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National Wildfire Coordinating Group

NWCG Standards for Fire Unmanned Aircraft Systems Operations

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The *NWCG Standards for Fire Unmanned Aircraft Systems Operations* standardizes the processes and procedures for interagency use of Unmanned Aircraft Systems (UAS), including pilot inspections and approvals. In support of fire management goals and objectives, the aviation community references these standards to utilize UAS in a safe, effective, and efficient manner. These standards further serve as a risk assessment for fire UAS operations and meet federal requirements for aviation safety and operational planning pertaining to recurring aviation missions. Agency level policy and guidance is provided through established federal or state plans and processes.

Please use the NWCG Publication Revision Form (https://www.nwcg.gov/publications/publication-review-form) to provide feedback on this publication to your agency representative on the steward committee.

The National Wildfire Coordinating Group (NWCG) provides national leadership to enable interoperable wildland fire operations among federal, state, Tribal, territorial, and local partners. NWCG operations standards are interagency by design; they are developed with the intent of universal adoption by the member agencies. However, the decision to adopt and utilize them is made independently by the individual member agencies and communicated through their respective directives systems.

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UAS Program Administration

Program Administration

Agencies are responsible for oversight and management of their respective Unmanned Aerial Systems (UAS) programs. National, regional, and state agency program managers are delegated by their respective agencies. To develop a standardized interagency program, the following roles and responsibilities of interagency program management are provided:

1. Coordinate with agency program managers, the Interagency Fire UAS Subcommittee (IFUASS) found at https://www.nwcg.gov/committees/interagency-fire-unmanned-aircraft-systems-subcommittee, and interagency UAS personnel.
2. Coordinate with other agency program managers to update the National Resource Qualifications Roster (Incident Qualifications and Certification System — IQCS).
3. Participate on interagency working groups, committees, and subcommittees.
4. Collaborate to develop owned, contracted, and cooperator interagency UAS aircraft, pilot specifications, and approval standards.
5. Provide quality assurance and oversight of operational and training performance standards.
6. Distribute UAS program information on an interagency basis.
7. Coordinate with agencies that have a desire to develop or enhance a UAS program.
8. Coordinate operational standards with international cooperators.
9. Provide input to the revision of the *NWCG Standards for Fire Unmanned Aircraft Systems Operations*, PMS 515, and interagency training management system.
10. Additional roles and responsibilities may be assigned based on agency specific needs.

Policy

1. Department of Interior (DOI) agencies operate under 14 Code of Federal Regulations (CFR), Part 107 (Federal Aviation Administration [FAA] Small UAS Rule), DOI Operational Procedures Memoranda (OPM) 11, and national aviation plans.
2. Department of Agriculture (USDA) Forest Service operates under 14CFR, Part 107 (FAA Small UAS Rule), Forest Service Manual (FSM) 5700, Forest Service Handbook (FSH) 5709.16, Forest Service Standards for Unmanned Aircraft Systems, and national and regional aviation plans.
3. State agencies shall follow their agency guidance.
4. The procedures in this publication pertain to fire/incident (unplanned/emergency) operations only. UAS operations on a fire after it has been declared out are considered a planned project and will adhere to departmental and agency specific UAS planning processes for UAS projects.
5. UAS aerial ignition operations shall be conducted in accordance with provisions contained in this publication and in the National Interagency Aviation Committee (NIAC) Memo 19-02, Interim Approval of UAS Aerial Ignition Payload (https://www.nwcg.gov/publications/pms515).

UAS Typing and Call Signs

UAS are built in a multitude of configurations which makes classification difficult. The following table should be used for reference only. Specific aircraft capabilities, performance, and typing should be discussed with the UAS pilot, UAS manager, or UAS coordinator. For incident management purposes, the classification in Table 1 closely represents aircraft currently being utilized.

Table 1 — UAS Types and Stats

Type	Configuration	Endurance	Data Collection Altitude (AGL.)	Max Range (miles)	Typical Sensors*
1	Fixed-Wing	6-14 hrs.	3,500-8,000	50	EO/ Mid Wave IR
1	Rotorcraft	NA	NA	NA	High Quality IR
2	Fixed-Wing	1-6 hrs.	3,500-6,000	25	EO/Long Wave IR
2	Rotorcraft	NA	NA	NA	Moderate Quality IR
3	Fixed-Wing	20-60 min.	2,500 and Below	5	EO/IR Video and Stills
3	Rotorcraft	20-60 min.	2,000 and Below	5	Moderate Quality IR
4	Fixed-Wing	Up to 30 min.	1,200 and Below	<2	EO/IR Video and Stills
4	Rotorcraft	Up to 20 min.	1,200 and Below	<2	Moderate Quality IR

*Sensor payloads are variable but typically include daylight (electro-optical), infrared (IR), thermal, or mapping cameras. Type 1 and 2 UAS carry multiple camera types in a gimbaled configuration.

Note: Certain aircraft are specialized and will not fit this classification.

Additional current information can be accessed on the interagency UAS website at https://uas.nifc.gov/.

Operational Characteristics

1. Type 1 and 2:
   a. These aircraft will generally be operated by contractors and provide strategic situational awareness (SA) and incident mapping.
   b. They typically operate above all other incident aircraft.
   c. Communications are maintained with the UAS crew on the assigned Victor (AM) or air-to-ground (FM) frequencies.
   d. All Type 1 and 2 contract aircraft will be equipped with Mode C transponders.
   e. Typical aircraft are the Scan Eagle, Aerosonde, or Penguin C.
2. Type 3 and 4:
   a. These aircraft are generally agency operated and perform SA, mapping, and aerial ignition missions on/near the fireline or incident.
   b. Type 3 and 4 aircraft do not carry Mode C transponders or Automatic Dependent Surveillance-Broadcast (ADS-B).
   c. Communications are maintained with the UAS crew only on assigned FM frequencies.
   d. None are equipped with Automated Flight Following (AFF) equipment.
   e. Typical aircraft are less than 55lbs and can be easily carried by UAS pilots or in small vehicles.

