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# THESIS

**SEEING EYE DRONES: HOW THE DOD CAN TRANSFORM CBRN AND DISASTER RESPONSE IN THE HOMELAND**

by

Matthew J. Jonkey

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Thesis Co-Advisors: Robert Simeral
Thomas Mackin

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Existing policy and doctrine are insufficient to accommodate the fielding of such a capability. This thesis identifies and discusses these gaps. This thesis also conducts an analysis of similar Department of Defense and other national UAS policy and programs and offers recommendations to implement a new domestic sUAS policy. The recommendations provide the framework for implementing an innovative technology while addressing complicated issues, such as national airspace system integration, intelligence oversight, and training programs.

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# SEEING EYE DRONES: HOW THE DOD CAN TRANSFORM CBRN AND DISASTER RESPONSE IN THE HOMELAND

Matthew J. Jonkey
Commander, 92nd Civil Support Team, Nevada National Guard
B.A., University of Nevada, 2002

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Approved by: Robert Simeral
Thesis Co-Advisor

Thomas Mackin
Thesis Co-Advisor

Erik Dahl
Associate Chair of Instruction
Department of National Security Affairs

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AGL | above ground level |
| AGR | active guard reserve |
| ANGI | Air National Guard instruction |
| ATC | air traffic control |
| ATM | aircrew training manual |
| C2 | command and control |
| CBRN | chemical, biological, radiological, nuclear |
| CBRNE | chemical, biological, radiological, nuclear, high-yield explosives |
| CFR | Code of Federal Regulations |
| CNGBM | Chief National Guard Bureau Manual |
| COA | certificate of waiver or authorization |
| COTS | commercial off the shelf |
| CRE | chemical, biological, radiological, nuclear response enterprise |
| CST | civil support team |
| DEPSECDEF | deputy secretary of defense |
| DOD | Department of Defense |
| DSCA | defense support to civil authorities |
| FAA | Federal Aviation Administration |
| FAR | federal aviation regulations |
| FM | field manual |
| FSDO | flight standardization district office |
| GPS | global positioning system |
| HAZMAT | hazardous material |
| HD | homeland defense |
| HSPD | Homeland Security Presidential Directive |
| IAA | incident awareness and assessment |
| IC | incident commander |
| MARS | Military Applications and Reconnaissance and Surveillance |
| MOA | memorandum of agreement |
| NAS | national airspace system |

| | |
|---|---|
| NCO | non-commissioned officer |
| NG | National Guard |
| NGB | National Guard Bureau |
| NGR | National Guard Regulation |
| NIOSH | National Institute for Occupational Safety and Health |
| NORTHCOM | Northern Command |
| NSSE | National Special Security Event |
| OSD | Office of the Secretary of Defense |
| PPD | presidential policy directive |
| PPE | personal protective equipment |
| PUM | proper use memorandum |
| QDR | quadrennial defense review |
| RAPS | Robotic Aircraft for Safety Project |
| SA | situational awareness |
| SAR | search and rescue |
| SCBA | self-contained breathing apparatus |
| SECDEF | secretary of defense |
| SPIE | International Society for Optics and Photonics |
| sUAS | small Unmanned Aircraft System |
| TC | training circular |
| TTP | tactics, techniques, and procedures |
| UAS | unmanned aircraft system |
| UGV | unmanned ground vehicle |
| USC | United States Code |
| VLOS | visual line of sight |
| VO | visual observer |
| VTOL | vertical takeoff and landing |
| WACS | WMD aerial collection system |
| WMD | weapons of mass destruction |
| WMD-CST | weapons of mass destruction—civil support team |

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# I. INTRODUCTION

The emergence of small unmanned aircraft systems (sUAS) has created an opportunity to transform disaster response in the homeland. This technology can provide increased situational awareness (SA) for civil authorities as well as remote air monitoring for the incident commander to enable more educated decisions, which results in safer, more effective response to disasters. The Department of Defense (DOD) is in an ideal position to facilitate this capability by equipping the National Guard's weapons of mass destruction—civil support teams (WMD-CSTs or CSTs) with sUAS capable of detecting and identifying chemical, biological, radiological, nuclear (CBRN) and hazardous material (HAZMAT) materials, as well as providing video to the incident commander. One of the primary benefits of providing this capability to the CSTs is to capitalize on its nationwide response capability, which makes this technology accessible to every community throughout the United States and its territories.

This thesis is a policy proposal intended to provide the DOD with recommendations about how to incorporate sUAS into domestic operations by revising current sUAS policy, generating new policy to address the new mission, and integrating it into the national airspace system (NAS). Current DOD sUAS policy and doctrine do not address domestic sUAS operations outside of special use airspace. Additionally, current doctrine is written for fixed wing sUAS rather than vertical takeoff and landing (VTOL) aircraft. This new capability requires thorough analysis to ensure all legal aspects of policy and doctrine align with domestic-specific issues, such as Federal Aviation Administration (FAA) integration and state/federal legislation constraints.

This thesis is limited to policy analysis and does not address specific technology or translate data analysis into technological requirements. The combination of sUAS and wireless air monitoring technology is a new concept, thus the availability of open source technological information is limited. There are opportunities for future analysis in the research and development of this capability as well as future force structure revisions, which may arise as a result of a robust training and sustainment program. Additionally, further research into Title 14 of the Code of Federal Regulations (CFR) Part 107 is necessary to determine specific operator training and certification requirements and how those will be nested into DOD operations. The limitations of future sUAS capabilities are limited only by the imagination. Future sUAS could include capabilities such as autonomous flight, all weather operations, as well as more advanced sensors and cameras. However, the intent of this proposal, utilizing current FAA policy as a framework, is to provide a useful framework for implementing a program with technology that is currently available on the commercial market or requires minimal research and development.

## A. PROBLEM STATEMENT

Emerging technology combining sUAS platforms and wireless CBRN detection sensors provides an opportunity for the DOD to develop a capability that can transform response to disasters within the United States. This thesis explores the feasibility of integrating sUAS equipped with video and CBRN sensor technologies into the equipment of DOD civil support teams for use in support of civil authorities during domestic incidents. These threats can be natural or manmade, intentional, or unintentional, and include both terrorist attacks and HAZMAT incidents. One of the DOD's primary objectives in its mission to protect the homeland is to maintain the ability to support civil authorities during domestic CBRN events.[1] According to the *Strategy for Homeland Security and Defense Support of Civil Authorities*, "DOD will continue to improve CBRN force posturing and refine force sourcing processes to meet future national requirements for domestic CBRN incident response."[2] The use of sUAS equipped with wireless CBRN sensors would increase responder safety by maximizing the standoff distance between responders and contamination zones as well as improve situational awareness for incident commanders during all disaster responses.

Current DOD domestic UAS policy and doctrine are insufficient to support sUAS for several reasons. First, current DOD UAS policy restricts use to case-by-case

[1] Department of Defense, *Strategy for Homeland Security and Defense Support of Civil Authorities* (Washington DC: Department of Defense, 2013), 15.

[2] Ibid.

operations approved by the secretary of defense (SecDef), or in the event of a search and rescue, the Northern Command (NORTHCOM) commander has approval authority. This level of approval is unrealistic if domestic response teams need to use the capability immediately. Second, current domestic UAS policy does not consider VTOL sUAS. This is understandable since the technology has not been fielded, but VTOL sUAS policies must be addressed prior to implementation. Integration into the NAS will require significant policy implementation. Third, current DOD sUAS doctrine contains gaps addressing the unique challenges associated with defense support to civil authorities (DSCA) operations, such as intelligence oversight (IO), airspace limitations, and state legislation. This thesis conducts an analysis of current DOD UAS doctrine as well as domestic UAS policy and offers solutions to integrate this capability into civil support teams.

## B. RESEARCH QUESTION

The primary goal of this research is to determine how the DOD can support civil authorities with a revolutionary sUAS technology that can provide additional situational awareness, remote CBRN/HAZMAT detection and identification, and ultimately increase safety for all personnel involved in a disaster response. Secondary questions include:

- What policy barriers must be overcome to authorize the use of DOD sUAS in the domestic environment?
- What legal barriers must be overcome to integrate sUAS into the national airspace system?
- What training objectives must be met to ensure compliance with applicable law and the challenges listed above?

## C. SIGNIFICANCE OF RESEARCH

The 2010 *Quadrennial Defense Review* (QDR) assessed current capabilities and noted key goals that were of the “highest priority” for future support to civil authorities. Two of the four priorities are 1) “Accelerate the development of standoff radiological/nuclear detection capabilities, and 2) Enhance capabilities for domain awareness."[3] sUAS can accomplish both of these priorities. This thesis seeks to capitalize on the DOD's mission to support civil authorities during disaster response. It offers an idea that could transform civil response to dangerous CBRN and HAZMAT events by utilizing existing DOD force structure as well as existing sUAS doctrine as a foundation. Adoption of this proposal and use of sUAS in the CST could make this capability accessible to every community in the United States and its territories.

The author is the commander of the Nevada National Guard's 92nd WMD-CST as well as a rotary wing aviator and is in an ideal position not only to understand the benefits this technology could provide to CSTs and civil authorities, but also how to integrate it into the NAS. Acceptance of this proposal could further unify the relationship between civil authorities and the DOD by providing a revolutionary capability aimed at increasing responder safety.

### D. METHODOLOGY

This thesis explores the theoretical application of an emerging technology (CBRN-sensing sUAS with remote video capability). Research suggests that the DOD is currently developing the technology for overseas operations; however, there is no literature to indicate this capability is being considered for domestic operations.[4] The integration of this technology into domestic operations will require significant changes to current DOD domestic unmanned aircraft systems (UAS) policy and is based on the identification of an opportunity to improve the safety of civil authorities and increase the situational awareness for incident commanders. The reason for focusing on DOD policy rather than commercial aviation policy is twofold.

First, DOD policy is standard across the country. If a successful technology can be implemented across the DOD, it will be easier for other public agencies to adopt similar policies and utilize similar equipment. A well-researched policy analysis can provide useful data for any public agency to adopt for its own use.

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[3] Department of Defense, *Quadrennial Defense Review Report* (Washington DC: Department of Defense, 2010), 19–20.

[4] Steve Johnson, "Come Fly with Me…," *CBRNe World* (Spring 2010): 79–81.

Second, the decision to focus on CSTs is due to the mission of that organization. The civil support team is the National Guard's primary CBRN response organization. Its mission is to "identify, assess, advise and assist incident commanders during intentional and unintentional CBRN incidents as well as natural or manmade disasters resulting in potential loss of life or property."[5] Each state has at least one CST capable of 24/7 response anywhere in the state. Additionally, the CST is a federally funded organization dedicated to supporting civil authorities, and one is provided at no cost to the requesting organization.[6] If this sUAS capability is integrated into these teams, every community in the United States will have access to this technology at no cost to the requesting agency. This policy analysis determines whether existing DOD and national policy and doctrine are sufficient to support sUAS equipped with a video camera and CBRN sensors for use in DSCA. Additionally, this policy analysis explores how existing frameworks can be used to support a capability that does not yet exist.

The research is conducted in three parts. The first part is focused on setting the stage for understanding the CST, the WMD/CBRN threat, and how this capability can improve life safety and increase situational awareness. It is important to understand what the CST is, its mission, its role in DSCA, and how this sUAS concept is nested into national and DOD strategic guidance for disaster response. Moreover, it provides a brief historical review of international WMD attacks as well as major disasters. This review is intended to highlight the WMD threat and provide examples of disasters that could *or did* benefit from sUAS technology.

The second part of the research conducts an analysis of existing policy and doctrine as well as gaps in policy. Since the DOD does not use domestic VTOL sUAS technology, there is no precedent for comparison. Instead, the research looks into the existing framework of DOD domestic UAS policy to identify areas that could support sUAS and the gaps that would need to be addressed to make it successful. Significant topics that provide the foundation for existing policy include intelligence oversight,

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[5] National Guard Bureau, *Weapons of Mass Destruction Civil Support Team Management* (NGR 500-3/ANGI 10-2503) (Arlington, VA: National Guard Bureau, 2011), 2.

[6] Ibid., 2.

national airspace integration, authorized mission sets, and approval authority. Moreover, these topics are explored in detail to determine their role in current policy and what gaps exist in relation to a sUAS program. Additional topics that are part of this research include training and procurement.

The third part of this research provides a conclusion and recommendations to policy and doctrine. The implementation of sUAS for use in DSCA requires comprehensive revision of multiple layers of policy and will likely involve approval at the secretary of defense level due to the sensitive nature of sUAS in the United States. Finally, these recommendations provide a framework for policy revision by offering specific solutions to bridge the gap between existing and future policy.

## E. LITERATURE REVIEW

The review of the literature focuses on the feasibility of a revised DOD policy incorporating sUAS with video capability and remote CBRN sensors for use by National Guard WMD-CSTs. Research indicates the concept of using sUAS equipped with CBRN sensors for DOD domestic operations has been discussed, but it is still in the very early stages of development. Although there is literature addressing sUAS and separate literature addressing remote CBRN sensors, literature addressing the combination of the two is limited. Repeated attempts to obtain research data on such systems from the commercial and private sectors were unsuccessful, likely due to the sensitive nature of intellectual property. This thesis conducts a synthesis of the available literature between the two concepts and explores the policy options for integrating them into a resource for the DOD. The objective is to improve response to domestic disasters by improving safety and increasing situational awareness as well as providing a valuable capability to every community in the United States. The literature underpinning this research can be broken down into four themes: 1) national strategy, 2) Department of Defense policy, 3) federal government policy, and 4) private sector research

### 1. National Strategy

U.S. national strategy provides the guidance to continuously strive for improvement in the realm of CBRN response. Literature published by federal government agencies, such as the Office of the President of the United States, the Department of Homeland Security, the Congressional Research Service, and the Department of Defense, provide the background for the CBRN threat and the need to continuously improve our CBRN detection and response capability. The president's *2015 National Security Strategy* provides clear guidance concerning remaining at the forefront of technology, combatting terrorism, and preventing weapons of mass destruction.[7] Additionally, *Homeland Security Presidential Directive-8* (HSPD-8) establishes guidance to develop an all-hazards preparedness goal.[8] This goal is outlined in the *National Preparedness Guidelines* and complements the *National Security Strategy* by establishing national preparedness priorities, one of which is to "Strengthen CBRNE Detection, Response, and Decontamination Capabilities."[9]

Further guidance for continued CBRN response capabilities can be found in the *Strategy for Homeland Defense and Defense Support of Civil Authorities*. This document provides the framework for the DOD's two primary missions in support of civil authorities and accompanying objectives to achieve the missions. One of those objectives is to "maintain defense preparedness for domestic CBRN incidents."[10]

The 2010 *Quadrennial Defense Review* lays the foundation for continued pursuit of new technology. It outlines several key initiatives resulting from an assessment of future priorities.[11] These key initiatives provide the necessary guidance to continuously evaluate current capabilities and develop new strategies to improve response protocol. These initiatives include: 1) providing "faster, more flexible consequence management response forces," 2) "enhance capabilities for domain awareness," and 3) "accelerate the

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[7] White House, *National Security Strategy* (Washington, DC: White House, 2015).

[8] White House, *Homeland Security Presidential Directive / HSPD-8* (Washington, DC: White House, 2011), http://fas.org/irp/offdocs/nspd/hspd-8.html.

