Research Report

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Small Uncrewed Aircraft Systems (SUAS) in Divisional Brigades

Small UAS and Counter-UAS Training

For more information on this publication, visit **www.rand.org/t/RRA2642-5**.

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About This Report

This report documents research and analysis conducted as part of a project entitled *Unmanned Aircraft Systems (UAS) to Support Fires at Division, Brigade Combat Team (BCT), and Battalion*, sponsored by XVIII Airborne Corps. The purpose of the project was to identify options for the Army to identify, field and employ uncrewed aircraft systems (UAS)—including commercial off-the-shelf (COTS) systems—at the division, BCT and battalion-level to enhance fire support capabilities. Expanded employment of UAS at scale brings implications across doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy (DOTMLPF-P), including how the Army organizes and trains soldiers and formations for SUAS operations as another combined arms tool. This report addresses training issues, to include requirements for home station training support, key Army institutional training requirements and processes, master trainer challenges, and individual and unit-level training. This volume also includes analysis, insights, and implications for the counter-uncrewed aircraft systems (C-UAS) mission.

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Summary

This volume addresses the challenges and provides recommendations for improving U.S. Army training with respect to the increasing importance of SUAS. Army installations manage access to local training facilities to meet the training objectives of senior commanders. The following key findings emerged from our research:

- Effective SUAS integration with combined arms maneuver requires more than operator proficiency; however, few units move beyond basic operator-level proficiency or plan for the integration of SUAS in combined arms operations.
- Observations from the combat training centers (CTCs) as well as the Russo-Ukrainian War indicate effective combined arms maneuver that integrates SUAS requires:
  - Operators who can use advanced techniques and understand how they fit in airspace management, ground maneuver, and fires schemes
  - Company and field grade leaders who can maximize the operational value and survivability of SUAS
  - Battle staffs that are quick and efficient at planning intelligence collection and managing airspace, and
  - Well-rehearsed air net and fires net "kill chains" for mission execution.
- The U.S. Army training ecosystem lacks the capability and capacity for units to "train the way you fight" with SUAS at home station due primarily to range control, airspace, and spectrum management limitations, and property accountability policies that deter SUAS use.
  - Many obstacles to "train the way you fight" are solvable or waivable but require Headquarters, Department of the Army (HQDA) attention and urgency to resolve as they require coordination across the joint communities (e.g., airspace and spectrum management), and with the Federal Aviation Administration (FAA).
  - Unit SUAS training plans lack training models that leaders could easily adopt or adapt to execute a step-by-step individual and collective SUAS training program.
  - Tactics for SUAS employment are rapidly evolving, but the Army lacks a mechanism, repository, or forum for operators, leaders, and units to share tactics, techniques, and procedures (TTP) and standard operating procedures (SOPs).
  - Battalion and Brigade Combat Team (BCT) staff require training and decision aids in airspace and risk management to accommodate increased numbers of SUAS in the airspace while still employing rotary and fixed-wing aviation, fires, and other capabilities across the warfighting functions.
  - Counter-UAS training needs to be integrated across echelon collective training, which includes creating opposing force (OPFOR) uncrewed aircraft systems (UAS) capabilities.

- The 2023 training pipeline for SUAS operators is insufficient for both basic qualification throughput and preparing expert operators, and it will be overwhelmed when the U.S. Army starts fielding SUAS in greater numbers. Part of the solution is "train the trainer"—units need battalion master trainers who can qualify company unit trainers, as well as a routine battle rhythm for maintaining currency and developing expertise.

The SUAS Master Trainer course requires refinement to increase throughput and to better prepare master trainers to assisting commanders in implementing SUAS training plans.

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Small Uncrewed Aircraft Systems in Divisional Brigades: Small UAS and Counter-UAS Training

Background

Given the proliferation of SUAS in the Russo-Ukrainian War that began in 2022, the battlefield environment of UAS and SUAS looks very different in complexity and threat. The continued fielding of SUAS to more formations has created a dense, congested airspace environment. Meanwhile, the commercial sector has driven major improvements in SUAS technology, including UAS performance, payload, capabilities, and multi-ship autonomous swarms (Shaikh, et al., November 2023, pp. 13-14). The rise of major drone manufacturers and a large supply of SUAS types has rapidly decreased the cost of acquisition (Shaikh, et al., November 2023, p. 13). The combination of rapidly evolving SUAS capabilities and long-term trends for affordability creates the potential for many more use cases and much wider usage of SUAS across Army echelons and force types.

Adversaries are aggressively adopting SUAS—in some cases faster and more innovatively than the U.S. military. State military complexes and violent non-state actors are deploying large UAS with advanced sensors as well as cheap, lethal SUAS, often modifying commercial-off-the-shelf (COTS) systems for detection and targeting (Borsari and Davis, 2023). Conflicts in the late 2010s and early 2020s in Syria, Iraq, Nagorno-Karabagh, the Gaza Strip, and especially in Ukraine, are sobering examples of this phenomenon.

Adversary training and combat employment have quickly adapted as well (RWOW TROIKA, November 15, 2023). The best trained adversary units now employ SUAS with sophisticated tactics and multi-ship formations. For example, in Russia, competition to become a SUAS pilot is fierce and the individual operator training pipeline has scaled up rapidly. Dedicated SUAS formations have proliferated, where individual training quickly progresses to advanced flying techniques and combat experience. The net result is that a Russian or Ukrainian SUAS pilot in early 2024 is likely to be better equipped and trained than their U.S. counterparts.

This explosion of SUAS technology is not the first time the U.S. Army has encountered a technology that heavily influenced TTP from the squad to the corps. In the 1970s and 1980s, the proliferation of night vision capabilities, as well as new sensing and digital communication technologies changed how units maneuvered and executed direct and indirect fires. An essential component to U.S. Army mastery of these technologies was their incorporation into a comprehensive, cutting-edge training ecosystem—one created after the Vietnam War to foster combined arms excellence from the individual to the Corps level.

The “training revolution” of the 1970s and 1980s prioritized realistic training to “train as you fight” (Chapman, 1994). Critical elements of “train as you fight” included building realistic training environments where units could employ all their battlefield operating systems, developing a body of training guides and assessment mechanisms (e.g., the Army Training Evaluation Program (ARTEP)) and tactics, techniques and procedures (TTP) that integrated the new technologies, providing units essential resources (time, ranges, training aids, and training management tools), and finally assessing and tracking unit performance on specified tasks (including the use of new technologies) in realistic conditions against explicit, rigorous standards (tasks, conditions, standards). The capstone of this approach was the advent of the Army’s combat training centers (CTCs) to create the most realistic force-on-force and live-fire combat simulation environment possible. But it also extended to the adoption of challenging, realistic training programs at home station to practice bringing all the battlefield operating systems to bear. This created the Army of Desert Storm and Operation Iraqi Freedom—the preeminent combined arms ground force in the world.

The demands of counterinsurgency (COIN) in Iraq and Afghanistan caused the Army to evolve its training ecosystem to meet these new demands. Since the end of these conflicts, it has refocused on the demands of large-scale combat operations (LSCO), but this transition is incomplete, as discussed below. The U.S. Army now risks falling behind potential competitors in preparing soldiers and units for the unforgiving conditions of today’s rapidly evolving technological environment and LSCO—in particular, the proliferation of SUAS.

The Army fielded its first generation SUAS, Shadow and Raven, at the BCT and company between 2002 and 2004 (Institute of Land Warfare, 2010, p. 6). These systems saw heavy use in Iraq and Afghanistan, providing small unit leaders with an organic intelligence, surveillance, and reconnaissance (ISR) capability that had previously only existed at echelons above the brigade (EAB). Training on these systems generally focused on launch, recovery, and operating these systems from fixed locations in relatively permissive airspace against a foe with only rudimentary air defense and electronic warfare capabilities. Many of the training techniques adopted for SUAS were scaled down adaptations of larger UAS procedures (e.g., flying static orbits) versus training techniques that integrated SUAS into all aspects of combined arms operations. Training focused on basic individual operator tasks, yet finding training facilities, airspace, and frequency allocations still proved difficult for installations and units, as will be discussed later in this document. Until the late 2010s this rudimentary training ecosystem was sufficient, as the greatest innovation in UAS occurred in the larger, high medium altitude systems, while systems from Group 1 (small uncrewed aircraft systems [SUAS] weighing less than 20 pounds, flying below 1,200 feet above ground level (AGL) and at speeds less than 100 knots) and Group 2 (SUAS weighing between 21 and 55 pounds, flying below 3,500 feet AGL and at speeds less than 250 knots)- saw only

incremental increases in capability (Federal Aviation Administration, 2024).[1] For example, in 2023 the Raven was still the primary SUAS in companies over 20 years after its initial fielding, and most battalions had no organic SUAS at the battalion level.[2]

This volume addresses the challenges and provides recommendations for improving U.S. Army training with respect to the increasing importance of SUAS. Army installations manage access to local training facilities to meet the training objectives of senior commanders. We provide observations and recommendations on how to do that below.

Methodology

To identify and develop the observations and recommendations noted above, the RAND Arroyo Center research team examined the Army's ability to adapt the training revolution and mindset it launched in the 1970s, characterized by "train as you fight," for the 2020s.

A key question that guided RAND research was: What are the challenges to U.S. Army formations trying to conduct realistic training using SUAS? A corollary set of questions addressed identifying whether the obstacles were doctrinal, organizational, training, material, leadership, personnel, facilities, or policies. The research used a mix of historical training support data, interviews with commanders, staff, and SUAS operators, and battlefield assessments for its research. RAND researchers interviewed personnel from the 3d Infantry Division (3ID), 10th Mountain Division (10th Mtn Div), 82nd Airborne Division (82nd Abn Div), 101st Airborne Division (101st AA Div [Air Assault]), 75th Ranger Regiment, as well as XVIII Airborne Corps units and staff. For each division we interviewed representatives of the division's staff, as well as staff and SUAS operators and leaders from at least one BCT. We also interviewed representatives from two divisions' division artillery (DIVARTY) and one division's Division Support Brigade (DSB). Several of these elements provided their training SOPs. RAND researchers also interviewed experts from the National Training Center (NTC) and the Joint Readiness Training Center (JRTC)—collectively, Combat Training Centers (CTCs), as well as experts from the Maneuver, Fires, Intelligence, and Maneuver Support Centers of Excellence (COEs) and the U.S. Marine Corps Warfighter Lab. RAND interviewed elements of the U.S. Army training base responsible for the Master UAS Trainer course and senior warrant officer proponents for 150U (Tactical Unmanned

[1] All definitions of uncrewed aerial system group classifications in this paper come from Federal Aviation Administration regulations.

[2] The Army announced the end of the Raven program and the impending end of the Shadow program in late 2023, after this research was done. Even though the publication date of this document is after that time, we left references to it intact, as the elimination of Raven and Shadow and replacement of it with COTS systems (initially) does not change those findings and recommendations materially. For insights on limitations of SUAS fielded at battalion and company levels (Hamilton and Egan, "2023).

Aerial Systems Operations Technician) and 150A (Air Traffic and Air Space Management Technician). RAND researchers also drew on interviews with and information provided by the Security Assistance Group-Ukraine (SAG-U) supporting the North Atlantic Treaty Organization (NATO) training of Ukrainian forces. For data-informed historical UAS usage trends, RAND used training data from the Range Facility Management Support System (RFMSS) for Forts Bragg, Campbell, Stewart, and Drum for the period of June 2022 to May 2023, as well as training data collected at JRTC across six consecutive rotations between 2022 and 2023. Finally, RAND Arroyo Center researchers reviewed pertinent doctrinal and regulatory publications and memoranda from the Federal Aviation Administration, Department of Defense, Chairman of the Joint Chiefs of Staff, Department of the Army, and installation range control, airspace management, and spectrum management operations.

