

AERIAL SUPPRESSION OF WILDLAND FIRES

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The speed, mobility and fire retardant-delivery capability of aerial firefighting aircraft make them effective resources in support of firefighters on the ground.

Over the last two years, wildland fires have destroyed significant areas in both the U.S. and abroad. Because of this, there has been an increased interest by airborne law enforcement units to add aerial firefighting to their mission profiles. The variety of aircraft available within U. S. aviation assets provides an appropriate firefighting capability for nearly every wildland fire situation, from wilderness to the urban interface.

This article will discuss the complexities of adding aerial firefighting to your unit's mission profile and the recommended training and coordination that should be implemented prior to deployment.

Fire Response Coordination & Management

Unlike many other disaster-response missions, wildland firefighting is usually a highly coordinated response, especially in the U.S. Two tools that help facilitate that coordination are the Incident Command System (ICS) and the Interagency Helicopter Operations Guide (IHOG). ICS provides the framework and management system for the entire response, while the IHOG is the rulebook for helicopter operations on wildland fires in the U.S., which could be adaptable in other parts of the world.

The objectives of the IHOG are to:

- Promote safe, cost-efficient and effective aviation services in support of agency and interagency goals and objectives.
- Define and standardize national, interagency helicopter management and operational procedures for participating agencies.
- Through standardization, facilitate the ability of personnel from different agencies to work cooperatively on incidents or projects.
- Provide a common, interagency approach in the government's relationship with helicopter vendors.
- Provide a framework within which areas, regions, states and local units can provide supplemental, site-specific guidance.

The IHOG lists the recommended pilot and crew requirements for firefighting missions, but it also discusses numerous other mission profiles, including law enforcement and search and rescue. (The IHOG can be found at the National Interagency Fire Center website: www.nifc.gov/ihog and downloaded as a PDF file.)

Getting Carded

One of the elements of beginning the firefighting mission discussed in the IHOG is getting carded, or typed. Being carded means having met the minimum standards for an assigned position and then being checked out by an approved agency or individual for those positions.

The minimum requirements for a pilot to be carded are shown in table 1. In addition to meeting the minimum hours, you will also be required to pass

an initial checkride for each type of aircraft to be flown, while also demonstrating proficiency in all of the mission profiles you intend to fly. This includes long line operations, Bambi Bucket or tank operations, short haul, rappelling and heli-torching, to name a few. After passing the initial checkride, you can look forward to repeating the process on an annual basis. In addition to the aicrew, aircraft must be typed and carded, as well. Typing criteria can be found in the IHOG chapter 6 and are listed in table 2.

Table 1

Minimum Experience Flying Hours	
Total time	1,500
Pilot-in-command hours	
PIC	1,500
Helicopter (last 12 months)	100
Weight class	100
Specific Experience Flying Hours	
Make & model	50
Make, model, series (last 12 months)	10
Helicopter (last 60 days)	10
Plus minimum turbine helicopter ops time	100
Or minimum piston helicopter ops time	200

Table 2

Helicopter Class	1	2	3
Payload (Lbs. at sea level and 59o F)	5000	2500	1200
Helicopter Seats (including pilot)	15+	9-14	4-8
Fire Retardant or Water Capacity (gal.)	700	300	100
Max Gross TakeOff/Landing Weight (lbs.)	12,501+	6000-12,500	up to 6000
Examples	Skycrane/Chinook	Bell 205/212/412	B3/L1-4, AS350

The Helicopter Coordinator

The actual tactics and strategy to be used in a firefighting mission are decided by the incident commander and/or his designee, which usually would be the operations section chief. In some areas, the helicopter crew may be first on scene, which makes them initially the incident commander and responsible for immediate tactics and strategy to be used on the fire, directing incoming ground units, and offering a general overview of the scene.

One of the ways to decrease this workload on the pilot is through the use of a helicopter coordinator (HELCO). The HELCO is an airborne incident commander position responsible for managing helicopters in and around a fire, with specific emphasis on controlling and directing helicopter water dropping operations. Following the IC's incident objectives, the HELCO directs the tactical efforts of all helicopters assigned to the incident. It is essential that the incident commander monitor the air-to-ground net from the time of dispatch. The HELCO role is fulfilled initially by one of the pilots in an assigned water dropping helicopter. In some agencies, it is filled by a firefighter, usually a captain or above, and can be either in one of the water dropping helicopters or in a command and control aircraft.

In this configuration, the pilot may have the option to direct air-to-air operations, and the fire officer will:

- Assist the incident commander in developing a well coordinated attack utilizing responding resources.

- Notify the incident commander of potential structure protection problems, monitor fire behavior and rate of spread, assist with access and egress for incident assigned resources and act as a safety officer in the air.

Coordination of all aircraft on a fire is the responsibility of the air tactical group supervisor or the HELCO. In the absence of either, one of the aircraft on scene must assume the role and accept the responsibility of the position.

Constant monitoring of the dedicated communications channel is required for safe traffic flow. Dedicated air-to-ground channels for communication with ground firefighters are needed for efficient mission completion and assistance in an emergency, should the ground crew need it. If you are assisting another agency that has an ICS system in place, ask for a copy of ICS form 205, the communications plan. This will list all radio frequencies for the incident, including command, operations, air-to-air, air-to-ground and medical.

It is suggested that helicopter crews make appropriate radio calls to aid the air tactical group and other pilots in flight-route coordination. Good practice would include calls when departing a helibase or helispot, departing the water source, arriving on the fire scene, departing the fire scene and arriving at a helibase.