Call Signs

Unmanned Aircraft Systems Pilots (UASP) will follow established incident communications protocols and will make radio calls with the following information:

Unmanned Aircraft

- Configuration (fixed-wing or rotor-wing)
- Type
- Assigned aircraft number

Call Sign Examples

- Unmanned R41: Rotor-Wing, Type 4 UAS, Assigned number #1
- Unmanned F12: Fixed-Wing, Type 1 UAS, Assigned number #2
- Unmanned R23: Rotor-Wing, Type 2 UAS, Assigned number #3

  Note: If a pilot switches aircraft between a Type 3 or Type 4 UAS, to maintain continuity of call signs, they will continue to use the original call sign. Change in aircraft configuration, rotor-wing to fixed-wing, should be discussed with aerial supervision and/or participating aircraft.

Operational Requirements

Aircraft and pilots will be given a certificate in accordance with FAA and interagency policy. Interagency certification and FAA registration cards are required to be with the aircraft while on an incident.

Mode C transponders are required for all fire operations except when:

1. Otherwise authorized by the aerial supervisor on scene at the incident.
2. On incidents with no aerial supervision on scene. The UASP must deconflict with other incident and/or non-incident aircraft using the established communications protocols contained in this publication.
3. On incidents with no aircraft on scene. The UASP must coordinate UAS operations with the Incident Commander (IC), or designee, and the appropriate flight following entity for that incident as required by this publication.

The UASP will:

1. Obtain approval from the IC or designee prior to conducting incident missions.
2. Obtain one of the following airspace authorizations prior to conducting incident missions:
   a. FAA part 107
   b. Special Government Interest (SGI) waiver for flights Beyond Visual Line of Sight (BVLOS) in a Temporary Flight Restriction (TFR)
   c. DOI/FAA memorandum of agreement for night flights or flights below 1,200’ Above Ground Level (AGL)
   d. DOI/FAA Certificate of Authorization (COA) for Extended Visual Line of Sight (EVLOS) flights

e. USDA/FAA Memorandum of Agreement for United States Forest Service (USFS) flights

Note: Flights utilizing an FAA memorandum of agreement or SGI have additional provisions, which must be followed by the UASP.

3. Conduct aerial ignition operations in accordance with approved aerial firing plans.
4. File a Notice to Airmen (NOTAM) as soon as practical and in accordance with interagency and FAA regulations (typically 24 -72 hours preflight for planned missions or as soon as practical during initial attack).

   Note: A NOTAM is issued by the FAA when a TFR is established.
5. Confirm airspace deconfliction with dispatch or the TFR-controlling authority, when applicable, prior to conducting incident missions.
6. Prior to conducting incident missions, obtain clearance for mission flights from aerial supervisors such as Air Tactical Group Supervisor (ATGS), Aerial Supervision Module (ASM), Helicopter Coordinator (HLCO), or Lead Plane.
7. Coordinate mission flights with participating aircraft when aerial supervision is not on scene.
8. Make a blind call on both the assigned Victor (AM) and the air-to-ground frequency (FM) when no aircraft are reported to be on scene.
9. Respond to blind radio calls from incoming aircraft when the UAS is the only aircraft on scene.
10. Give way to all crewed aircraft.
11. Have the capability to determine operational altitudes based on an altimeter setting.
12. Monitor AM/FM frequencies.
13. Ensure that landowner notifications are attempted prior to flights over private land.

Mission Planning and Mobilization

Incident UAS missions may be conducted by agency owned and operated UAS or contractor/cooperator owned and operated UAS. There is an on-call UAS coordinator available to answer questions regarding ordering procedures, UAS capabilities, as well as overhead needed [e.g., UASP, Unmanned Aircraft System, Data Specialist (UASD), Unmanned Aircraft System, Manager (UASM), or Unmanned Aircraft System, Module Leader (UASL)]. The ordering unit can contact the UAS Fire Coordinator (https://uas.nifc.gov/uas-coordinator) at 208-387-5335. For specifics on how to order UAS, please see NIFC UAS ordering at https://uas.nifc.gov/interagency-fire-uas-ordering.

Planning Considerations

1. Objective: What is the data objective for the mission [e.g., photos, video, SA, mapping, thermal, or infrared (IR)]?
2. Size: What is the mission area?
3. Endurance: Consider length of mission, distance from launch area, and area of availability.
4. Aircraft performance: Consider operating environment, payload, density altitude, and terrain in which operations are conducted.
5. Maneuverability: It is essential that the UAS can be positioned to meet mission observation requirements. Multi-rotors are excellent for SA on the fireline.
6. UAS Launch and Recovery Zone (LRZ): Mission requirements may necessitate the need for a designated launch and recover zone (Type 1 or Type 2 operations).
7. Terrain: Can the UAS maintain link with the Ground Control Station (GCS)?
8. Communications: Consider the capability to effectively monitor and transmit on AM and FM frequencies. Do not fly a mission if you cannot communicate with air and ground resources.
9. Data sharing: How will data be delivered to decision makers? Internet connectivity is key.
10. Incident operational tempo/complexity: Check before requesting clearance to fly. The UAS mission may not be a priority.

Mobilization

1. Obtain a resource order prior to mobilization.
2. Ensure vendor crews are ordered as required/requested.
3. Initiate contact with ordering unit (IC, Operations Section Chief [OSC], Air Operations Branch Director [AOBD], etc.).
4. Determine the data objective (final data product) for the incident.