What We Found

From these operator interviews, battlefield observations, doctrinal and operational regulations and memoranda, and historical training data, RAND Arroyo Center researchers concluded that the U.S. Army training ecosystem does not support efforts to train as the Army will fight. We know from detailed installations training area usage records that there are far fewer SUAS flights per day than the SUASs that units using the training areas have on their tables of organization and equipment (TOEs).[3] We know from interviews with XVIII Airborne Corps units that many do not take their SUAS to the field with them because of the challenges of coordinating training areas, spectrum, and airspace, but also because they fear Financial Liability Investigation of Property Loss (FLIPL) investigations should their SUAS be lost or damaged.[4] Further, CTC opposing forces (OPFOR) and observer/controller-trainers (O/C-Ts) note that units are generally neither proficient in employing their SUAS nor in conducting counter-uncrewed aircraft systems (C-UAS) operations (Interviews conducted from November 2022–October 2023). If the Army remains committed to training as it expects to fight, its current processes and training support capabilities for integrating SUAS into realistic training are inadequate. While the Army recognizes this challenge, it must make adjustments across doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy (DOTMLPF-P) to accommodate future SUAS demands.

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[3] These data come from the Range Facility Management Support System (RFMSS) records from (then) Forts Bragg, Campbell, Stewart, and Drum from June 2022 – May 2023.

[4] Units are not using their sUAS during home station training for several factors. Some of those have to do with the training environment at home station and are addressed in this report. Other factors, such as how sUAS are accounted for also contribute to this hesitancy and are discussed in the companion reports of this project (Camm, Girardini, and Kelly, 2025).

The RAND Arroyo Center research team found that the Army's training ecosystem suffers from three major challenges preventing more and better SUAS training:

- First, units face significant imposed constraints on realistic SUAS training at home station training areas—particularly in range policies, airspace management, spectrum allocation, and property liability. As a result, while individual units can and have conducted realistic training and demonstrated excellence, it is not possible for most battalions and brigades to do this across the board or at scale.
- Second, units have too few highly trained personnel (e.g., UAS master trainers, UAS expert operators, and expert airspace managers)—to employ SUAS with advanced tactics at scale.
- Third, formations lack battle staff and leader expertise in combined arms maneuver employing SUAS—particularly in the enabling functions of airspace control, spectrum management, and sophisticated multi-ship or layered UAS tactics, and in including SUAS in unit planning and operations.

In sum, units encounter challenges in *where, when, and how* they can train, *who* they have to train, and guides on *what to do* for training. Most of the solutions to these three challenges are beyond the resources and authorities of brigade and subordinate commanders to resolve, but they are addressable in part by senior commanders and in whole by the institutional U.S. Army, working with the Defense Department (DoD) and the FAA.

Overall, the institutional U.S. Army must work with the DoD and the FAA to create a training ecosystem that supports greatly expanded integration of SUAS in combat operations. The Army needs to think of SUAS as part of a battlefield system of systems that includes platforms, operators, airspace management, communication networks (hardware, software, spectrum management), and kill chains that all need to be trained to operate together.

Organization

In what follows, we first present our analysis of the data we collected from the CTCs and RFMSS to help quantify the problem. Next, we look at training constraints that limit the XVIII Airborne Corps' and the Army's ability to train. Then we examine the state of individual training for operators and master trainers. Finally, we look at the ability of units to integrate SUAS into combined arms operations in training and operations. Appendix A provides the methodology RAND used to estimate future training demands for SUAS.

Quantifying the Problem and Requirements

To quantify the problem and requirements, we interviewed and examined data from the CTCs and training support functions at all four XVIII Airborne Corps divisional installations.

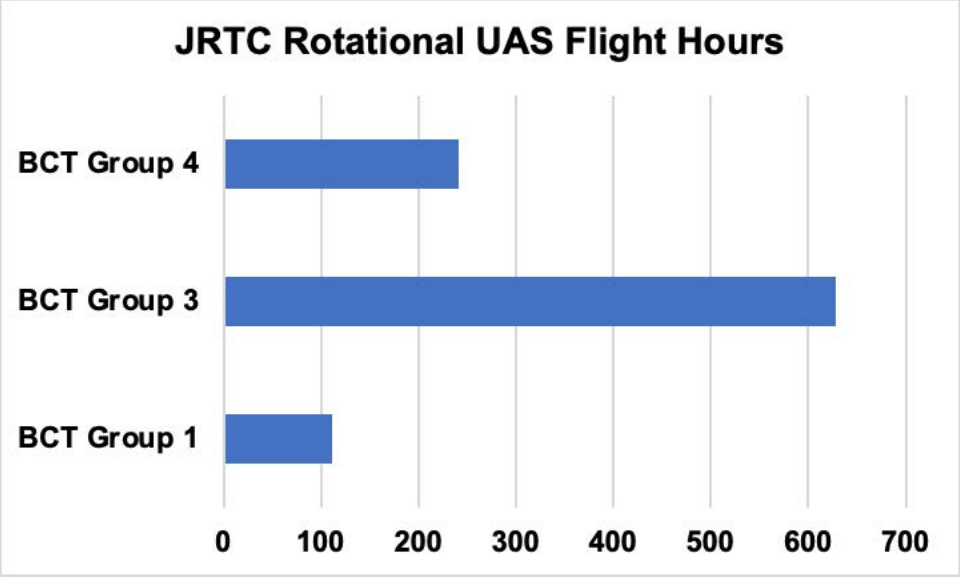
Identifying the Problem: What CTC Data Tells Us

U.S. Army formations at the Combat Training Centers (CTC) have often demonstrated deficiencies in employing SUAS on-hand to their full potential, largely due to lack of training across multiple levels. Difficulties deconflicting airspace, sluggish staff processes, and lack of operator proficiency often plague units that struggle to effectively employ SUAS at the CTCs (Hayball, Kerkhoff, and Sarver, 2019, pp. 65–72). Data from the JRTC demonstrates that some units rely heavily on larger UAS at the BCT and Combat Aviation Brigade (CAB) levels, and rarely employ the SUAS organic at the battalion and company levels (data provided by JRTC staff, August 2023).

Limited usage of SUAS at the Battalion level and below usually means that the UAS assets at the BCT and CAB level—Group 3 (systems weighing between 56 and 1,320 lbs, flying less than 18,000 AGL and at speeds less than 250 knots) and Group 4 (systems weighing more than 1,320 lbs, flying at any altitude and speed)—are overburdened with tasks and that the ISR potential of Battalion and lower is underutilized. CTC data suggests that BCTs are planning for the employment and integration of Group 3 and Group 4 UAS to support their collection efforts but in most cases paying little regard to SUAS. This inefficient resource allocation could indicate a lack of awareness of the potential of SUAS, and of staff training.

There may be good reasons for the disparity between Group 1 and Group 3/4 usage by BCTs. The restrictive terrain at the JRTC (Fort Johnson) limits suitable takeoff sites and may place named area of interests beyond the range of non- vertical takeoff and landing (VTOL) Group 1 systems. However, comparing Group 1 usage across six recent BCT rotations reveals that while five BCTs used Group 3 and Group 4 for 90 percent or more of their total UAS flight hours (and two BCTs did not use Group 1 SUAS at all), one BCT flew Group 1 SUAS for upwards of 40 percent of its UAS hours—this one BCT accounted for more than 80 percent of the total Group 1 UAS flight hours during these six rotations. Figures 1 and 2 below illustrate these usage patterns.

Figure 1. JRTC UAS Flight Data

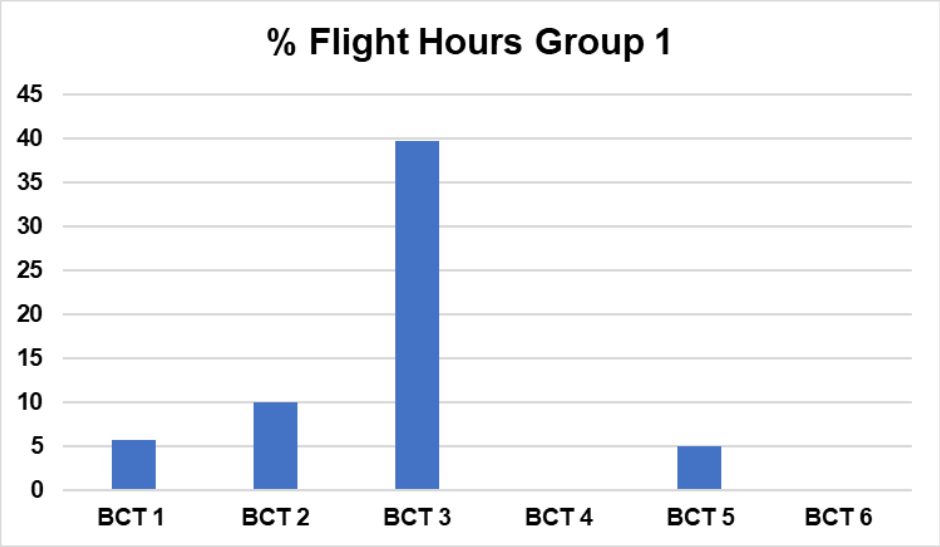


SOURCE: Joint Readiness Training Center, data files, August 2023. Group 1 systems weigh less than 20 lbs and fly below 1,200 feet AGL and at speeds less than 100 knots. Group 3 systems weigh between 55 and 1,320 lbs and fly up to 18,000 feet AGL and at speeds less than 250 knots. Group 4 systems weigh more than 1,320 lbs and fly at any altitude and speed.

The significant difference in SUAS usage by one of the six BCTs was not a fluke. The RAND Arroyo Center research team had the opportunity to interview the leadership of the cavalry squadron for this BCT. This unit had consolidated its SUAS at squadron level under the S-2 (in Headquarters and Headquarters Company [HHC]) in a robotics platoon, led by a dedicated Lieutenant (a branch detailed military intelligence officer) and Platoon Sergeant. In addition to their modified table of organization and equipment (MTOE) Raven SUASs, they also had two different COTS systems for this JRTC rotation. This consolidation of operators ensured more focused training; these soldiers' primary duty was as SUAS operators rather than having it as an additional duty, and training included not only operational functions but also time at the Division's Airborne Innovation Lab where they could experiment with SUAS. The consolidation under the S-2 likely allowed for smoother integration with headquarters staff functions (e.g., they were collated with the targeting officer in the S-2 shop to translate SUAS developed ISR into actionable targets) at the squadron level. Troops requested SUAS support as needed from the squadron, which managed support requirements. Finally, the research team's interview included the squadron commander, who clearly had indicated focused on this mission not only though reorganizing SUAS capabilities in the squadron, but also to both drive integration and overcome bureaucratic obstacles. Interviews with the unit and with JRTC observer/controller-trainers confirmed that the way this BCT had organized and trained at home station helped maximize the organization's ability to integrate SUAS into operations

(Interviews with squadron commander and staff, November 29, 2022). This squadron was one of only two battalion-sized organization the research team met with that had similarly organized itself to enhance the role of SUAS and training of operators. Recent analysis based on the Russo-Ukrainian indicates that focused UAS units may be more effective than how the Army is currently organized (Bronk and Watling, 2024).

Figure 2. JRTC Percentage Flight Hours (Group 1)



SOURCE: Joint Readiness Training Center, data files, August 2023.

As a counterpoint to how most BCTs in these rotations used SUAS, the dedicated OPFOR employs SUAS as well at JRTC in well-practiced drills that require it to manage airspace, fuse data, and quickly prosecute targets. Furthermore, JRTC staff tell us that the first time a BCT encounters threat UAS is often at the CTC—they have no OPFOR at home station to help them train for the C-UAS tasks (Interview with National Training Center staff, February 2, 2023). In sum, most BCTs are inadequately trained or not trained at all on almost all collective unit SUAS and C-UAS tasks.