[9] Department of Homeland Security, *National Preparedness Guidelines* (Washington DC: Department of Homeland Security, 2007), 18.

[10] Department of Defense, *Strategy for Homeland Security*, 15.

[11] Department of Defense, *Quadrennial Defense Review*, 19–20.

development of standoff radiological/nuclear detection capabilities."[12] These key initiatives are precisely what this policy analysis hopes to achieve.

### 2. Department of Defense Policy and Literature

An analysis of existing DOD policy provides a useful framework from which a comprehensive UAS program can be developed. This literature covers several aspects of existing policy such as the domestic use of *large* UAS, overseas use of fixed wing sUAS, intelligence oversight and the legality of domestic imagery, and training. Additionally, DOD literature provides the basis for the concept of the National Guard WMD-CST, its mission, and its role in defense support to civil authorities. Conversely, a thorough analysis of DOD policy and literature highlights the lack of policy or literature addressing the concept of domestic VTOL sUAS and how they can be utilized to support civil authorities.

Existing DOD domestic UAS policy guidance can be found in deputy secretary of defense's (DEPSECDEF) Policy Memorandum 15-002, *Guidance for the Domestic Use of Unmanned Aircraft Systems*. This policy memorandum outlines the authorized use of DOD UAS as well as the approval criteria for domestic use. In addition, it also provides guidance on considerations while operating DOD UAS, such as intelligence oversight and national airspace integration. It is noteworthy that there is no mention of *small* UAS in this memorandum; therefore, its use is limited to understanding the framework supporting the existing domestic UAS program.[13]

Current training, flight proficiency/currency requirements, and flight rules fall under the purview of the *Rapid Action Revision to Unmanned Aircraft System Flight Regulations* (AR 95-23). AR 95-23 establishes guidance for the use of all Army sUAS.[14] It applies to all personnel operating Army UAS including active Army, National Guard, Reserves, and Department of the Army civilian and contract personnel. It serves as a

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[12] Ibid.

[13] Deputy Secretary of Defense, *Guidance for the Domestic Use of Unmanned Aircraft Systems*, Policy memorandum 15-002 (Washington DC: Department of Defense, 2015).

[14] Department of the Army, *Rapid Action Revision to Unmanned Aircraft System Flight Regulations* (AR 95-23) (Washington DC: Headquarters, Department of the Army, 2006), i.

reference for all sUAS operations but is limited in its scope. Moreover, it is intended for the management of tactical sUAS programs rather than domestic response units. Additionally, the regulation does not address VTOL systems discussed in this thesis. However, it does address nonstandard sUAS, which applies to sUAS that are not part of the Army inventory.[15] This regulation provides useful information regarding the acquisition and use of nonstandard aircraft.

*Unmanned Aircraft System Commander's Guide and Training Manual (ATM)* (Training Circular [TC] 3-04.61) is used to determine proper training and standardization programs. This ATM is the "how to" source for performing aircrew duties.[16] The ATM also provides task, conditions, standards, and description of each authorized maneuver for UAS. However, this TC is limited in scope because it deals with fixed wing UAS and is limited to training for combat missions; however, it will be useful when discussing the training strategy for a future VTOL sUAS program.

Intelligence oversight is an instrumental component of a successful domestic sUAS program. It is the DOD's program of record based on the Fourth Amendment to "ensure all US persons are secure in their persons, houses, papers, and effects, against unreasonable searches and seizures."[17] The 1981 Executive Order 12333, United States Intelligence Activities, prevents the surveillance of persons without approval from the head of the agency and the attorney general.[18] This applies to all persons subject to U.S. surveillance. In 1982, the Department of Defense went a step further and published DOD regulation *Procedures Governing the Activities of DOD Intelligence Components That Affect United States Persons* (DOD 5240.1-R).[19] This regulation "set forth procedures governing the activities of DOD intelligence components that affect United States

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[15] Ibid., 25.

[16] Department of the Army, *UAS Commander's Guide and Aircrew Training Manual* (TC 3-04.61) (Washington DC: Headquarters, Department of the Army, 2014), viii.

[17] Fourth Amendment of the Bill of Rights.

[18] Exec. Order No. 12333, 3 CRF (1981).

[19] Department of Defense, *Procedures Governing the Activities of DOD Intelligence Components That Affect United States Persons*, DOD 5240.1R (Washington DC: Department of Defense, 1982), 1.

persons."[20] The policy outlined in this regulation establishes the legal framework for the intelligence oversight program. Additionally, DOD 5240.1-R mandates that all telecommunications regarding national security be secure to ensure authenticity.[21] Although this mandate specifically refers to "telecommunications," a logical argument can be made that video and sensor signals generated from aerial systems must be secure as well.

Specific intelligence guidance regarding the National Guard can be found in Chief National Guard Bureau Manual (CNGBM) 2000.01, *National Guard Intelligence Activities*. This document outlines the requirements for collecting, retaining, and disseminating information on US persons, which units are authorized to collect this information, and by what means. Additionally, CNGBM 2000.01 outlines the criteria for determining the need for a proper use memorandum (PUM) and the process for submission. This information is important because domestic sUAS use within the DOD will require a PUM.[22]

The weapons of mass destruction-civil support team is a resource that is not widely understood outside of the DOD. National Guard Regulation (NGR) 500-3/Air National Guard Instruction (ANGI) 10-2503, *Weapons of Mass Destruction Civil Support Team Management*, outlines the responsibilities, mission, and process management of a CST. It outlines the response management plan and how a CST is able to maintain 24-hour nationwide coverage through the use of response sectors and availability cycles.[23] This information is useful when analyzing whether a CST is the appropriate agency to manage sUAS.

Army Techniques Publication (ATP) 3-11.46, *Weapons of Mass Destruction-Civil Support Team Operations*, provides the "foundation of civil support team doctrine and focuses on the organization, mission, command and control, and operations of the WMD-

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[20] Ibid., 2.

[21] Ibid., 7.

[22] National Guard Bureau, *Chief of the National Guard Manual*, CNGBM 2000.01 (Washington, DC: National Guard Bureau, 2012), www.ngbpdc.ngb.army.mil/pubs/CNGBI/CNGBM2000_01_20121126.pdf.

[23] National Guard Bureau, *Weapons of Mass Destruction*.

CST."[24] It also provides a historical review of the CSTs, including the various presidential policy directives (PPD) and congressional authorizations that eventually created the team. It also provides a list of significant disasters that CSTs have been involved in and to what types of events the CSTs generally provide support.[25] This information is useful when discussing the context of the CST in relation to homeland security.

### 3. Federal Government Policy

The Federal Aviation Administration (FAA) published comprehensive sUAS policy in 2016.[26] 14 CFR Part 107 stipulates the requirements for private and commercial use of sUAS.[27] Part of this framework includes the operational limitations that private and commercial operators must meet to maintain their license.[28] Part 107 outlines the "operating and certification requirements" for allowing small unmanned aircraft to operate within the national airspace system.[29] This policy does not apply to DOD aircraft; however, it provides a useful framework that could be adopted by the DOD to streamline sUAS operations.

The FAA and the DOD currently operate under a memorandum of agreement (MOA) signed in 2013. This document outlines the policies and procedures the DOD and the FAA agreed upon to integrate UAS into the NAS. The intent of the agreement is to streamline the process for requesting a certificate of authorization or waiver (COA) from the FAA and is a helpful source document for previous DOD-FAA agreements regarding

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[24] Department of the Army, *Weapons of Mass Destruction-Civil Support Team Operations* (ATP 3-11.46) (Washington DC: Headquarters, Department of the Army, 2007), iv.

[25] Ibid., 1-1.

[26] Operation and Certification of Small Unmanned Aircraft Systems, 14 CFR Part 107 (2016), https://www.faa.gov/uas/media/RIN_2120-AJ60_Clean_Signed.pdf.

[27] Ibid.

[28] Ibid., 10–11.

[29] Ibid. 8.

UAS.[30] Admittedly, it is limited in scope as it does not address VTOL capability used in immediate response missions. Finally, Presidential Decision Directive 62, *Protection Against Unconventional Threats to the Homeland and Americans Overseas*, signed in 1998, provides the impetus for the development of DOD WMD units by tasking the DOD to develop consequence management units designed to respond to WMD as well as train first responders.[31]

#### 4. Private Sector Research

This research used white papers and other documents written by private industry conducting research and development on remote *ground-based* CBRN air monitoring sensors as well as remote sensors mounted to sUAS. These sources provide excellent data regarding the progress of this capability. Although this research did not focus on the technological aspect of these sensor capabilities, there is information within the private industry research that is used to validate the feasibility of the concept. According to the International Society for Optics and Photonics (SPIE), this technology is not only feasible but also field tested for use by the DOD.[32] SPIE's research was conducted in cooperation with Physical Sciences Inc. as well as with Intelligent Optical Systems. This research provides insight into the research and development of this capability into the DOD. In addition, other commercial companies are conducting research and development in the hopes of selling their products to the DOD. Finally, an advertisement brochure from FLIR Systems offers a sensor that has already been tested on programs such as the DOD's WMD Aerial Collection System (WACS) and Military Applications and

[30] Department of Defense and Federal Aviation Administration, *Memorandum of Agreement Concerning the Operation of Department of Defense Unmanned Aircraft Systems in the National Airspace System* (Washington, DC: Department of Defense, 2013), http://www.usaasa.tradoc.army.mil/docs/br_Airspace/DoDFAA_MOA_OpsinNAS_16Sep2013.pdf, 1–8.

[31] White House, *Protection Against Unconventional Threats to the Homeland and Americans Overseas* (Presidential Decision Directive 62) (Washington, DC: White House, 1998), https://fas.org/irp/offdocs/pdd/pdd-62.pdf.

[32] William J. Marinelli et al., "Cooperative Use of Standoff and UAV Sensors for CBRNE Detection" in *Proceedings SPIE 9455, Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Sensing*, XVI (May 2015): 94550U–94550U, doi: 10.1117/12.2177023.

Reconnaissance and Surveillance (MARS).[33] MARS was a program sponsored by the U.S. Army Research Development and Engineering Command and was intended to "enhance early warning for chemical/biological threats, improve hazard awareness, and ultimately improve the decision support confidence."[34] The test proved that aerial sensors could work on sUAS platforms, even when subjected to adverse environmental conditions and the vibration associated with the sUAS. Unfortunately, the MARS program was terminated in 2011 due to fiscal constraints.[35]

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[33] FLIR Systems, *UAV Integrated Sensors for CBR Threat Monitoring* [brochure] (Wilsonville, OR: FLIR Systems), http://www.psicorp.com/products/isr-systems/instanteye%C2%AE.

[34] U.S. Army Research Development and Engineering Command, "Military Applications in Reconnaissance/Surveillance for Joint Force Protection (MARS JFP)," accessed October 15, 2016, http://www.ecbc.army.mil/design/atd/MARS.html.

[35] Ibid.

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# II. THE CIVIL SUPPORT TEAM

## A. INTRODUCTION

The civil support teams are instrumental resources in the nation's response to weapons of mass destruction involving CBRN materials as well as other natural or manmade disasters that threaten life or property. They serve as the National Guard's first response capability in support of civil authorities. Additionally, the role of CSTs in homeland security is to act as subject matter experts for CBRN and hazardous material (HAZMAT) response as well as to assist and to advise incident commanders during all hazards response. A CST is strategically located in all states and territories and can to respond to any incident 24 hours a day, 365 days a year, anywhere in the United States and its territories. CSTs are also air, rail, and water mobile, enabling each team to reinforce other CSTs throughout the country and U.S. territories in the event of a large-scale disaster. The primary goal of CSTs is to support state governors by providing specialized CBRN/HAZMAT detection and identification capabilities as well as consequence management and liaison services for follow on forces.[36]

The CSTs utilize highly technical equipment, which should undergo continual assessment to ensure it is fielded with the most effective resources available. In addition, as new technologies emerge, they should be explored and harnessed to ensure the DOD's domestic response effort maximizes life safety and provides critical support to communities during disaster response. One such emerging technology is the small unmanned aircraft system. The sUAS can change the way civil authorities respond to disasters by providing situational awareness as well as CBRN detection and identification. Various national and DOD strategic-level guidance documents outline the importance of maintaining a highly deployable and proficient CBRN response force.[37] The CSTs are optimal organizations to utilize sUAS. Their strategic locations throughout the country can ensure the technology is rapidly deployable to all communities, and the

[36] National Guard Bureau, *Weapons of Mass Destruction*, 2.

[37] Department of Defense, *Strategy for Homeland Defense*.

DOD's standardized training program can ensure all operators are highly skilled and proficient.

## B. BACKGROUND

On May 22, 1998, President Clinton signed Presidential Decision Directive 62 (PDD 62), which tasked the DOD with "providing training to metropolitan emergency responders and maintaining military units (active and reserve components) to serve as augmentation forces for weapons of mass destruction consequence management." [38] In 1998, the United States Congress, under the authority of 10 U.S. Code § 12310 (Reserves: for Organizing, Administering, etc., Reserve Components), recognized the need for specially trained and equipped National Guard units capable of responding to CBRN events.[39] The first WMD-CSTs were fielded to the National Guard in 1999. The intent of the WMD-CSTs was to provide each of the 50 states and four territories with a Title 32 active duty team capable of providing 24-hour CBRN incident response (intentional or unintentional) in support of civil authorities anywhere in the United States. In 2007, Congress expanded the mission of the WMD-CST to include all hazards response meaning they not only respond to CBRN incidents but also "natural or manmade disasters in the United States that result, or could result, in the catastrophic loss of life or property."[40] Today, there are 57 CSTs; one for each state and territory plus two teams each for California, Florida, and New York.[41] Each team consists of 22 Army and Air National Guard personnel serving on USC Title 32 status in Active Guard Reserve (AGR) status.[42]

CSTs have deployed to thousands of response missions as well as standby missions since their inception. Major operational missions for the CSTs include support to 9/11 and "subsequent anthrax attacks, support for Hurricanes Katrina, Wilma, and Rita

[38] Clinton Digital Library, "Declassified Documents Concerning Presidential Decision Directive 62 (PDD-62)," accessed July 8, 2016, http://clinton.presidentiallibraries.us/items/show/16200.

[39] Department of the Army, *Weapons of Mass Destruction*, 1-1.

[40] National Guard Bureau, *Weapons of Mass Destruction*, 2.

[41] Ibid., 40.

[42] Ibid., 2.

in 2005, assessments of the debris field resulting from the crash of the space shuttle Columbia," Super Bowls, Democratic and Republican National Conventions as well as presidential inaugurations, and many other national special security events (NSSE).[43]

## C. MISSION

According to Department of the Army, *Weapons of Mass Destruction-Civil Support Team Operations* (FM 3-11.46),

> The mission of the WMD-CST is to support civil authorities at domestic chemical, biological, radiological, and nuclear incident sites by identifying CBRNE agents and substances, assessing current and projected consequences, advising on response measures, and assisting with appropriate requests for additional support.[44]

The acronym "CBRNE" is referenced multiple times throughout this thesis. The "E" stands for high-yield explosives. Some supporting quotes reference CBRNE and others reference CBRN, depending on the source. For the purpose of this thesis, the terms are used synonymously.

