipment or the unmanned aircraft. The safety of persons, manned aircraft, and property should be prioritized over the risk to the UAS equipment.
4. Flight Over populated areas- The RPIC should make every effort to select a landing site that avoids approaches over populated areas.
5. Landing Safety & Crowd control - All landing sites should be maintained and operated in the same manner as the launch sites. A buffer of at least 50 feet should be maintained at all times between aircraft operations and all nonessential personnel (all personnel other than the UAS Operator/RPIC and the Visual Observer).

9. ACCIDENT REPORTING

Within 10 calendar days after an accident (as defined by regulation) and before additional flights, the operator must provide notification to the FAA per Part 107.9.

FAA defines an accident when:

1. any person suffers death or serious injury.
2. damage to any property, other than the small UAS if the cost is greater than \$500 to repair or replace the property.

The accident report can be submitted FAA Regional Operations Center (ROC) electronically (https://www.faa.gov/uas/report_accident/) or by telephone using the following directory:

Figure 4-1. FAA Regional Operations Centers Telephone List

FAA REGIONAL OPERATIONS CENTERS	
LOCATION WHERE ACCIDENT OCCURRED:	TELEPHONE:
DC, DE, MD, NJ, NY, PA, WV, and VA	404-305-5150
AL, CT, FL, GA, KY, MA, ME, MS, NC, NH, PR, RI, SC, TN, VI, and VT	404-305-5156
AK, AS, AZ, CA, CO, GU, HI, ID, MP, MT, NV, OR, UT, WA, and WY	425-227-1999
AR, IA, IL, IN, KS, LA, MI, MN, MO, ND, NE, NM, OH, OK, SD, TX, and WI	817-222-5006

Source: FAA Advisory Circular (AC) 107-2

The ROC Reports may also be made to the nearest jurisdictional FSDO

(https://www.faa.gov/about/office_org/field_offices/fsdo/). The report should include the following information:

1. RPIC's name and contact information;
2. RPIC's FAA airman certification number;
3. sUAS registration number issued to the aircraft, if required (FAA registration number);
4. Location of the accident;
5. Date of the accident;
6. Time of the accident;
7. Person(s) injured and extent of injury, if any or known;
8. Property damaged and extent of damage, if any or known; and
9. Description of what happened.

SUAS accidents are reported to the FAA ROC. However, in some cases, according to FAA AC 107-2 (4.5.2), a sUAS accident must be reported to the National Transportation Safety Board (NTSB). The AC directs the RPIC reporting an accident to the FAA to consult the NTSB website (www.nts.gov) for more information. It is important to understand the regulations so that proper reports and notifications can be prepared following an accident. Enforcement action can be taken against the operator if notification is not made within the prescribed timeframe.

10. FLIGHT CREW COMMUNICATIONS

The knowledge of flight management process flows is crucial for effective communication. It is important for the RPIC, Person Manipulating the Controls, Visual Observer(s), and other essential flight personnel to maintain communication at all times. During all operations observer and other flight personnel to acknowledge that he/she received a message. This way the flight crew can coordinate flight operations in an organized and effective manner. A proper decision making structure (communications plan) should be identified prior to Pre Flight Operations and should be followed by the flight crew at all times, i.e. (in-order of the hierarchy from highest to lowest) RPIC, Person Manipulating the Controls and the Visual Observer(s).

11.EXTERNAL COMMUNICATIONS

Waiver must be obtained before flight operations are conducted in Class B, C, D, and E airspace. The FAA maintains a website to file waivers.

- https://www.faa.gov/uas/request_waiver/

Instructions for filling out the waiver are linked to the website link above. Applications with incomplete or incorrect information will be rejected. The RPIC will need to follow the provisions of the waiver which will vary by location.

According to AC 107-2 5.8.1, “Unless the flight is conducted within controlled airspace, no notification or authorization is necessary to operate at or near an airport.” When operating in the vicinity of an airport, the RPIC must be aware of all traffic patterns and approach corridors to runways and landing areas (AC 107-2 5.8.1, 5.8.1.1, 5.8.1.2). Operations in the vicinity of airports in uncontrolled airspace do not require airport operator/management notification. However, adherence to CFR 107.43 “Operations in the vicinity of airports” is required. 107.43 states, “No person may operate a small unmanned aircraft in a manner that interferes with operations and traffic patterns at any airport, heliport, or seaplane base.” As a result, it is important to allow for additional pre-flight planning time to become knowledgeable about the specific non-towered airport operations.

When operating in the vicinity of a non-towered airport within Class G Airspace two-way radio communication with the Common Traffic Advisory Frequency (CTAF) or Unicom is not required under Part 107. Never-the-less, it is recommend that the UAS flight crew monitor the airport’s CTAF or Unicom, and be familiar with airport operations and radio communication procedures. It is also best practice to have the local emergency responder’s phone number on hand in case of emergencies.

12. REFERENCES

- Final Rule of FAA Part 107:
<https://www.federalregister.gov/documents/2016/06/28/2016-15079/operation-and-certification-of-small-unmanned-aircraft-systems>
- FAA Advisory Circular 107 – 2:
https://www.faa.gov/documentlibrary/media/advisory_circular/ac_107-2.pdf
- NCDOT Division of Aviation website: <https://www.ncdot.gov/aviation/uas>

Unmanned Aircraft Systems (UAS)

Effective: March 22, 2017

UDOT 01-07

Revised: New

Purpose

To define the use of Unmanned Aircraft Systems (UAS) for the purposes of conducting Utah Department of Transportation (Department) business.

Policy

UAS Use

- UAS may be used when it provides cost efficiency, improved data quality, or improved personnel safety over an existing method or process. Examples of permitted uses include, but are not limited to, aerial photography, photogrammetry, bridge inspections, geotechnical field investigations, Light Detection and Ranging (LiDAR) applications, public outreach, mapping construction sites and conditions, asset management, asset inspections, traffic monitoring, incident management, disaster response, and training exercise.
- Employees are prohibited from using privately owned UAS for Department business.
- Employees operating agency owned UAS will document compliance with FAA policies, to include airworthiness of the UAS, licensing, training, notifications and acquisition of all waivers and approvals prior to any UAS operation.
- Employees requiring assistance complying with Federal Aviation Association (FAA) policies and Certificate of Waiver or Authorization (COA) process will consult with the UAS Coordinator.
- Aspects of this policy will not be construed as to restrict the safe, rapid deployment of an agency owned or contracted UAS in response to an emergency or exigent situation to protect life and limb, critical transportation infrastructure, or the environment.
- Employees and UAS service providers are required to follow the UAS Procedures.

UAS Procurement

- The procurement of a Department owned UAS requires the approval of the Deputy Director or designee.
- Procurement will be in accordance with applicable statutes, rules and Department Procurement policies and procedures.

UAS Contracting Services

- Contracting for UAS services requires the approval of the Deputy Director or designee.
- UAS service providers contracting will be in accordance with Department Consultant Services policies and procedures or Department Procurement policies and procedures based on need.

Operational and Training Requirements

- Employees and UAS service providers operating UAS will meet FAA UAS pilot or operator certification requirements.
- Department owned and UAS service provider flights will be logged and tracked following the UAS Procedures.
- Training for employees involved in UAS operations will be in accordance to the defined training requirements in the UAS Procedures.

Safety Procedures

- Employees and UAS service providers operating an UAS will comply with Department safety policies and FAA safety regulations. Refer to the UAS Procedures.

Protection of Individual Privacy and Personal Information

- UAS operators will limit operations to the specific approved purpose of the project and employ reasonable precautions to avoid capturing images of the public except those that are incidental to the project.

