
Purpose: This series of tests examined the ability of a small UAS (sUAS) to be employed from within a TFR in the intelligence, surveillance, and reconnaissance role, while being safely flown BVLOS and segregated from manned aircraft.

Test Objectives:
1. Examine the ability to deploy and operate an sUAS completely within an established TFR.
2. Establish procedures for notification and deconfliction procedures for potential non-participating aircraft with access to the TFR (e.g. law enforcement, emergency medical aircraft, etc.).
3. Develop and employ airspace segregation protocols for separating manned and unmanned aircraft operating over the fire during the same time period.
4. Assess the ability of the sUAS to be operated BVLOS in the fire environment.
5. Evaluate the ability of sUAS hotspot detection through dense smoke.
6. Gauge the ability of the sUAS to provide outcome effectiveness assessments of manned aircraft suppression/retardant drops.
7. Evaluate the utility of sUAS developed precision map products for near-real time incident command and field use.

**Test Conditions:** The Paradise Fire was a “managed” fire (nature-caused, in a remote area, and being allowed to burn within specified boundaries) in the Olympic National Park in Washington. Due to the remote location of the fire, the threat of non-participating aircraft was low. Because the fire was being managed as opposed to being fought, the number of ground personnel and manned aircraft participating in this fire was minimal, mitigating this risk during testing. The fire produced thick smoke (shown at the end of the video referenced on page 3), making it ideal for examining the potential of the infrared (IR) sensor on the sUAS to detect hotspots and map their location. During the test period, the specified test weather conditions were not met one day (August 20, 2015; low clouds), precluding tests on that day.

**Test Aircraft:** An Insitu ScanEagle sUAS was employed during these tests. The aircraft was operated and paid for by the company as part of a government-sponsored notice of demonstration for which this aircraft was offered and was selected.

**Flight Data:** The test aircraft flew on six separate days. Although the test aircraft was capable of much longer flight durations, time to accomplish individual flight test objectives dictated daily flight totals. Daily and total flight times:

<table>
<thead>
<tr>
<th>Date</th>
<th>Flight Time</th>
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<tbody>
<tr>
<td>8/19/15</td>
<td>2.84 hrs.</td>
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<tr>
<td>8/21/15</td>
<td>4.29 hrs.</td>
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<tr>
<td>8/22/15</td>
<td>7.62 hrs.</td>
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<tr>
<td>8/23/15</td>
<td>7.28 hrs.</td>
</tr>
<tr>
<td>8/24/15</td>
<td>7.99 hrs.</td>
</tr>
<tr>
<td>8/25/15</td>
<td>6.97 hrs.</td>
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**TOTAL 36.99 hrs.**

**Results / Lessons Learned:** The mobility of the ScanEagle launch and recovery systems enabled the sUAS to be deployed in remote terrain. Prior planning to locate the launch and recovery equipment on high ground reduced the clear space requirements for safe launch and recovery operations. Aircraft deconfliction procedures with participating helicopters were easily accomplished through preflight planning and disciplined flight execution. Segregation of manned and unmanned aircraft on the initial flights was achieved through the use of geographic fences (Figure 1). Later, separation was achieved through the use of designated altitude reservations (ALTREV’s) with a minimum 1,000’ altitude buffer between manned and unmanned aircraft operating in the same geographic area. This...
enabled the sUAS to monitor helicopter water drops and provide an outcome effectiveness assessment for each drop. Note the white hot, black cold in the following video, related to where the fire is and where the helicopter has been applying suppressant water: (https://youtu.be/VdVaL4eHJls).

The sUAS was easily integrated into the existing fire incident communications structure. The onboard electro-optical (EO) capability allowed for good views of the fire from a long distance away, enabling real-time course/mission refinements based on actual observations. The onboard IR capability enabled the sUAS to see through heavy smoke to identify hotspots, fire boundaries, and assess the effectiveness of suppressant drops.

When conducting long-duration flights, it is important to update the weather prediction and observations to account for potential significant changes in weather from launch time to recovery.

Collaboration between the vendor’s GIS specialist and the incident GIS specialist prior to and during the mission is key to successful mapping. It is possible to plug
video directly into the fire geospatial portal so those with a “need-to-know” can view anywhere there is web access.

**Conclusions:** With proper coordination, briefing, and inflight discipline, sUAS and manned aircraft can operate safely together over a managed fire in a BVLOS mode, within a TFR. While raw images provided some useful data, continued development of actionable geo-referenced mapping data that can be shared securely over a mobile network should be pursued.

**Recommendations for Further Testing:** Additional testing in more complex fire and airspace environments should be conducted to continue to refine protocols for safely employing sUAS on fires in a BVLOS mode of operation. Continued development and refinement of *data-to-information-to-knowledge-to-action* processes that provide critical UAS outcome products is also recommended. Ongoing improvements in the speed, fidelity, and utility of these critical “back-end” processes are recommended.

**Additional Information Resources:**