A WMD-CST is a "governor's 911 for all hazards" response in support of civil authorities.[45] Each CST is divided into six sections: command, operations, administrative and logistics, communications, medical and analytical, and survey. In addition to technical CBRN response, the communications section can provide robust command and control (C2) capabilities to civil authorities. These capabilities are designed to provide the supported agency with access to information and resources that it might not otherwise have, such as satellite communication, radio frequency cross-banding, secure and non-secure mobile internet, and fax capability. One of the benefits of these capabilities is to provide civil authorities with an increased situational awareness.

The Coast Guard defines situational awareness as "the ability to identify, process, and comprehend the critical elements of information about what is happening to the team

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[43] Department of the Army, *Weapons of Mass Destruction*.

[44] Ibid., vi.

[45] Ibid., vi.

with regards to the mission."[46] An incident commander's ability to interpret data collected from an incident is instrumental to maintaining a safe and effective response. When incident commanders lack situational awareness, the result is increased risk. A CST is equipped with various resources designed to provide additional situational awareness to the incident commander so he/she can make educated decisions, thus reducing risk. These resources include hand-held, remote video cameras and unmanned ground vehicles (UGV), otherwise known as robots. These resources and their limitations are discussed in detail in Chapter III.

## D. WHY THE CST?

A CST is in a unique position to provide support to every community in the United States and its territories, 24 hours a day, 365 days a year. Civil support teams are strategically located to provide timely response to all major metropolitan areas within the continental United States using organic transportation assets.[47] Additionally, all CSTs are divided into six "response sectors" (see Figure 1).[48] Each response sector contains between nine and 10 CSTs. Teams in each response sector rotate response status each month so that one team is always in "immediate response," or "gold" status.[49] Teams in immediate response status must be prepared to deploy from home station within three hours of notification.[50] This ensures there are always six deployable teams at all times and allows team members not in a response status to manage leave, schools, and other training that would otherwise preclude them from deploying their entire team. When not in an official response cycle, all teams remain responsible for being prepared to respond within their respective state 24/7. If a team cannot support a mission, they are considered

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[46] U.S. Coast Guard, *Team Coordination Training Student Guide (8/98)* (Washington, DC: U.S. Coast Guard, 1998), https://www.uscg.mil/auxiliary/training/tct/.

[47] Consequence Management Program and Integration Office, *Weapons of Mass Destruction Civil Support Teams WMD CST Doctrine Handbook* (No. 1-2000) (Washington DC: Consequence Management Program and Integration Office, 2000), https://www.hsdl.org/?view&did=450810, 5.

[48] National Guard Bureau, *Weapons of Mass Destruction*, 4.

[49] Ibid.

[50] Ibid.

"black" and must report that to the National Guard Bureau.[51] Figure 1 is a map of the 57 teams and their locations.

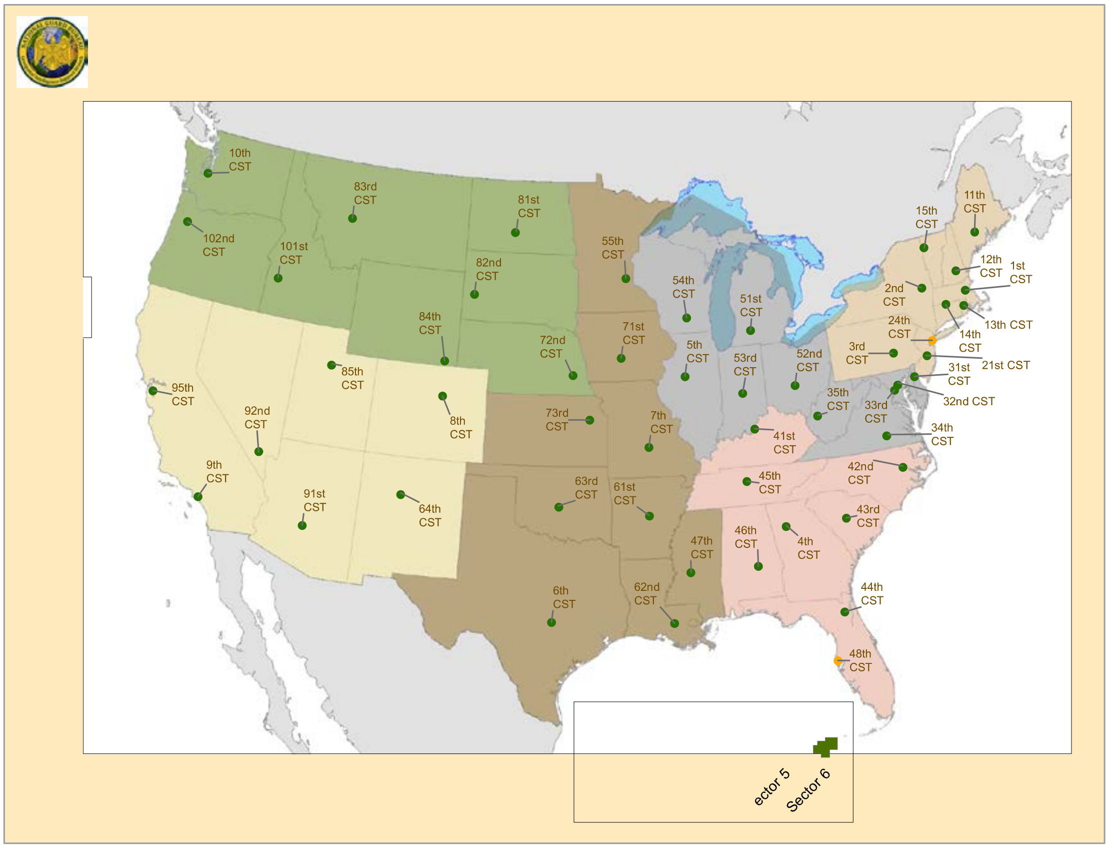

Figure 1. CST Locations[52]

A natural or manmade CBRN or HAZMAT threat is always present in any region or city. Not all communities are equally prepared to respond to these threats, and numerous factors can affect a community's ability to respond to incidents. For instance, some communities have multiple resources at their disposal while others have limited resources due to lack of personnel, budget, equipment, or legal constraints. Additionally, many communities rely on mutual aid agreements with other agencies for assistance in

[51] Ibid.

[52] Source: Washington National Guard, "Homeland Response Force," last modified November 21, 2016, http://mil.wa.gov/homeland-response-force.

specialized support. When this support is insufficient or otherwise unavailable, the local incident commander can request CST support through the governor. If each CST had sUAS, it would be able to provide better support to the entire country within a short amount of time. Additionally, the equipment and training can be standardized, provided at no cost to the requestor, and increase the potential to save lives.

## E. THE CIVIL SUPPORT TEAM OF THE FUTURE

One of the deciding factors to the success of any organization is its ability to adapt to new opportunities and harness emerging technologies. The rapid advancement of sUAS technology provides a unique opportunity to explore ways to improve existing capabilities. Each new capability afforded to the CST instantly changes the disaster response nationwide and serves to enhance support to civil authorities. Ample federal guidance exists to justify the development of improved CBRN response capabilities. The 2010 *Quadrennial Defense Review* (QDR) conducted an assessment of key CBRN capabilities and determined the need for the following in the future:[53]

- <u>"Field faster, more flexible consequence management response forces."</u> The success of these CBRN response forces demonstrates the need to maintain the capability; however, reorganization is necessary to "improve **lifesaving** capabilities, maximize their flexibility, and **reduce response times**."[54]
- <u>"Enhance capabilities for domain awareness."</u> This initiative is aimed at partnering with our neighboring countries to improve **domain awareness** capabilities. This initiative is written in a global context but is also pertinent to domestic operations. The use of military resources to improve awareness is already commonplace in the United States and can be improved. Current domestic doctrine utilizes incident awareness and assessment (IAA), which is an information collection process used to "analyze the impact of events and conditions involved with defense support to civil authorities (DSCA) operations."[55] IAA is a mission generally conducted with manned aircraft equipped with cameras and video downlink systems. This information enables decision makers to

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[53] Department of Defense, *Quadrennial Defense Review*, 19–20. These three initiatives are discussed throughout the thesis.

[54] Ibid.

[55] Joint Chiefs of Staff, *Defense Support of Civil Authorities* (JP3-28) (Washington DC: Joint Chiefs of Staff, 2013), IV-2.

"see" the incident without having to be inside the aircraft, thus increasing situational awareness. These systems can be expensive and are often unavailable due to maintenance or weather. A sUAS with a video feed could provide similar capabilities at a fraction of the cost.

- "Accelerate the development of standoff radiological/nuclear detection capabilities." This initiative provides the guidance to continue to develop improved, remote sensors. Developing and fielding remote sensors capable of **increased standoff distance** will greatly enhance the ability of response forces to detect and identify radiological or nuclear threats without endangering response personnel.[56]

The 2014 QDR acknowledges the improvements made as a result of the 2010 QDR and stresses the need to continue improvements in response to threats through better pre- and post-incident coordination with civil authorities.[57] These initiatives outline the DOD's expectations for the future of CBRN response. Additionally, they reflect goals of the entirety of the DOD CBRN response enterprise (CRE); however, they also identify the need to continually improve current capabilities. Moreover, this guidance can be adapted to meet the needs of the homeland. In fact, there is similar guidance from departments within the federal government. For example, the Department of Homeland Security's *National Preparedness Guidelines* states, "Strengthening CBRNE detection, response, and decontamination capabilities" as one of their top eight priorities.[58]

## F. CONCLUSION

The civil support teams have supported civil authorities during intentional and unintentional disaster response incidents since 1999. These teams are comprised of highly skilled technicians capable of providing a multitude of capabilities to civil authorities, including CBRN detection and identification, communications support, and command and control resources intended to increase situational awareness. Emerging technologies highlight the importance of continuously assessing and improving current capabilities.

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[56] Department of Defense, *Quadrennial Defense Review*, 19–20.

[57] Department of Defense, *Quadrennial Defense Review* (Washington, DC: Department of Defense, 2014), 33.

[58] Department of Homeland Security, *National Preparedness Guidelines*, 18.

The rapid advancement of sUAS technology creates an opportunity to enhance CBRN detection through the integration of CBRN response, aerial remote sensing, increased situational awareness, and life safety. The CSTs' strategic locations throughout the country make them accessible to any community within the United States and its territories within a short time. This nationwide accessibility makes CSTs ideal candidates for a specialized technology that might otherwise be difficult for resource-constrained communities to acquire.

The role of CSTs in CBRN response is clear; they are to assist in the detection and identification of the CBRN threat as well as provide situational awareness to civil authorities. The current threat dictates established tactics, techniques, and procedures (TTPs). These TTPs are sufficient given the current resources; however, the emergence of sUAS technology could dramatically improve responder safety and operational capabilities. An understanding of the current and historical threat will further build the foundation for the CSTs' role in homeland security as well as how sUAS capability could be used to improve response.

# III. THE THREAT AND HOW SUAS TECHNOLOGY CAN MITIGATE IT

## A. INTRODUCTION

> No threat poses as grave a danger to our security and well-being as the potential use of nuclear weapons and materials by irresponsible states or terrorists.
>
> 2015 *National Security Strategy*[59]

The use of weapons of mass destruction continues to be a serious threat to the United States. This threat includes chemical, biological, radiological, and nuclear materials.[60] The United States has been relatively successful at preventing WMD attacks; to date, only two successful attacks have occurred on U.S. soil. These attacks resulted in five deaths and injured over 750 people, and they demonstrate the need for continued diligence regarding the prevention of the use of WMD.

The release of CBRN material, whether intentional or unintentional, is a dangerous threat, and it requires quick and accurate detection and identification. For the purpose of this thesis, it does not matter whether the threat of release is intentional or unintentional as the resulting response is often similar in nature. The threat of an unintentional release of CBRN material via natural disaster or HAZMAT accident has a higher likelihood of occurrence and requires equal attention as an intentional attack. A brief review of previous U.S. and international CBRN events demonstrates the devastation such an event can cause.

Federal guidance dictates that continuous efforts must be made to improve the nation's response to CBRN events.[61] These improvements include better TTPs, training, equipment, and detection and identification capabilities. Current detection and

[59] White House, *National Security Strategy*.

[60] Ibid., 11.

[61] Department of Homeland Security, *National Preparedness Guidelines*, 18.

identification capabilities are robust; however, emerging technology in unmanned aircraft systems has the potential to revolutionize the homeland CBRN response.

## B. BACKGROUND

To understand the CBRN threat, several major historical CBRN events are reviewed below. These events demonstrate the need for robust CBRN response capabilities in the United States.

### 1. Intentional attacks

There have been only two successful WMD attacks in the United States (1984 salmonella poisoning and post-9/11 anthrax attacks). It is noteworthy that U.S. citizens, not international terrorists, committed these attacks.

#### *a. United States*

- **Oregon salmonella poisoning**. This attack occurred in the Dalles, Oregon in 1984 when a Buddhist cult attempted to infect locals with salmonella by sprinkling it on various food items at local restaurants and a supermarket. Their intent was to influence a vote by sickening likely voters and flooding the voting booths with homeless people. There were no deaths, but over 750 people became ill.[62]
- **U.S. anthrax attack**. Shortly after 9/11, several mailings containing anthrax arrived at media outlets and two Democrat senators' offices. Five Americans were killed, and 17 injured in what was the worst biological attack in U.S. history.[63] The investigation finally closed in 2010 when the only suspect in the case committed suicide after learning he was going to be arrested.

#### *b. International*

This thesis considers two international WMD attacks, the Tokyo sarin gas attack and the water poisoning in the Philippines.

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[62] Philip Elmer-DeWitt, "America's First Bioterrorism Attack," *Time*, September 30, 2001, http://content.time.com/time/magazine/article/0,9171,176937,00.html.

[63] Federal Bureau of Investigation, "Amerithrax Investigation," accessed December 27, 2015. https://www.fbi.gov/about-us/history/famous-cases/anthrax-amerithrax/amerithrax-investigation.

- **Tokyo sarin gas attack**. The doomsday cult known as Aum Shinrikyo released sarin gas in the Tokyo subway station during rush hour in 1995 killing 13 people and leaving over 6,000 sick or injured. The attack involved five people located through several lines of the Tokyo subway system. The sarin gas was inside plastic bags and then wrapped in newspaper. Each individual used the end of a sharpened umbrella to puncture the bag exposing the other passengers to the sarin.[64]

- **Manila, Philippines water poisoning**. Residents of a village in the Philippines gave water poisoned with pesticide to members of the Philippine Constabulary while on a run in Manila in 1987. The poison killed 19 members of the constabulary.[65]

### 2. Accidents

WMD incidents are not just intentional. There is also the potential for accidents involving CBRN, such as the case of the train derailment in Weyauwega and that of the the Fukushima power plant.

- **Weyauwega, WI train derailment**. In 1996, there was a train derailment involving 37 cars, including 16 tankers (14 hauling liquid petroleum gas and two hauling sodium hydroxide) in the rural town of Weyauwega, WI. The local fire department was unaware of the contents of the tankers for several hours until the train company arrived with the manifest. The assistant fire chief noted that the tankers were a "ticking time bomb" and the entire community would have been devastated if the tankers had exploded.[66] The incident resulted in the evacuation of 2200 residents for three weeks as responders worked to eliminate the danger.[67] This incident and its relationship with sUAS is discussed later in this chapter.