Other militaries, including our adversaries, are adapting their training ecosystem to address today's battlefield demands for cunning, expert SUAS operators using sophisticated, multi-ship tactics. Both Ukraine and Russia have created training pipelines at brigade and division-level bases to select and train expert operators and employ them in specially organized UAS formations (Horton and Korolchuk, 2023; Rommen, 2023; Melkozerova, 2023; Tucker, 2022). A telling indicator of how the U.S. and NATO training ecosystem is lagging is Ukrainian frustrations with the limits placed on SUAS training in Europe (Dettmer, 2023). In less than two years, Russia's SUAS production of operators is in the thousands, surpassing U.S. and NATO output (Rommen, 2023; Melkozerova, 2023;

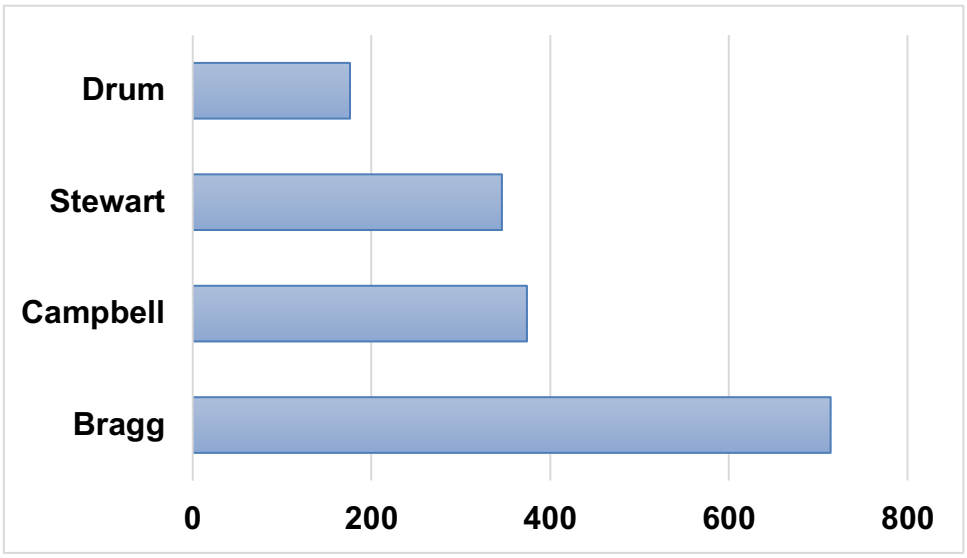
Tucker, 2022). Failure to train U.S. Army units on SUAS to their full capabilities (and for the C-UAS mission, the enemy's full capabilities) puts mission success and soldier lives at risk, as demonstrated by this analysis of home station training data, CTC performance results, and Ukrainian battlefield reports.

Estimating Home Station Training Requirements—Now and in the Future

To quantify the demand for home station training support, the RAND Arroyo Center research team needed a way to quantify the capabilities and capacity that range operations, spectrum managers, and airspace managers would need. We sought to determine the maximum number of SUAS flights that an installation could expect to have if units were training with their SUAS as they would expect to fight. We assessed that this number would provide a strong basis for home station requirements for range control, spectrum management, and airspace management. To predict the maximum number of daily SUAS flights, we examined daily training usage as captured by RFMSS (the Army's system of record for managing training area and firing range usage) at Forts Bragg, Campbell, Drum and Stewart over a 24-month period from June 2021 – May 2023, and combined this with anticipated fielding of SUAS as articulated by the *U.S. Army Small Unmanned System Strategy*, published by Army Forces Command in 2020. We assumed that SUAS should routinely be employed in training (as would any primary weapon or communication system).

We sought to estimate the number of daily training events at XVIII Airborne Corps installations that employ SUAS, if these units fully implemented their commander's guidance to use SUAS in training. The research team screened the RFMSS training data to remove cancelled training events, range control maintenance, training events conducted by organizations without organic UAS systems, and training events that had a set program of instruction that did not afford UAS opportunities (e.g., pre-Ranger courses or expert infantryman badge training). These data were for all units that could expected to fly SUAS, from company through BCT, as well as special operation forces (SOF). From these data, we extracted the busiest training day of potential UAS training events for each installation to predict the demand that an installation would need to support (see Figure 3).

Figure 3. Maximum Number of Potential UAS Training Events Per Day June 2021 – May 2023



SOURCE: Range Facility Management Support System, data for June 2022 – May 2023.

Using the data in the 2020 Army Small Unmanned Aircraft System (SUAS) Strategy about how many SUAS are expected to be in units that trained at these installations allowed us to estimate how many UAS would have entered the airspace on this "busiest day" if units flew their systems according to their MTOE-designed distribution (Army Futures Command, 2020, p. 8). Fort Bragg could experience over 700 SUAS flights and a smaller installation such, as Fort Campbell or Fort Drum, could experience over 200 SUAS flights (see Appendix A for details on how these numbers were derived, as well as details for these installations). This provides a rough estimate of the daily capacity required for a training ecosystem that supports a robust SUAS training requirement. Specifically, range operations, airspace managers and spectrum managers would need to be able to support this number of flights for units to conduct realistic training. Note as well that this analysis assumes units that have SUAS will fly them once per day when training, so may underestimate certain aspects of required training support should they be flown more frequently.

We note that this is a ceiling for needed capabilities based on 2022-2023 training data and the 2020 Army SUAS strategy, but one that is likely to increase as the Army acquires and fields additional SUAS to divisional units. Observations from the Russo-Ukrainian War indicate the necessity of fielding UAS to all branches of ground operations for security, reconnaissance, protection, and communications (Zabrodskyi, et al., 2022, pp. 57-58). Proposed expanded SUAS fielding options for the Infantry BCT suggest that the density of

SUAS in maneuver formations could increase significantly.[5] We should expect SUAS fielding will continue to expand in combat support and combat sustainment formations as well, based on how the 2020 SUAS strategy envisions its mid-term and far-term development (Army Futures Command, 2020, pp. 10-11). The Army is also accelerating development of a SUAS lethal munitions capability for maneuver formations.[6] A lethal munitions capability would require additional training demands for impact areas as units practiced integrating them into a range of tactical tasks.

Estimates of the SUAS demand on the training ecosystem should also address greatly expanded use of SUAS by OPFOR in any force-on-force training event or lane. The Russo-Ukrainian War and other analyses of foreign military UAS efforts indicate that adversaries will employ SUAS in large numbers, including quadcopters, first-person-view strike UAS, and small fixed wing SUAS (Zabrodskyi, et al., 2022; Shaikh, et al., 2023). Even in late 2023, the Russians are using SUAS in multi-ship packages to outflank or overwhelm Ukrainian battle positions. Much like how counter-improvised explosive device (counter-IED) training was widely integrated into battalion and below training during the 2000s and 2010s, counter-UAS training with OPFOR using multiple SUAS must become routine. U.S. formations must expect airspace in combat to be congested with friendly and enemy UAS systems—and they must train to fight through these conditions, beginning at home station (Zabrodskyi, et al., 2022).

Thus, the density of SUAS usage during training will likely increase significantly. For example, a single day in a battalion-level training event that included supporting fires and logistical units could experience dozens to over a hundred SUAS sorties. Each maneuver company would be employing multiple quadcopters in support of its attacks or defense. Multiple battalion SUAS hunter-killer teams consisting of a reconnaissance SUAS and a lethal munitions SUAS could range the battalion area of operations, seeking out battalion high payoff targets (particularly OPFOR SUAS ground control stations) or supporting companies in contact. An attached engineer platoon would use SUAS to look for mines or seed a rapidly deployed mine obstacle. Battalions resupplying companies would utilize SUAS for reconnaissance and overwatch tasks. The battalion combat trains might execute an emergency resupply mission for light, high-value items such as blood or batteries to a

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[5] Maneuver Robotics Strategy, concepts from Robotics Requirement Division, Maneuver Capabilities Development and Integration Directorate (CDID); draft Infantry Brigade Combat Team (IBCT) force design updates; AFC's 2020 Army sUAS Strategy allowed us to calculate the number of UAS systems per unit type and echelon. For example, the future IBCT will be equipped with 189 total Group 1 and Group 2 systems, ranging from the Soldier borne sensor (SBS) at the squad and scout section level to the Shadow (and its eventual replacement) at the BCT.

[6] During the course of this research, units on Forts Bragg and Benning planned for and conducted live grenade drops, and interviews revealed that Army Forces Command is emphasizing sUAS with lethal capabilities.

forward company or platoon using SUAS for route reconnaissance and some delivery. A firing battery supporting the training event would be using SUAS as well for target acquisition, firing position selection, and route reconnaissance. Meanwhile, the training event could also include an OPFOR element (composed, for example, of another battalion's UAS platoon or installation level assets) to employ their own OPFOR SUAS multi-ship packages for reconnaissance, call for fire, and even strike swarms. Each of these training tasks represents a way that SUAS are being used today in the Russo-Ukrainian war.

Home Station SUAS Training Challenges

A recurring theme during interviews with unit leaders and UAS operators was the difficulty of conducting home station training that integrates maneuver and UAS capabilities—with airspace and spectrum management arguably the biggest barriers to realizing the potential of the SUAS at home station (Interviews, 2022-2023). Range regulations also impose significant limitations, though we understand these are under revision; however, Range Control budgets, staffing, and equipment might also require significant changes, depending on the risk the senior mission commander on an installation is willing to accept for SUAS operations.[7] Interviews revealed broad dissatisfaction with the processes required to launch and operate SUAS at home station—particularly in support of collective unit training. As a result, training with SUAS in 2023 can only occur in frequency and scope that are too small to meet Army needs (Interviews, 2022-2023). Spectrum constraints and ways to mitigate them are discussed in the third volume of this series of reports (Osburg et al., 2025).

Many of these polices are beyond the ability of a single brigade or division commander to solve, much less a battalion or company commander. Yet, many of the issues in these three categories are self-imposed Army policy constraints—some can be solved by the Corps Commander, but many require intervention from U.S. Army Forces Command (FORSCOM) or HQDA. The core issue is often how the Army understands risks from SUAS flights, and how that risk is managed. Policies in place in 2023, for example, required two forms of communications with Range Control and two operators in place before SUAS were permitted to fly, which at any distance from Range Control makes SUAS use very difficult and prevents their use in combined arms, tactical training (e.g., could require large antennas or other arrangements to facilitate communications that are not mobile). The desire to mitigate risk during home station training may in fact be transferring risk to future combat operations (Zabrodskyi, et al., 2022). Risk approaches should facilitate

[7] In our interviews with Range Operations on one of the XVIII Airborne Corps installations, the issue of the need for a common operating picture, additional staff, and other technical capabilities was noted. Also, current range regulations treat sUAS and larger UAS as identical, as is discussed in a subsequent section.

making Army formations and leaders comfortable operating in an environment characterized by many SUAS operating in the airspace while also employing rotary and fixed-wing aircraft, fires, and other capabilities.