5. Identify the UAS module (vendor or agency activation):
    a. Unmanned Aircraft System, Module Leader (UASL) https://www.nwcg.gov/positions/unmanned-aircraft-system-module-leader
    b. Unmanned Aircraft System, Pilot (UASP) https://www.nwcg.gov/positions/unmanned-aircraft-system-pilot
    c. Unmanned Aircraft System, Data Specialist (UASD) https://www.nwcg.gov/positions/unmanned-aircraft-system-data-specialist
    d. Unmanned Aircraft System Manager (UASM) https://www.nwcg.gov/positions/unmanned-aircraft-system-manager
    e. Vendor crew as required
6. Coordinate mobilization of personnel. Schedule planning calls as needed.
7. Obtain the Incident Action Plan (IAP).
8. Obtain/confirm airspace authorization (SGI, TFR, etc.).
9. Acquire Geographic Information System (GIS) data/maps for the area.
10. Identify possible LRZ locations for vendor aircraft.
11. Determine mission complexity:
    a. Location
    b. Land status (ownership)
    c. Size of area
    d. Topography
    e. Vegetation type
    f. Expected weather
    g. Data collection timeframe (window)
12. Start a paper trail or build an assignment folder with:
    a. Crew Qualification Cards
    b. Aircraft Data Cards
    c. Airspace authorizations
    d. Maps:
        i. Project location
        ii. TFR/NOTAM
        iii. Incident perimeter
        iv. Flight hazards
        v. Financial codes
        vi. Cooperator agreements/letters (aircraft, pilots, etc.)
        vii. Land use permits/authorizations

e. Vendor documents
    i. Contract
    ii. Invoice forms (Aircraft Use Report [AMD 23E], etc.) See — https://ibc.doi.gov/acquisition/aviation/customer/forms

13. Gather equipment.
    a. Determine aircraft to be used
    b. Determine sensor payloads to be used
    c. Cameras/mounts
    d. Data storage
14. Determine computer hardware and software requirements.
    a. Laptop and GIS: Make sure the computer has appropriate permissions to add/update software
    b. GCS: Ensure base maps are built for the mission area
    c. Data processing (GIS, mapping, Digital Elevation Model (DEM), orthomosaic, etc.)
15. Verify authorizations:
    a. Agency
    b. Incident
    c. Airspace
16. Ensure crew is within work/rest policy for flight and duty limitations.

Incident Arrival

1. Follow established incident check-in procedures.
2. Verify chain of command.
3. Confirm hours of operation, mission location(s), data objective(s), final product, and data delivery.
4. Discuss meeting/briefing attendance with assigned supervisor.
5. Perform site survey and consider:
    a. Access and egress
    b. Proximity to fire activity
    c. Communications (AM and FM)
    d. Takeoff and landing area
    e. GCS link to aircraft (terrain/vegetation)
    f. GCS video/data link to remote display at Incident Command Post (ICP) or designated location
    g. Cell/Wi-Fi coverage

6. Establish an LRZ when applicable (vendor aircraft/Type 1 or 2 UAS).
    a. Coordinate with incident personnel to identify potential LRZs.
    b. Plot potential LRZ locations.
    c. Perform a viewshed analysis to confirm GCS link can be maintained.
    d. Ensure LRZ location is documented, communicated to incident Geographic Information System Specialist (GISS), and depicted on appropriate incident maps.
7. Build GCS maps and download applicable base map data.
8. Perform UAS/sensor preflight inspection.
9. Verify weight, balance, and attachment of payloads.
10. Ensure proper fuel load/batteries fully charged.
11. Obtain a weather briefing.

Airspace Coordination

Airspace policy is referenced in the *NWCG Standards for Airspace Coordination*, PMS 520 (https://www.nwcg.gov/publications/pms520).

Fire Traffic Area (FTA) Protocol

Firefighting aircraft follow a communications protocol known as the FTA, which is a 12-mile radius from the center point of an incident. UAS are typically launched and recovered from inside the FTA. UASPs must follow this protocol before the aircraft is launched.

1. All wildland fire incidents, regardless of aircraft on scene, have an FTA. Reference the FTA diagram and find more information in *NWCG Standards for Aerial Supervision*, PMS 505 (https://www.nwcg.gov/publications/pms505). The airspace surrounding an incident is managed by the aerial supervisor who must implement FTA procedures. If an incident has an active TFR in place, FTA rules apply to the TFR, and clearance from the controlling aircraft is required prior to TFR UAS operations. If aerial supervision is not on scene, the first aircraft on scene will establish the FTA protocol.
2. The FTA is a communication protocol for firefighting agencies. It does not pertain to other aircraft who have legal access within a TFR (medevac, law enforcement, media, Visual Flight Rule [VFR] airport traffic, or Instrument Flight Rule [IFR] traffic cleared by the FAA).
3. Key components and procedures of the FTA include:
    a. Initial Communication (ICOM) Ring: A ring 12 nautical miles (nm) from the center point of the incident. At or prior to 12nm, inbound aircraft contact the ATGS or appropriate aerial resource for permission to proceed to the incident. Briefing information is provided to the inbound aircraft by the aerial supervision resources over the incident (ATGS, ASM, and HLCO).
    b. No Communication (NOCOM) Ring: A ring 7nm from the center point of the incident that should not be crossed by inbound aircraft without first establishing communications with the appropriate aerial supervision resource.
    c. Three Cs of initial contact: Communication requirements and related actions to be undertaken by the pilot of the inbound aircraft:
        i. Communication: Establish communications with the controlling aerial supervision resource over the incident (ATGS, ASM, HLCO).
        ii. Clearance: Receive clearance from aerial supervision prior to proceeding with UAS operations. The inbound pilot will acknowledge receipt of clearance or hold outside the NOCOM ring or on the ground, until the clearance is received and understood.
        iii. Comply: UAS aircraft will comply with clearance from aerial supervision resource. If compliance cannot be accomplished, the UAS will remain on the ground until an amended clearance is received and understood.
4. UAS departing incident airspace must follow assigned departure route and altitude. Aerial supervisors must establish/deconflict routes for departing aircraft through or away from other incident aircraft operations.
5. UAS flights by accredited news representatives within a TFR shall adhere to current FAA policy.