- **Fukushima Daiichi nuclear power plant**. The fifteenth largest nuclear power plant in the world. Damage from a 9.0 earthquake and subsequent major tsunami in 2011 caused the nuclear reactors to lose their cooling ability resulting in melted cores. The resulting meltdown caused

[64] Tomohiro Osaki, "Deadly Sarin Attack on Tokyo Subway System Recalled 20 Years On," *The Japan Times Online*, March 20, 2015, http://www.japantimes.co.jp/news/2015/03/20/national/tokyo-marks-20th-anniversary-of-aums-deadly-sarin-attack-on-subway-system/.

[65] Mark Fineman, "Filipino Troops Given Poisoned Water; 19 Die," *Los Angeles Times*, September 7, 1987, http://articles.latimes.com/1987-09-07/news/mn-4192_1_poisoned-water.

[66] Duke Behnke, "Weyauwega 1996: 'I Will Never Forget It,'" *Post-Crescent Media*, March 4, 2016, http://www.postcrescent.com/story/news/local/2016/03/04/weyauwega-1996-never-forget/80750018/.

[67] Ibid.

> explosions releasing radioactive material into the surrounding air.[68] Of note and since the incident in 2011, sUAS have been used to conduct wide area radiation monitoring of the power plant. In 2015, Japanese scientists developed a sUAS capable of flying inside the reactors using laser technology for guidance. The sUAS was able to guide itself throughout the power plant without using GPS data as well as replace its own batteries.[69]

The WMD threat from hostile state and non-state actors continues to be a significant concern.[70] Experts note there is a 100 percent probability that the United States will encounter a WMD at some point.[71] This level of certainty insinuates there is nothing the United States can do to prevent all attacks; therefore, it is imperative to continually improve response capabilities to minimize the damage when an attack occurs. The Weyauwega train accident demonstrates that some threats may go unnoticed by responders upon arrival at the incident. The ability to detect and identify these threats could save the lives of both responders and members of the local community. Additionally, early identification of these threats is a function of situational awareness.

## C. SITUATIONAL AWARENESS AS A THREAT

The lack of situational awareness during a CBRN incident is itself a threat. The first priority of every incident commander is life safety,[72] and every other objective is subordinate to safety. An inaccurate or incomplete understanding of the environment limits the incident commander's ability to manage resources and can compromise safety. The second priority is the stabilization and safety of the incident.[73] The incident

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68 World Nuclear Association, "Fukushima Accident," last modified November 2016, http://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-accident.aspx.

69 Anna Paternnosto, "Game of Drones: The Unmanned Revolution in CBRNe Security," CBRNe Portal, February 29, 2016, http://www.cbrneportal.com/game-of-drones-the-unmanned-revolution-in-cbrne-security/.

70 Joint Chiefs of Staff, *National Military Strategy to Combat Weapons of Mass Destruction* (JP 3-40) (Washington DC: Joint Chiefs of Staff, 2006), II-9.

71 Ronald Kessler, "FBI: 100 Percent Chance of WMD Attack," *Newsmax*, February 14, 2011, http://www.newsmax.com/RonaldKessler/zawahiri-weapons-mass-destruction/2011/02/14/id/386055/.

72 Ready.gov, "Emergency Response Plan," accessed October 15, 2016, https://www.ready.gov/business/implementation/emergency.

73 Ibid.

commander cannot stabilize the incident without proper situational awareness. The ensuing confusion following a disaster can complicate response efforts and lead to hasty decisions by the command, which can result in increased risk to rescuers and those needing to be rescued. Every resource should be utilized to maximize the understanding of the operational environment as soon as possible. Incident commanders have limited resources available to assist them during a CBRN response. Hand-held Video Cameras

CSTs are equipped with hand-held video cameras carried by personnel entering the potentially contaminated area. The intent is to use the camera to conduct a site characterization and provide the incident commander with an actual picture of the environment rather than rely only on radio communication. This resource can be valuable because it provides the decision makers with a clear understanding of a situation; however, it does not increase standoff distance or provide situational awareness to the IC *prior* to sending responders into a potentially contaminated area.

### 1. Unmanned Ground Vehicles

Some agencies utilize remote ground vehicles with CBRN sensors and video cameras that are deployable into a suspected contamination zone; however, those assets are uncommon. Currently, unmanned ground vehicles equipped with remote detection equipment provide standoff distance for responders but also have limitations. First, they are expensive; UGVs cost between $20,000 and $195,000, depending on the equipment ordered.[74] UGVs equipped with CBRN sensors and video capabilities tend to be on the higher end of the cost spectrum. Second, they are slow. The maximum speed for many of these vehicles is less than six miles per hour.[75] Third, they are unable to assess a large-scale incident from all angles or to include aerial imagery and air monitoring. Aerial imagery and air monitoring could provide useful data for plume modeling as well as

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[74] U.S. Securities and Exchange Commission, Commission Form K-10 file no. 000-51598, iRobot Corporation, http://investor.irobot.com/phoenix.zhtml?c=193096&p=irol-SECText&TEXT=aHR0cDovL2FwaS50ZW5rd2l6YXJkLmNvbS9maWxpbmcueG1sP2lwYWdlPTY3NzYyNjcmRFNFUT0wJlNFUT0wJlNRREVTQz1TRUNUSU9OX0VOVElSRSZzdWJzaWQ9NTc%3D, 7.

[75] Army Technology, “iRobot 510 PackBot Multi-Mission Robot, United States of America,” accessed October 2, 2016, http://www.army-technology.com/projects/irobot-510-packbot-multi-mission-robot/.

provide damage assessments for inaccessible areas of an incident. Finally, UGVs are limited to ground operations and susceptible to barriers or obstacles encountered on the ground.

## D. CURRENT CBRN CHALLENGES TO RESPONDERS

A CBRN incident complicates many facets of a response. As discussed in the Weyauwega train derailment incident, there are times when an incident does not demonstrate the immediate characteristics of a CBRN event, and responders must adapt quickly. In addition, incident commanders can be faced with multiple challenges as they develop a situation. Response tactics, techniques, and procedures are limited to the resources available at the time, which means incident commanders must often send responders into a potentially dangerous environment without fully understanding the complexity of the situation. This presents several significant and potentially unnecessary safety and operational challenges including challenges to safety, operational considerations, and situational awareness.

### 1. Safety

The incident commander is responsible for all aspects of a response including the lives of the responders as well as the victims.[76] The safety and operational challenges posed by disasters can be mitigated to a manageable level by proper training and equipment, but risks can remain high. First, the detection and identification of any CBRN material requires personnel to enter a contamination zone with detection equipment. This action places the entry personnel at risk of exposure. To mitigate the risk of exposure, responders must wear appropriate personal protective equipment (PPE). In the case of a CBRN event, responders are required to wear a certain level of HAZMAT PPE commensurate to the type of threat. The most protective ensemble is called level A. This suit is selected when the responder requires the highest level of respiratory, eye, and skin

[76] U.S. Department of Labor, "Incident Command System (ICS) eTool—Incident Commander," accessed July 12, 2016, https://www.osha.gov/SLTC/etools/ics/inci.html.

protection.[77] The suit is totally encapsulating and provides oxygen via a self-contained breathing apparatus (SCBA).

The level A suit is very effective at personnel protection but creates significant concerns for incident commanders. First, the sheer weight of this ensemble causes slower movement. The weight of the SCBA is 40 pounds and that does not include the weight of the garment.[78] Second, the restricted breathing causes the onset of exhaustion more rapidly as well as limiting time on station to the duration of the oxygen tank. Third, there is always a risk of a level A suit tearing while in a contaminated area resulting in contamination of a responder. This situation can be potentially fatal depending on the substance exposed to the skin. Fourth, the wearer has limited vision, which can be dangerous if entering an area with multiple obstacles, such as a residence or building.[79] Tripping hazards increase the risk of injury or suit tear resulting in a potential contamination situation. Firefighting suits are designed for durability; however, level A HAZMAT suits are made of Tyvek and are more easily torn. Finally, and possibly most important, are the multiple psychological and physiological stressors that accompany CBRN entry.

The complete encapsulation of a person causes considerable physiological stress. The National Institute for Occupational Safety and Health (NIOSH) studied the effects of workers wearing chemical protective suits and found that worker tolerance time was reduced by 56 percent while wearing level A suits compared to working in light clothing.[80] Additionally, heat stress and exhaustion occur more quickly when operating in a level A suit due to the lack of air circulation. The NIOSH recommends wearing suits

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[77] U.S. Department of Labor, "Occupational Safety and Health Standards: Hazardous Materials," August 1994, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9767, 1910.120 App B.

[78] Chemical Stockpile Preparedness Section, Nuclear and Chemical Hazards Branch, Preparedness Division, DHS/FEMA, *Fact Sheet: Personal Protective Equipment Levels and Risks* (Washington, DC: Chemical Stockpile Preparedness Section, Nuclear and Chemical Hazards Branch, Preparedness Division, DHS/FEMA, 2004), https://www.cseppportal.net/csepp_portal_resources/ppe_factsheet.pdf, 3.

[79] CHEMM, "Personal Protective Equipment (PPE)," accessed July 12, 2016, https://chemm.nlm.nih.gov/ppe.htm.

[80] Nancy J. Bollinger and Robert H Schutz, *NIOSH Guide to Industrial Respiratory Protection* (Washington, DC: U.S. Department of Health and Human Services, 1987), 122.

in the morning or evening when possible.[81] However, this is unrealistic given the unpredictable nature of the incident.

### 2. Operational Considerations

Time is essential for the quick detection, identification, and decontamination of CBRN materials. Responders must work quickly to assess the immediate environment as well as conduct a plume analysis to prepare for potential follow-on effects on the population. Current resources are effective but not conducive to a quick response. Preparing for entry into a CBRN environment is methodical and tedious. Donning a Level A suit equipped with a SCBA takes valuable time. Although there is no industry standard for a minimum time in which one must be able to don a Level A suit, Figure 2 is a sample checklist published by OSHA of the steps that should be accomplished when donning a suit.[82] This 16-step checklist is extensive in nature and indicates the donning process can take considerable time.

[81] Ibid., 123.

[82] Occupational Safety and Health Administration, "VI. Clothing Donning, Duffing, and Use," in *OSHA Training Manual* (Washington, DC: Occupational Safety and Health Administration, 1999), last modified April 14, 2016, https://www.osha.gov/dts/osta/otm/otm_viii/otm_viii_1.html#6, Table VIII:1-5.

**TABLE VIII:1-5. SAMPLE DONNING PROCEDURES**

1. Inspect clothing and respiratory equipment before donning (see Paragraph on Inspection).
2. Adjust hard hat or headpiece if worn, to fit user's head.
3. Open back closure used to change air tank (if suit has one) before donning suit.
4. Standing or sitting, step into the legs of the suit; ensure proper placement of the feet within the suit; then gather the suit around the waist.
5. Put on chemical-resistant safety boots over the feet of the suit. Tape the leg cuff over the tops of the boots. If additional chemical-resistant safety boots are required, put these on now. Some one-piece suits have heavy-soled protective feet. With these suits, wear short, chemical resistant safety boots inside the suit.
6. Put on air tank and harness assembly of the SCBA. Don the facepiece and adjust it to be secure, but comfortable. Do not connect the breathing hose. Open valve on air tank.
7. Perform negative and positive respirator facepiece seal test procedures. To conduct a negative-pressure test, close the inlet part with the palm of the hand or squeeze the breathing tube so it does not pass air, and gently inhale for about 10 seconds. Any inward rushing of air indicates a poor fit. Note that a leaking facepiece may be drawn tightly to the face to form a good seal, giving a false indication of adequate fit. To conduct a positive-pressure test, gently exhale while covering the exhalation valve to ensure that a positive pressure can be built up. Failure to build a positive pressure indicates a poor fit.
8. Depending on type of suit: Put on long-sleeved inner gloves (similar to surgical gloves). Secure gloves to sleeves, for suits with detachable gloves (if not done prior to entering the suit). Additional overgloves, worn over attached suit gloves, may be donned later.
9. Put sleeves of suit over arms as assistant pulls suit up and over the SCBA. Have assistant adjust suit around SCBA and shoulders to ensure unrestricted motion.
10. Put on hard hat, if needed.
11. Raise hood over head carefully so as not to disrupt face seal of SCBA mask. Adjust hood to give satisfactory comfort.
12. Begin to secure the suit by closing all fasteners on opening until there is only adequate room to connect the breathing hose. Secure all belts and/or adjustable leg, head, and waistbands.
13. Connect the breathing hose while opening the main valve.
14. Have assistant first ensure that wearer is breathing properly and then make final closure of the suit.
15. Have assistant check all closures.
16. Have assistant observe the wearer for a period of time to ensure that the wearer is comfortable, psychologically stable, and that the equipment is functioning properly.

Figure 2. Sample Checklist for Level A Donning[83]

Considerable care must be given to the proper fitting of the suit as well as ensuring all equipment is in working order. Once inside the contamination zone, the assessment process is equally methodical and tedious. Slow-moving entry teams must navigate through a potentially unknown and dangerous environment while conducting site characterization. The contaminated environment may be the scene of a recent explosion or a house with unknown hazards inside, and the entry team may have limited situational awareness about the environment they are entering. Once the site characterization is complete, the members of the entry team must proceed to the decontamination area where they will be decontaminated by a separate team of personnel before reporting to the incident commander for debrief. This process is well established and practiced, but new technology can offer significant process improvement.

Communication between the entry personnel and the command post is difficult. The gas mask with associated oxygen tank makes talking difficult from inside the suit. Words are often muffled or distorted, leading to a breakdown in communication. Communication can be further degraded by factors such as the physical fitness of the

[83] Source: Occupational Safety and Health Administration, "VI. Clothing Donning, Duffing, and Use."

entry team members, quality of the radios, and the amount of equipment team members carry. One team member must have a free hand to push the transmit button on the radio, so that member can only carry a limited amount of equipment or must place it on the ground to transmit.

### 3. Situational Awareness

Situational awareness is the key to a safe and successful response effort. Incident commanders can better manage scenes, make better decisions, and allocate resources more effectively if they have a clear understanding of the situation. CBRN incidents are unique in that they prevent most people from entering the area, thus degrading the IC's ability to assess the situation. The IC is totally dependent on the capabilities of the entry team members and their ability to assess the environment and communicate that assessment to the IC. This method works but fails to capitalize on emerging technologies that could provide faster, more effective assessments of the environment.

## E. SUAS BENEFITS, EMERGING CAPABILITIES, AND JUSTIFICATION FOR CST

> sUAS could be valuable tools for emergency responders for rapid response and gaining invaluable situational awareness before responding to and engaging in potentially dangerous operations.
>
> Representative for the Department of Homeland Security Robotic Aircraft for Safety (RAPS) Project[84]

Emergency responders respond to hundreds of HAZMAT/CBRN incidents every year. An analysis of the North American HAZMAT Situations and Deployment Map shows 550 responses resulting from biological, chemical, explosions/explosives/fires, odors/fumes/suspicious fumes, radiation/radiological, and suspicious or threatening powder between June 1, 2015, and May 31, 2016.[85] Many of these calls resulted in evacuations, injuries, and hospitalizations. These are the incidents that can benefit the

[84] Department of Homeland Security, *Privacy Impact Assessment for the Robotic Aircraft for Safety (RAPS) Project* (Washington DC: Department of Homeland Security, 2012), 2.