Airspace Regulations and Policies

Air space constraints on Army installations are dictated by a hierarchy of federal, DoD, Army, and installation regulations and policies regarding UAS flight operations. Many of these regulatory and policy documents were originally written and implemented for deconflicting larger UASs and associated hazards, and they are in some cases evolving to an environment of ubiquitous SUAS usage. While the FAA is adapting to the proliferation of SUAS, the Army and DoD need to adapt as well.[8]

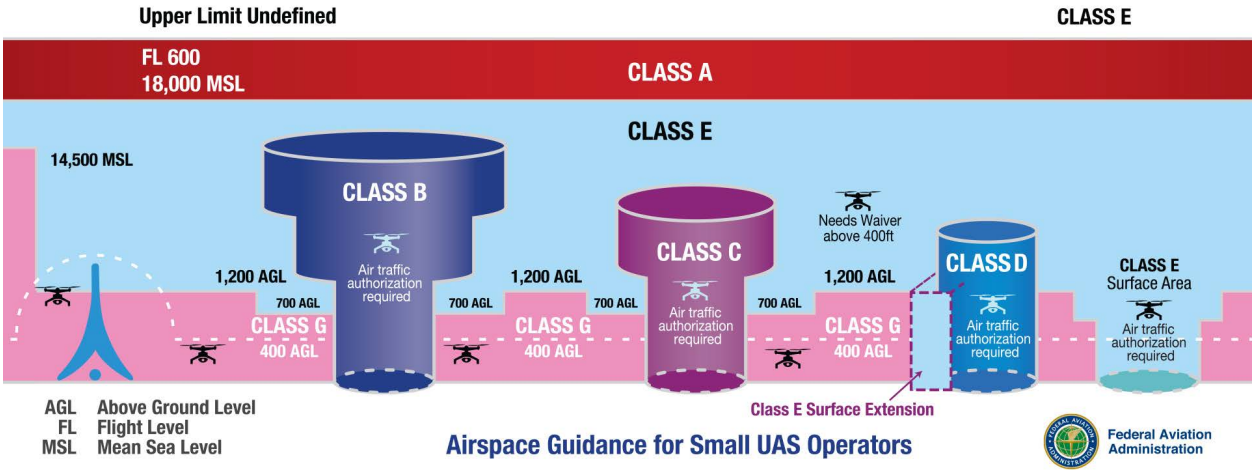
A complementary step to adapting policies is gaining a better understanding of collision risks between SUAS and rotary-wing aircraft. Even with Army and Joint procedures to deconflict airspace, ubiquitous use of SUAS by the enemy and civilian populations suggests this is a risk worthy of further investigation. Current policy is based on a 2015 United States Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC) assessment regarding "nano and micro UAS" (AMRDEC, 2015). This study relied on computer simulation and approximations of bird strikes, although the composition of UASs is significantly different in terms of soft vs. hard impact dynamics. Additional testing should consider the dynamics of different types of UAS material frangibility (frangible plastics, cardboard, etc.) as well as probable impact trajectories. Lacking authoritative testing for Group 1 and Group 2 SUAS leads installations and commanders to make assumptions about the collision risks that in some cases may be too conservative.

The Federal Aviation Administration sets regulatory requirements for the use of the National Airspace System (NAS), including the integration of UAS into the system. A basic understanding of how FAA categorizes airspace aids in understanding the Army's freedom of action in this space. The FAA categorizes national airspace as either regulatory or non-regulatory airspace. Regulatory airspace is classified in four types: controlled, uncontrolled, special use, and other airspace. The FAA determines categories and types of airspace based on the complexity and density of aircraft operations, level of safety required, and national or public interest. Controlled airspace is airspace within which air traffic control service is provided according to its class (Federal Aviation Administration, 2024). In some cases, such as Class G airspace, FAA guidance for operating SUAS is *less restrictive* than installation

[8] See U.S. Government Accountability Office, *FAA Should Improve Its Approach to Integrating Drones Into the National Airspace System* 2023 for report GAO-23-105189, and for status of recommendations based on 180-day letter GAO received from FAA on July 10, 2023. For information on recent sUAS operation waivers see Daleo, 2023.

requirements for range airspace. (see Figure 4 for the FAA's depiction of its guidance for SUAS operations in different categories of airspace).

Figure 4. FAA Airspace Categories



SOURCE: Federal Aviation Administration, undated.

Most military training occurs within the category of special use airspace—specifically, military operating areas. FAA delegates control of military operating areas to the DoD; however DoD must still adhere to FAA regulations and policy regarding training certifications and employment of UAS. A 2019 memorandum of understanding (MOU) between DoD and FAA is the current operant policy regarding military SUAS usage in DoD-controlled airspace.

The FAA regulates airspace to ensure that accidents are reasonably minimized. Unfortunately, the 2019 MOU referenced above no longer fully addresses the military employment potential of SUAS and Commercial of the Shelf (COTS) UAS systems. Specifically, the FAA SUAS regulations (Part 107) affect both operator qualification and flight operation. For military UAS operator qualification, all Group 1 and Group 2 operators must gain the FAA's Remote Pilot Certificate (FAA, 2020)—which includes online classes and a certification exam at an FAA-approved knowledge testing center. Part 107 also restricts how military Group 1 and Group 2 SUAS (SUAS under 55 lbs) can be used in military operating areas—including visual flight rule (VFR) minimums and beyond-visual-line-of-sight (BVLOS) operations. Part 107 explicitly states that UASs can be employed only when VFR weather minimums are met and stipulates that there must be a qualified operator and an observer present when a UAS is in the airspace so that the UAS team can maintain visual contact with the system during operation. This prevents the employment of SUAS beyond-visual-line-of-sight without a waiver from both the Department of the Army

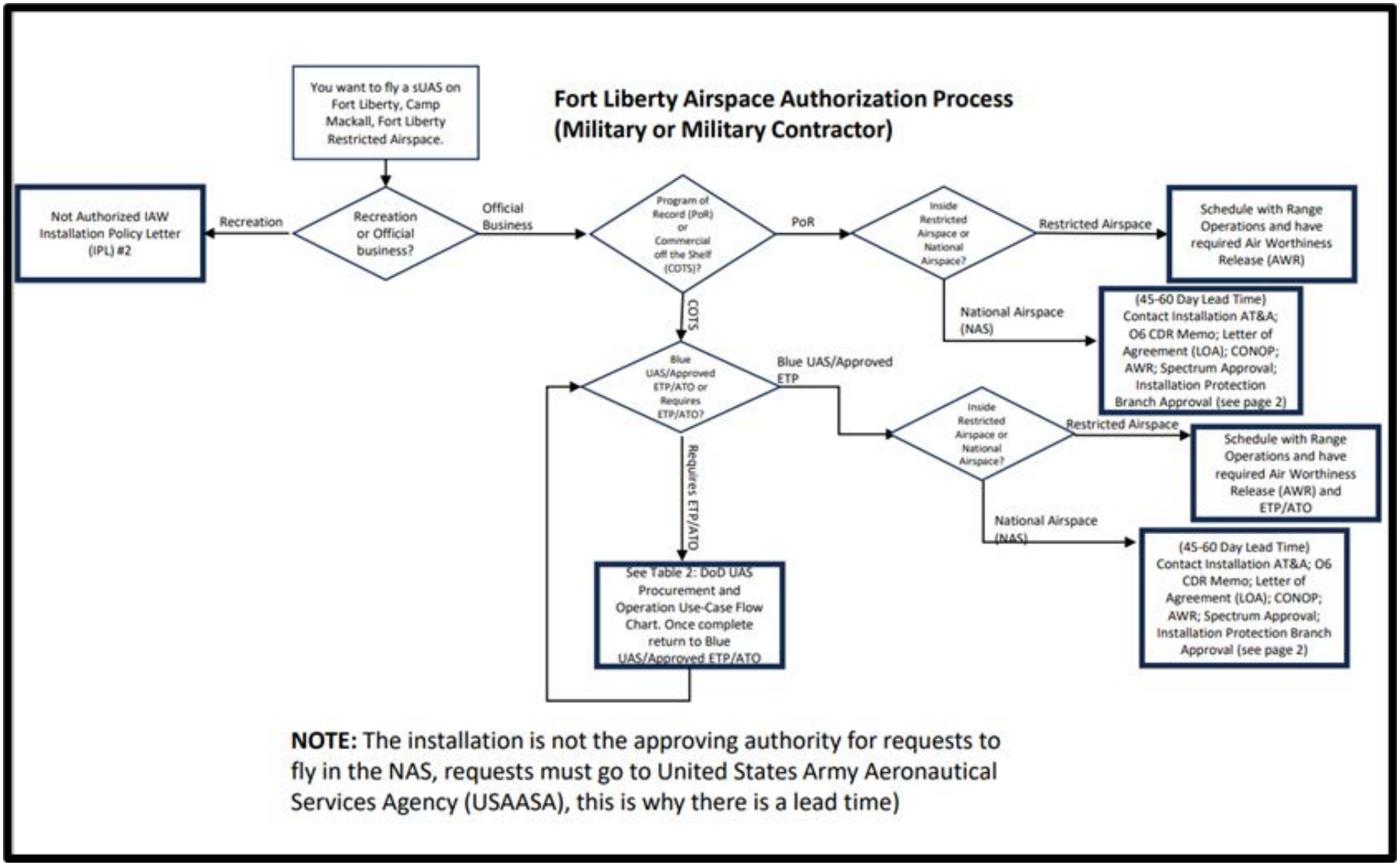
and FAA—but employing them in this manner is precisely how they are meant to be used in combat operations: beyond the front line of troops in all types of weather and illumination conditions. However, it is worth noting that Part 107 rules allow the operation of UAS without radio communication with air traffic control or coordination with FAA in uncontrolled airspace (Class G), which usually extends from the ground to the base of Class E airspace (often either 700 feet or 1200 feet above ground level, depending on the location) (Federal Aviation Administration, 2024).

Over the last three years, the FAA has become more open to changing its rules on SUAS employment in the civilian sector. The FAA has recognized the evolving SUAS environment and begun reviewing rule changes to its SUAS regulations (U.S. Government Accountability Office, 2023). The FAA established a BVLOS rulemaking committee in 2021, which developed several recommendations for the FAA to consider in developing a final BVLOS rule. As of September 2023, the FAA granted waivers to three commercial companies to allow them to fly SUAS under 55 lbs BVLOS (Daleo, 2023).

Army units must request such waivers on a case-by-case basis (in some cases from Department of the Army, FAA, and the U.S. Army Aeronautical Services Agency [USAASA]). These waiver requests must be summited 45-60 days before the training event and usually go to USAASA for approval. This time horizon may be lengthened due to administrative requirements accompanying the request and can be further lengthened if Army formations plan to fly COTS UAS, which require an exception to policy signed by Department of the Army (DA). Figure 5 illustrates this process for Fort Bragg. These extensive constraints for a class of systems that is rapidly proliferating in the force suggests that the Army should reexamine its regulations. In addition, the Army needs more rapid processes for adjudicating risk that push risk acceptance to lower command levels that are better situated to understand the training event's specific tactical context and airspace risks.

One obstacle to making better risk informed decisions is the lack of empirical air worthiness experimentation data about collision risk between rotary-wing aircraft and SUAS. The controlling U.S. Army Research, Development, and Engineering Command (ARDEC) memo from 2015 notes that bird strike data is not representative of SUAS collisions and that "to determine the risk posed to the manned Army aircraft further research and testing is required to define the threshold "size" tolerable to Army aircraft"(ARDEC, 2015, p.2). Given the rapid proliferation of enemy, civilian, and ally and partner SUAS in the battlespace, irrespective of U.S. Army usage, better understanding SUAS collision risks is worthy of Army investigation. Better understanding of the effects of different material types (e.g., cardboard), frangibility, collision avoidance systems, and flight dynamics for SUAS could assist commanders in making better informed risk decisions regarding both system acquisition and operational parameters.

Figure 5. Fort Bragg SUAS Approval Flow Chart



SOURCE: Regulation 350-6, *Installation Range Operations*, Fort Bragg, 2018.

FAA regulations are not the only constraints on SUAS usage. DoD policy delegates approval authority for employment of Groups 1, 2, and 3 UAS to the service secretaries. The policy authorizes further delegation down to the O6-command level, but only for program of record systems—COTS UAS are explicitly prohibited from operation on installations without an approved DA exception to policy. Army policy delegates approval authority to operate Army systems of record to the O6-command level (Secretary of the Army, 2020).

In sum, gaining waivers or easing constraints on SUAS training will require revision of several policy documents:

- The Federal Memorandum of Understanding between the Department of Defense and Federal Aviation Administration for Unmanned Aircraft System Operations in the National Airspace System, May 9, 2019;
- Army Regulation (AR) 95-1 (Flight Regulations), 22 March 2018;
- Headquarters, Department of the Army (HQDA) Execute Order 029-20 (Army Implementation of the Department of Defense and Federal Aviation Administration for Unmanned Aircraft System Operations in the National Airspace System), 2 January 2020;
- Various installation 95-1 (Flight Regulations) policies.

This level of cross-DoD and interagency effort should be led by the Department of the Army.

To address these issues, the Army, DoD and FAA should consider the recommendations below. These revisions should be written broadly enough to capture the anticipated rapid increase in the number of SUAS across Army formations and installations.