Mission Flight Procedures

The following procedures shall be followed by all UAS flight crews:

Before Takeoff:

1. Confirm authorizations (agency, incident, airspace).
2. Confirm/test communications (AM/FM/cell/satellite).
3. Coordinate with dispatch, helibase, aircraft, and ground personnel in the area.
4. Record launch coordinates (latitude and longitude).
5. Calibrate altimeter (inHg).
6. Determine mission altitude — feet, Mean Sea Level (MSL).
7. Confirm sensor payload is attached and functioning.
8. Complete the aircraft preflight inspections and checklists.
9. Obtain takeoff clearance from aerial supervisor or coordinate flight as required.

After Takeoff:

1. Record takeoff time.
2. Monitor assigned AM/FM frequencies.
3. Complete the aircraft checklists.
4. Establish flight following as required.
5. Coordinate/communicate with aircraft and ground personnel.
6. Monitor performance of sensors to ensure proper data collection.

After Landing:

1. Notify aerial supervision, aircraft in the area, or ground personnel.
2. Close out flight following as required.
3. Record landing time.
4. Verify data quality and transfer to appropriate storage device.

Post Mission:

1. Confirm need for UAS for next operational period.
2. Debrief with available air resources and appropriate incident management or dispatch personnel.
3. Attend or provide input to incident planning meeting for next day's operations.
4. Complete required documentation: invoices, agency flight reports, Aviation Safety Communiqué (SAFECOM) (https://www.safecom.gov/), etc.
5. Process and deliver desired data products.

UAS Emergency Procedures

Approved UAS have built in failsafe systems. The aircraft will return to home (LRZ) in the event of low battery voltage or loss of link with the GCS. Emergency situations are dynamic events, and not all conditions or procedures can be anticipated or applied during the event. No procedure is a substitute for a thorough understanding of aircraft systems and sound pilot judgment. If an emergency occurs, three basic actions can be applied to most situations:

1. **Maintain aircraft control:** Small emergencies can quickly escalate if the pilot is distracted by attempting to troubleshoot the problem. Perform immediate action items. Always maintain visual contact with the aircraft during an emergency, if possible, to reduce the likelihood of losing orientation.
2. **Analyze the situation:** Once the aircraft is stabilized, begin to assess the cause of the emergency if practical.
3. **Take appropriate action:** In many cases, the appropriate action will be to land the aircraft as soon as possible.

Always consider the safety of yourself and others before attempting to save the aircraft in an emergency. In the event of loss of control, communication, or visual contact with UAS:

1. Notify aerial supervision, aircraft in the area, and ground personnel.
2. Clear the affected airspace and suspend air operations in the area.
3. Notify flight following contact and/or dispatch as required.
4. Wait for the duration of the fuel/battery load to ensure the UAS is on the ground.
5. Resume air operations.
6. Search for the missing UAS.
7. Follow established mishap reporting procedures:
    a. Agency guidance and notification process
    b. 1-800-MISHAP
    c. SAFECO
    d. Local mishap response plan
    e. Incident within an Incident (IWI) plan
    f. FAA Part 107 and National Transportation Safety Board (NTSB) requirements for qualifying accidents or incidents (www.faa.gov/documentlibrary/media/order/faa_order_8020.11d.pdf)

Aircraft Coordination and Separation

UASP and UASM are responsible for ensuring separation and deconfliction with crewed aircraft on scene.

Do not fly UAS until you have established positive contact with on scene aircraft/aerial supervision.

Pilots shall maintain aircraft separation by:

1. Adhering to FTA protocols.
2. Using standard aviation see-and-avoid visual flight rules.
3. Having access to the appropriate radio frequency for position reporting.
4. **Giving way to crewed aircraft**.

Aircraft Coordination Scenarios

There are four typical scenarios:

1. Aerial supervision is on scene.
2. Aerial supervision is not on scene, but other aircraft are.
3. There are no aircraft on scene.
4. Aircraft arrive on scene and UAS is in flight.

Aircraft Coordination Examples:

The following scripts are examples of how to safely integrate UAS into incident operations. UAS pilots should plan for and be prepared for alternate direction.

Scenario 1: Aerial supervision is on scene. Initiate radio contact with aerial supervision. Give your call sign, location, mission, and requested operating altitude.

> *"Harper River Air Attack, Unmanned Romeo 41 on air-to-ground."*
>
> *"Unmanned Romeo 41, Harper River Air Attack."*
>
> *"UR 41, on the ground Div. A, requesting altimeter."*
>
> *"Unmanned Romeo 41, Altimeter 30.02."*
>
> *"Harper River Air Attack Unmanned Romeo 41, altimeter 30.02, requesting 6,500 and below for UAS mission in Div. A."*
>
> *"Unmanned Romeo clear to lift, maintain 6,500 and below, AA is at 8,500 no other aircraft in your area. Advise when your mission is complete."*
>
> *"Unmanned Romeo 41 copies."*

Scenario 2: Aerial supervision is not on scene, but other aircraft are. The uncrewed and crewed aircraft pilots are responsible to maintain separation.

> *"Helicopter 32B, Unmanned Romeo 41 on air-to-ground."*
>
> *"Unmanned Romeo 41, Helicopter 32B."*
>
> *"32B, Unmanned Romeo 41 on the ground Div. C, say altimeter."*
>
> *"UR41, 32B altimeter 30.02."*
>
> *"32B will remain on the ground, advise when your mission is complete."*

"32B copies, I'll advise when clear."

"Unmanned Romeo 41 copies, standing by."

Scenario 3: No aircraft on scene. The UASP must verify that no aircraft are on scene. Call dispatch and the IC to confirm and then make a blind call on air-to-ground prior to launch.

"Dispatch Unmanned Romeo 41, on command."

"UR41 Dispatch."

"UR41 operating on the Harper River Fire please advise any aircraft en route to the incident."

"Dispatch copies, will advise."

"UR41, in the blind, altimeter 29.92, at or below 5,500. Any aircraft in the vicinity of the Harper River Fire, please advise on air-to-ground."