[85] Global Incident Map, "North American HAZMAT Situations and Deployment Map," accessed on July 12, 2016, from http://hazmat.globalincidentmap.com/home.php.

most from emerging sUAS technology. The concept of equipping CSTs with small, unmanned aircraft systems has the potential to transform CBRN response in the homeland by creating a nationwide capability that could be invaluable to all communities.

The sUAS concept is not new; in fact, government agencies are already conducting testing on sUAS equipped with CBRN sensors and video cameras with the intent of providing them to emergency responders to improve disaster response. For example, DHS conducted testing on fixed wing and VTOL sUAS to improve response to multiple disasters, including "natural and hazardous materials disaster evaluation and response."[86] In another example, the Department of Defense is currently conducting testing on fixed wing and VTOL sUAS with the intent of detecting and identifying chemical and biological agents.[87] However, analysis of current DOD testing programs indicates that these capabilities are being tested for use overseas and not for use within the United States.

Much of the work conducted by the CST is done inside buildings or structures where personnel conduct site characterization to identify potential WMD materials. In these cases, the operator may be unable to maintain line of sight with an aircraft. This creates a challenge since the benefit of this system relies on increasing standoff distance for responders. Most sUAS today use GPS for navigation. While GPS navigation is very accurate, it is not conducive for flight indoors where satellite signal may not be present or for the more precise navigation required for maneuvering through the inside of a building.[88] Emerging technology uses alternate navigation capabilities that do not rely on GPS and will enable a sUAS to navigate inside a building without human interaction. For example, one technology involves the use of lasers for navigation. The VTOL sUAS interacts with a tripod ground station located in the vicinity of the sUAS.[89] Although this

[86] Department of Homeland Security, *Privacy Impact Assessment*, 2.

[87] Global Defense, "Thunderstorm: Drones in CBRN Detection and Terrorism," November 3, 2014, http://globalbiodefense.com/2014/11/03/thunderstorm-drones-cbrn-detection-terrorism/.

[88] Mike Senese, "PreNav Reveals Centimeter-Accurate Drone System," *Make*, August 27, 2016, http://makezine.com/2015/08/26/prenav-reveals-centimeter-accurate-drone-system/.

[89] Ibid.

technology is not yet applicable to this proposal due to the necessity of manually placing a ground station inside the building, it is an indication of how this technology is evolving. Another technology involves the use of algorithms, gyroscopes, accelerometers, and camcorders to create autonomous navigation.[90] These technologies are only the first step to creating the capability to use sUAS to conduct site characterization inside structures without endangering personnel.

The potential benefits of sUAS are numerous, and five major ones are outlined in the following section. First, sUAS can reduce human exposure to unsafe environments by increasing the standoff distance between the responders and the contaminated area. This will enable the incident commander to reduce the risk of exposures to responders. The use of sUAS will not likely eliminate the need for entry personnel; however, they can greatly reduce the risk if able to detect and identify CBRN matter prior to entry. Once personnel enter an area, they will likely have much better situational awareness based on the information gained from the sUAS.

Second, sUAS can improve the life safety of victims affected by the disaster by remotely transmitting video of the condition of any injured personnel. This will enable the incident commander to develop an effective medical evacuation plan prior to deploying responders into the contamination zone.

Third, sUAS can establish the parameters of the incident. They can isolate the source, determine the size of the incident, detect plume movement, and send valuable video to the IC.[91] They can also provide valuable data regarding any spillage or runoff of chemicals into neighboring areas.[92] Potential video information might include sensory information such as the placard information on an overturned rail or truck tanker or other

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[90] Press Trust of India, "New Autonomous Flying Drones Don't Require GPS to Navigate," *Gadgets 360,* May 27, 2015, http://gadgets.ndtv.com/others/news/new-autonomous-flying-drones-dont-require-gps-to-navigate-696750.

[91] Robin R. Murphy et al., "Projected Needs for Robot-Assisted Chemical, Biological, Radiological, or Nuclear (CBRN) Incidents," in *IEEE International Symposium on Safety, Security, and Rescue Robotics* (Piscataway, NJ: IEEE, 2012), http://ieeexplore.ieee.org/document/6523881/, 3.

[92] Ibid.

details, such as the color of the smoke, type of liquid on the ground, as well as other defining characteristics that might assist in the identification of the material.[93]

Fourth, sUAS will greatly reduce the time required to send assets into a contamination zone. The asset could deploy almost immediately after arrival on scene. The operator could deploy the sUAS into the incident area to collect data while the entry personnel are preparing themselves and their equipment. Moreover, the results of the sUAS flight could help determine what level of PPE the entry personnel would wear and what additional detection and sampling equipment they would need. Furthermore, there would likely be times when the sUAS determined there is no danger at all and personnel could enter the incident area with minimal PPE to confirm initial results.

Fifth, additional operational benefits of sUAS are cost, size, and disposability. sUAS will likely be relatively inexpensive compared to UGV. Many agencies do not have the resources to purchase and maintain this capability, but they could request it through their respective state's CST if it was so equipped. sUAS are small in size and weight. sUAS selection criteria should be based on size groupings established by the Chair of the Joint Chiefs of Staff minimum training standards. These details are discussed in detail later in this thesis.

An example in which a combination of the above sUAS attributes might have a live-saving impact might be the train derailment in Weyauwega (see Figure 3), discussed earlier in this chapter. The train derailed resulting in a massive chemical spill and fire. Emergency responders lacked situational awareness due to the limited resources available at the time, the rural location of the community, and the lack of a manifest detailing the contents of the train. The local fire department spent an hour battling the blaze before the train operator arrived with the manifest, and it was discovered that the contents of the tanker were explosive and could level the community.[94] The incident commander would likely have managed the incident much differently if he/she had the ability to identify the contents of the tanker quickly. In this case, a sUAS could prove instrumental by flying

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[93] Ibid.

[94] Behnke, "Weyauwega 1996."

close enough to the tanker to identify the HAZMAT placard. Additionally, it could take an aerial view of the fire to help responders get a clearer understanding of the source of the fire, identify the type of tanker involved, and potentially obtain plume data to determine evacuation procedures.


Figure 3. The Weyauwega Area Train Crash[95]

## F. CONCLUSION

The CBRN threat continues to be one of the most dangerous threats to our country. Whether the attack is intentional or unintentional, the response is relatively the same. History demonstrates the frequency of CBRN events and the need for continued improvements to response capabilities. Emergency responders have worked tirelessly to develop TTPs that maximize life safety, incident safety, and minimize property damage; however, there may be new resources that can improve capabilities. Emerging technologies in sUAS create an opportunity to harness a new capability to transform disaster response in the homeland.

[95] Source: Behnke, "Weyauwega 1996."

The Department of Homeland Security is currently testing this capability because it recognizes the value of increased situational awareness for incident commanders and increased safety for response personnel. Additionally, the Department of Defense is also already using fixed wing UAS with CBRN sensors in overseas operations. The DOD is also testing VTOL capabilities; however, it appears focused on overseas operations rather than domestic use. The private industry is also working to create autonomous navigation technology that may enable a sUAS to navigate inside structures and perform site characterization and damage assessment with minimal human interaction. The challenge is nesting the two organizational resources together to create a framework for homeland CBRN defense involving sUAS. National Guard CSTs remain poised to accept this technology and are well positioned to support any community in the United States with this capability. The following chapters discuss current sUAS policy and strategy as well as identify gaps within that framework and make recommendations for implementation.

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# IV. POLICY AND STRATEGY ANALYSIS

## A. INTRODUCTION

The central premise of this thesis is that current DOD policy is limited in scope and should be revised to authorize sUAS for use in support of civil authorities when responding to CBRN or HAZMAT incidents. There is no current DOD domestic sUAS policy; however, the existing large UAS domestic policy and sUAS fixed wing policies provide a useful framework for the development of small, VTOL sUAS policy. The intent of current policy is to provide governors the ability to include *large* UAS in their emergency planning and request federal UAS assets in support of homeland defense (HD), defense support to civil authorities, and military training and exercises during large-scale disasters.[96] This policy is sufficient for current UAS operations but does not address the sUAS capability as discussed in this thesis.

Current UAS guidance is restrictive in nature and requires SecDef approval for all missions except search and rescue, which can be approved by a four-star combatant commander.[97] This approval process is time consuming and not conducive to providing immediate support to civil authorities. The CST is an immediate response organization and the authority to employ its resources remains with a governor or his/her designated representative as with all other National Guard assets. The current UAS approval process precludes rapid deployment. Ultimately, rapid deployment is necessary to provide valuable, time-sensitive situational awareness to incident commanders.

The DOD's current domestic UAS policy is outlined in deputy secretary of defense (DEPSECDEF) policy memorandum 15-002, *Guidance for the Domestic Use of Unmanned Aircraft Systems*. For the purpose of this thesis, the term "UAS" refers to large fixed wing aircraft, such as the Air Force RQ-1 Predator or the MQ-9 Reaper. Each of these aircraft have a wingspan of over 50 feet wide and are at least 27 feet long.[98] The

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[96] Deputy Secretary of Defense, *Guidance for the Domestic Use*, 2.

[97] Ibid.

[98] Joakim Kasper Oestergaard Balle, "About the Predator and Reaper," Aeroweb, June 27, 2016, http://www.bga-aeroweb.com/Defense/MQ-1-Predator-MQ-9-Reaper.html.

term “sUAS” refers to *small, handheld* UAS normally operated by the U.S. Army. The term “sUAS” can refer to fixed wing or vertical takeoff and landing aircraft. Any reference to fixed wing sUAS is termed “fixed wing sUAS.” The term “sUAS” refers to VTOL aircraft. This thesis is the first step towards developing the foundation for the proposed sUAS policy.

Though current DOD sUAS training is focused on overseas operations, it does provide a useful framework for developing a domestic training program. The domestic training program should encompass elements from existing literature and incorporate domestic-specific elements that have not been addressed to date. The flight characteristics of most sUAS today are simplistic and semi-autonomous. Many sUAS are designed with features such as auto-hover, return-to-home, and auto-land features. These features enable flight with minimal operator input. Future DOD sUAS should have similar flight characteristics providing safety mechanisms, which could prevent operation outside established parameters, such as max altitude, airspeed, and obstruction detection.

Ensuring the privacy of U.S. persons remains one of the most important factors when considering sUAS use by the DOD. This is accomplished via the DOD Intelligence Oversight Program. Any sUAS with a camera and sensing equipment requires strict control measures to ensure the Fourth Amendment rights of U.S. persons are maintained and that the intent of Executive Order 12333 U.S. Intelligence Activities is adhered to. DOD policy should be nested with state “drone” legislation to ensure all privacy concerns are addressed and that sUAS are utilized within legal constraints in each state. The existing intelligence oversight program is robust and provides a workable framework for establishing a successful sUAS program.

Finally, a significant challenge of this program is the integration of DOD assets into the national airspace system. Recent FAA guidance authorizes very specific guidelines for the private and commercial use of sUAS in national airspace. Several aspects of this proposal may challenge the current guidelines. Close coordination between the DOD and the FAA will be instrumental in the successful implementation of this proposal.

## B. ANALYSIS OF CURRENT DOD UAS POLICY

Current DOD UAS policy encompasses two different operating environments: combat/overseas operations and domestic operations. *Small* UAS use is primarily restricted to combat operations due to the lack of a mission set within the homeland as well as the lack of policy addressing domestic issues, such as intelligence oversight, training, and comprehensive FAA integration. There is domestic sUAS fixed wing policy, but it is intended to authorize training within special use airspace or through the use of a COA. This policy is set out in training manuals and regulations governing the use of sUAS. However, there is policy governing the use of large UAS for domestic operations. This thesis and its framework can be utilized as a foundation for development of a domestic sUAS program. Current policy is not intended to address sUAS employed by the National Guard in support of disaster response; therefore, it lacks key components that are necessary for successful implementation. There are five pillars that establish the framework of current domestic UAS policy.[99]

### 1. Approved Missions

Current deputy SecDef policy memorandum 15-002 authorizes the use of *large* UAS for five mission sets: DOD operations, state/National Guard operations, search and rescue, DOD-required exercises and training, and exercises, training, and activities not required by DOD.

#### *a. DOD Operations*

UAS may be used in lieu of manned aircraft when:

- "Sustained endurance efforts are required
- Unmanned aircraft provide superior capabilities; or
- Physical infrastructure limitations prohibit the use of manned rotary—or fixed-wing aircraft"[100]

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[99] Deputy Secretary of Defense, *Guidance for the Domestic Use*.

[100] Ibid., 2.

### *b. State/National Guard Operations*

The policy memorandum stipulates that governors may *not* employ DOD UAS assets without approval from the SecDef. Governors may incorporate the use of UAS into their disaster response plans and should include procedures for obtaining approval and coordination with the FAA.

### *c. Search and Rescue*

UAS may be used for search and rescue (SAR) provided a UAS is the most useful platform, and it does not interfere with other military duties of the unit concerned.

### *d. DOD-required Exercises and Training*

UAS are approved to conduct normal proficiency training as well as participate in scheduled exercises that provide essential training for the Federal mission area.

### *e. Exercises, Training, and Activities Not Required By DOD*

UAS are authorized to participate in state-sponsored disaster response exercises with prior approval from the SecDef.

## 2. Approval Authority

The SecDef reserves the right to approve all domestic UAS operations with the exception of SAR. The appropriate combatant commander, either U.S. Northern Command or U.S. Pacific Command, may approve SAR. The strict approval process is likely due to public sensitivity of DOD UAS operating within the United States. Although sufficient for current domestic UAS doctrine, this process is time consuming and not conducive to rapid response.

## C. INTELLIGENCE OVERSIGHT

The purpose of the intelligence oversight program is to ensure that "intelligence activities are carried out in ways that do not infringe on the constitutional rights of U.S. persons."[101] U.S. persons are defined as

> A person who is a lawful permanent resident as defined by 8 U.S.C. 1101 (a) (20) or who is a protected individual as defined by 8 U.S.C. 1324b (a) (3). It also means any corporation, business association, partnership, society, trust, or any other entity, organization or group that is incorporated to do business in the United States. It also includes any governmental (federal, state or local) entity. It does not include any foreign person as defined in § 120.16 of this part.[102]

A key component of the intelligence oversight program is to ensure any information obtained on U.S. persons is "collected, processed, retained, and disseminated properly."[103] It closely mirrors the intent of the Fourth Amendment by ensuring people are "secure in their persons, houses, papers, and effects against unreasonable searches and seizures."[104] The authority of the DOD to collect information on U.S. persons is rooted in current policy. DOD 5240.1-R authorizes the collection of information by DOD assets on U.S. persons, as long there is a need to protect the safety of any person or organization.[105] The same policy authorizes the use of overhead reconnaissance as long as it is not directed at *specific* U.S. persons.[106]

This thesis explores the utility of using a video camera to maximize situational awareness for the incident commander. Although this capability is solely intended to save lives, it is likely that some video will unintentionally include private information about U.S. persons during the course of the operation; therefore, efforts must be taken to ensure any private information is obtained legally. This private information could present itself

[101] Department of Defense Senior Intelligence Oversight Official, "Welcome to Department of Defense," last modified November 22, 2016, http://dodsioo.defense.gov/.

[102] 22 CFR § 120.15 (2006).

[103] Ibid.

[104] Fourth Amendment of the Bill of Rights.

[105] Department of Defense, *Procedures Governing the Activities* 17–18.