Background

The use of UAS is expanding rapidly, as are the agencies using them. The Federal Aviation Administration has worked to standardize UAS policies and integrate unmanned aircraft into the National Airspace System (NAS). The Department is establishing the policy, roles and responsibilities, and procedures for operating UAS.

Definitions

Certificate of Waiver or Authorization (COA)

An authorization issued by the FAA to grant NAS access for a specific UAS activity. COAs contain requirements the holder must follow. The FAA issues COAs for both public UAS operations and civil UAS operations.

Flight

An individual operation of the UAS from takeoff to landing. Each flight is required to have defined parameters for area of operation, altitudes, flight plan, and length of flight.

Pilot in Command (PIC)

A person who holds a pilot certificate with an UAS rating and has the final authority and responsibility for the operation and safety of an UAS operation conducted under part 107

Project

A project normally has a specific purpose, timeframe, and defined location. A project may require multiple flights.

Unmanned Aircraft (UA)

The flying portion of the system, flown by a pilot via a ground control system, or autonomously through use of an on-board computer, communication links, and any additional equipment that is necessary for the UA to operate safely.

Unmanned Aircraft System (UAS)

The UA and all the associated support items such as equipment, control station, data links, telemetry, communications, and navigation equipment necessary to operate the unmanned aircraft.

Visual Observer (VO)

A person acting as a member who assists the PIC to see and avoid obstacles.

Procedures

General Information

UDOT 01-07.1

Responsibility: Deputy Director or Designee

Actions

1. Provide approval or disapproval for all UAS requests
2. Provide updates on UAS use to the Governor and legislature as requested

Responsibility: UAS Committee

3. Coordinate UAS Committee business related to UAS needs
4. Review UAS requests
5. Recommend approval or disapproval of UAS use requests
6. Maintain and update the UAS Procedures
7. Approve UAS Procedures updates

Responsibility: UAS Coordinator

8. Manage all agency owned UAS
9. Coordinate purchases of UAS
10. Coordinate UAS flights
11. Facilitate training as needed
12. Verify proper individual credentials in place prior to flights
13. Review flight plans and compliance with FAA regulations
14. Maintain UAS database of flights, captured data, and equipment



Unmanned Aircraft Systems (UAS) Procedures

Approval Process

Procurement

- A. The procurement of an agency owned UAS requires the approval of the Deputy Director or designee.
- B. The requesting Division will submit a detailed explanation and justification for a particular aircraft, the particular purpose, time, manner and location of use. Identify cost efficiencies or improved quality of data or improved safety over an existing method or process. Use the Request UAS Form and submit to the UAS Coordinator.
- C. Procurement will be in accordance with applicable statutes, rule, and UDOT Procurement policies and procedures.

Contracting

- A. Contracting for UAS service providers requires the approval of the Deputy Director or designee.
- B. The requesting Division will submit a detailed explanation outlining the ownership, purpose and deliverable. Identify cost efficiencies or improved quality of data or improved safety over an existing method or process. Use the Request UAS Form and submit to the UAS Coordinator.
- C. UAS service providers contracting will be in accordance with UDOT Consultant Services policies and procedures or UDOT Procurement policy and procedures based on need.
- D. All contracted UAS service providers will follow all requirements as defined in the UDOT UAS Policy and the UAS Procedures.

Roles and Responsibilities

Deputy Director or designee

- Provides approval or disapproval for all UAS requests
- Provides updates on UAS use to the Governor and legislature as requested

UAS Committee

- Coordinates UAS Committee business related to UAS needs
- Reviews UAS use requests
- Recommends approval or disapproval of UAS use requests
- Maintains and updates the UAS Procedures
- Provides approval of UAS Procedures updates

UAS Coordinator

- Manages all agency owned UAS
- Coordinates purchases of UAS
- Coordinates UAS flights
- Facilitates training as needed
- Ensures proper individual credentials in place prior to flights
- Reviews flight plans and compliance with FAA regulations
- Maintains UAS database of flights, captured data, and equipment

Project Development Director; Region Director; Division Director

- Reviews all UAS requests as applicable to area of need



Federal Law

- A. UAS use will follow all requirements as listed in Title 14 of the Code of Federal Regulations (14 CFR) Part 107.
- B. UAS use in a manner not defined in Part 107 will obtain FAA approval through a Certificate of Waiver or Authorization (COA).

Protection of Privacy

- A. UAS pilots will limit operations to the specific approved purpose of the project and employ reasonable precautions to avoid capturing images of the public except those that are incidental to the project.
- B. UAS pilots will complete a thorough review of the flight plan prior to flight to determine if privacy is a concern.

Purpose of use

- A. Permitted UAS use includes, but is not limited to, aerial photography, photogrammetry, bridge inspection and planning, geotechnical field investigations, Light Detection and Ranging (LiDAR) applications, public outreach, mapping construction sites and conditions, asset management, asset inspections, traffic monitoring, incident management, disaster response and training exercise.
- B. The purpose of each flight will be documented.

Policy Management

- A. UAS Procedures and Department implementation will be reviewed annually to keep up with technology and respond to public concerns.
- B. UAS Procedures will be available online. The UAS Committee will maintain the UAS Procedures.
- C. The Department will conduct public education and outreach regarding the UAS Policy and UAS Procedures.

Safety Requirements

- A. UAS use will follow all requirements as listed in Title 14 of the Code of Federal Regulations (14 CFR) Part 107.
- B. UAS use in a manner not defined in Part 107 will obtain FAA approval through a Certificate of Waiver or Authorization (COA).
- C. All UAS flights require a flight plan detailing, date, time, area to be flown, altitude, and purpose of flight.
- D. Prior to any UAS flight the UAS maintenance log must be reviewed and accepted.
- E. Prior to any UAS flight the study area will be reviewed using the FAA B4UFLY App to ensure flight is not prohibited in the area.
- F. A preflight inspection of the UAS by the pilot is required prior to takeoff to ensure the UAS is airworthy for flight.
- G. A post flight inspection of the UAS by the pilot is required after flight to document any problems or deviations from the original flight plan.
- H. Prior to use all UAS pilots will receive Department approved training on proper operation and care.
- I. UAS pilots must understand the Department's policy and procedures on UAS operations before flight is conducted.



Training Requirements

- A. UAS operations will be conducted by trained UAS pilots as required by FAA and Part 107.
- B. UAS pilots will attend UAS Pilot Ground School to understand the National Airspace System (NAS) and learn the rules associated with safe flight within the NAS. This requirement does not apply if the individual has a current UAS pilot license.
- C. UAS pilots will complete the Computer Assisted Testing Service (CATS) Testing for UAS pilots and obtain a passing score. This requirement does not apply if the individual has a current UAS pilot license.
- D. UAS pilots will maintain an UAS pilot license at all times.
- E. UAS pilots will register with the UAS Coordinator.
- F. UAS training areas and test ranges will be created where training and proficiency checks can be accomplished in a safe manner.
- G. UAS pilots will be required to execute two test flights with the UAS Coordinator prior to self-performing any flight.
- H. All UAS pilots will undergo a pilot proficiency check consisting of aeronautical knowledge areas, areas of operations, and tasks required for safe operation every 24 months.

UAS Equipment

- A. All UAS will be registered with the FAA and display the appropriate markings as required.
- B. All UAS equipment will require an identification number.
- C. All UAS equipment will be locked, stored and checked out by the UAS Coordinator.
- D. Equipment malfunctions will be brought to the attention of the UAS Coordinator as soon as practical.

UAS Maintenance

- A. All UAS equipment will be properly maintained according to the manufacture's recommendations and will undergo a preflight and post flight inspection along with an annual inspection.
- B. All maintenance and annual inspections will be documented in the maintenance log for the each individual UAS equipment.
- C. The UAS maintenance log will document at a minimum the following information: UAS identification number, date, maintenance performed, inspection performed and additional notes for comments.