Scenario 4: UAS is in flight and incoming aircraft calls in the blind. The UASP must respond and coordinate with the incoming aircraft.

"Harper River Fire air traffic, Helicopter 42B is 12 miles out, inbound from the south."

"Helicopter 42B, Unmanned Romeo 41, altimeter 29.92, at or below 2,500, on Div. B."

"Helicopter 42B copies, altimeter 29.92, will maintain 3,500, en route to Div. B for bucket work."

"Unmanned Romeo 41 copies, returning to Drop Point 31 to land."

Table 2 — Vertical Separation (typical aircraft altitudes)

Mission	Altitude (agl)	Normal Pattern
Media	As assigned	Right or left
ATGS — Fixed-Wing	2,000 to 2,500	Right
ATGS — Helicopter	500 to 2,000	Right or left
Airtanker Orbit	1,000 to 1,500	Left — outside to observe
Airtanker Maneuvering	150 to 1,000	Left
Lead Plane	150 to 1,000	Left
Helicopter	0 to 500 (hard ceiling)	Left or right
Smokejumper Ram Air Chute	3,000	Left
Smokejumper Round Chute	1,500	Left
Paracargo	150 to 1,500	Left
Unmanned Aircraft (T1)	3,500 and above	Variable
Unmanned Aircraft (T2)	3,500 and above	Variable
Unmanned Aircraft (T3)	2,500 and below	Variable
Unmanned Aircraft (T4)	1,200 and below	Variable

Horizontal Separation

1. UAS crews must ensure there is adequate visibility to conduct operations safely regardless of the airspace classification.
2. Patterns must be adequate and not hindered by terrain.
3. Consult aerial supervision or on scene aircraft before finalizing patterns and routes. UAS may be required to report arrival at a check point or virtual fence and wait for clearance from ATGS before proceeding.

Known geographic locations make effective check points and virtual fences.

UAS Aerial Ignition

The Interagency Fire Unmanned Aircraft Systems Subcommittee (IFUASS), Office of Aviation Services (OAS), and National Technology Development Program (NTDP) will work with the Interagency Aerial Ignition Unit (IAIU) to develop, coordinate, and implement strategic and tactical UAS operations. These organizations will also collaborate with other UAS associated personnel; aviation managers, geographic area coordination groups, and interagency partners/cooperators.

UAS Aerial Ignition Operations

UAS aerial ignitions (UAS Ai) operations require two remote pilots; a minimum of one fully qualified UAS Ai pilot and one UAS Ai trainee. UAS Ai operation may require additional support staff referred to collectively as a UAS module. The exact number and configuration may vary by UAS type, but each module will have a designated module leader. A UASL may be ordered, if not already assigned to coordinate with personnel such as the local unit managers, state/regional aviation officers, or Air Support Group Supervisor (ASGS) to gain general familiarity regarding the request. Once a specific work assignment is made and the UAS pilot is preparing to initiate aerial ignition activities, the module will work under the direct supervision of the assigned aerial ignition supervisor (e.g., Firing Boss, Burn Boss).

For planned events only (prescribed fire), UAS Ai can take place with a single Ai pilot that is recognized by IFUASS as an Ai Inspector, as long as the second remote pilot has completed S-373, UAS Incident Operations.

Operational Considerations

The following are some operational considerations based on recent experience using UAS for aerial ignition on both planned and unplanned wildfires.

1. Duration and capacity: UAS platforms typically have a maximum payload (i.e., number of spheres it can carry) and battery life. A typical operation will require the aircraft to land several times to change batteries and reload the ignition device.
2. Flight times: Generally speaking, UAS ignition is faster than ground ignition but slower than traditional helicopter-based aerial ignition.
3. Operational tempo: Field units noted that the operational tempo of the prescribed (Rx) burn, and aerial ignition can feel more at ease or relaxed with UAS as compared to occasionally experiencing a more stressful tempo while utilizing piloted aircraft.
4. Operational functionality: UAS Ai operations functions similarly to helicopter ignitions with respect to communication and standard firing patterns. Communication with the UAS Ai pilot needs to take place prior to mission as launch and recovery areas may be adjusted based on the mission. UAS Ai operations require time to design and plan before operations start. Ignition time frames and organizational structure are different than normal helicopter aerial ignitions.
    a. The assigned Firing Boss/aerial ignition supervisor coordinates and communicates similar to the way they would flying in the front seat of a helicopter except they are on the ground.
    b. The assigned Firing Boss/aerial ignition supervisor stands close to the UAS Ai pilot who controls the aircraft through use of a GCS that shows the location and activity (i.e., ignition points) of the aircraft. The Firing Boss can point to specific locations on the screen to direct

the pilot(s) as to the desired timing and location of spheres. In some instances, mirroring the GCS to a larger screen is utilized.

c. The normal communication sequence used for Plastic Sphere Dispenser (PSD) operations (prepare to fire, start firing, prepare to stop, stop firing) is used. Firing Bosses and UAS Ai pilots have noted the importance of describing the pattern the supervisor wants flown to the pilot on the screen and that the pilot confirms with the supervisor before the mission is started.

5. Connectivity: Generally, UAS are controlled by a ground control unit that must remain within line of sight of the UAS. Terrain, vegetation, or other obstructions can interfere with the signal or connectivity, limiting the effective operational distance of the UAS.
6. Firing patterns: As noted above, firing patterns can be executed like helicopter firing.
7. Advantage of infrared (IR): With thermal imagery on many platforms, UAS can see clearly through smoke. Firing patterns do not usually need to be changed even if that means flying directly into smoked out areas.
8. Spacing of ignition spheres: UAS aerial ignition devices can change the drop spacing of ignition spheres during flight to a specific distance, (50 feet, 100 feet, 300 feet, etc.).
9. Multiple Aircraft: Large burns (1,000+ acres) have been completed with both a single and multiple UAS. Having the ability to use multiple UAS with aerial ignition on the same burn presents a significant advantage. Ignition time frames are reduced, which can aid in smoke management. It can be difficult during larger burns to reach the "far corners" with a single UAS. Having multiple aircraft operating from different locations can more easily cover the areas of larger burns. Fatigue on a single UAS pilot is reduced, as well as wear-and-tear on a single aircraft.
10. Integration: Field units noted that integration of UAS technology into the Rx fire operation was straightforward and manageable once local units were briefed on UAS operations by qualified UAS personnel.
11. Communications: On large incidents such as Type 1 wildfires, UAS operations would typically utilize an air-to-ground frequency as well as monitor the tactical channel(s) on the divisions they are assigned to. For prescribed fire operations, it may be more practical to stay on the local tactical channel used for normal Rx burn operations — this would allow all personnel the ability to listen and communicate with the aerial ignition Firing Boss who is with the UAS pilot.