[106] Ibid, 18.

in the form of people observed during a disaster site reconnaissance, subjects inside a location suspected of being contaminated by dangerous CBRN materials, or privately owned buildings or property that is considered "U.S. persons."

### 1. Proper Use Memorandum

Current intelligence oversight policy is robust and capable of supporting domestic sUAS operations as long as appropriate measures are taken. There is clear policy regarding the use of video from manned aircraft. Deputy SecDef policy memorandum 15-002 states, "All UAS acquisition, collection, retention, and dissemination of information will be in accordance with standing DOD regulations and policy, including DOD Component intelligence oversight guidance, and will require a PUM."[107] A proper use memorandum (PUM), is a memorandum of request by an organization to conduct domestic imagery while acknowledging the "legal and policy" limitations regarding the "collection, retention, dissemination, and use" of acquired imagery.[108] For National Guard units, the PUM is sent to the state intelligence officer (the J2), and then must be reviewed by the state's judge advocate and the inspector general prior to sending to the National Guard Bureau J2 for approval. Figure 4 depicts the current process for submitting a PUM, which can be for one-time approvals or annual approvals to accommodate repeated training in the same location. It is noteworthy that the state's adjutant general has immediate approval authority for airborne domestic imagery collection when time precludes obtaining an approved PUM as long as the information collected is a lawful acquisition and that the support is in accordance with the Constitution and all applicable policy and guidance.[109]

[107] Deputy Secretary of Defense, *Guidance for the Domestic Use*.

[108] National Guard Bureau, *Chief of the National Guard Manual*, E-4.

[109] Ibid.

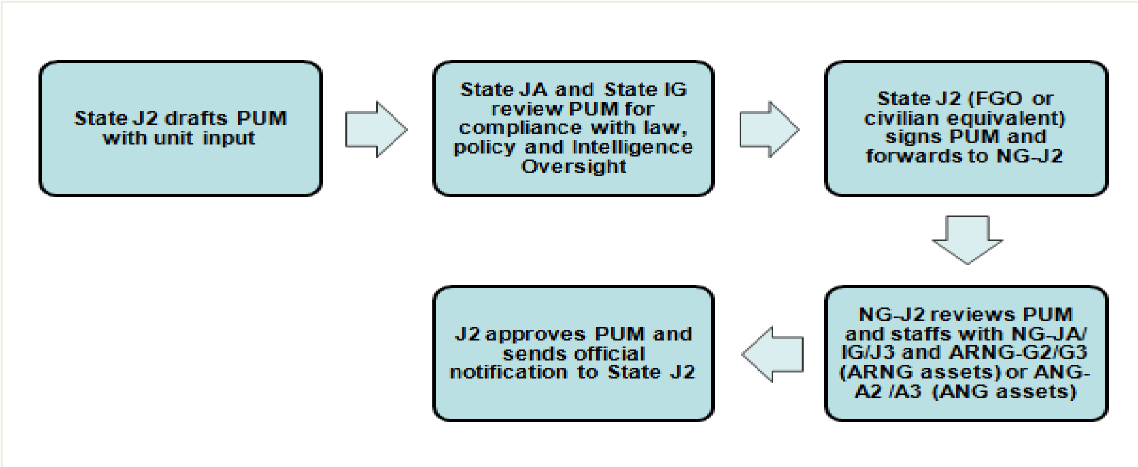


Figure 4. Current Process to Submit a PUM[110]

### 2. The CST and Intelligence Oversight

The daily operating status of the National Guard (NG) is called the "NG Baseline Operating Posture,"[111] and the "NG conducts training, planning, and exercises as well as domestic operations" while in this posture.[112] In general, the goal is to ensure the NG is prepared to fulfill its state or federal role if requested as well as to maintain situational awareness of the homeland operating environment. Within the baseline operating posture, some units are authorized to collect information on non-DOD affiliated persons or organizations when performing DSCA activities to "maintain situational awareness and detect threats or concerns;" however, there must be a relationship between the information collected and the NG unit's mission and function.[113] In the manual, it lists a state's CST as one of the units whose mission authorizes the collection of information of non-DOD affiliated persons in support of DSCA operations.[114] Once the mission is complete, all information regarding U.S. persons must be redacted from any reports.[115]

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[110] Ibid., E-7.

[111] Ibid., D-3.

[112] Ibid.

[113] Ibid.

[114] Ibid., D-4.

[115] Ibid., D-3-5.

The retention of collected information can be problematic if not properly conducted. Chapter VI proposes control measures to ensure any information collected remains in the chain of custody of the supported civil authorities and the system does not have organic data retention capability.

### 3. Legality of Aerial Domestic Imagery

Responses to natural disasters and civilian emergencies are generally considered legal for domestic imagery.[116] A PUM must be on file before domestic imagery can be taken from aerial platforms for "the use of IAA platforms, assets, or personnel to collect sensor data; the systems, or organizations to analyze sensor data; or the use of sensor data for intelligence, intelligence-related, or IAA purposes."[117] This would reasonably include air monitoring sensors used to detect CBRN matter.

One challenge with the DOD intelligence oversight policy is the lack of authorization to use sUAS for domestic imagery. This policy gap is discussed in further detail in Chapter V.

## D. NATIONAL AIRSPACE SYSTEM INTEGRATION

The integration of VTOL sUAS into the NAS is a relatively new concept and is instrumental to the success of this proposal. Although the FAA recently published comprehensive sUAS guidance for private and commercial operators, the guidance does not apply to public use; however, the DOD still has to comply with the airspace and traffic rules set out in Title 14 of the Code of Federal Regulations (CFR) Part 91, General Operating and Flight Rules.[118] The integration of DOD VTOL sUAS into the NAS will require innovative solutions and close coordination with the FAA to ensure safe operation and compliance with current regulatory guidance. The FAA authorizes the use of DOD UAS through a COA or through *voluntary* compliance with CFR Part 107. A COA is an authorization given by the FAA to public agencies to operate sUAS for specific

[116] Ibid., E-1.

[117] Ibid., D-3.

[118] 14 CFR, Part 107, 61–62.

activities.[119] The capability discussed in this thesis must be deployable to varying locations and cannot be limited to specific activities limited by a COA; therefore, every effort should be made to manage this capability in concert with CFR Part 107. This will be discussed in more detail in Chapter VI.

sUAS have two unique characteristics that separate them from manned aircraft and define their safety role within the NAS: 1) the ability to “see and avoid” other traffic, and 2) operator loss of positive control.[120] Currently, commercial-off-the-shelf (COTS) sUAS are capable of mitigating these risks to an acceptable level, enabling safe operations, and they are continuously becoming safer as the technology improves. The FAA developed a list of operational limitations in CFR Part 107 in order to address these safety issues. Table 1 is an extract from Part 107 and outlines the requirements commercial operators must meet to be approved for sUAS operations within the NAS.

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[119] Federal Aviation Administration, “Certificates of Waiver or Authorization (CAO)” last modified August 19, 2016, https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/aaim/organizations/uas/coa/.

[120] Adapted from: 14 CFR, Part 107.

Table 1. Summary of the Major Provisions of Part 107[121]

| | |
|---|---|
| **Operational Limitations** | Unmanned aircraft must weigh less than 55 lbs. (25 kg).<br>Visual line-of-sight (VLOS) only; the unmanned aircraft must remain within VLOS of the remote pilot in command and the person manipulating the flight controls of the small UAS. Alternatively, the unmanned aircraft must remain within VLOS of the visual observer.<br>At all times the small unmanned aircraft must remain close enough to the remote pilot in command and the person manipulating the flight controls of the small UAS for those people to be capable of seeing the aircraft with vision unaided by any device other than corrective lenses.<br>Small unmanned aircraft may not operate over any persons not directly participating in the operation, not under a covered structure, and not inside a covered stationary vehicle.<br>Daylight-only operations, or civil twilight (30 minutes before official sunrise to 30 minutes after official sunset, local time) with appropriate anti-collision lighting.<br>Must yield right of way to other aircraft.<br>May use visual observer (VO) but not required.<br>First-person view camera cannot satisfy "see-and-avoid" requirement but can be used as long as requirement is satisfied in other ways.<br>Maximum groundspeed of 100 mph (87 knots).<br>Maximum altitude of 400 feet above ground level (AGL) or, if higher than 400 feet AGL, remain within 400 feet of a structure.<br>Minimum weather visibility of 3 miles from control station.<br>Operations in Class B, C, D and E airspace are allowed with the required ATC permission.<br>Operations in Class G airspace are allowed without ATC permission.<br>No person may act as a remote pilot in command or VO for more than one unmanned aircraft operation at one time.<br>No operations from a moving aircraft.<br>No operations from a moving vehicle unless the operation is over a sparsely populated area.<br>No careless or reckless operations.<br>No carriage of hazardous materials.[122] |

[121] Adapted from: 14 CFR, Part 107.

[122] 14 CFR, Part 107, 10.

The requirements contained in Table 1 provide useful control measures that could be readily applied to DOD operations and remain within the scope of this proposal. These control measures would ensure DOD operations are executed in concert with FAA regulatory requirements. The uniqueness and immediacy of the DOD mission create additional challenges for operations.

### 1. FAA Mission Approval

The nature of the CST mission would require a near immediate approval mechanism from the FAA to deploy the asset in a timely manner. Events requiring this capability occur without warning and do not provide sufficient time to plan and submit for approval to deploy resources. First responders must establish situational awareness immediately following a disaster; however, many disasters occur in populated areas with a commercial airport nearby. Commercial airports are accompanied by controlled airspace, which necessitates coordination with the local air traffic control tower prior to sUAS deployment. The DOD and the FAA could develop an agreement that provides a framework for immediate approval of sUAS deployment within controlled airspace. Furthermore, CSTs must also be prepared to utilize alternate resources if the FAA denies approval due to high traffic congestion in the area or due to any other safety concerns.

### 2. Airspace Violations

Airspace violations are a very serious issue with manned aircraft. The FAA has the authority to remove an airmen's certification at any time for flight violations compromising safety. Since the FAA has no authority over DOD operations, there should be mechanisms in place to ensure operators who violate the approved parameters are held accountable for any deviations during the operation of the mission. These mechanisms could include suspension or revocation of the operator's certification based on the severity of the violation. In addition, reports should be submitted through the local FAA Flight Standardization District Office (FSDO) and forwarded to the military chain of command. Standardized operator training and sUAS with programmed flight parameter limitations will be instrumental to the success of the program and will help mitigate the risk of deviation from the authorized parameters contained in Part 107. Training is discussed in detail in Chapter V. Additionally, flight profile tracking mechanisms could be implemented to monitor factors such as altitude, airspeed, and geographic location tracking in order to ensure the sUAS is being used in accordance with regulatory guidelines.

## E. ARMY MISSION APPROVAL POLICY

Current policy outlines the mission approval process for Army sUAS. The process is three tiered and is intended to ensure all policies and regulatory guidance are followed and all risks are identified and mitigated from the initial receipt of a mission to mission completion.[123] The three tiers always involve the chain of command, apply to every flight, and cannot be circumvented or delegated. A commander in the grade of O-5 or above must identify qualified personnel to perform the duties within each tier.[124] The levels of approval are outlined in AR 95-23 as:[125]

### 1. Initial Mission Approval Authority

This is the first level of approval. The commander or his/her designated representative evaluates the legality and feasibility and either accepts or rejects the mission.

### 2. Briefing Officer or Noncommissioned Officer

Briefing officers/ noncommissioned officers (NCOs) need to be designated in writing by the commander to identify, assess, and mitigate sUAS risk. The commander selects briefing officers/NCOs based on their "level of experience, maturity, judgment, and their ability to effectively mitigate risk."[126] This individual is responsible for verifying crew qualifications/currency, weather, accuracy of paperwork, and any other factors considered prior to deployment of the sUAS.

[123] Department of the Army, *Rapid Action Revision*.

[124] Ibid.

[125] Ibid.

[126] Ibid.

### 3. Final Mission Approval Authority

The final mission approval authority (FAA) is the ultimate approval authority for all missions. The FAA is always a member of the chain of command and approves the mission based on a risk value generated by the operator and briefing officer/NCO. Missions with higher risk require a higher level of approval authority, whereas low risk missions may only require a lower level of approval. The FAA can only approve missions based on the level of risk it is approved to accept.

## F. RISK ASSESSMENT

Current Army policy requires a risk assessment worksheet for every manned or unmanned flight. This policy is easily replicated and could be readily integrated into any new sUAS program. The worksheet is a compilation of factors such as crew rest, weather, complexity of the mission, proficiency of the crew, and any other factors the commander deems important. Each risk is assigned a risk value and then these are compiled at the end of the worksheet. The resultant number falls into one of several different categories that now define the level of risk. For example, the normal risk levels are low, medium, high, and extremely high. An individual of lower rank can usually approve a low risk mission, whereas a high-risk mission may require a general officer to approve. For example, a flight in uncontrolled airspace in a sparsely populated town may be considered a low risk mission and could be approved by lower level of authority, but a damage assessment in the middle of a large city with a busy airport in the vicinity may require approval from the unit commander. The goal of the operator is to determine an initial risk and then explore ways to mitigate that risk to a lower level. If the risk cannot be mitigated, the mission must be approved by the appropriate level of approval authority.

## G. ACQUISITION AND USE

Integrating a new technology into the Army procurement system can be a complex, expensive, and time-consuming process. This particular proposal involves a lightweight, inexpensive sUAS that can be procured commercially. Additionally, this could be a low-density fielding since less than 60 aircraft would be in the field at any time. An analysis of Army policy identified an avenue that could streamline acquisition and use of a *nonstandard* UAS. Nonstandard UAS include “trainers, prototype, test bed, and UAS procured in such a low density that treating them as standard UASs would create a burden to the system.”[127] Acquisition of nonstandard UAS is authorized only when standard aircraft cannot accomplish the mission.[128] The mission discussed in this thesis cannot be completed with standard Army unmanned aircraft systems because they lack VTOL capability. Additionally, the acquisition of nonstandard aircraft is beneficial to unit commanders because it provides them greater flexibility to develop their own flying hour program.[129] Finally, nonstandard aircraft allow the commander to establish a sUAS training program that does not hinder the rest of the CST mission.

This sUAS capability may not generate additional force structure to accommodate sUAS operators; therefore, operator duties may be assigned to personnel as an addition to their assigned role within the team. A robust training program that mirrors standard UAS training policy could be overwhelming for a small team due to the extensive training requirements for all existing CST personnel; however, the existing training program framework could be useful for developing new sUAS training policy. The next step in this research is identifying gaps in existing policy and doctrine. A recommended training program is discussed in further detail in Chapter VI.

[127] Ibid., 25.

[128] Ibid., 25.

[129] Ibid., 27.

# V. GAP ANALYSIS OF CURRENT DOD UAS POLICY

## A. INTRODUCTION

The previous chapters explored current policies and protocol for response to WMD and HAZMAT events requiring CST assistance, and they discussed considerations such as responder safety, standoff distance, and CST capabilities. Additionally, an analysis of current DOD policy regarding the use of UAS provided insight into how the framework of existing policy can be used to support new technology with the introduction of sUAS. This chapter addresses the gaps in current response protocol as well as gaps in current DOD policy regarding the use of sUAS within the homeland. Although there is a foundational framework, significant gaps present policy challenges and require revision of existing doctrine to be successful.