Documentation and Data Retention

- A. All Request UAS Forms will be stored in the UDOT ProjectWise UAS area per the UAS Coordinator. Use ProjectWise UAS area and UDOT UAS naming convention.
- B. All data derived from internal UAS use, contracted UAS service providers, or for the Department use through projects will be maintained according to the Department policies.
- C. All raw data will be stored in the UDOT ProjectWise System including data, images, video, and metadata captured. Use ProjectWise UAS area and UDOT UAS naming conventions.
- D. All processed data will be stored on other servers subject to the approval of the Division Director in coordination of the UAS Coordinator.

Steps for Use

- Establish a flight plan include at a minimum:
 - Airspace review
 - Standard weather briefing
 - Area to be flown
 - Limitations
 - Obstacle clearance
 - Purpose of flight
 - Time of flight
 - Expected duration of flight
 - Communication plan
 - Emergency/contingency procedures
- Complete a Request UAS Form
- Submit the Request UAS Form to the UAS Coordinator two weeks prior to planned flight for review
- Check out UAS equipment from UAS Coordinator once approved for use
- Complete preflight checklist within the UAS Management Software for the appropriate UAS
- Complete takeoff checklist within the UAS Management Software for the appropriate UAS
- Perform post flight checklist after flight within the UAS Management Software for the appropriate UAS
- Copy all data, images, video, metadata captured into ProjectWise UAS area and use UDOT UAS naming conventions.
- Return UAS equipment to UAS Coordinator

General Flight Requirements

- A. Allowed flight times: flight can be accomplished during daylight or in civil twilight (30 minutes before official sunrise to 30 minutes after official sunset, local time) with appropriate anti-collision lighting.
- B. Battery life: flight must be conducted with enough remaining battery to ensure safe landing at home point or other landing point determined on flight plan and with enough reserve battery life to ensure safe landing at alternative site if landing at primary landing site is not possible.
- C. Weather visibility: the minimum weather visibility distance is three miles from your control station.
- D. Flight altitude: the maximum flight altitude is 400 feet above the ground, and higher if the UAS remains within 400 feet of a structure.
- E. Flight speed: the maximum flight speed is 100 mph (87 knots).

Unauthorized Uses

- A. Intentionally observing, following, or zooming in on any vehicle, license plates, on people either inside or outside of vehicles, on residences, businesses, or other buildings, especially in non-public areas where individuals have an expectation of privacy, within the flight area is strictly prohibited.

Consequences of Misuse

- A. All unauthorized uses can result in legal action by third parties. Even without any third party legal action, individuals operating UAS contrary to the law, policy or procedures are subject to disciplinary action, up to and including termination.

Appendix I: AMA sUAS Flight Safety Guide



sUAS Flight Safety Guide

Guidance for safe,
responsible flying

**Join Now Get All
of 2014 and 2015!**

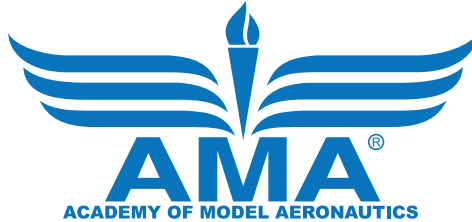
Join Now

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Foreward

If this is your first purchase of a recreational small Unmanned Aircraft System (drone) or the first time you've ventured into the world of model aviation, welcome! Welcome to the stimulating and enjoyable world of model aviation and a community of thousands of aeromodeling enthusiasts who for more than 100 years have enjoyed the fascination and allure of virtual flight through model aircraft.

Model aircraft have operated in the National Airspace System (NAS) for decades and have done so safely and responsibly. The aeromodeling activity conducted within the safety guidelines of the Academy of Model Aeronautics has achieved an excellent safety record, a record that surpasses most other forms of aviation. The success of this community was recently recognized by Congress in the FAA Modernization and Reform Act of 2012 with the addition of the Special Rule for Model Aircraft, now Public Law 112-95, Sec. 336.

The establishment of this Special Rule reflects Congress' recognition of community-based programming as an effective and sensible means of managing the recreational small unmanned aircraft activity, and it was Congress' intent to protect this community from onerous and unnecessary federal regulation.

The key to the success of the community and the longevity of the aeromodeling activity is the individual commitment to operating their aircraft in a safe and responsible manner and in accordance with a community-based set of standards.

sUAS are defined as being less than 55 pounds; however, the majority of the platforms in use today are less than 20 pounds, and most are less than 10 pounds. This safety guide is intended to help the sUAS operator to fly his or her aircraft in a safe and responsible manner.

Flying sUAS in a safe and responsible manner certainly means doing so in way that does not endanger persons or property. But, it also means operating your device in a manner that is respectful of community standards, the concerns of others, property and privacy rights, and flying in a community friendly manner. As a general rule:

- Don't operate on or fly over private property without first obtaining permission from the property owner and/or the property tenant.
- Don't fly where the operation of radio control aircraft is prohibited.
- Don't fly near open assemblies of people without first obtaining permission or otherwise making prior arrangements to do so.
- Don't fly near or over sensitive infrastructure or property such as power stations, water treatment facilities, correctional facilities, heavily traveled roadways, government facilities, etc. without making prior arrangements to do so.

Fly friendly, fly safely, and enjoy the hobby!



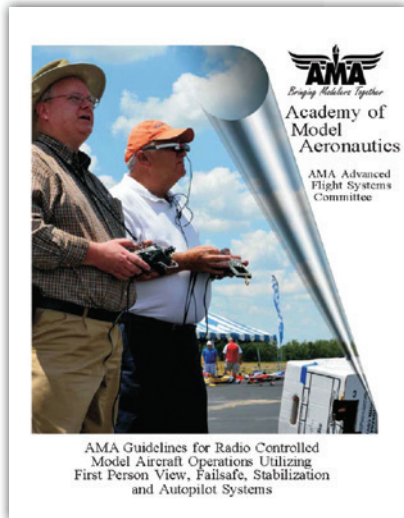
Academy of Model Aeronautics

Basic sUAS Safety Principles

- Do not interfere with manned aircraft operations.
- Yield the right of way to manned aircraft. See and avoid other aircraft at all times ([AMA Doc #540-D](#)).
- Do not endanger persons or property. No intentional overflight of moving vehicles or unprotected persons. Fly no closer than 25 feet.
- Fly no higher than necessary (less than 400 feet). Remain below surrounding obstacles when possible.
- Avoid operations in close proximity to airports. When within 5 miles of an airport, contact the airport/Air Traffic Control (ATC).
- Ensure pilot competency/proficiency and the safe operation of the aircraft.
- Remain within visual line of sight (VLOS). Use a spotter when necessary/appropriate.



Academy of Model Aeronautics



AMA's Privacy Policy

“The use of imaging technology for aerial surveillance with radio control model aircraft having the capability of obtaining high-resolution photographs and/or video, or using any types of sensors, for the collection, retention, or dissemination of surveillance data or information on individuals, homes, businesses, or property at locations where there is a reasonable expectation of privacy is strictly prohibited by the AMA unless written expressed permission is obtained from the individual property owners or managers.”