Recommendations for addressing airspace regulation constraints:

- The DoD and Army should update their policies and regulations to differentiate between (1) rotary-type quad-copters and fixed-wing UAS for all maneuver formations (Group 1); (2) rotary-type quad-copters for Group 2; (3) fixed-wing UAS at medium altitude into operational depth (Group 2 and Group 3); and (4) high-altitude platforms (Group 4 and 5) (Zabrodskyi, 2022).
- The FAA should refine the Part 107 rule to allow DoD to operate BVLOS for Group 1 and Group 2 SUAS during military training and operations. If the complete removal of this restriction is not feasible, a feasible solution would be for FAA to delegate BVLOS approval authority for SUAS operations to the DoD (and DoD to appropriate level Army commands) when these operations take place in DoD-controlled airspace and in national airspace over DoD installations below a coordinating altitude. This alternative solution would increase SUAS training flexibility while not altering FAA airspace management.
- The DoD and FAA should consider removing VFR weather minimum waiver requirements from their 2019 MOU for SUAS operations in DoD-controlled airspace. Specifically, delegate waiver approval authority to military leaders when VFR

weather minimums, defined for Group 1 and Group 2 systems in Part 107 as three statute miles of visibility from the ground control station and 500 feet vertical and 2000 feet horizontal separation from clouds, are not met (Federal Aviation Administration, 2019). This would allow commanders to assess potential hazards and set controls and the resultant risk.

- HQDA should define the Army risk management and waiver approval process for SUAS employment to provide lower-level commanders more realistic management of risks and greater flexibility in training (e.g., company commander – low risk; battalion commander – medium risk; brigade commander – high risk; division commander – extremely high risk).[9]
- DoD should update the approval process for operation of SUAS in the NAS to reduce the number of days in advance of a training event that a waiver must be requested.
- The DoD should delegate approval for Group 1 and 2 COTS UAS operations in DoD-controlled airspace to the appropriate risk level instead of requiring a Department of the Army (DA) waiver. DoD should treat Group 1 and 2 DoD approved COTS UAS used for military purposes in DoD-controlled airspace as no different than program of record systems (see Putney et al., 2025, for a discussion of approved COTs UAS).
- ARDEC should conduct further research and testing on the collision risks across the range of Group 1 and Group 2 SUAS to better understand risk parameters.

Range Control Regulations and Polices

Range regulations across XVIII Airborne Corps vary with respect to SUAS operations. Differences in unit density, land and airspace availability, and mission essential task lists (METL) account for some of the variation. A key question for range regulations is: how is risk understood and addressed while supporting training requirements? Installation range regulations and policies generally appear to have been written in a manner that treats SUAS the same as larger UAS, such as the Shadow or Gray Eagle.

Current training environments and constraints do not accommodate the Army training principle in FM 7-0, *Training*, which states, "The Army trains the way it operates. It does this by replicating in training how we expect to fight" (Department of the Army, 2021, 1-1). Local range control regulations and policies require several revisions to facilitate realistic home station training that integrates SUAS into combined arms operations instead of treating the systems as an ancillary capability. This section summarizes some of the key constraints identified during interviews and by reviewing the pertinent regulations and policies from the federal to the installation level. Table 1 summarizes these constraints

[9] The 75th Ranger Regiment uses a composite risk management process for UAS operations that is outlined in the organization's sUAS SOP. The organization's risk assessment worksheet includes risk factors such as: wind, visibility, ceiling, precipitation, crew rest, communications, 60-day currency of the UAS operator/s, number of crewed and uncrewed aircraft in the airspace, and other considerations.

across Federal, DoD, XVIII Airborne Corps' four division-level installations' regulations and policies.

Table 1. SUAS Range Operations Constraint Summary

Agency / Installation	2-means Comms	BLOS Operations	Greater than 1 SUAS	UAS within SDZ
DA	?	P	?	?
Fort Bragg	?	P	P	?
Fort Campbell	R	P	?	C
Fort Drum	R	P	P	C
Fort Stewart	R	P	?	P

NOTES: 2-means Comms = units must maintain two means of communication with range control; BLOS = beyond line of sight; SUAS = small uncrewed aircraft system; SDZ = surface danger zone; DA = Department of the Army
C = Permitted with pre-training event coordination
P = Prohibited by regulation or policy
R = Requirement by regulation or policy
? = No mention of a requirement or prohibition

First, SUAS use is constrained by requiring units to maintain two forms of communication with range control during training and operations. This requirement often results in units struggling to maintain communications with organic equipment and resorting to administrative communications means, potentially preventing tactical use of SUAS (Fort Bragg Regulation 350-6, Fort Campbell Regulation 385-5, the Fort Stewart Range Guide, and Fort Drum Regulation 350-4). Future refinements to installation policies must examine the utility of current communications requirements as they relate to managing the balance between risk and realistic training—range control requirements should reinforce the use of equipment that army organizations will employ in combat, including use of a common operating picture to de-conflict airspace at both the unit-level and range control. It is worth mentioning here as well that this requirement coupled with orders of magnitude greater SUAS use would not only make integrating SUAS into realistic training extraordinarily difficult but would also create an enormous burden on Range Operations, which would have to maintain equipment and operators to support a far greater number of communications channels than they currently monitor.

Second, some installations constrain SUAS operations by allowing no more than two systems to operate in the same training area simultaneously without special permission from range control personnel and by prohibiting BVLOS operations (Fort Bragg Regulation 350-6, Fort Campbell Regulation 385-5, the Fort Stewart Range Guide, and Fort Drum Regulation 350-4). As the Army fields SUAS down to the platoon, squad, and scout section level, this will unacceptably limit SUAS use and deny small unit leaders the opportunity to

gain needed experience integrating multiple SUAS systems into their operations. For example, current constraints would limit an infantry company commander—who would have at least one company level SUAS, and platoon and squad level SUAS for each subordinate platoon and squad—to using only one SUAS. This would fundamentally change how that company could conduct any mission (e.g., a movement to contact that would require integrating company, platoon and potentially squad level SUAS with maneuver to gain contact with the enemy BVLOS to develop the situation). Indeed, Army concepts tout the ability of SUAS to extend the reach of tactical formations by allowing operators and unit leaders to understand the battlefield BVLOS (Forces Command, 2020). Moreover, this restriction limits the ability to train simultaneous force-on-force operations with both sides using SUAS. In short, it makes it impossible for Army forces to train as they will fight.

Third, employment of SUAS within the surface danger zone (SDZ) of a weapon system is in some cases prohibited (Fort Campbell Regulation 385-5). The character of contemporary conflict and potential missions that SUAS will conduct in the future lends itself to assuming that to best support the close fight at the battalion and below, leaders and SUAS operators must be competent and confident with integrating SUAS operating within the SDZ and minimum safe distances (MSD) of a unit's organic direct and indirect fire weapon systems. In particular, SUAS must be within the SDZ and MSD of organic systems if unit leaders are to employ them to their full capabilities and improve the organization's ability to detect and deliver fires against a threat.

These challenges are amplified by the administrative nature of range control operations, which prohibit units from controlling the airspace in a manner like they would in combat, including the use of organic mission command systems and establishment of a common operating picture (COP). As a result, CTC rotational units routinely establish restricted operations zones (ROZs) not integrated into the BCT's maneuver plan for fear of not being able to deconflict airspace in a timely manner when they need SUAS capabilities. In other words, there is a cascading effect from operator mastery to staff planning that muddles the airspace through emplacement of airspace coordination measures (ACMs), which in turn hinder synchronization of capabilities across the warfighting functions and prevent realistic training.

In summary, range regulations and policies were written and implemented without consideration of the future ubiquity of SUAS down to the squad level and, as such, hinder the building of confidence and capability from the individual to the collective level. Installations must remove administrative barriers that, while mitigating accidental risk, unreasonably limit realistic training and do so in a manner that units could not implement in combat. As is discussed in the fourth volume of this series (Camm, Girardini, and Kelly, 2025), the risks of SUAS lost in training should not be measured against a goal of zero losses, but should rather be commensurate with the value of the gains in proficiency

needed for combat. To do this, the Army should consider training with SUAS in a manner as close to how they will be used combat as possible. There are a number of policy, procedural and material options to make it easier for units to train both individual UAS operators and unit combined arms operations at home station.

Recommendations for simplifying range regulations:

- In the short term, XVIII Airborne Corps installations should consider creating specific areas with permanent ROZs as SUAS training areas. Fort Campbell overcame part of the air space challenge with permanent UAS ROZs at the Shadow training area.
- XVIII Airborne Corps installations should revise range regulations to allow operation of Group 1 and Group 2 UAS beyond-visual-line-of-sight and allow multiple Group 1 and Group 2 UAS to operate in the same airspace, to the maximum extent permitted by Army regulations.
- XVIII Airborne Corps installations should consider range control processes that deconflict airspace via time and horizontal and vertical separation of systems rather than hard limits on how many systems can be used in a training area at a time. These processes and regulations should recognize that the risk of SUAS loss or damage rests with the owning unit, rather than the installation, while continuing to manage risk to soldiers.
- XVIII Airborne Corps installation range operations should be equipped with systems that can track UAS and create a common operating picture of UAS operating in the range areas. The creation and use of such airspace management and tracking systems could minimize risk and allow additional revisions to range policies that would permit more realistic training.
- XVIII Airborne Corps installations should examine options for, and where feasible implement, changes to regulations that permit units to operate in, and manage, airspace as closely as possible to how they will do so in combat while managing training risks. This will cause units with staffs (typically battalion and above) to exercise airspace planning and management routinely, and cause all tactical units to operate more closely to how they would in combat.

SUAS Individual Training

The Army of 2023 has too few *expert* operators, airspace management technicians, commanders and staff who can plan and execute operations using SUAS, and trainers—the essential "doers" that execute advanced SUAS employment in combined arms operations. In this section we focus on trainers and operators.

The training pipeline for master trainers and operators is insufficient for 2023's force, much less the force with more SUAS that will come about in the next few years (Interviews, 2022 and 2023). Because operators are trained at home station by master trainers who

graduate from a course offered by the Maneuver Center of Excellence (MCOE) at Fort Benning, training pipeline throughput is a function of the institutional-level master trainer school requirements and basic operator qualification and proficiency programs at home-stations or unit-level.

Combined arms SUAS employment requires operators with more than basic qualification and currency. These milestones represent a minimum for operating SUAS but are too often treated as the end point. Contemporary examples from Ukraine and Russia illustrate how both sides have adopted selection and training programs, often at the unit level, for producing expert operators (Skove, 2023; Shoaib, 2023; Myre, 2023). In the Russo-Ukrainian war, expertise is essential for not only tactical effectiveness, but also operator survival. Comparisons with the combat orientation of Russian and Ukrainian SUAS training programs suggest U.S. Army individual training needs upgraded instruction for flight operations in a contested environment, better training simulations for practicing TTP, and more repetitions with the SUAS systems (Melkozerova, 2023; RFE/RL's North.Realities, 2023; Borsari and Davis, 2023).

Additionally, given the much more congested friendly airspace environment, U.S. Army SUAS operators face an additional training requirement to be knowledgeable about how to operate safely within the joint force airspace coordination environment (not to mention the peacetime training airspace environment). Interviews indicated that comfort and speed with the processes for SUAS airspace management is a key deficiency for individual operators, battalion battle staff, and brigade Air Defense and Airspace Management (ADAM) cells.

The variation and overlapping roles of operators by military occupational specialty (MOS), personal development skills identifiers, and certification levels can cause confusion. Per AR 95-23 and TC 3-04.62, all Group 1 SUAS operators require Basic Unmanned Aerial System Qualification Level-I (BUQ-I) and unit-level Mission Qualification (MQ) (Army Regulation 95-23, 2018; Chairman of the Joint Chiefs of Staff Instruction 3255.01, 2012, p. 1).