The intent of this response protocol gap analysis is not to suggest that current TTPs are insufficient but rather to identify opportunities to improve responder safety by maximizing standoff distance for personnel from a dangerous environment. Additionally, the gap analysis examines how incident situational awareness can be greatly improved by the adoption of emerging technology to provide greater decision-making capabilities to civil authorities.

Existing DOD policy is sufficient to support current capabilities. However, this proposal involves technology that does not yet exist; therefore, requires policy revision. The DOD's domestic large UAS program is intended only to provide UAS as a last resort in support of civil authorities, and it is not conducive to immediate activation. Additionally, the integration of DOD sUAS into the NAS *without a COA* has not been addressed. This chapter explores possibilities that could bridge the gap between what the FAA has implemented and what could work for the DOD.

Finally, the relationship between DOD sUAS operations and local/state legislation must be congruent. Some states have passed restrictive drone legislation that requires careful review prior to implementing this proposal. The DOD will have to evaluate state and local laws to ensure the sUAS are used in accordance with local and state laws.

## B. RESPONSE PROTOCOL

Current response protocol has proven safe when used properly but the addition of sUAS could greatly improve safety by increasing responder standoff distance as well as providing valuable information to responders prior to entry. Currently, civil authorities use available resources on scene to develop the situation and make response decisions. Their available resources could include eyewitnesses and visible cues such as smoke or structure damage or personnel who are able to enter the incident area and make an assessment the situation. Some first response agencies have unmanned ground vehicles capable of maneuvering into a potentially dangerous situation and transmitting video back to the IC, but not only are these vehicles are limited in what they can observe from the ground, they are susceptible to obstacles.

Current HAZMAT protocol requires personnel to don appropriate PPE and enter a potential contamination zone with appropriate equipment to conduct operations. This process is time consuming and puts personnel in a potentially unsafe situation. Prior to entry, there is a considerable amount of coordination and preparation that must be completed. Personnel must conduct entry briefings, prepare and inspect their equipment, and don PPE. Moreover, a typical CBRN or HAZMAT response involves multiple personnel responsible for various tasks. Personnel entering a potentially contaminated area must have backup personnel on standby as well as personnel prepared to conduct decontamination operations. Additionally, there must be medical staff on site that can attend to injuries or other medical issues. Personnel numbers may be adjusted based on the type of threat. The ability to develop a comprehensive understanding of the threat prior entry could result in mitigated risk and more informed decision making.

A sUAS aerial platform capable of transmitting live video as well as CBRN sensor data could provide civil authorities with invaluable information regarding an incident. This technology could be deployed almost immediately while response teams are preparing for entry. In addition, it could quickly map the area with monitoring equipment as well as video cameras. A sUAS could also look in windows of structures to search for potential casualties or other clues to help understand the situation inside. This capability would not replace personnel; rather, it would complement personnel and provide valuable information allowing responders to make better informed decisions.

## C. LACK OF DOMESTIC SUAS POLICY

Gaps in existing DOD UAS policy must be identified and addressed to accommodate sUAS. These gaps exist because domestic VTOL sUAS do not exist in current framework and must be integrated into new or existing policy.

### 1. No Domestic sUAS Guidance

DEPSECDEF UAS policy memorandum 15-002 does not address sUAS.[130] The memorandum reflects a compilation of policy and regulatory information from other documents that is compiled into one memorandum, and it was written to provide guidance on the domestic use of UAS, not sUAS. The DOD recognizes that UAS can provide invaluable assistance to civil authorities during disaster response, and it has made efforts to support the integration of these resources into state emergency plans. Acceptance of this proposal could generate revision of the policy memorandum and associated regulatory documents acknowledging the use of sUAS in support of immediate civil authority response missions.

### 2. Mission Approval Authority

Current policy retains UAS approval authority at the SecDef level.[131] This is to ensure that any domestic use of military UAS is given the highest level of approval due to the public sensitivity of military operations in the homeland. In the event of a major disaster, this approval process can be completed in a relatively short amount of time, but it is not conducive to supporting first responders, whose need for support is determined in minutes, not hours or even days. This sUAS proposal involves a much smaller, less expensive, and less intruding capability. Mission success depends on the ability to assist civil authorities immediately, and approval must be delegated to the lowest level possible to accommodate rapid response. Additionally, the current policy memorandum

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[130] Deputy Secretary of Defense, *Guidance for the Domestic Use*.

[131] Ibid., 3.

specifically prohibits DOD UAS from supporting “federal, state, or local immediate response.”[132] This prohibition is likely the result of concern about using DOD surveillance assets in support of civil authorities without appropriate approval. The capabilities and mission sets for a sUAS would be minimal and should not generate the same level of concern for the DOD.

### 3. Doctrine

New sUAS technology necessitates new employment doctrine. New doctrine should focus on the differences between traditional Army sUAS overseas employment considerations and the non-traditional (domestic) considerations. New challenges in domestic sUAS employment include having a thorough understanding of intelligence oversight and how it relates to the collection, dissemination, and retention of information on U.S. persons. Additional challenges include understanding airspace rules and regulations. Currently, Army doctrine restricts unmanned aircraft system use to special use airspace unless the flight is conducted within the parameters of a COA.[133] This proposal involves sUAS whose missions will occur inside controlled airspace in the vicinity of civil aircraft and require direct coordination with an FAA air traffic control tower. Finally, the capabilities and mission sets for VTOL aircraft are distinctly different than fixed wing aircraft and require different employment doctrine. For example, the ability to hover and fly at slow airspeeds enables VTOL aircraft to operate in situations that might otherwise pose a safety hazard to low-flying fixed wing aircraft. Some situations that could benefit from a VTOL aircraft include operations in confined areas, urban settings in which line of sight may be quickly lost by fast-moving aircraft, operations in close proximity to structures/windows, and operations during which a sustained view of a stationary target is necessary, such as with a suspicious package or other potential WMD device.

[132] Ibid., 2.

[133] Ibid., 16.

### 4. Training

Current UAS training manuals are intended for more complex fixed wing aircraft and are focused on overseas missions. For example, operators are required to become proficient at tasks that pertain to surveillance, gunnery, target tracking, radio operating procedures, and many other tasks that would not necessarily pertain to a domestic VTOL platform.[134] Existing Army UAS doctrine requires operators to be proficient at 30 tasks outlined in their *Aircrew Training Manual*.[135] The intent of this proposal is to recommend an operator-friendly capability that utilizes a training program focused on effective operation of essential sUAS tasks only.

## D. NATIONAL AIRSPACE INTEGRATION

Chapter IV explored the existing framework for civil sUAS integration into the NAS. Current DOD UAS/sUAS airspace integration policy is not written to accommodate domestic operations. The DOD and the FAA signed the most recent airspace agreement in 2013.[136] This memorandum of agreement (MOA) applied to all DOD UAS specifically listed by nomenclature at the time,[137] and it authorized DOD UAS operations in civil airspace outside of restricted, warning, or prohibited areas as long as operations were conducted within certain parameters.[138] Prior to this MOA, the only approved process for flying UAS outside special use airspace at the time was via a COA.[139] The FAA issues COAs for specific operations, and they must be periodically renewed or they expire. It is a method for the FAA to ensure it is able to deconflict manned traffic with unmanned traffic and maintain safety at all times. However, this time-consuming process is not feasible for this proposed use of sUAS. Unlike units that can plan their flights months in advance, CST-operated sUAS must be deployable

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[134] Department of the Army, *UAS Commander's Guide*, A-3.

[135] Ibid.

[136] Department of Defense and Federal Aviation Administration, *Memorandum of Agreement,* 2.

[137] Ibid., 6.

[138] Ibid., 1.

[139] Ibid., 2.

anytime, anywhere. Recent FAA guidance provides a useful framework that could bridge the gap between the current DOD policy and immediate launch capability.

The FAA approved Part 107 of the Federal Aviation Regulations in June 2016. Part 107 establishes rules for the use of sUAS within the NAS. This rulemaking does not apply to the DOD, but DOD could readily adopt relevant rules set forth by the FAA and integrate them into a comprehensive policy to fulfill the requirements of sUAS capability.

## E. STATE AND LOCAL LEGISLATION

In 2014 and 2015, 36 states passed 45 laws involving drones/sUAS.[140] These laws range from prohibiting the use of drones for hunting to prohibiting the use of drones by law enforcement without a warrant except in emergencies. The DOD must consider specific state and local legislation when determining the authorized uses of sUAS and ensure DOD policies run parallel with civil legislation. As regulation varies between states, it may require additional restrictions in certain locations. For example, Part 107 does not include a general preemption clause; this means local and state legislation has legal authority over the federal rulemaking.[141] This conflict could become problematic when a federally funded agency, such as the National Guard, attempts to employ sUAS in states with restrictive legislation. The FAA considers preemption requests on a case-by-case basis only.[142] Each state with sUAS legislation has an exception for emergencies, and the DOD could likely use this contingency to find a workable solution. There is no state legislation to date outright prohibiting the use of sUAS. The most restrictive legislation involves the use of sUAS by law enforcement agencies. Chapter VI discusses the policy proposal and provide recommendations to policy and doctrine.

[140] National Conference of State Legislatures, "Current Unmanned Aircraft State Law Landscape," October 7, 2016, http://www.ncsl.org/research/transportation/current-unmanned-aircraft-state-law-landscape.aspx.

14 CFR, Part 107, 228.

[142] Ibid.

# VI. SUMMARY OF BENEFITS, CONCLUSION, AND RECOMMENDATIONS

## A. INTRODUCTION

> sUAS could be valuable tools for emergency responders for rapid response and gaining invaluable situational awareness before responding to and engaging in potentially dangerous operations.
>
> Representative for the Department of Homeland Security Robotic Aircraft for Safety (RAPS) Project[143]

The previous chapters sought to define the National Guard's CSTs and their role as the DOD's first response to civil authorities in support of natural and manmade disasters. These chapters also discussed the daily WMD and HAZMAT threats the country faces and how a CST is an ideal response unit tailored to meeting the needs of communities during these events. Current technological challenges limit an incident commander's ability to quickly and accurately assess the situation without dispatching response personnel into a potentially unsafe environment. Emerging technology provides an opportunity to improve safety and increase situational awareness for civil authorities.

Part of a CST's mission is to "support civil authorities at domestic incident sites during specified events," such as during:

- The use or threatened use of WMD.
- A terrorist attack or threatened attack in the United States that results, or could result, in catastrophic loss of life or property.
- The intentional or unintentional release of nuclear, biological, radiological, or toxic or poisonous materials in the U.S. that results, or could result, in catastrophic loss of life or property.
- A natural or manmade disaster in the U.S. that results, or could result, in catastrophic loss of life or property."[144]

[143] Department of Homeland Security, *Privacy Impact Assessment*, 2.

[144] Department of the Army, *Weapons of Mass Destruction*, 4-1.

This mission can be vastly improved with emerging sUAS technology, which can enhance the CSTs' ability to detect and identify CBRN agents and substances as well as to provide critical visual information regarding the incident site prior to personnel deployment. A CST is an ideal unit to operate this capability due to CSTs' presence in each state and territory and because they are the only National Guard resource that does not require reimbursement from the requesting agency.

## B. CONCLUSION

sUAS is a transformational capability that can change the way civil authorities respond to many incidents. Whether intentional or unintentional CBRN/HAZMAT events or natural disasters, the integration of sUAS has the potential to save lives by improving situational awareness for incident commanders and increasing standoff distance for response personnel. The ability to detect and identify hazardous airborne matter without endangering personnel is invaluable. Additionally, the ability to conduct an aerial reconnaissance with a sUAS would give civil authorities a multi-dimensional perspective of an incident site, enabling them to formulate a more informed response plan and potentially save additional lives. CSTs are the ideal organizations to implement this technology for multiple reasons, including their mission as an all hazards response organization, highly trained personnel, WMD/CBRN expertise, its strategic locations throughout the United States and territories, continuous availability, and a CST is provided at no cost to the requesting agency.

This research proves that the technology provided by sUAS platforms is an ideal step to meeting national strategic guidance to continuously improve CBRN response in the homeland as well as to address key initiatives outlined in the 2010 QDR. These initiatives are: 1) Field faster, more flexible consequence management response forces, 2) Enhance capabilities for domain awareness, and 3) Accelerate the development of standoff radiological/nuclear detection capabilities.

Analysis of existing policy and doctrine demonstrates that there is a sufficient policy framework to support VTOL sUAS; however, there are gaps in the policy that must be addressed. This thesis identifies those gaps and provides recommendations for solutions. CFR Part 107 provides a valuable framework for integration of sUAS into the national airspace system. While Part 107 does not address DOD operations, research suggests that the DOD could adopt Part 107 with minimal changes. This would eliminate the need to develop a new, separate policy agreement, such as an MOU or COA between the FAA and the DOD.

Existing intelligence oversight doctrine is sufficient to support sUAS operations; however, policy must be revised to address sUAS. The gap between doctrine and policy is relatively simple to overcome. Current policy regarding intelligence oversight considerations for "airborne platforms" conducting domestic imagery is clear, as is policy for *large* (tactical) unmanned aircraft systems.[145] The term "airborne platforms" refers to manned aircraft. UAS capabilities discussed in this thesis are more closely related to airborne platform capabilities than large unmanned capabilities. This is because large UAS policy is written with regard to imagery taken from aircraft with "weapon system video and tactical intelligence, surveillance, reconnaissance (ISR) capabilities."[146] Since sUAS is not a weapon system, policy should reflect similar requirements as the airborne platform. The critical requirement for all imagery taken from an airborne platform is a PUM. The PUM can be approved in a short amount of time during a disaster and can be approved in advance provided operations remain within the parameters listed in the PUM.

The benefits of sUAS as discussed in this proposal include safety, increased situational awareness, reasonable cost, and they are an immediately available nationwide resource.

#### 1. Safety

Life safety is the primary objective during any response, and any technology that can improve life safety should be explored.[147] sUAS technology improves safety by increasing the initial standoff distance for responders and providing them with critical

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[145] National Guard Bureau, *Chief of the National Guard Manual*, E-2.

[146] Ibid., E-3.

[147] Ready.gov, "Emergency Response Plan."

visual and air quality data prior to deployment. When using an sUAS that provides both video and CBRN detection, the response personnel could enter the environment with a more comprehensive understanding of the situation.

### 2. Increased Situational Awareness

An incident commander's ability to gain information about a situation is key to response plan development. This proposal highlights new sUAS technology that could simplify and transform the amount of information available to decision makers without risking the safety of response personnel. Missions such as damage assessment, CBRN detection and identification, site reconnaissance, and site characterization could be accomplished *quickly* and provide invaluable information to an incident commander. The result would be quicker, more efficient response with more appropriate resources while placing fewer personnel at risk.

### 3. Cost

Specific sUAS and their cost were not in the scope of this research because exact appropriate sUAS specifications are not known at this time; however, capabilities should include: stabilized high definition (HD) video, long-range video transmission, long battery life, and payload capability for CBRN monitors. The cost of a sUAS equipped with secure transmission capability and CBRN detection would be more expensive than standard sUAS, but it would still be much less expensive than manned platforms. For example, a UH-72A helicopter equipped with video downlink used to conduct IAA costs $2,826 *per hour*,[148] and that cost does not include personnel. The goal of sUAS procurement should also be to find a system that is easily replaceable when damaged or contaminated. Cost and availability of remote, portable CBRN monitoring equipment that could be carried by a sUAS was outside the scope of this research, though it will likely cost more than the sUAS itself.