“SEE AND AVOID” GUIDANCE

A. General:

1. The primary means to avoid collisions between all aircraft flying within our National Airspace System (NAS) is “See and Avoid.”
2. Vigilance must be maintained by each person operating an aircraft (whether model or manned) so as to “see and avoid” other aircraft.
3. Model aircraft must avoid manned aircraft. Our privilege to fly model aircraft in the NAS depends on our commitment to remain “well clear” of manned aircraft.
4. Simply avoiding an actual collision is not enough. A “near miss” is not acceptable.
5. Unless flying at a mixed-use site where manned and model aircraft routinely share airspace through their own site-specific rules, model aircraft must fly sufficiently far away from manned aircraft so as not to create a collision hazard.
6. Model aircraft flying must not only be safe, it must be perceived to be safe by the greater manned aviation community. Modelers must continually demonstrate their respect for the safety of manned aircraft by remaining vigilant and well clear.
7. Whenever a potential conflict arises between model aircraft and manned aircraft, the pilot of the model aircraft must always give way to the manned aircraft.
8. The pilot of a model aircraft must never assume the pilot of a manned aircraft can see the model or will perform any maneuver to avoid the model’s flight path.
9. Visual Line of Sight is required by the Safety Code. It means that visual contact with the aircraft must be maintained without enhancement other than by corrective lenses prescribed for the model aircraft pilot. All RC flying must remain clear of clouds smoke or any other obstruction to the line of sight.
10. “Blue Sky” is a term used to explain the method used to increase separation between a model and a manned aircraft in the same vicinity. The modeler should maneuver the aircraft in such a way as to increase the amount of *blue sky* perceived between the model and the manned aircraft. By increasing the blue sky separation, the question about depth perception is taken out of the equation and the modeler need not worry whether the model is closer to him than the manned aircraft or further away. Increasing the blue sky between the model and the manned aircraft automatically increases separation between them.
11. A modeler should never place any consideration for the well-being of the model aircraft above the safety of manned aircraft. Maneuvering to avoid the conflict may require that the model aircraft be sacrificed.
12. Free flight models should not be launched with relatively low altitude manned aircraft in sight and downwind or headed downwind from the launch site.

8/2012

B. Spotters:

1. Before a flight, the pilot must insure that the spotter understands his/her duties and expectations.
2. A spotter should be used to assist in monitoring the surrounding airspace for manned aircraft whenever a flight is expected to exceed 400 feet above the ground and that operation is expected to be in proximity to known manned aircraft traffic such as at a mixed-use facility or within three miles of an airport. The spotter must have sufficient visual acuity and be mature enough to take this responsibility very seriously.
3. A spotter should also be prepared to assist his/her pilot in the event that another model aircraft or spectators become endangered or in turn are perceived to be a danger to the pilot or the pilot's model aircraft.
4. If a model aircraft pilot experiences what he or she considers a near miss with a manned aircraft, that model aircraft pilot should notify AMA Headquarters with a written report of the incident, including action taken by the model aircraft pilot to avoid the manned aircraft. This report is intended to help the modeler, the club, and the AMA capture as much detail as possible so that it may be used to assist all parties in recalling the particulars of the incident at a later time. Call 1-800-435-9262 (1-800-IFLYAMA) extension 230 or 251 for assistance with this report.



Radio Controlled Model Aircraft Operation Utilizing "First Person View" Systems

1. DEFINITION OF TERMS:

Please refer to Page 5 section 7 which contains an alphabetical listing of the definitions of the terms in italics that are used in this document.

2. GENERAL:

FPV flying of radio control model aircraft by AMA members is allowed only for noncommercial purposes as a hobby/recreational and/or competition activity and must be conducted in accordance with AMA's current National Model Aircraft Safety Code and any additional rules specific to a flying site/location.

3. OPERATIONS – REQUIREMENTS – LIMITATIONS:

- a) *FPV novice pilots* undergoing training at low altitude must use a buddy-box system with an *FPV spotter*, or must go to a safer altitude if no buddy-box system is used.
- b) All *FPV* flights require an AMA *FPV pilot* to have an AMA *FPV spotter* next to him/her maintaining *VLOS* with the *FPV aircraft* throughout its flight.
- c) The *FPV pilot* must brief the *FPV spotter* on the *FPV spotter's* duties, communications and hand-over control procedures before *FPV flight*.
- d) The AMA *FPV spotter* must communicate with the *FPV pilot* to ensure the *FPV aircraft* remains within *VLOS*, warning the *FPV pilot* of approaching aircraft, and when avoidance techniques are necessary.
- e) During an *FPV* flight, the *FPV spotter* must be prepared to acquire the transmitter/control from the *FPV pilot* and assume *VLOS* control of the model aircraft at any time safe operation of the flight is in question.
- f) If an *FPV pilot* experiences a safety issue that does not appear to be a brief glitch, they must abandon *FPV* mode and fly *VLOS*.
- g) Before the initial *FPV* flight of an *FPV model aircraft* and/or after any changes or repairs to essential flight systems, the *FPV model aircraft* must have an *R/C test flight* by conventional *VLOS*.
- h) *FPV model aircraft* must use frequencies approved by the FCC for both the RC system and the wireless video system. Pilots must meet applicable FCC licensing requirements if they choose to operate the RC flight control system or the wireless video system on Amateur Band frequencies.
- i) AMA *FPV pilots* must first be capable of flying their *FPV* model aircraft manually before utilizing *FPV* flight.

4. RANGE – ALTITUDE – WEIGHT – SPEED:

- a) One of the requirements in Federal Law (Public Law 112-95 Sec 336 (c) (2) February 14, 2012) for model aircraft to be excluded from FAA regulations is that model aircraft must be flown within VLOS of the operator.
- b) Model aircraft flown using *FPV* must remain at or below 400 feet AGL when within 3 miles of an airport as specified in the AMA Safety Code.
- c) Model aircraft flown *FPV* are limited to a weight (including fuel, batteries, and onboard *FPV* equipment) of 15lbs. and a speed of 70mph.

5. RECOMMENDATIONS & INFORMATION:

- a) *AMA FPV novice pilots* should consider using a cockpit view flight simulator to become accustomed to *FPV* flight.
- b) *AMA FPV pilots* should consider using a programmable *autopilot* (AMA Document #560) with a failsafe “return to launch” (RTL) feature that will maintain control of the aircraft in the event of signal loss.
- c) When purchasing *FPV* operational systems, always try to select quality equipment, verify its compatibility, install components for interference rejection, and determine that signal range is adequate for maximum VLOS range.

6. PRIVACY PROTECTION SAFEGUARDS:

The use of imaging technology for aerial surveillance with radio control model aircraft having the capability of obtaining high-resolution photographs and/or video, or using any types of sensors, for the collection, retention, or dissemination of surveillance data information on individuals, homes, businesses, or property at locations where there is a reasonable expectation of privacy is strictly prohibited by the AMA unless written expressed permission is obtained from the individual property owners or managers.

7. DEFINITIONS OF TERMS:

AMA FPV Pilot is an AMA member who is capable of maintaining stable flight of a model aircraft within its intended flight envelope when flown *FPV* without losing control or having a collision.

Buddy-Box System is a system that has one transmitter operating as the master controller, while a second transmitter is linked/slaved to it allowing dual control of an aircraft. The operator of the master transmitter allows one or the other transmitter to control the aircraft through the use of a spring-loaded switch. The switch provides instantaneous transfer of control from one transmitter to the other. The buddy-box system is an efficient and effective means of achieving a position transfer of control from one pilot to another.

Although this system is commonly used for training novice fliers, it is also useful in situations where an experienced pilot may have an increased likelihood of needing a second pilot's assistance in maintaining control of the aircraft. The use of the buddy-box may be helpful in assisting pilots with physical limitations, flying in congested environments, during times of reduced visibility, or anytime during FPV when a timely transfer of control may be beneficial.

Essential Flight Systems are any systems or components necessary to maintain stable flight within a model aircraft's flight envelope. (This includes primary radio control systems and any stabilization or gyros required to maintain stability and heading in certain types of model aircraft that would be uncontrollable/unstable without their use).

