

COLORADO Center of Excellence for Advanced Technology Aerial Firefighting

Department of Public Safety

2018 Yellowjacket Rx UAS and TAK Deployment Report

CoE-18-006.1

Purpose

This report describes the unmanned aerial system (UAS) and Team Awareness Kit (TAK) support provided by the Center of Excellence for Advanced Technology Aerial Firefighting (CoE) to Colorado Division of Fire Prevention and Control (DFPC) and San Juan National Forest firefighters on the Yellowjacket Prescribed Fire from September 13–14, 2018.

Overview

The CoE operates a variety of UAS to conduct research on missions related to wildland fire and public safety and, on occasion, to provide operational support to first responders. Additionally, the CoE has licensed the

TAK app from the U.S. Air Force Research Laboratory to develop the app as a situational awareness platform for public safety.

The CoE was requested by DFPC's Southwest Regional Fire Management Officer to provide support to personnel on the Yellowjacket Prescribed Fire, which took place in the Columbine Ranger District of the San Juan National Forest. Two CoE personnel and two firefighters from DFPC's Montrose Helitack crew responded with six UAS platforms and a cache of smartphones running the TAK app. The



Figure 1— DJI Matrice 210 in flight

CoE's UAS support trailer was used to transport the aircraft, provide shelter during the assembly of aircraft and processing of data, and to provide power from solar panels to recharge batteries and sustain operations.

Operations Summary

The crew arrived at the Yellowjacket Prescribed Fire midway through operations on September 13. After inbriefing with the burn boss, the crew coordinated with a Bureau of Land Management (BLM) employee who was trained in the U.S. Department of Interior UAS operations guidelines. The crew utilized protocols in the National Wildfire Coordinating Group (NWCG) *Interagency Fire Unmanned Aircraft Systems Operations Guide* (PMS 515) to conduct operations, as well as the *Colorado Department of Public Safety UAS Policy* (1.09.001) and the Federal Aviation Administration Part 107 commercial UAS rules. A Project Aviation Safety Plan was

Table 1— Aircraft Operated on the Yellowjacket Rx

| NWCG-Compliant Aircraft | Aircraft Make/Model |
|-------------------------|---------------------------|
| Designation | |
| Unmanned Romeo 31 | DJI Matrice 210 |
| Unmanned Romeo 41 | 3DR Solo (operated by BLM |
| | resource on-scene) |
| Unmanned Romeo 42 | 3DR Solo (operated by BLM |
| | resource on-scene) |
| Unmanned Romeo 43 | DJI Phantom 4 V2.0 |
| Unmanned Romeo 44 | DJI Phantom 4 Pro |
| Unmanned Romeo 45 | DJI Mavic Platinum |
| Unmanned Romeo 46 | DJI Mavic Pro |
| Unmanned Romeo 47 | Yuneec H520 |

written and approved by the U.S. Forest Service. The CoE will retain a copy for use on future operations.

Development of a UAS Project Request Form should be considered as this is useful to begin the discussion and make ordering decisions.

The crew contacted Durango Interagency Dispatch and relayed their area of operations, maximum flight altitude, and radio call sign. The crew utilized NWCG typing standards for the UAS for internal purposes, but used the radio call sign "unmanned DFPC" to avoid excessive radio traffic and confusion. The crew monitored the local forest command repeater channel, air-to-ground frequency, and

the tactical frequency utilized by personnel on the burn. Once dispatch and the burn boss had been notified, the crew commenced UAS operations. Initially, the crew utilized the Mavic Pro to scout areas that had been

fired earlier in the day and conducted an orthomapping mission, which was intended to test the ability of orthomapping software to create an accurate map in smoky conditions. The orthomap data was collected using the Pix4DCapture app, with data processed by Pix4DMapper. The orthomap and pointcloud were of high quality and the software was able to ignore the smoke in the air and accurately map the surface of the ground and vegetation, though in smoky areas the color of the terrain was washed out by smoke. During the manual scouting mission, it was noted that the Mavic



Figure 2— Oblique View of Pointcloud Generated by Pix4D Mapper

would occasionally perceive smoke in the air as an obstacle, causing the aircraft to automatically slow forward flight and hover. Once in a hover, the aircraft cleared the smoke as an obstacle and resumed forward



🌄 flight.

While the crew was swapping batteries on the UAS and all aircraft were on the ground, the sound of helicopter rotors was heard. The crew kept all UAS on the ground and watched as a helicopter assigned to the nearby Horse Fire flew directly over the burn. The helicopter was heard several miles before it arrived over the burn and the crew had clear line-of-sight to the helicopter well before it approached. After this event occurred, dispatch contacted the crew and advised them that the helicopter was operating on a different air-to-ground frequency assigned to the Horse Fire and that the crew

Figure 3— Conducting Flight Operations on the Fireline



Figure 4— Thermal and Visible Views from a Yuneec H520 of Holding Operations Along a Road

should monitor this frequency as well. Dispatch also began instructing the helicopter to transit south of the prescribed fire on its way to and from the Horse Fire.