- “BUQ Level I. BUQ-I is the minimum recommended training level for UAS crewmembers who perform duties other than pilot (e.g., Aircraft Operator/Sensor Operator). They must possess required aviation knowledge and UAS knowledge-based skills to fly under visual flight rules (VFRs) in Class E, G, and restricted/ combat airspace <1200’ above ground level (AGL)” (Army Regulation 95-23, 2018).
- Mission Qualified. Operators progress to MQ based on a commander’s evaluation and proficiency flight evaluation (PFE) that demonstrated proficiency in TC 3-04.62 defined 1000 and 2000 levels “and those tasks selected by the commander based on the unit’s METL” (Training Circular 3-04.62, 2013, p. 2-1).

Example systems flown by Group 1 SUAS operators include: RQ-11B Raven, RQ-20 Puma, RQ-128 Wasp, and R80D Skyraider (quadcopter). Note, the Soldier borne sensor (SBS) system UAS has no formal qualification or currency requirements.

MCOE-trained master trainers are the key link in the SUAS individual operator training pipeline. At home station, initial qualification training of SUAS operators must be managed by a master trainer at the brigade level or higher. Master trainers conducting initial qualification training must be designated by the first colonel in the chain-of-command (Training Circular 3-04.62, 2013, p. 1-1). Only a "school-house" trained master trainer can certify an individual operator as BUQ-I qualified and mission qualified, as well as certify company unit trainers. Although company unit trainers cannot certify basic qualification, they are authorized to certify currency training for qualified operators, as well as assist in initial qualification training. Company unit trainers help by executing currency training, tracking flying hours in the SUAS management (SUASMAN) system (the system of record for tracking SUAS qualifications), and providing leadership to company SUAS teams (Hayball, Kerkoff, Sarver, 2019, p. 66).

Master trainers are the key component to the system of individual training. Without enough master trainers, the unit production pipeline of certifying individual operators and maintaining their currency falls behind in a negative reinforcement loop that increases the burden on the few master trainers in the unit. Ensuring the Army can produce them at scale is critical.

Master Trainers—Insufficient Production at the Institutional Level

A snapshot of XVIII Airborne Corps units showed widespread shortages of school-house certified master trainers at the battalion and brigade levels (see Table 2). Having too few certified master trainers has pernicious downstream effects on numbers of qualified individual operators and unit trainers, as well as the quality of battalion/brigade individual operator training programs and the battle staff incorporation of SUAS into combined arms operations. Too few master trainers in a unit limits the number of individuals who can be trained in an initial qualification course, due to required instructor-student ratios. A healthy number of master trainers allows units in garrison to expand operator training to advanced TTP. During unit training or operations, a healthy number of master trainers can provide additional expertise to battalion battle staffs for airspace planning and coordination, as well as SUAS employment techniques for intelligence collection or fires support tasks.

Table 2. XVIII Airborne Corps SUAS Master Trainer Status

Unit	SUAS TYPE	SUAS UNIT MASTER TRAINERS	
		REQUIRED	CERTIFIED
3 Inf Div	RAVEN	10	4
10th Mtn Div	RAVEN	24	5
82d Abn Div	RAVEN	21	8
82d Abn Div	SKYDIO	5	3
101 Abn Div	RAVEN	26	8
18 FA Bde	RAVEN	2	0
20 En Bde	RAVEN	4	0
16 MP Bde	RAVEN	5	4
Corps Total		97	32

SOURCE: Data provided by XVIII Airborne Corps, July 28, 2023.

The causes of insufficient numbers of SUAS master trainers begins with the limited throughput at the centralized training course at Fort Benning. The course produced 90 SUAS master trainers in Fiscal Year (FY) 2022 and has a structure and manning decision review (SMDR) of 112 students for FY23 and FY24—well below future Army requirements.

According to some XVIII Airborne Corps soldiers interviewed in 2022-2023, many units and individuals do not place a high value on school-house master trainer certification. Units hesitate to send senior noncommissioned officers (NCOs) away from home station for three weeks, especially when course times do not align well with busy training schedules. From the individual perspective, numerous interviews with master trainers across the XVIII Airborne Corps and other UAS stakeholders indicated that having the master trainer course at Fort Benning, combined with little to no incentive for non-commissioned officers to attend the course, result in lower numbers of qualified master trainers proliferating across the XVIII Airborne Corps and the Army.

One reason why more NCOs are not anxious to become master trainers may be because they are awarded a personnel development skill identifier (PDSI) upon graduation, which lacks the career advancement value of an additional skill identifier (ASI)—like the Master gunner ASI—which is associated with a career advancing duty positions. Also, because

PDSIs are not associated with any duty position, Human Resources Command cannot manage SUAS master trainer allocations across the force.

Importantly, school-house training of master UAS operators focuses on FAA compliance, but neglects SUAS tactics, techniques, and procedures for combat employment. Appendix D, Army Regulation 95-23, *Unmanned Aircraft Flight Regulations*, standardizes training requirements for master trainers. The master trainer course is a three week program of instruction (POI) that was described by an Army leader as, "primarily a CONUS FAA compliance course to ensure we legally operate in restricted and controlled airspace."[10] The current training path produces competent SUAS operators, but seldom operators who have mastered SUAS employment or tactics in support of combined arms operations.

Recommendations for increasing master trainer production:

- First, the Army could increase master trainer production through MCOE increasing the number, frequency, and class size of master UAS trainer Mobile Teaching Team (MTT) visits to home stations. Home stations (Division) would need to coordinate the necessary training facilities, range areas, and airspace coordination, as well as emphasize maximum attendance from brigades and battalions. Home station MTTs could also help address Army National Guard challenges in certifying SUAS master trainers.
- Second and alternately, the Army could permit divisional installations to create their own Master Trainer courses, similar to the Jumpmaster course at Fort Bragg.
- Third, the Army could also use civilian contractors to surge production of Master Trainers (sUAS News, 2020; Manuel, 2023).

Individual Training—Moving Beyond Basic Proficiency

At first glance, the snapshot of SUAS individual operator qualified numbers across the XVIII Airborne Corps depicted in Table 3 does not reflect severe shortfalls in the number of required certified operators. However, the Army may be significantly underestimating the number of needed certified operators to maintain 24/7 combat employment of SUAS, while also planning for possible casualties, absences, and crew rest requirements. Given the anticipated density of SUAS, maneuver elements will want many more trained operators than SUAS, because they will not want to lose capability if they lose or are temporarily without some of their few operators. Furthermore, being a SUAS operator is an additional duty for most operators, which often takes second priority to that soldier's primary MOS duties according to those interviewed for this project. These bifurcated responsibilities can detract from proficiency and availability.

[10] Interview with Army leader, September 2023 (name withheld).

Table 3. XVIII Airborne Corps SUAS Operator Qualification Status

Unit	SUAS		SUAS OPERATORS	
	TYPE	AUTH	ON HAND	REQUIRED	CERTIFIED
3 Inf Div	RAVEN	38	38	76	104
10 Mtn Div	RAVEN	63	63	126	128
82d Abn Div	RAVEN	63	63	126	128
101 Abn Div	RAVEN	65	64	116	39
18 FA BDE	RAVEN	7	6	14	0
20 EN BDE	RAVEN	8	7	16	6
16 MP BDE	RAVEN	34	34	68	5
Total		278	275	512	410

SOURCE: Data provided by XVIII Airborne Corps, July 28, 2023.

Becoming certified as a Group 1 SUAS operator for combat operations is a three-step process:

1. BUQ-I operator online qualification,
2. Passing a two-week initial qualification course, and
3. Becoming mission qualified within a particular unit (Army Regulation 95-23, 2018).

A soldier gains general BUQ-I level qualification by taking the DoD online course via SUASMAN and passing its examination. This initial operator qualification course is a United States Army Training and Doctrine Command (TRADOC) -approved exportable training support package conducted by a qualified and current Master Trainer. Mission Qualification (MQ) standards are set at the brigade or division-level. TC 3-04.62 sets the minimum standards for MQ as a commander's evaluation/proficiency flight evaluation of level 1000 and 2000 doctrinal tasks and tasks selected by the commander based on the unit's METL. Units vary in how they have defined MQ. The 75th Ranger Regiment requires small UAS operators to achieve Joint Mission Qualification-A certification, which includes a range of joint fires coordination tasks based on their anticipated tactical integration with joint elements, but also significantly lengthens initial operator instruction to over 80 hours (Headquarters, 75th Ranger Regiment, 2021). At a minimum, Army policy mandates a SUAS operator must meet three requirements to remain current (Headquarters, Department of the Army, 2013, pp. 2-1 to 2-5):

- Pass the semi-annual proficiency and readiness test (S-APART). The S-APART consists of written and hands-on performance tests administered by a current UAS Master Trainer;
- Launch, recover, and conduct a 15-minute simulator or live flight every 30-days;
- Launch, recover, and conduct a 15-minute live flight every 150-days.

However, just as in marksmanship or gunnery training, initial qualification, MQ certification, and currency requirements set baseline proficiency standards but not the end state of individual training programs. While some units are producing the number of required operators, being able to competently fly a SUAS does imply an operator is capable of employing it in combined arms operations. An important shift in how the Army conceives of qualification would be to shift from focusing on *operator* currency to defining and requiring *unit* currency; for example, defining and meeting standards for integrating SUAS into operations based on combined arms TTP (Hayball, Kerkoff, Sarver, 2019, p. 71).

At the individual operator level, training proficiency needs to expand beyond basic operator tasks to include level 2000 and 3000 skills for advanced flying techniques and combat mission planning that make an operator combat proficient, such as:

- Night and low visibility flying;
- Restricted terrain flying, including urban environments;
- First-person view flying;
- Micro-level maneuverability, particularly for quadcopters;
- Mission planning, including selecting flight plans, sensors, and techniques dependent on mission, enemy, time, terrain, and civilian considerations (METT-TC);
- Electronic warfare threats and counter-measure techniques;
- Operator camouflage and survivability techniques;
- Combat employment techniques, including multi-ship techniques (Nicholson, 2019, pp. 14-15);
- Airspace management processes;
- Call for fire training; and
- Intelligence collection skills.

These advanced operator proficiency skills are proving essential to battlefield survivability and effectiveness for SUAS operators in Ukraine and elsewhere.

Consolidation of SUAS operators at the battalion level is an option that some XVIII Airborne Corps battalions have adopted. Managing SUAS training at the line company level is a significant challenge that includes reserving training areas, verifying certifications and tracking flight hours, and according to some commanders and staff officers interviewed for this report, places an undue burden on a line company commander. Consolidating operators in a UAS platoon in the battalion Headquarters and Headquarters Company (HHC) with the master trainer as the platoon sergeant increases training opportunities for operators, according to some XVIII Airborne Corps leaders. It also improves opportunities

for integrating SUAS in force-on-force exercises (including intel collection planning and airspace/fires planning), call for fire integrated training, and facilitates having dedicated vehicles in support with power inverters, battery chargers, antenna masts for improved line of sight communication, and mounted ground station monitors (Hayball, Kerkoff, Sarver, 2019, p. 66). Consolidating SUAS operators also elevates the problem created by the fact that being a SUAS operator in a line company is an additional duty. However, it removes a soldier from the normal career path for his or her MOS, which could affect proficiency in those skills and promotion—a topic that the Army should examine. This research did not examine the effect of organization on proficiency or promotion potential for SUAS operators, but these are important considerations that should be examined.

Recommendations for individual operator training:

- TRADOC should consider shortening the length of SUAS individual qualification course. While this research did not investigate how much it could be shortened, interviewees in the XVIII Airborne Corps proposed shorting it from two weeks (80 hours) to one week (40 hours) for smaller Group 1 quadcopters (such as the R80D Skyraider and the Skydio short range reconnaissance UAS) based on what operators need to know given their limited operating altitude and range (Interviews 2022-2023).[11]
- The Army should standardize SUAS individual training by establishing baseline training tasks, conditions, and standards for the operation of SUAS platforms in a manner analogous to how it approaches training via the Integrated Weapons Training Strategy (IWTS) (see the bullet below on IWTS and Table 5). This training methodology will ensure that SUAS operators establish proficiency at various training gates before moving on to the next progression in their training path, thus providing company and battalion commanders with assessments of operator and unit proficiency. A unit SUAS training program should not only focus on maintaining operator qualifications and currency, but on employment in support of unit mission essential tasks.
- The XVIII Airborne Corps should consider requiring a higher level of flight proficiency for SUAS quadcopters, such as what is used by the 75th Ranger Regiment.[12]
- XVIII Airborne Corps units should consider making training new operators and proficiency sustainment battle rhythm events. (Hayball, Kerkoff, Sarver, 2019, p. 71)

[11] During our interviews with XVIII Airborne Corps Soldiers, it was suggested that the course be shortened from two weeks to one week. The interviewee did not indicate specifically what part of the program of instruction should be cut out, or whether any analysis was done to verify that this was reasonable. That would need to be investigated. However, XVIII Airborne Corps soldiers we interviewed were consistent in their opinion that the course contains information not needed by those operating sUAS and that it should be shortened.