First Person View (FPV) refers to the operation of a radio controlled (R/C) model aircraft using an onboard camera's cockpit view to orient and control the aircraft.

Flight Envelope is defined as the range of airspeeds, attitudes, and flight maneuvers which a model aircraft can safely perform/operate for its intended use.

FPV Aircraft is an RC model aircraft equipped with a video transmitter to send real-time video images from an onboard camera to a ground based receiver for display on a pilot's video monitor/goggles. (*FPV model aircraft* types include: Fixed Wing, Rotary Wing, and Multi-Rotor Platforms).

FPV Novice Pilot is an AMA member learning to fly *FPV* utilizing a buddy-box system with an experienced *AMA RC pilot* operating the master transmitter and serving as the *FPV spotter*.

FPV Spotter is an experienced *AMA RC pilot* who has been briefed by the *FPV pilot* on the tasks, responsibilities and procedures involved in being a spotter; is capable and mature enough to perform the duties and is able to assume conventional *VLOS* control of the aircraft.

Non-Essential Flight Systems are any systems or components that are not necessary to maintain stable flight within the model aircraft's *flight envelope*. (This includes *autopilot* or *stabilization systems* that can be activated and deactivated in flight by the pilot without affecting stable flight).

R/C Test Flight requires an *AMA Pilot* to manually operate an R/C transmitter to control a model aircraft's flight path and determine if the aircraft is capable of maintaining stable flight within its *flight envelope*.

Visual Line Of Sight (VLOS) is the distance at which the pilot is able to maintain visual contact with the aircraft and determine its orientation without enhancements other than corrective lenses.

**Academy of Model Aeronautics**

AMA Advanced Flight Systems Committee
amaflightsystems@gmail.com

Radio Controlled Model Aircraft Operation
Utilizing Failsafe, Stabilization and Autopilot Systems

1. DEFINITION OF TERMS:

Please refer to Page 3, section 7 which contains an alphabetical listing of the definitions of the terms in italics that are used in this document.

2. GENERAL:

All model aircraft flights utilizing *stabilization* and *autopilot* control systems must be conducted in accordance with AMA's current National Model Aircraft Safety Code and any additional rules specific to a flying site/location.

3. OPERATIONS – REQUIREMENTS – LIMITATIONS:

- a) AMA members flying radio controlled model aircraft equipped with flight *stabilization* and *autopilot* systems must maintain VLOS with the aircraft at all times including programmed autopilot waypoint flight.
- b) *AMA Pilots* must be able to instantaneously deactivate programmed flight of *autopilot systems* at any time during flight and resume manual control of the model aircraft.
- c) *AMA Pilots* must perform an *R/C Test Flight* of a model aircraft before activating a newly installed *autopilot* or *stabilization system* and/or after any repairs or replacement of model aircraft *essential flight systems*.
- d) Model aircraft exceeding 15lbs and/or 70mph may only use an *autopilot* for a programmed "return to launch" (RTL) flight and not for programmed waypoint flying of a predetermined course.

e) STABILIZATION & AUTOPILOT SYSTEMS MAY BE USED FOR/TO:

- Stabilization/automatically stabilize aircraft to level flight when control sticks are centered.
- Recovery/activate TRX switch to recover an out of control aircraft to level flight.
- Heading/activate TRX switch to hold a model aircraft's heading for precision flight path.
- Altitude/activate TRX switch to maintain fixed aircraft altitude while allowing directional control.
- Return GPS/activate TRX switch to return aircraft via GPS to launch point.
- Return FSS/failsafe activated from radio signal loss to return aircraft via GPS to launch point.
- Fixed circle/activate TRX switch to circle aircraft at point of activation at fixed altitude.
- Waypoint/activate TRX switch to initiate an autopilot programmed flight path via waypoints.
- Fencing/autopilot programed to display site unique boundaries on video monitor/goggles.

4. **RANGE – ALTITUDE – WEIGHT – SPEED:**

- a) One of the requirements in Federal Law (Public Law 112-95 Sec 336 (c) (2) February 14, 2012) for model aircraft to be excluded from FAA regulations is that model aircraft be flown within *VLOS* of the operator.
- b) Model aircraft must be flown at or below 400 feet AGL when within 3 miles of an airport as stated in the AMA Safety Code.
- c) Model aircraft utilizing an *autopilot* for waypoint flying are limited to a maximum weight (including fuel, batteries, and onboard *autopilot systems*) of 15lbs and a speed of 70mph.

5. **RECOMMENDATIONS & INFORMATION:**

- a) If your radio system lacks *failsafe* capability, consider using programmable digital servos or auxiliary *failsafe* modules. In the event of a radio signal failure these components will activate desired safe servo settings or an *autopilot* for return to base/launch (RTL).
- b) When using an *autopilot system* the “return to launch” (RTL) feature should be programmed to return the aircraft to a safe location and safely terminate the flight should manual control of the aircraft be lost. When using RTL, pay particular attention to the manufacturer’s throttle recommendations to prevent stalling.
- c) The use of *stabilization systems* is recommended when flying FPV to improve flight stability and video quality.
- d) Pilots usually choose to incorporate *stabilization* and *autopilot systems* for model aircraft flying to enhance flight performance, correct bad tendencies of the model aircraft, maintain stability in windy weather, establish precision heading holds for takeoffs/landings, flight training for novice pilots, create a steady flight platform for cameras, and generally just to make an airplane easier and safer to fly.
- e) When purchasing *stabilization* and *autopilot systems*, always try to select quality equipment from reputable dealers, ensure for compatibility with other onboard systems, and install components according to manufacturers’ instructions.

6. **PRIVACY PROTECTION SAFEGUARDS:**

The use of imaging technology for aerial surveillance with radio control model aircraft having the capability of obtaining high-resolution photographs and/or video, or using any types of sensors, for the collection, retention, or dissemination of surveillance data or information on individuals, homes, businesses, or property at locations where there is a reasonable expectation of privacy is strictly prohibited by the AMA unless written expressed permission is obtained from the individual property owners or managers.

7. DEFINITIONS OF TERMS:

AMA Pilot is an AMA member who is capable of manually operating an R/C transmitter to control a model aircraft's flight path within its safe intended *flight envelope* without losing control or having a collision.

Autopilot Systems incorporate programmable flight *stabilization* with an altitude sensor and a GPS receiver for accurate positioning and to navigate/control a radio controlled model aircraft's flight path. Advanced systems offer software for entering navigable waypoints. The flight data waypoints may be saved to autopilot's/GPS memory for programmed flight.

Essential Flight Systems are any systems or components necessary to maintain stable flight within a model aircraft's *flight envelope*. (This includes primary R/C systems and any *stabilization* or gyros required to maintain stability and heading in certain types of model aircraft that would be uncontrollable/unstable without their use).

Failsafe Systems are designed to minimize or prevent damage and safely terminate a flight when a radio controlled model aircraft loses radio signal. Modern radio systems can be programmed to position servos to a desired control setting in the event of radio signal failure.

First Person View (FPV) refers to the operation of a radio controlled (R/C) model aircraft using an onboard camera's cockpit view to orient and control the aircraft. (AMA Document #550).

Flight Envelope is defined as the range of airspeeds, attitudes and flight maneuvers which a model aircraft can safely perform/operate for its intended use.

Non-Essential Flight Systems are any systems or components that are not necessary to maintain stable flight within the model aircraft's intended flight envelope. (This includes *autopilot* or *stabilization systems* that can be activated and deactivated in flight by the pilot without affecting manually controlled stable flight).

R/C Test Flight requires an AMA Pilot to manually operate an R/C transmitter to control a model aircraft's flight path and determine if the aircraft is capable of maintaining stable flight within its safe intended *flight envelope*.