    a. Announcing the location of aircraft: Ground resources have noted that due to its small size and relatively little noise created, it was difficult to locate and keep a mental picture of where the UAS aircraft was in relation to the burn area and ground personnel. This can be easier with a helicopter due to its size and the amount of noise created.

    b. The Firing Boss (FIRB) must be more intentional and active in announcing the actions of the UAS so that ground personnel are made aware of where and when ignitions are occurring.

    c. The use of landmarks may suffice in an emergency, but when time allows, the use of drop points or even a grid-pattern overlay on the burn map are extremely useful for the FIRB to relay the location of the UAS to ground resources on the burn ("lighting from DP 5 to DP 6" or "ignition complete from block A1 on the north flank to A5, and down the east flank to DP 6").

12. Smoke management: UAS is an effective tool for monitoring and documenting smoke dispersion via camera and IR sensors.
13. Georeferenced maps: For prescribed burn units or ignitions where map references are critical, accurate georeferenced maps of the burn units are necessary for the UAS GCS to upload in advance. These are displayed on the pilot's control unit and must be accurate to avoid firing outside of the unit or intended control lines. UAS pilots will confirm accuracy of maps with a recon flight before ignition and can adjust as necessary. Use of recon flights for SA and alternative launch locations is critical to mission success.
14. Planning/prework: Planning/logistics is completed by UAS personnel behind the scenes before UAS Ai commence. This includes studying airspace requirements, airspace deconfliction with local dispatch, filing NOTAMs, uploading digital maps into the GCS, and scouting the burn unit in advance for optimal launch and recovery areas. UAS modules require this information at least a day in advance so that they can complete these tasks. These actions will result in a better product on the day of the burn.
15. Experience of UAS Ai remote pilot: UAS pilots with a strong background in wildland fire have shown to be essential. Although a FIRB is required during UAS Ai operation (separate from the remote pilots) it has been shown to be more effective having advance knowledge of fire behavior and firing techniques to aid in the mission. This knowledge helps when building a plan and the ability to make adjustments during missions.

UAS Aerial Ignition Equipment Review and Approval Process

The IFUASS will ensure completion of technical reviews for new/proposed UAS Ai payloads, in collaboration with OAS and the Forest Service. IFUASS will coordinate with the IAIU prior to recommending payload approval to the National Interagency Aviation Committee (NIAC). The appropriate chair will forward NIAC's documentation to all agencies/bureaus regarding decision of new equipment. The IAIU or IFUASS Chair will formally notify vendor of NIAC/IFUASS decision.

UAS Aerial Ignition Training and Qualification

UAS remote pilots must attend approved agency sponsored training. Only remote pilots that attend training and obtain an OAS 30U or FS5700-20B Remote Pilot Card are authorized to operate Ai on under Federal Operational Control.

Prerequisites:

1. Current OAS-30U or FS5700-20B, Remote Pilot Card for the designated make and model of UAS used for the aerial ignition payload, or Associated Cooperator Letter
2. S-373, UAS Incident Operations
3. Qualified as a UASP
4. Qualified Single Resource Boss (NWCG) (Currency Not Required)
5. Attend UAS Aerial Ignition Steering Committee Approved UAS aerial ignition training
6. Complete Extended/BVLOS training
7. The trainee must participate in UAS aerial ignition operations with a fully qualified UAS aerial ignition pilot.

a. All evaluation or inspection flights must be conducted under the supervision of the fully qualified UAS aerial ignition pilot who is designated as a UAS Evaluator or Inspector and identified as such on the UAS Master qualification list.

b. UAS Aerial Ignition Mission Evaluation forms must be completed by the UAS Evaluator or Inspector and discussed with the trainee (https://uas.nifc.gov/aerial-ignition).

c. When the trainee is ready for a final Ai evaluation a UAS Inspector or Pilot Evaluator will complete the final UAS Aerial Ignition Mission Evaluation form and recommend the trainee become fully qualified.

   i. Upon successful completion of a final Ai flight evaluation the UAS Inspector/Pilot Evaluator will email all UAS Aerial Ignition Flight Mission Evaluation forms to:

      (1) DOI — OAS UAS Representative

      (2) Forest Service (FS) – Regional UAS Specialist

      (3) The FS National UAS Aerial Ignition Specialist will be cc'd on all final flight evaluations.

UAS Aerial Ignition Currency

Aerial ignition remote pilots are required to fly the aerial ignition payload for a minimum of three (3) hours of operational missions within the preceding 12 months or the interval specified within your agency's policy, whichever is more restrictive. Flight evaluators during evaluation flights may record up to two (2) hours of this time towards the UAS Aerial Ignition Currency. Remote pilots failing to meet this requirement shall fly under the supervision of a carded and current Ai remote pilot and perform the flight maneuvers and emergency procedures for that aircraft and payload to regain currency.

UAS Aerial Ignition Roles and Responsibilities

The following three roles have been identified to ensure effective interagency UAS training:

- UAS Inspector
- UAS Instructor ["fully qualified" by Interagency Aviation Training (IAT) definition]
- UAS Flight Evaluator

All Inspectors, Instructors and Flight Evaluators will be identified on an Interagency/Contract UAS Master Instructor List. The Master Instructor List, including each position's requirements, can be found in IAT Guide (https://www.iat.gov/)

Safety Considerations

Safety is the principal consideration in all aspects of UAS operation. A safe UAS operation depends on accurate risk assessment and informed decision-making.