[12] The 3rd Battalion 75th Ranger Regiment's sUAS qualification program mirrors the National Institute Standards Technology (NIST) Bucket Test by putting operators through the paces of maneuvering their respective system in and amongst obstacles of varying dimensions during both day and night.

- XVIII Airborne Corps should consider standardizing and tracking levels of operator proficiency through proficiency tiers.
- SUAS operators who fly SUAS at altitudes above 400 feet above ground level (AGL) should be trained on airspace management techniques as part of a SUAS qualification course and during sustainment training at home station.
- XVIII Airborne Corps should consider developing a unit training program modeled on the IWTS' progressive approach to developing skill proficiency (Department of the Army, 2019). The IWTS is designed to be used for each weapon, system, or platform (regardless of echelon) to build, sustain, and assess task proficiency. Critical to this methodology is assessment of proficiency at each training gate up to a culminating training event under live fire conditions. Table 5 outlines an example of training progressions mirroring the methodology of the IWTS. Similar to IWTS, the Army should consider creating a Table progression of increasingly more advanced or complex SUAS employment from operator qualification to advanced flight techniques to situational training exercise (STX) lanes to employment with ground unit live fires (See Table 4).

Table 4. IWTS Training Progression Example

	Table I	Table II	Table III	Table IV	Table V	Table VI
Function	**Operator Qualification**	**Bucket Test**	**S-APART**	**Collective Task Proficiency**	**Live Fire Rehearsal / Practice**	**Live Fire Proficiency Gate**
Principle	Crawl	Walk	Walk	Walk	Run	Run
Environment	Live	Live	Live Virtual	Live	Live	Live
Condition	Hands-on	Hands-on	Hands-on or TADSS	TADSS or STX	Dry-blank Fire	LFX

NOTES: EXEVAL = external evaluation; LFX = Live Fire Exercise; S-APART = semiannual proficiency and readiness test; STX = situational training exercise; TADSS = training aids, devices, simulators, and simulations

- TRADOC should develop exportable training support packages for advanced SUAS operator techniques.
- Installations that support divisions should consider building an installation-level threat UAS capability as a training enabler for C-UAS training section.

Required Staff Proficiency

An often overlooked individual and staff competency requirement for effective SUAS employment at the brigade and battalion levels is air-ground operations coordination experts. The Army relies on several different military occupational specialty (MOS) positions to coordinate air-ground operations at the brigade level and below. Combat

aviation brigades have airspace management warrant officers (MOS 150A) leading a team of technicians that are well integrated into flight operations and well-practiced in coordinating of Army aviation with MQ-1C Gray Eagles (Group 4 UAS). BCT-level tactical UAS platoons have UAS operations warrant officers (MOS 150U) to support airspace coordination requirements for RQ-7B Shadow (Group 3 UAS). In each case, these formations are manned with the necessary expertise in the necessary numbers to manage complicated air-ground coordination responsibilities.

Given the anticipated scale of Group 1 and Group 2 SUAS fielding, it is probable that maneuver brigades and battalions do not have sufficient airspace management expertise on their staffs for the future battlefield. If the brigade does not have an attached Brigade Aviation Element (BAE), then the ADAM cell's air defense technicians provide the sole airspace management expertise at the brigade level—without aviation branch personnel to guide airspace management or provide additional manpower coverage for 24/7 operations (Van Loan, 2022, pp. 11-13).

While the division is the primary airspace manager, the brigade-level ADAM/BAE element is the focal point role for coordinating tactical SUAS employment. The division-level Joint Air-Ground Integration Center (JAGIC) relies on subordinate brigades to plan and manage their airspace users (Cronen and Rich, 2022, p. 4; Army Field Manual 3-52, *Airspace Control*, 2016). The BAE includes dedicated aviation operations sergeants (MOS 15P) and airspace control sergeants (MOS 15Q) to process mission requests and operate the Tactical Airspace Integration System (TAIS) in support of brigade airspace activities. One challenge is that ADAM/BAEs only exist in brigade combat teams, which means that non-BCT formations such as fires, sustainment, and maneuver enhancement brigades rely solely on air defense personnel for airspace management (Army Techniques Publication 3.01-50, 2013, p. 1-1).

At the battalion level, responsibility for airspace management is not clearly identified in doctrine between the S-3 operations sections and the fires coordination element (Army Techniques Publication 3-21.20, 2017, pp. C-8 to C-9 and Army Field Manual 3-96, 2021, pp. 4-71 to 4-73). The battalion level is a key link in SUAS employment as the battalion operations element must collect, manage, and submit SUAS airspace requests to higher headquarters—both pre-planned and immediate requests. This gap in expertise is even more apparent when compared to Tactical UAS platoons (Shadow) at the Brigade level that have a dedicated UAS operations technician (MOS 150U) to integrate reconnaissance mission planning, airspace coordination, and indirect fire support coordination to support four Group 3-size aircraft (Van Loan, 2022, p. 11). At the battalion level, a battle staff could be coordinating the employment of dozens of SUAS flying at altitudes below 1200 feet AGL, as well as integrating them into battalion fires support execution and the battalion intelligence collection plan.

Battalion TOEs lack a designated staff for airspace management, this task often falls to a member of the battalion operations element or battalion fires coordination element, who may lack familiarity with airspace request procedures and potential methods for deconfliction if a request is denied. Interviews with the CTCs indicate that frictions at the battalion level are a key cause of unresponsive or poor employment of SUAS. Since company/troop/battery level commands do not have staffs they are not capable of airspace management operations but need to make their requirements known to their battalion headquarters, placing additional requirements on battalion staffs. The Army may need to consider augmenting the staffs of maneuver and artillery battalions with the personnel and equipment capacity to help manage airspace.

Recommendations for airspace technician training

- The Army should recognize that airspace management will be integral to all units large enough to have formal staffs, and examine how to develop officers and senior NCOs to understand and effectively integrate airspace management into plans. It should examine, and if need be, update TOEs to ensure that battalions and brigades have the expertise to manage airspace and interact with airspace managers at higher echelons as required for their expected missions.
- The Army should explore whether airspace management expertise and equipment (e.g., the Tactical Airspace Integration System) are needed at the maneuver battalion level during combat operations, and if so how to provide it.
- In the short-term, the Army should designate responsibility for air-ground coordination in the maneuver battalion battle staff and formalize their training.
- Alternately, instead of assigning additional airspace management expertise to brigades and maneuver battalions, the Army could create a division airspace management platoon that attaches airspace management technicians to designated brigades and battalions as operations indicate. These teams could operate under habitual relationships, much like the Brigade Aviation Element. A division-level consolidated pool would facilitate training and professional development, as well as allow cross-leveling of personnel and equipment to meet mission requirements.

Collective Training of SUAS in Combined Arms Operations

Effective employment of SUAS in support of combined arms operations relies on commanders and staff who understand how to plan for and employ them, as well as three critical cross-functional, cross-echelon teams to execute air-ground operations: airspace management, intelligence fusion, and fires coordination. Individual operator and airspace technician skills at several echelons are the building blocks for these cross-echelon teams, but they are insufficient by themselves. U.S. Army brigades and below lack sufficient training on the cross-organization groupings (or "kill chains") used to coordinate SUAS, maneuver, aviation, and fires in the tactical battlespace. These cross-functional, cross-

echelon chains must be able to rapidly, yet safely, execute their tasks in a 3-dimensional, congested battlespace. Weak coordination and sclerotic execution cede a precious combat power advantage that U.S. ground forces possess. Well-rehearsed TTP and well-practiced, robust communications links are the foundation of rapid and safe execution of these critical, cross-functional, cross-echelon chains. SOPs must be commonly understood and executed across division, brigade, and battalion echelons, lest a weak link slows or unhinges execution. The proliferation of SUAS to the platoon and company levels means these echelons may need to be integrated in some fashion into the airspace management, intelligence fusion, and fires coordination chains, for example through passive distribution of the data their SUAS collect and report. At the battalion level, a battle staff could be coordinating the employment of dozens of SUAS flying at nominal operating altitudes below 1200 feet, as well as integrating them into battalion fires support execution and the battalion intelligence collection plan.

Too often at CTCs, air-ground operations teams are not executing at the speed required on a battlefield of fleeting enemy targets and a multitude of SUAS-equipped friendly formations. The issue is not equipment. The diffusion of TAIS, the Army Field Artillery Tactical Data System (AFATDS), the Integrated Tactical Network (ITN), and associated common operational picture systems provides the needed tools, although the Army may want to consider pushing the TAIS system to some battalions as noted above. While the Army continues to work on improving the integration of data from all of these systems, a key issue is one of training—knowing what to do, practicing it under a range of conditions, and incorporating adaptations and lessons learned to address a learning, adapting foe. SUAS integration is about more than just incorporating new collection and weapons systems. The wide proliferation of SUAS to the smallest units as well as to adversaries means ground forces must now fight in a new battlespace—three dimensional, near-ground airspace.

Training Doctrine for SUAS and C-UAS

Army experience in the 1980s with the adoption of AirLand Battle and in the late 1990s with Military Operations in Urban Terrain (MOUT) demonstrate the importance of creating a training ecosystem supported by a robust set of published tactical drills, “how to train” guides, explicit performance standards, and networks for sharing TTP. The AirLand Battle case is illuminating as two of its key implicit challenges were the incorporation of new technology (e.g., night vision devices) and synchronization of multiple battlefield operating systems. The MOUT case is illustrative as one of its key challenges was developing methods for fighting in a 3-dimensional battlespace that required methodical synchronization of maneuver, fires, and aviation. In both cases, the Army published a robust set of training circulars, battle drill guides, lessons-learned notes, and explicit ARTEP standards to coach units (from squad to battalion) toward an advanced level of expertise. The Army also

quickly incorporated AirLand Battle and MOUT tactics into its school-house leader development and education, and tests for company-grade and field-grade leaders.

In the case of SUAS integration into combined arms operations, U.S. Army training literature and tactical instruction is necessarily catching up as SUAS integration in combined arms combat rapidly develops—and the result is a force with wide variability in integrating SUAS into combined arms operations. Interviewees across the XVIII Airborne Corps illustrate a gap in doctrine and standards for integrating SUAS, like infantry battle drills (Interviews, 2022-2023). Also, SUAS integration proficiency is not linked to METLs, tracked in Digital Training Management System (DTMS), or reported in unit status reports (USRs)—which means that it is challenging subordinate leaders to know what is expected and for more senior leaders to hold subordinate units accountable.

Based on matching JRTC observations of unit performance to unit interviews, the few battalions that have achieved excellence integrating SUAS into their operations have done so as a result of persistent commander attention, intense training regimens, and self-created SOPs (Interviews, 2022-2023). These units incorporated SUAS employment into all battalion, company, and platoon situational training exercises. They also maintained a battle rhythm of weekly crew-training flights in local training areas, including the training of micro-maneuver and other advanced flying techniques (Hayball, Kerkoff, Sarver, 2019, p. 71). And these units trained the battle staff elements integrating SUAS: ADAM/BAE cells, battalion/brigade operations sections, fires coordination elements, and the S-2 (intelligence) cell. The Army could draw on these units' products to rapidly deepen its training literature on SUAS integration.