Stabilization Systems are designed to maintain intended model aircraft flight attitudes. The pilot can install, program and/or activate a system to stabilize yaw, pitch, or roll or any one attitude or combination of attitudes. Systems are often based on rate/heading hold gyros or inertial motion sensors utilizing multi-axis gyros and accelerometers for attitude stabilization.

Visual Line of Sight (VLOS) is the distance at which the pilot is able to maintain visual contact with the aircraft and determine its orientation and attitude without enhancements other than corrective lenses.

Academy of Model Aeronautics National Model Aircraft Safety Code

Effective January 1, 2014

- A. **GENERAL:** A model aircraft is a non-human-carrying aircraft capable of sustained flight in the atmosphere. It may not exceed limitations of this code and is intended exclusively for sport, recreation, education and/or competition. All model flights must be conducted in accordance with this safety code and any additional rules specific to the flying site.
1. Model aircraft will not be flown:
 - (a) In a careless or reckless manner.
 - (b) At a location where model aircraft activities are prohibited.
 2. Model aircraft pilots will:
 - (a) Yield the right of way to all human-carrying aircraft.
 - (b) See and avoid all aircraft and a spotter must be used when appropriate. (AMA Document #540-D.)
 - (c) Not fly higher than approximately 400 feet above ground level within three (3) miles of an airport without notifying the airport operator.
 - (d) Not interfere with operations and traffic patterns at any airport, heliport or seaplane base except where there is a mixed use agreement.
 - (e) Not exceed a takeoff weight, including fuel, of 55 pounds unless in compliance with the AMA Large Model Airplane program. (AMA Document 520-A.)
 - (f) Ensure the aircraft is identified with the name and address or AMA number of the owner on the inside or affixed to the outside of the model aircraft. (This does not apply to model aircraft flown indoors.)
 - (g) Not operate aircraft with metal-blade propellers or with gaseous boosts except for helicopters operated under the provisions of AMA Document #555.
 - (h) Not operate model aircraft while under the influence of alcohol or while using any drug that could adversely affect the pilot's ability to safely control the model.
 - (i) Not operate model aircraft carrying pyrotechnic devices that explode or burn, or any device which propels a projectile or drops any object that creates a hazard to persons or property.
Exceptions:
 - Free Flight fuses or devices that burn producing smoke and are securely attached to the model aircraft during flight.
 - Rocket motors (using solid propellant) up to a G-series size may be used provided they remain attached to the model during flight. Model rockets may be flown in accordance with the National Model Rocketry Safety Code but may not be launched from model aircraft.
 - Officially designated AMA Air Show Teams (AST) are authorized to use devices and practices as defined within the Team AMA Program Document. (AMA Document #718.)
 - (j) Not operate a turbine-powered aircraft, unless in compliance with the AMA turbine regulations. (AMA Document #510-A.)
 3. Model aircraft will not be flown in AMA sanctioned events, air shows or model demonstrations unless:
 - (a) The aircraft, control system and pilot skills have successfully demonstrated all maneuvers intended or anticipated prior to the specific event.
 - (b) An inexperienced pilot is assisted by an experienced pilot.
 4. When and where required by rule, helmets must be properly worn and fastened. They must be OSHA, DOT, ANSI, SNELL or NOCSAE approved or comply with comparable standards.
- B. **RADIO CONTROL (RC)**
1. All pilots shall avoid flying directly over unprotected people, vessels, vehicles or structures and shall avoid endangerment of life and property of others.
 2. A successful radio equipment ground-range check in accordance with manufacturer's recommendations will be completed before the first flight of a new or repaired model aircraft.
 3. At all flying sites a safety line(s) must be established in front of which all flying takes place. (AMA Document #706.)
 - (a) Only personnel associated with flying the model aircraft are allowed at or in front of the safety line.
 - (b) At air shows or demonstrations, a straight safety line must be established.
 - (c) An area away from the safety line must be maintained for spectators.
 - (d) Intentional flying behind the safety line is prohibited.
 4. RC model aircraft must use the radio-control frequencies currently allowed by the Federal Communications Commission (FCC). Only individuals properly licensed by the FCC are authorized to operate equipment on Amateur Band frequencies.
 5. RC model aircraft will not knowingly operate within three (3) miles of any pre-existing flying site without a frequency-management agreement. (AMA Documents #922 and #923.)
 6. With the exception of events flown under official AMA Competition Regulations, excluding takeoff and landing, no powered model may be flown outdoors closer than 25 feet to any individual, except for the pilot and the pilot's helper(s) located at the flightline.
 7. Under no circumstances may a pilot or other person touch an outdoor model aircraft in flight while it is still under power, except to divert it from striking an individual.
 8. RC night flying requires a lighting system providing the pilot with a clear view of the model's attitude and orientation at all times. Hand-held illumination systems are inadequate for night flying operations.
 9. The pilot of an RC model aircraft shall:
 - (a) Maintain control during the entire flight, maintaining visual contact without enhancement other than by corrective lenses prescribed for the pilot.
 - (b) Fly using the assistance of a camera or First-Person View (FPV) only in accordance with the procedures outlined in AMA Document #550.
 - (c) Fly using the assistance of autopilot or stabilization system only in accordance with the procedures outlined in AMA Document #560.
- C. **FREE FLIGHT**
1. Must be at least 100 feet downwind of spectators and automobile parking when the model aircraft is launched.
 2. Launch area must be clear of all individuals except mechanics, officials, and other fliers.
 3. An effective device will be used to extinguish any fuse on the model aircraft after the fuse has completed its function.
- D. **CONTROL LINE**
1. The complete control system (including the safety thong where applicable) must have an inspection and pull test prior to flying.
 2. The pull test will be in accordance with the current Competition Regulations for the applicable model aircraft category.
 3. Model aircraft not fitting a specific category shall use those pull-test requirements as indicated for Control Line Precision Aerobatics.
 4. The flying area must be clear of all utility wires or poles and a model aircraft will not be flown closer than 50 feet to any above-ground electric utility lines.
 5. The flying area must be clear of all nonessential participants and spectators before the engine is started.



About AMA

We stand on our own for our members and for the future of aeromodeling.

The Academy of Model Aeronautics is the world's largest model aviation association. It is the official sanctioning body for model aviation in the United States, representing the interests of aeromodeling across the United States and around the world. As a self-supporting, nonprofit organization, its purpose is to promote the development of model aviation as a recognized hobby, sport, and family recreational activity that is both fun and educational.

Founded in 1936, the Academy of Model Aeronautics was charged with promoting the popularity of aeromodeling and associated contests, which coincided with the development and advancement of commercial and military aircraft design, engineering, and manufacturing. Today, the AMA still fosters the innovation born from competition on an international scale through the sanctioning of more than 2,000 aeromodeling competitions each year.

Government relations

The AMA has a long and successful history of advocating for the flying privileges of the aeromodeling community. As the liaison with the Federal Aviation Administration, Federal Communications Commission, Environmental Protection Agency, and other governmental entities, AMA works diligently with some of the most respected organizations in aviation and government to protect modelers' right to fly in the national airspace while providing an exceptional safety program.

Educational outreach

Our active educational outreach program assists teachers who utilize aviation activities in support of science, technology, engineering, and math curricula. Additionally, AMA has awarded more than \$800,000 dollars in scholarships to hundreds of students in pursuit of study in the fields of aerospace design and engineering along with other aviation-related fields.

To learn more about the Academy of Model Aeronautics, or to become a member, visit www.modelaircraft.org or call **1-800-I-FLY-AMA**.