The crew resumed flights after notifying dispatch and the burn boss and then used a Yuneec H520 to conduct a thermal patrol of the green side of the fireline. The intent of this mission was to scout for any spot fires that



had developed across the fireline, though no spot fires were found. The crew experimented with different contrast settings on the thermal camera during this time and found that flying over an area of known fire and locking the thermal contrast allowed the crew to continue flying with a search image in mind of what a spot fire would look like on the camera.

The next day, the crew arrived for morning briefing with burn personnel and handed out smartphones

running the Android version of the TAK app to crews on the south side of the burn area. CoE personnel used both the Android (ATAK) and iOS (iTAK) versions of TAK to conduct their operations. The map for the burn was available on the TAK app and included checkpoints and other features relevant to the operation. As CoE

personnel were unsure of the availability of cellular connectivity throughout this area, the crews were also issued goTenna Pro radios, which provide basic location tracking and mapping functionality in the TAK app in areas that lack cell coverage. However, this was ultimately unnecessary as 4G cell service was available throughout the area of operations.

Figure 5— Personnel and UAS Locations in iTAK

To further mitigate any airspace conflicts, the crew obtained the air-to-air frequency for the Horse Fire and began monitoring it, as well as



Figure 6— UAS and Field of View in ATAK

the air-to-ground frequencies for both the Yellowjacket and Horse incidents. The crew also deployed an ADS-B (Automatic Dependent Surveillance-Broadcast) receiver, which decodes the transponder signals for many

manned aircraft and maps the locations of aircraft in the TAK app. A CoE member set up a 5-mile ring around the prescribed fire in the TAK app as a geofence, which caused his phone to ring and vibrate any time a resource entered the ring.

As resources began blacklining ignitions, the CoE notified dispatch and the burn boss and then commenced UAS operations. Initially, the crew flew a Phantom 4 Pro with the ATAK Go app to observe firing and holding operations and patrol for spot fires. The ATAK Go app plotted the location of the UAS and the camera's field-of-view live in the TAK app, allowing firefighters to see where the UAS was and what it was looking at. The pilot used ATAK Go and TAK in a split-screen configuration on his tablet to receive both video and map-based situational awareness as he flew.

The crew also utilized the Yuneec H520 with thermal camera to patrol during holding operations, as well as the





Matrice 210 with the Z30 camera. While the Matrice lacked Figure 7-Z30 Camera at Max and Min Zoom

thermal imaging capabilities, the Z30 camera provided a 30x optical zoom and greater digital zoom, allowing the pilot to closely inspect suspicious areas for spot fire development. While other UAS typically required the pilot to patrol by flying the aircraft up and down the fireline, the Matrice with Z30 camera allowed the pilot to hold the aircraft in a hover and patrol the line by panning and zooming on the camera.

As the day progressed, fire activity increased on the nearby Horse Fire and a helicopter was ordered to that fire for reconnaissance and bucket work. The helicopter aired their mission into the blind on the air-to-air radio and the UAS crew responded and deconflicted the airspace. Additionally, the ADS-B receiver picked up the helicopter as it departed the airbase and displayed its real-time location in TAK. The helicopter did enter the 5-mile geofence around the prescribed fire, which caused an alert to display through the TAK app on the



Figure 8— Batteries Charging in the Support Trailer

phones of the CoE flight crew.

The UAS support trailer was used throughout day two to offload data from the aircraft to a laptop and to charge batteries using the solar panel and battery system. At one point, three sets of batteries were being charged and a laptop was being run off the inverter without any issues noted. Additional missions were conducted with the Mavic and Phantom aircraft to scout the fireline and a portion of the crew spilt off to conduct operations on the north side of the burn. The crews communicated by tactical channel to deconflict their simultaneous operations during this time. As holding operations wound down for the day, the crew hiked the fireline to collect the smartphones running the TAK application and then packed up the

support trailer. Dispatch and the burn boss were notified that flight operations had concluded and the crew demobilized from the burn.

Conclusion

On the first day of operations, the crew conducted seven sorties; on the second day, they conducted sixteen sorties. The UAS operations were well received by the burn personnel, with one firefighter stating that he appreciated the extra set of eyes during holding, especially when smoke at ground level limited the firefighter's view. The TAK app was also well received, with the crews utilizing the app stating that they liked the ability to see the locations of other crews in real-time, which helped them judge the progression of the burn and determine appropriate spacing of the crews.



Figure 9— Conducting Flight Operations with Video Feed and TAK Map

The missions demonstrated that UAS can significantly expand firefighter's ability to obtain remote data critical to fulfilling many mission requirements—including those of prescribed burns—and to do so with increased safety, less cost, and less environmental impact. The District Fire Management Officer had positive feedback, and praised the TAK application. The San Juan National Forest firefighters and burn bosses also seemed very receptive to the CoE's involvement on the burn.



Figure 10— Observing Ignition Operations from a DJI Phantom 4 Pro