The integration of SUAS into combined arms maneuver should not be viewed as generating new company, battalion, or brigade mission essential tasks for units (such as "conduct UAS operations"), but rather as an aid to units in accomplishing their existing mission essential tasks better (e.g., through changes in their training and evaluation outlines). For example, deliberate attack, movement to contact, route reconnaissance, and defense missions—to name a few—do not change in nature because of SUAS, but how they are conducted will change. While there are some units that are doing this well, as demonstrated by their use of SUAS during CTC rotations, this research found that integration of SUAS in training is lagging behind their potential use in most cases. To rectify this, the Army could modify unit training expectations by incorporating SUAS into the tasks that are expected, measured, and reported.

The first step in doing this might be revision of the Army Training Network's (ATN's) training and evaluation outlines (T&EOs) to ensure that SUAS employment is accounted for in leader, individual, and collective task performance measures and training assessments. Unit METLs are also a primary guide for training, and SUAS integration into unit missions

and tasks could be examined there as well. Finally, a search of the Army Universal Task List (AUTL) produced no results for uncrewed aircraft vehicle (UAV), UAS, or SUAS, and only nine mentions of "unmanned" systems in Army tactical tasks across the warfighting functions. The Army may want to reexamine the AUTL as well in light of the importance of UASs.

Much like the development of MOUT techniques, the Army will likely need to remain flexible as units experiment with and refine tactics and improving technology. The goal could be to reach the level of Training Circular (TC) 90-1 *Training for Urban Operations*, which includes TTP, training regimens, and performance standards from the individual to the team to the combined arms formation level (TC 90-1, *Training for Urban Operations*, 2008). Doctrinal consistency and common TTP across the Army would also help mitigate risk, as aviators and operators could hold each other to shared expectations and standards (McLamb and Dane, 2020). Major units, and perhaps the Army, should develop ways to share developing lessons that respect operational security.

The Army also needs to incorporate SUAS instruction into its school-house professional development and education of tactical leaders—particularly at the company and field-grade command and battalion and brigade battle staff levels. Interviews with operational units indicated that tactical leaders and battle staffs could employ SUASs like the Raven and quadcopters more effectively. The Army should also expand training instruction on air-ground coordination to leaders, drawing, perhaps, on material from the Air-Ground Operations school.

Training for the Counter-SUAS (C-SUAS) Mission

Finally, the Army needs to better address the enemy SUAS threat in training doctrine and leader instruction. The use cases, variety, and employment of SUAS have increased dramatically compared with the past decade of usage against U.S. forces in Afghanistan, Iraq, and Syria. Similar to friendly SUAS employment, countering UAS should be incorporated into collective training and tasks.

The first steps in improving unit counter-UAS capabilities is air defense training across echelons from brigades to platoons. Brigades and battalions need to increase integration of air defense assets into field exercises. Small units need to practice react to air contact and C-UAS battle drills against a realistic opposing force (OPFOR)—much as they did during the Cold War. If installation OPFOR SUAS platforms are not available, the Army should explore other options to facilitate C-UAS training. Mobile Teaching Teams could be utilized to augment training exercises. As the Army explores the need for C-UAS capabilities, it may field technology (e.g., kinetic as well as electronic warfare [EW] systems) that could be organic to small units—innovation and experimentation with these will also be important.

Another benefit of MTTs is that they could offer units recommendations for countering SUAS through kinetic and EW methods, as well as concealing their positions and avoiding detection.

Implicit in conducting realistic c-UAS training is the existence of an OPFOR that can fly UAS against units in training. These could come from other TOE units or be standing table of distribution and allowances (TDA) entities created at major unit or installation levels.

Recommendations for needed training guidance and documentation: The Army should develop:

- Brigade, battalion, and company operational doctrine and procedures for combined arms integration of SUAS for the attack, defense, movement to contact, and rear/sustainment operations. This includes methods for how to emplace (jump sites/ launch sites/recovery sites) and how to employ (echelons) SUAS (Interview with 75th Ranger Regiment Military Intelligence Battalion, June 23, 2023).
- Battle staff doctrine and procedures for airspace management and fires deconfliction, particularly at the battalion and brigade levels (Interview with Fires COE October 25, 2022).
- Battle staff TTP for SUAS-related intelligence collection management, utilizing SUAS for quick response taskings, and planning for task-echeloned employment of SUAS. This includes mission planning TTP for matching task to vehicle, sensor, and payload (Hayball, Kerkoff, Sarver, 2019).
- TTP for rapidly clearing airspace for rotary-wing aviation.
- Small unit TTP: for example, scan/recon/overwatch micro-tactical maneuver.
- Multi-ship SUAS tactics, particularly the layering of SUAS in space and echelon; target acquisition and maintaining custody of a target; stimulating enemy action to cue for targeting; and the use of hunter-killer teams of observer SUAS and loitering munitions (Interview with Defense Innovation Unit (DIU) personnel, October 28, 2022).
- C-UAS TTP as well as the deconfliction/synchronization of SUAS employment and the C-UAS fight; airspace and air and missile defense command control at treetop level.
- Updated TTP for react to air contact for small units (Interview with Fires COE, October 25, 2022).
- Communications TTP for building and maintaining robust, resilient, flexible tactical communication architectures for large scale SUAS employment.
- TTP for detecting and self-assessing spectrum interference.
- TTP to adjust between bands, waveforms, and line-of-sight versus satellite communications (SATCOMs), as well as solutions for retrans and distributing data (Interview with United States Marine Corps Warfighting Lab – Experiment Division, January 31, 2023).

- TTP for Cyber Electromagnetic Activities/EW and SUAS assets working together (Interview with 75th Ranger Regiment Military Intelligence Battalion, June 23, 2023).

Recommendations for leader training and development: TRADOC should

- Expand familiarization instruction on air-ground coordination to company- and field-grade leaders.
- Incorporate training on tactics of SUAS employment and C-UAS operations at company-grade officer and NCO schools.
- Include practical exercises to familiarize company leaders with both the potential of friendly SUAS and threat from enemy SUAS (C-UAS).

Recommendations for fostering the exchange of SUAS TTP across the force:

- The Army should create and use mechanisms for exchanging and adapting TTP among units on SUAS integration and the near-ground battlespace that protects lessons learned from potential enemies (e.g., creating a designated site for collecting and disseminating TTP at relevant commands, schools, or COEs). These should facilitate operational security (e.g., not be open source).
- Army leaders should direct Center for Army Lessons Learned (CALL) to make SUAS integration and C-UAS priority topics.
- Senior commanders should encourage tactical leaders to submit new or updated TTP and reward them for doing so.

Appendix. SUAS Maximum Training Demand Methodology

This appendix supplements the report's section on home station training data and future SUAS demand by depicting the data used. First, we used the 2020 U.S. Army SUAS strategy to develop Table 6, which depicts the future equipping of UAS at the BCT-level in accordance with this strategy (Army Futures Command, 2020).

Table 5. Future SUAS Allocation for BCTs

Unit	# units per BCT	# UAS	Total
BCT TUAS Platoon	1	4	4
Subtotal			**4**
IN Battalion	3	1	3
IN Co	12	1	12
IN PLT	15	1	15
IN Squad	27	1	27
Subtotal			**57**
CAV Squadron	1	1	1
CAV Troop	3	1	3
Scout Platoon	9	1	9
Scout Section	18	1	18
Scout Squad	36	1	36
Subtotal			**67**
Fires Battalion	1	1	1
Battery	3	1	3
Firing Platoon	9	1	9
Section	18	1	18
Subtotal			**31**

Unit	# units per BCT	# UAS	Total
EN Battalion	1	1	1
EN Company	2	1	1
EN Platoon	7	1	7
EN Squad	21	1	21
Subtotal			**30**
Total # of UAS per BCT			**189**

NOTES: BCT = Brigade Combat Team; CAV = Cavalry; EN = Engineer; IN = Infantry; TUAS = Tactical Uncrewed Aircraft System.
SOURCE: Quantities derived from *Army Small UAS Strategy* (Army Futures Command, September 2020).

Second, we used RFMSS to identify the units training at Fort Bragg on the installation's highest demand training day during the 24-month period under review and used the 2020 Army SUAS strategy to determine how many UAS these organizations will have in the future. This allowed us to estimate how many UAS would have entered the airspace on this day if the units flew all their systems. Next, we divided the total number of estimated future SUAS flights (721) by the number of RFMSS entries (356) to arrive at an estimate of future SUAS demand on Fort Bragg of 2.03 UAS flights per RFMSS entry. Table 7 shows these data. Finally, we repeated the second step for Forts Campbell, Drum, and Stewart by determining their busiest training demand days during the 24-month period and the associated future SUAS allocation of the units training, and multiplied these numbers of potential future SUAS flights by 2.03 UAS flights per RFMSS entry to estimate how many UAS these installations must be prepared to support in the future.

Table 6. SUAS Flights per Training Event

Units	# UAS (Army SUAS Strategy)
Brigade Combat Team 1	189
Brigade Combat Team 2	189
Fires Battalion	31
Corps Fires Battalion	31
Engineer Battalion	30
Corps EN Battalion	68
Infantry Battalion 1	57
Infantry Battalion 2	57
Infantry Battalion 3	57
Division Gray Eagle	12
Total	721
# RFMSS Entries	356
UAS Flights / Training Event	721 / 356 = 2.03
Future UAS Flights per Installation: # RFMSS Entries x 2.03 flights per RFMSS Entry	
Fort Bragg	721
Fort Campbell	107 x 2.03 = 217
Fort Drum	102 x 2.03 = 208
Fort Stewart	150 x 2.03 = 305

NOTES: RFMSS = Range Facility Management Support System; UAS = Uncrewed Aircraft Systems

SOURCE: Quantities derived from *Army Small UAS Strategy* (Army Futures Command, 2020).

Abbreviations

ADAM	Air Defense and Airspace Management
AFC	Army Futures Command
AGL	above ground level
ARDEC	Army Research, Development, and Engineering Command
ARTEP	Army Training and Evaluation Program
ASI	additional skill identifier
AUTL	Army Universal Task List
BAE	Brigade Aviation Element
BCT	Brigade Combat Team
BUQ-I	Basic Unmanned Aerial System Qualification Level-I
BVLOS	beyond visual line of sight
COE	Center of Excellence
COIN	counterinsurgency
COTS	commercial off-the-shelf
CTC	combat training centers
C-UAS	counter-uncrewed aircraft system(s)
DA	Department of the Army
DoD	Department of Defense
EW	Electronic Warfare
FAA	Federal Aviation Administration
FY	Fiscal Year
HHC	Headquarters and Headquarters Company
HQDA	Headquarters, Department of the Army
ISR	intelligence, surveillance, and reconnaissance

IWTS	Integrated Weapons Training Strategy
JRTC	Joint Readiness Training Center
LSCO	large-scale combat operations
MCOE	Maneuver Center of Excellence
METL	Mission Essential Task List
MOS	military occupational specialty
MOUT	Military Operations in Urban Terrain
MQ	Mission Qualification
MSD	minimum safe distance
MTOE	modified table of organization and equipment
MTT	Mobile Teaching Teams
NAS	National Airspace System
NATO	North Atlantic Treaty Organization
NCO	noncommissioned officer
NTC	National Training Center
OPFOR	opposing force
PDSI	personnel development skill identifier
RFMSS	Range Facility Management Support System
ROZ	restricted operations zone
RWOW TROIKA	Russian Way of War (TROIKA is the English phonetic spelling of the Russian for “Russian Way of War”)
SBS	Soldier borne sensor
SDZ	surface danger zone
SOP	Standard Operating Procedure
SUASMAN	small uncrewed aircraft system(s) management
SUAS	small uncrewed aircraft system(s)
T&EO	training and evaluation outline

TAIS	Tactical Airspace Integration System
TOE	table of organization and equipment
TRADOC	United States Army Training and Doctrine Command
TTP	Tactics, techniques, and procedures
UAS	uncrewed aircraft system(s)
USAASA	United States Army Aeronautical Services Agency
VFR	visual flight rules

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