Appendix J: Sample Safety Culture Survey

SCORE YOUR SAFETY CULTURE

In *Managing the Risks of Organizational Accidents*, Dr. James Reason argues that three ingredients are vital for driving a company's safety engine, all of them the purview of top managers: commitment, competence and cognizance—the three Cs. But managers come and go. This is a fact of life. So how does a company maintain a commitment to safety in the face of personnel turnover, volatile market forces and economic reality? James Reason suggests that this is where an organization's safety culture comes in to play! Dr. Reason states that "A good safety culture is something that endures and so provides the necessary driving force." To find out if your organization has or is well on its way to having a good safety culture, Dr. Reason prepared the following checklist.

HEALTH WARNING

High scores on this checklist provide no guarantee of immunity from accidents or incidents. Even the "healthiest" institutions can still have bad events. But a moderate to good score (8-15) suggests that you are striving hard to achieve a high degree of robustness while still meeting your other organizational objectives. The price of safety is chronic unease: complacency is the worst enemy. There are no final victories in the struggle for safety.

CHECKLIST FOR ASSESSING INSTITUTIONAL RESILIENCE

SCORING: YES = This is definitely the case in my organization (scores 1); ? = "Don't know," "maybe" or "could be partially true" (scores 0.5); NO = This is definitely not the case in my organization (scores zero).	YES	?	NO
MINDFUL OF DANGER: Top managers are ever mindful of the human organizational factors that can endanger their operations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ACCEPT SETBACKS: Top management accepts occasional setbacks and nasty surprises as inevitable. They anticipate that staff will make errors and train them to detect and recover from them.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
COMMITTED: Top managers are genuinely committed to aviation safety and provide adequate resources to serve this end.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
REGULAR MEETINGS: Safety-related issues are considered at high-level meetings on a regular basis, not just after some bad event.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
EVENTS REVIEWED: Past events are thoroughly reviewed at top-level meetings and the lessons learned are implemented as global reforms rather than local repairs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
IMPROVED DEFENCE: After some mishap, the primary aim of top management is to identify the failed system defences and improve them, rather than to seek to divert responsibility to particular individuals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
HEALTH CHECKS: Top management adopts a proactive stance toward safety. That is, it does some or all of the following: takes steps to identify recurrent error traps and remove them; strives to eliminate the workplace and organizational factors likely to provoke error; brainstorm new scenarios of failure; and conducts regular "health checks" on the organizational process known to contribute to mishaps.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
INSTITUTIONAL FACTORS RECOGNIZED: Top management recognizes that error-provoking institutional factors (under-staffing, inadequate equipment, inexperience, patchy training, bad human-machine interfaces, etc.) are easier to manage and correct than fleeting psychological states, such as distraction, inattention and forgetfulness.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
DATA: It is understood that the effective management of safety, just like any other management process, depends critically on the collection, analysis and dissemination of relevant information.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
VITAL SIGNS: Management recognizes the necessity of combining reactive outcome data (i.e., the near-miss and incident reporting system) with active process information. The latter entails far more than occasional audits. It involves the regular sampling of a variety of institutional parameters (scheduling, budgeting, fostering, procedures, defences, training, etc.), identifying which of these vital signs are most in need of attention, and then carrying out remedial actions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
STAFF ATTEND SAFETY MEETINGS: Meetings relating to safety are attended by staff from a wide variety of departments and levels.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
CAREER BOOST: Assignment to a safety-related function (quality or risk management) is seen as a fast-track appointment, not a dead end. Such functions are accorded appropriate status and salary.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
MONEY VS. SAFETY: It is appreciated that commercial goals and safety issues can come into conflict. Measures are in place to recognize and resolve such conflicts in an effective and transparent manner.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
REPORTING ENCOURAGED: Policies are in place to encourage everyone to raise safety-related issues (one of the defining characteristics of a pathological culture is that messengers are "shot" and whistleblowers dismissed or discredited).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
TRUST: The organization recognises the critical dependence of a safety management system on the trust of the workforce—particularly in regard to reporting systems. A safe culture—that is, an informed culture—is the product of a reporting culture that, in turn, can only arise from a just culture.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
QUALIFIED INDEMNITY: Policies relating to near-miss and incident reporting systems make clear the organization's stance regarding qualified indemnity against sanctions, confidentiality, and the organizational separation of the data-collecting department from those involved in disciplinary proceedings.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
BLAME: Disciplinary policies are based on an agreed (i.e., negotiated) distinction between acceptable and unacceptable behaviour. It is recognized by all staff that a small proportion of unsafe acts are indeed reckless and warrant sanctions but that the large majority of such acts should not attract punishment. The key determinant of blameworthiness is not so much the act itself—error or violation—as the nature of the behaviour in which it was embedded. Did this behaviour involve deliberate unwarranted risk-taking or a course of action likely to produce avoidable errors? If so, then the act would be culpable regardless of whether it was an error or a violation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
NON-TECHNICAL SKILLS: Line management encourages their staff to acquire the mental (or non-technical) as well as the technical skills necessary to achieve safe and effective performance. Mental skills include anticipating possible errors and rehearsing the appropriate recoverable recoveries. Such mental preparation at both individual and organizational levels is one of the hallmarks of high-reliability systems and goes beyond routine simulator checks.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
FEEDBACK: The organization has in place rapid, useful and intelligible feedback channels to communicate the lessons learned from both the reactive and proactive safety information systems. Throughout, the emphasis is upon generalizing these lessons to the system at large.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ACKNOWLEDGE ERROR: The organization has the will and the resources to acknowledge its errors, to apologize for them and to reassure the victims (or their relatives) that the lessons learned from such accidents will help to prevent their recurrence.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

INTERPRETING YOUR SCORE
 16-20 So healthy as to be barely credible.
 11-15 You're in good shape, but don't forget to be uneasy.
 6-10 Not at all bad, but there's still a long way to go.
 1-5 You are very vulnerable.
 0 Jurassic Park

This checklist was written by Professor James Reason and presented at the 2000 Manly Conference. Reprinted with permission.
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POUR TESTER VOTRE CULTURE DE LA SÉCURITÉ

Dans son livre « Managing Risks of Organizational Accidents », le Dr James Reason soutient que trois éléments, que l'on pourrait surnommer « les trois C », sont essentiels pour assurer la sécurité au sein d'une compagnie : conviction, compétence et connaissance. Mais il faut bien se rendre à l'évidence : les gestionnaires sont appelés à changer de poste avec le temps. C'est une réalité de la vie!

Comment une compagnie peut-elle alors s'assurer que la sécurité demeure un objectif primordial alors qu'elle doit faire face à un renouvellement du personnel constant, à un marché et à une réalité économique imprévisibles?

Selon James Reason, c'est là qu'entre en jeu la philosophie d'une organisation en matière de sécurité.

Le Dr Reason énonce qu'une philosophie saine résiste à tout et constitue ainsi l'élément moteur nécessaire pour assurer la sécurité.

Pour déterminer si votre entreprise fait déjà preuve d'une philosophie saine ou est en voie d'en adopter une, le Dr Reason a élaboré la liste de vérification suivante.

MISE EN GARDE

Si vous avez obtenu un pointage élevé sur cette liste de vérification, cela ne garantit pas l'absence totale d'accidents ou d'incidents. Même les établissements les plus « en santé » peuvent connaître des événements malheureux. Mais si vous avez obtenu un pointage acceptable ou élevé (entre 8 et 15), cela signifie que vous déployez beaucoup d'efforts pour que votre établissement parvienne à un niveau de santé optimal tout en continuant d'attendre vos autres buts organisationnels. La sécurité nécessite une préoccupation constante : le relâchement est votre pire ennemi.

Il n'existe aucune victoire définitive dans la bataille pour la sécurité.