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[148] Army Cost and Economic Analysis Center, "FY17 DOD Rotary Wing Aviation Reimbursable Rates," accessed October 15, 2016, http://asafm.army.mil/offices/office.aspx?OfficeCode=1400.

### 4. Immediate Nationwide Resource

The role of CSTs in homeland security is to act as subject matter experts for WMD response and to be able to respond to any incident 24 hours a day, 365 days a year, *anywhere* in the United States *and* its territories. In addition to being located throughout the country, the CSTs maintain the same standards, are all equipped with the same number of personnel, and have the same capabilities. This standardization differs from local first response agencies because their capabilities are based upon their budget and priorities of the locally elected officials. Some agencies may have the resources to support a sUAS program while other agencies may not. The use of sUAS by CSTs would provide a standard capability that would be available to every community in the country.

## C. RECOMMENDATIONS

Based on the research in this thesis, the following are offered as recommendations for sUAS acquisition and establishing new sUAS operating policies.

### 1. sUAS Capabilities

The following sUAS capability recommendations reflect equal or more restrictive measures that those outlined in Part 107. This will enable DOD sUAS to be integrated within an established framework.

#### *a. Size and Operational Limitations*

Ideally, a sUAS used by CST would weigh no more than 50 pounds, including payload. The DOD UAS size classification published by the Chair of the Joint Chiefs of Staff (CJCS) in 2011 classifies this type of UAS as a Group 2 UA, meaning it weighs between 21 and 50 pounds and normally operates at altitudes less than 3500 feet (') above ground level (AGL) and less than 250 knots airspeed.[149] sUAS speed and altitude should be limited to the maximum airspeed and altitude established in CFR Part 107—30 knots airspeed and 400' AGL.[150] The CJCS classification also dictates the minimum

[149] Chair of the Joint Chiefs of Staff, *Joint Unmanned Aircraft Systems Minimum Training Standards*, CJCSI 3255.01 (Washington, DC: Chair of the Joint Chiefs of Staff, 2009), 4.

[150] CFR, Part 107, 10.

training that all operators must accomplish based on the size of the UAS. This will be discussed below.

### *b. Equipment*

Based on the mission requirements, the sUAS should be configurable with or without CBRN monitoring equipment. Monitoring equipment should be small enough to be effective yet not interfere with the flight characteristics of the sUAS. Ideally, the monitoring equipment should be able to transmit air sample data to the operator in real time so the system does not have to be decontaminated when it returns if it has negative results. The video camera should have high resolution and zoom capability as well as the ability to transmit a *secure* signal to the operator. The security of the transmission is important to satisfy intelligence oversight requirements and ensure no private information on U.S. persons is obtained from unauthorized sources.

### *c. Recording Capability*

The receiver should be outfitted with the ability to accept an external storage device and the ability to record information gathered by the sUAS should be limited to external media devices only. In addition, the chain of custody should remain with the supported agency. This will prevent possible intelligence oversight conflicts and protect the DOD if the recorded imagery is used as evidence during civil or legal litigation.

## 2. Policy

DEPSECDEF Policy Memorandum 15-002 is an all-inclusive document for DOD policy regarding the domestic use of sUAS. This policy is not intended to address sUAS. The policy was intended to allow governors the flexibility to incorporate large UAS into their state emergency plans and request these resources during a disaster. Additionally, this policy memorandum is ill-suited to provide guidance for the domestic use of large UAS and small UAS congruently.[151] The two systems have vastly different missions and

[151] Deputy Secretary of Defense, *Guidance for the Domestic Use*.

operate in different airspace. DOD VTOL sUAS should be treated the same as civil sUAS and a new, specific sUAS DOD policy is needed.

A working group should be appointed to review current policy and develop recommendations that accommodate new sUAS policy. This working group should be comprised of staffers and planners from the Office of the Secretary of Defense (OSD), the National Guard Bureau (NGB), subject matter experts from the field who represent the CSTs, as well as representatives from state and local fire agencies to determine the requirements for a functional mission set. The working group should analyze approved missions and doctrine and training.

### 3. Approved Missions

As stated in Chapter IV, there are only five approved missions for domestic UAS: 1) DOD operations, 2) state/National Guard operations, 3) search and rescue, 4) DOD-required exercises, and 5) training, and exercises, training, and activities not required by the DOD. sUAS used in support of civil authorities should be a separate mission in this policy or addressed in a separate policy altogether.

#### *a. Approval Authority*

Current approval authority for each domestic UAS flight is the SecDef; search and rescue is the only exception.[152] The mission set for this sUAS will necessitate immediate deployment and the current level of approval is time consuming. The existing approval authority policy works in the current framework because *large* UAS are not intended to support DSCA missions. Even so, the DOD recognizes the value of their technology and is willing to allow them to be used on a case-by-case basis during emergency situations. These situations afford ample time to request approval from the SecDef. The primary purpose of sUAS is to support civil authorities, and the parameters for use should already be established; therefore, the approval authority should be authorized within the CST command.

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[152] Ibid.

#### *b. Currently Approved IAA Capabilities*

Most issues discussed in this thesis are currently addressed by similar programs within the DOD. The sUAS technology is new but the IAA mission is not. There are current programs to perform the IAA mission with different equipment; sUAS are not significantly different. One example of a similar capability is the unmanned ground vehicle provided to some CSTs. These UGVs are capable of providing the same information to civil authorities, but they are slow and restricted to ground operations. The sUAS simply improves that capability by adding the ability to collect information from the air. Additionally, manned aircraft currently conduct IAA. Many helicopters and fixed wing aircraft are equipped with video downlink capability as well as CBRN sensors. sUAS would not utilize any capabilities that do not already exist other than the aircraft itself.

### 4. Doctrine and Training

New doctrine and training guidance must be developed prior to implementation. sUAS doctrine can include training guidance, intelligence oversight, and elements from AR 95-23.

#### *a. Training Guidance*

The sUAS needs new *Unmanned Aircraft System Commander's Guide and Aircrew Training Manual* (ATM). Every Army aircraft has an ATM to provide guidance to the commander about how to build a training program and maintain crew proficiency. VTOL sUAS is a vastly different aircraft than a fixed wing sUAS and requires its own training program. This thesis recommends developing a simple training program based on the capabilities and mission parameters of the sUAS. In addition, flight tasks and academic knowledge requirements should be limited to those who are relevant to the mission. For example, important academic topics may include: airspace rules, intelligence oversight considerations and PUM process, lost link procedures, weather effects on sUAS operations, operational considerations, crew member qualifications, and flight characteristics. Important flight tasks should focus on aircraft control, emergency procedures, and TTPs that are specific to the mission, such as how to conduct air monitoring/sampling and video downlink.

CJCSI 3255.01 addresses the joint use of unmanned aircraft systems. This instruction is intended to establish minimum training standards for UAS operations in support of joint forces.[153] Although this document is intended to provide guidance for tactical assets, it provides a useful framework for establishing training standards based on system weights and capabilities. For example, operators of heavier, faster aircraft must meet different training standards than operators of smaller, slower aircraft. The document establishes minimum training topics that must be discussed for *all* UAS operators, regardless of the aircraft used. Some of these topics may be irrelevant to sUAS operations, but CJCSI 3255.01 could still be used as a framework for developing a training program. Key points include:

"(1) Airspace design and operating requirements

(2) Air traffic control procedures, rules, and regulations

(3) Aerodynamics, including effects of controls

(4) Aircraft systems and emergency procedures

(5) Performance

(6) Navigation

(7) Meteorology

(8) Communication procedures

(9) Mission preparation"[154]

#### ***b. Intelligence Oversight***

Current DOD IO policy is nested in a range of policy and doctrinal documents. The primary challenge is that current IO policy does not recognize sUAS capability because a VTOL sUAS capability does not yet exist. In addition, current IO UAS policy is written for the use of large, tactical UAS rather than VTOL sUAS. This thesis recommends that sUAS and large UAS be treated as separate aircraft in DOD manuals

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[153] Chair of the Joint Chiefs of Staff, *Joint Unmanned Aircraft Systems*, 4.

[154] Ibid., A-2.

and policy documents. For example, CNGBM 2000.01 currently authorizes the use of domestic imagery in support of DSCA operations by airborne platforms as long as a PUM is on file.[155] The same regulation later states, "NG UAS assets will NOT be employed for DSCA purposes without specific SecDef approval."[156] The section in CNGBM 2000.01 discussing UAS is written to address "tactical" capabilities. The sUAS discussed in this thesis is not a tactical asset and should be authorized to collect imagery under the "aerial platform," subsection of CNGBM 2000.01. The proper use memorandum request process provides a useful framework for ensuring the rights of U.S. persons are maintained. Figure 5 is an example of a useful decision matrix that could be used to determine the need for a PUM prior to mission execution.

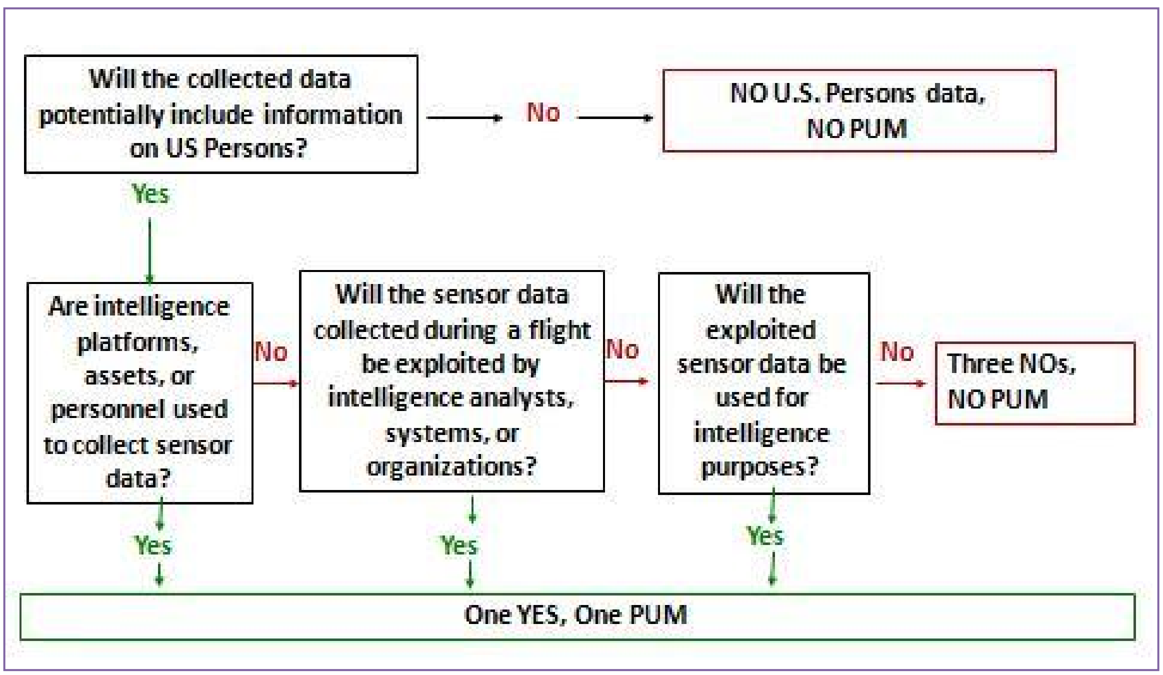


Figure 5. Is a PUM Required?[157]

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[155] National Guard Bureau, *Chief of the National Guard Manual*, E-2.

[156] Ibid., E-3.

[157] Source: National Guard Bureau, *Chief of the National Guard Manual*, E-7.

### c. *Army Regulation 95-23 Unmanned Aircraft System Flight Regulations*

Regulation 95-23 *Unmanned Aircraft System Flight Regulations* currently does not address VTOL aircraft. Although the framework of AR 95-23 is an excellent resource for a comprehensive aviation program, it is written for fixed wing UAS and is too onerous for a simplistic system operating at slow airspeeds and low altitudes. This thesis recommends a new AR that addresses VTOL aircraft and simplifies training and qualification requirements or adding a new chapter to AR 95-23. Some features of the AR 95-23 should be adopted into the sUAS program, features such as the mission approval process, risk assessment, guidance for crew member evaluations, and flight maneuver task, condition, and standards.

## 5. National Airspace Integration

The FAA published FAR Part 107 to govern the operation of private and commercial sUAS. This rulemaking offers workable solutions to DOD sUAS operations and ensures the safety of bystanders as well as other manned aircraft. The DOD should adopt the operational limitations as outlined in Part 107 with minor changes. This will eliminate the need for a COA. Table 2 parallels Part 107 but is more restrictive in several respects. First, it considerably reduces the airspeed limit from 100 knots to 35 knots groundspeed. Second, it reduces the max weight from 55 pound to 50 pounds. Third, this proposal mandates the use of a visual observer when the video camera or air monitoring equipment is in use. The authorization to carry hazardous materials is less restrictive in this figure because the nature of the mission may require the aircraft to carry samples of hazardous materials; however, the aircraft should always remain within the perimeter of the established contamination zone where appropriately protected personnel can recover the samples and decontaminate the aircraft.

Table 2. Summary of the Modified Major Provisions of Part 107[158]

| | |
|---|---|
| **Operational Limitations** | Unmanned aircraft must weigh less than 50 lbs. (22.6 kg).<br>Visual line-of-sight (VLOS) only; the unmanned aircraft must remain within VLOS of the remote pilot in command and the person manipulating the flight controls of the small UAS. Alternatively, the unmanned aircraft must remain within VLOS of the visual observer.<br>At all times the small unmanned aircraft must remain close enough to the remote pilot in command and the person manipulating the flight controls of the small UAS for those people to be capable of seeing the aircraft with vision unaided by any device other than corrective lenses.<br>Small unmanned aircraft may not operate over any persons not directly participating in the operation, not under a covered structure, and not inside a covered stationary vehicle.<br>Daylight-only operations, or civil twilight (30 minutes before official sunrise to 30 minutes after official sunset, local time) with appropriate anti-collision lighting.<br>Must yield right of way to other aircraft.<br>Must use visual observer (VO) when the video camera or air monitoring equipment is in use.<br>First-person view camera cannot satisfy "see-and-avoid" requirement but can be used as long as requirement is satisfied in other ways.<br>Maximum groundspeed of 35 mph (30 knots).<br>Maximum altitude of 400 feet above ground level (AGL).<br>Minimum weather visibility of 3 miles from control station.<br>Operations in Class B, C, D and E airspace are allowed with the required ATC permission.<br>Operations in Class G airspace are allowed without ATC permission.<br>No person may act as a remote pilot in command or VO for more than one unmanned aircraft operation at one time.<br>~~No operations from a moving vehicle unless the operation is over a sparsely populated area.~~<br>No careless or reckless operations.<br>No carriage of hazardous materials. *Carriage of hazardous materials is authorized in emergency circumstances and must remain inside a controlled area capable of handling such materials.*<br>External load operations are allowed if the object being carried by the unmanned aircraft is securely attached and does not adversely affect the flight characteristics or controllability of the aircraft.[159] |

[158] Adapted from: 14 CFR, Part 107.

[159] 14 CFR, Part 107, 10.

### 6. Capability Name

Finally, this thesis proposes a name for this technology. The WMD Aerial Awareness System, Pilotless, or WAASP. This name embodies the mission set of the system and reflects the size and agility of the proposed sUAS.

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