Risk levels are established by the severity of possible events and the probability that they will occur. Assessing risk identifies the hazard and associated risk, and it places the hazard in a relationship to the mission. A decision to conduct a mission requires weighing the risk against the benefit of the mission, and deciding whether the risks are acceptable.

Examples of the Risk Management Process are available in the *NWCG Incident Response Pocket Guide (IRPG)*, PMS 461 (https://www.nwcg.gov/publications/pms461), the *Interagency Standards for Fire and Fire Aviation Operations (Red Book)* at https://www.nifc.gov/standards/guides/red-book, CAL FIRE 8300 Handbook (https://fs-prod-nwcg.s3.us-gov-west-1.amazonaws.com/s3fs-public/2023-06/iabs-calfire-8300-handbook.pdf), and the *NWCG Standards for Helicopter Operations (NSHO)*, PMS 510 (https://www.nwcg.gov/publications/pms510).

Factors to consider during the risk assessment process:

1. Any flight mission has a degree of risk that varies from 0% (no flight activity is conducted) to 100% (aircraft and/or personnel experience a mishap).
2. The UAS crew must identify hazards, analyze the degree of risk associated with each, and place hazards in perspective relative to the mission or task.
3. Hazards might not always be limited to the performance of flight but may include hazards to personnel if the flight is not performed.
4. The risk assessment may include the aerial supervisor, AOBD, duty officers, agency fire management staff, ICs, dispatchers, and line officers/managers.
5. Ultimately the pilot-in-command has the authority to decline a flight mission that they consider excessively hazardous.

Risk Mitigation Considerations

UAS operations must not proceed until risk mitigation measures are implemented.

1. Monitor the overall aviation operation for issues related to human factors.
2. Operational tempo or complexity
3. Task saturation
4. Fatigue, burnout, and stress
5. Acceptance of risk as normal
6. Lack of SA
7. Complacency
8. Not using checklist
9. Rushing or a sense of urgency
10. Utilize the appropriate aircraft for the mission
11. Fixed-wing vs. rotor-wing

12. Density altitude
13. Payload types
14. Flight duration
15. LRZ

Communications

Ensure communication can be maintained on assigned frequencies.

Obtain Input

Discuss operations safety with other pilots. Mission debriefings are an excellent source of information. UAS crew members will utilize After-Action Reviews (AAR) to critique mission effectiveness with other incidents and airbases when possible.

UAS Intrusion

The following information pertains to UAS intrusion during incident operations.

A UAS intrusion is defined as a non-participating UAS operating over or near an incident that intrudes into a TFR or interferes with fire management efforts. The intrusion is documented through the appropriate reporting system such as SAFECOM, SAFENET, or a reporting system used by one of the states. Refer to the UAS intrusion protocol (page 22) flowchart for more information.

Considerations

1. UAS are like any other hazard; "if you see something, say something."
2. Incident personnel should report all unauthorized UAS activity via the SAFECOM (https://www.safecom.gov/) system. UAS information (color, size, altitude, flight pattern) should be reported if known. All UAS intrusions should be reported to FAA through established reporting systems.
3. Dispatch centers should report UAS intrusions to the nearest Air Traffic Control Center.
4. Safety of flight should be primary over any incident aircraft locating the operator.
5. The FAA provides additional guidance for law enforcement (https://www.faa.gov/sites/faa.gov/files/uas/resources/policy_library/FAA_UAS-PO_LEA_Guidance.pdf) personnel.

Job Aids for UAS Operations

UAS Operations Kit

UAS crewmembers should have and maintain a kit. The following items are recommended:

1. Handheld radios (AM and FM)
2. Bad Elf GPS Pro+
3. Computer with agency approved software, including:
    a. Flight planning software
    b. Adobe Pro
    c. ArcMap with Full Motion Video (FMV) and Spatial Analyst extensions
    d. Photogrammetry software
    e. Google Earth
4. Tablet
    a. GCS app
    b. ForeFlight app
    c. Low Altitude Authorization and Notification Capability (LAANC) provider
    d. Avenza app
    e. GAIA app