LISTE DE VÉRIFICATION POUR ÉVALUER LA SANTÉ DE VOTRE ÉTABLISSEMENT

POINTAGE : OUI = Cet énoncé s'applique parfaitement à mon organisation (compter 1 point); ? = « Je ne sais pas », « Peut-être » ou « Cela est vrai dans certains cas » (compter 0,5 points); NON = Cet énoncé ne s'applique pas du tout à mon organisation (aucun point).	OUI	?	NON
TENIR COMPTE DU DANGER : Les cadres supérieurs sont toujours conscients des facteurs humains organisationnels qui peuvent rendre leurs activités dangereuses.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ACCEPTER LES REVERS : Les cadres supérieurs considèrent les revers occasionnels et les mauvaises surprises comme inévitables. Les cadres s'attendent à ce que les membres du personnel fassent des erreurs, mais les forment afin qu'ils puissent les détecter et être en mesure de les corriger.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ENGAGEMENTS : Les cadres supérieurs ont véritablement la sécurité aérienne à cœur et fournissent les ressources appropriées à cette fin.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
RÉUNIONS RÉGULIÈRES : Les questions liées à la sécurité sont discutées lors de réunions de haut niveau tenues régulièrement et non simplement à la suite d'un incident.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
EXAMEN DES ÉVÉNEMENTS : Les événements passés sont examinés sous tous leurs angles au cours de réunions de haut niveau et les leçons tirées sont appliquées dans des réformes générales plutôt que dans des correctifs locaux.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
AMÉLIORER LES MÉCANISMES DE DÉFENSE : Après un incident quelconque, les cadres supérieurs ont comme principal objectif de déterminer les mécanismes de défense du réseau qui ont flanché et les moyens pour les améliorer au lieu de jeter le blâme sur des personnes en particulier.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
BILANS DE SANTÉ : Les cadres supérieurs adoptent une démarche proactive en ce qui concerne la sécurité. En d'autres termes, les cadres prennent toutes ou la plupart des mesures suivantes : faire le nécessaire pour déterminer les pièges les plus fréquents qui peuvent causer des erreurs et les éliminer; s'efforcer d'éliminer tous les facteurs qui, dans l'organisation ou dans le lieu de travail, sont susceptibles d'entraîner une erreur; effectuer un remue-méninges pour trouver d'autres scénarios de défaillance et effectuer régulièrement des « bilans de santé » sur le processus organisationnel reconnu comme facteur contributif des incidents.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
RECONNAÎTRE LES FACTEURS INSTITUTIONNELS : Les cadres supérieurs reconnaissent que les facteurs institutionnels pouvant causer des erreurs (manque de personnel ou d'expérience, matériel inadéquat, formation de piètre qualité, mauvaises interfaces homme-machine, etc.) sont plus faciles à gérer et à corriger que les états d'esprit momentanés comme la distraction, l'inattention et l'étourderie.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
DONNÉES : Il va de soi que la gestion efficace de la sécurité, comme tout autre processus de gestion, dépend grandement de la collecte, de l'analyse de données pertinentes, et de leur diffusion.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
SIGNES VITAUX : Les cadres comprennent la nécessité de combiner les données recueillies à la suite d'événements [c.-à-d. une quasi-collision et le système de rapports sur les incidents] avec le processus actif d'information. Ce dernier suppose beaucoup plus que des vérifications occasionnelles. Il comprend en fait l'échantillonnage fréquent de divers paramètres institutionnels (établissement des horaires et des budgets, encouragements, procédures, moyens de défense, formation, etc.), la détermination des signes vitaux nécessitant une attention particulière, ainsi que la mise en application des mesures correctives.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PRÉSENCE DU PERSONNEL AUX RÉUNIONS PORTANT SUR LA SÉCURITÉ : Les membres du personnel de divers services et niveaux sont présents aux réunions ayant trait à la sécurité.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
AVANCEMENTS : La nomination à un poste lié à la sécurité (gestion de la qualité et des risques) est perçue comme un avancement de carrière rapide et non une impasse. Ces nouvelles fonctions entraînent un statut et un salaire appropriés.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
LA RENTABILITÉ PAR OPPOSITION À LA SÉCURITÉ : Il est possible que les objectifs commerciaux entrent en conflit avec les questions relatives à la sécurité. Des mesures sont en place afin de reconnaître et de résoudre de tels conflits en toute efficacité et transparence.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ENCOURAGER LES RAPPORTS : Les politiques en place encouragent tous et chacun à soulever tous les problèmes ayant trait à la sécurité (une des caractéristiques déterminantes d'une culture pathologique reste que l'on « fait taire » les messages et que les dénonciateurs ne sont pas écoutés et sont discrédités).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
CONFIANCE : L'organisation reconnaît le lien essentiel qui existe entre un système de gestion de la sécurité et la confiance de l'effectif en ce système, spécialement en ce qui concerne les systèmes de comptes rendus. Une culture de la sécurité, c'est-à-dire celle où chacun est informé, est le résultat d'une culture de communication de l'information qui, à son tour, ne peut se développer que dans une culture qui favorise l'équité.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
INDEMNITÉ QUALIFIÉE : Les politiques liées aux quasi-collisions et au système de rapports sur les incidents rendent la position de l'organisation évidente en ce qui a trait à l'indemnité qualifiée contre les sanctions, la confidentialité et la séparation, au sein de l'organisation, du service chargé de la collecte des données des autres services s'occupant des audiences disciplinaires.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
CULPABILITÉ : Les politiques disciplinaires se fondent sur une distinction convenue [c.-à-d. négociée] entre un comportement acceptable et non acceptable. Le personnel reconnaît qu'une infime partie des comportements dangereux sont bel et bien imprudents et justifient des sanctions, mais que la grande majorité de ces comportements ne doivent pas, à juste titre, être punis. Le critère déterminant le blâme n'est pas tant l'activité elle-même (l'erreur ou l'infraction) mais bien la nature du comportement dans lequel l'action s'inscrit. Ce comportement comprenait-il une prise de risque injustifiée et intentionnelle ou un plan d'action entraînant des erreurs qui auraient pu être évités? Si tel est le cas, alors l'action demeure une faute peu importe s'il s'agissait d'une erreur ou d'une infraction.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
APTITUDES À CARACTÈRE NON TECHNIQUE : Les cadres hiérarchiques encouragent leur personnel à acquérir les aptitudes mentales (ou non techniques) et les compétences techniques nécessaires pour atteindre une performance sécuritaire et efficace. Les aptitudes mentales comprennent la capacité de prévoir les erreurs possibles et d'envisager un redressement approprié, le cas échéant. Une préparation mentale sur le plan personnel et organisationnel est l'un des critères des systèmes à haute fiabilité et va au-delà des vérifications régulières sur simulateur.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
RÉTROACTION : L'organisation possède un réseau permettant une rétroaction rapide, utile et intelligible afin de communiquer les leçons tirées des deux systèmes d'information sur la sécurité (système réactif et proactif). Dans toute l'organisation, on met l'accent sur l'application des leçons dans tout le réseau.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ADMETTRE SES ERREURS : L'organisation a la volonté et les ressources pour admettre ses erreurs, s'en excuser et rassurer les victimes (ou leur parenté) en leur disant que les leçons tirées de ces accidents contribueront à empêcher que d'autres erreurs du même type ne se reproduisent.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

INTERPRÉTATION DE VOTRE POINTAGE

- 16-20** Votre établissement est incroyablement en santé!
- 11-15** Votre établissement est en forme, mais prudence!
- 6-10** Bien, mais il vous reste du chemin à faire.
- 1-5** Votre établissement est très vulnérable.
- 0** Vous en êtes encore à l'être Jurassique.

Cette liste de vérification a été écrite par le professeur James Reason et présentée à la conférence tenue à Mirny en 2000. Rempression autorisée.

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