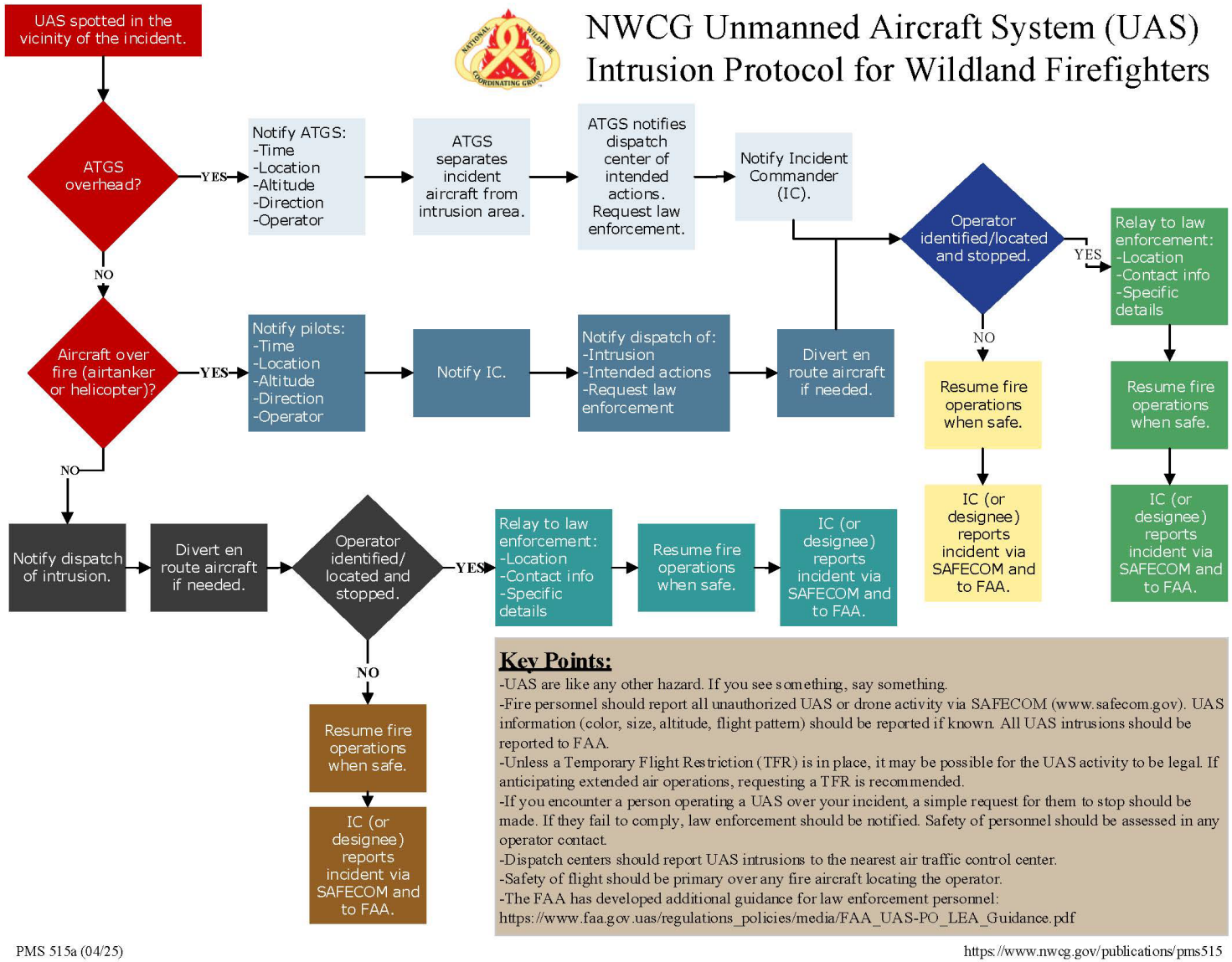
5. High-capacity portable hard drive
6. Portable internet connection (Wi-Fi/smart phone)
7. Frequency guide
8. Batteries and cables
9. Flashlight
10. Camera
11. Overnight Bag
12. Maps:
    a. Current FAA sectional chart coverage area
    b. Agency maps
    c. Local hazard map (from dispatch)
    d. Incident map (updated daily)

Publications

1. Aviation Safety Communiqué (SAFECOM): FS-5700-14 and OAS-34
2. National Interagency Standards for Resource Mobilization: (https://www.nifc.gov/nicc/logistics/reference-documents)
3. Geographic (agency) mobilization guide
4. Local mobilization guide
5. Agency aviation management manuals/handbooks
6. DOI — USDA aircraft radio communications and frequency guide
7. Agency aviation plan
8. *NWCG Aviation Mishap Response Guide and Checklist,* PMS 503 (https://www.nwcg.gov/publications/pms503)
9. Applicable UAS operator manual/user guide

NWCG UAS Intrusion Protocol for Wildland Firefighters, PMS 515a

Figure 1 - UAS Intrusion Protocols



Website References

NWCG References

Interagency Fire UAS Subcommittee: https://www.nwcg.gov/committees/interagency-fire-unmanned-aircraft-systems-subcommittee

NWCG Position Catalog, Air Operations: https://www.nwcg.gov/positions/air-operations

UAS Policy

FAA part 107 Summary: https://www.faa.gov/newsroom/part-107-summary

FAA Part 107 Waiver Request: https://www.faa.gov/uas/commercial_operators/part_107_waivers

DOI UAS Policy Sites: https://www.doi.gov/aviation/uas/policy

DOI Memorandums of Agreement

FAA — Blanket DOI Public Agency COA:
https://www.doi.gov/sites/doi.gov/files/uploads/faa_form_7711-1_2016-csa-185_doi_rev_1.pdf

Blanket Area sUAS Class G COA Extended Visual Line of Sight Operations (EVLOS):
https://www.doi.gov/sites/doi.gov/files/uploads/blanket_area_suas_class_g_coa_-_doi_-_september_6_2018_update.pdf

FAA — BVLOS Operations in a TFR MOA:
https://www.doi.gov/sites/doi.gov/files/uploads/FAA_DOI_UAS_TFR_MOA_8-13-15.pdf

FAA — Class G Operations (<1,200') MOA:
https://www.doi.gov/sites/doi.gov/files/uploads/DOI_FAA_MOA_Class_G_09112015.pdf

Agency Websites

Interagency UAS: https://uas.nifc.gov

Interagency UAS Training: https://uas.nifc.gov/training-overview

DOI UAS Information: https://www.doi.gov/aviation/uas

USFS UAS Homepage: https://www.fs.usda.gov/managing-land/fire/aviation/uas

BLM Aviation Homepage: https://www.blm.gov/programs/fire/aviation

BLM UAS Training Homepage: https://www.doi.gov/aviation/uas/training

USGS UAS Project Office: https://www.usgs.gov/programs/national-land-imaging-program/science/national-uncrewed-systems-office

Interagency SAFECOM System: https://www.safecom.gov/

Interagency Aviation Training (IAT): https://www.iat.gov/

Flight Planning

Sky Vector DROTAM (drone NOTAM) page: https://skyvector.com/

NOTAM submission & Flight briefing: https://www.1800wxbrief.com/Website/#!/

Foreflight: https://www.foreflight.com/

The *NWCG Standards for Fire Unmanned Aircraft Systems Operations* is developed and maintained by the Interagency Fire Unmanned Aircraft Systems Subcommittee (IFUASS), under the direction of the National Interagency Aviation Committee (NIAC), an entity of the National Wildfire Coordinating Group (NWCG).

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