Flight Paths And Coordination

Often an assignment will require working with other helicopters. In this situation, the pilots can work out a flight path procedure and maintain a daisy chain. The daisy chain is simply an informal "follow the leader" pattern.

Working in close proximity to the ground provides an ever present potential for wire strikes. It is therefore essential that a thorough search for wires be made before dipping or conducting water drops. During reconnaissance, look for supporting towers, corners that may have wires cutting diagonally and places where power would likely be needed, such as a pump house.

Information should be immediately relayed to other flight crews as wires, towers and other hazards are discovered. It is also recommended that wire cutters be installed. Make hazards known to the air tactical group and helibase manager and ensure they are posted for everyone to see.

Since there are frequently other aircraft working a fire and the occasional unannounced news helicopter, it is necessary that constant vigilance be maintained. Notify the air tactical group of rogue aircraft.

Reduced visibility presents an increased hazard in terrain avoidance, wire strikes and midair collision. Be certain that you know what is on the other side of smoke before flying through it. Do not fly through a smokescreen if you cannot see through it. If you go IFR, get on the instruments and climb above the surrounding terrain. Let the air tactical group and other aircraft know what you are doing.

TECHNIQUES FOR FIGHTING FIRES

Fighting a wildland fire is similar to putting up a perimeter for containing a suspect. You want to lock down an area on all four sides, start big in your containment and work your way towards the suspect, which in this case would be the fire. Initially, you can use cardinal direction (north, south, east and west) to describe positions on the fire, but the preferred method is to describe the head, heel, flanks, spots and anchor points, as shown in Figure 1.

The three basic attack methods used in wildland firefighting are direct, indirect and parallel:

- Direct Attack - A direct attack involves dropping water on the burning fuel along the fire line or the head of the fire for direct extinguishment (Figure 2). Oftentimes, terrain and or the rate of spread of the fire makes this approach impractical and can cause the head to split, which is extremely dangerous for ground personnel.
- Indirect Attack - An indirect attack is usually done on larger fires in conjunction with bulldozers, hand crews and air tankers. This method utilizes natural barriers, such as large bodies of water, dry riverbeds or tilled fields. Your fire line, or containment area, is a large distance away from the main fire, and your water drops may be used as a "wet line" so that ground crews can burn out fuel between your line and the approaching fire (Figure 3).
- Parallel Attack - Parallel attack is the most dangerous method used by ground forces but can be quite effective, especially with the proper use of aerial firefighting assets. The method requires the ground crews to work a short distance from the fire's edge and take advantage of any natural or manmade barriers or fire breaks. The reason this is dangerous is that ground crews are working in "the green," which means they have unburned fuel between themselves and the fire. The idea is for the ground crews to put in a wet line from an anchor point, while the helicopter works the flanks and or head of the fire. After the wet line is installed, the ground crews can then "fire out" the unburned fuel (Figure 4).

Helicopter water buckets are a common water delivery tool for wildland fire suppression and are widely used by those airborne law enforcement units that currently fight fire. Buckets have a relatively low cost when compared to fixed tanks, are relatively simple to install, are easily jettisoned, and can be filled from lakes, streams and remote fill sights.

Installation of the bucket should be in accordance with any applicable regulations, STCs or, if working with or for a federal agency, in accordance with contract specifications.

After installation of the bucket, the real fun begins, in the filling of the bucket in various bodies of water and in various conditions. Following are some general guidelines for filling and flying the bucket.

Approaching The Source

The approach to the water source should be made carefully, observing for obstacles and planning for unseen ones. Wires frequently cross bodies of water, and their support poles or towers may be difficult to see. Rivers in mountainous regions often have cables crossing them near the surface, and low head dams are occasionally found.

The basic technique in filling is to approach the water in a steep approach. Watch the bucket's shadow on the water surface and note that the bucket itself and the shadow will appear to move toward each other as the bucket nears the water surface. This reference will aid the pilot in determining the bucket height. Very slight forward movement will help tip the bucket over when it touches the surface. This will also help prevent rotor wash from blowing the bucket in front of the aircraft as it reaches the surface.

As the bucket sinks, refer to fixed objects on the shore to prevent drifting. It is easy to watch the water surface and try to reference to the ripples, which will cause drifting as the ripples and waves move. Staying

near the shoreline aids in remaining stationary and makes for a short swim if a power failure occurs.

Continuing forward at a very low speed will fill the bucket rapidly, and after minimal practice, a pilot should be able to dip and go without stopping. Do not maintain enough forward speed to cause jerking on the cargo hook. It is recommended that the neophyte dipper touch down with no forward movement and remain stopped before lifting the bucket out of the water.

When empty at low airspeeds, the bucket cables may occasionally wind up. While lifting, the weight of the bucket will cause the cables to unwind as they straighten out. If the bucket unwinds too rapidly, it will place a severe twisting load on the cargo hook. Try to watch the bucket as it is being lifted, either in a mirror, directly or by using a crewmember. If the cables have wound up, do not lift the bucket completely out of the water. Lifting it partially out will control the rate of this unwinding effect.

Large Bodies Of Water

Very large bodies of water can present some difficulty in maintaining a stable hover during filling. The illusion of movement from the swells and waves is pronounced, with the pilot trying to maintain a static horizontal position by referencing his/her position with this moving surface. In these cases, it is even more important to fix on points on the shore or rocks and pilings in the water to prevent drift.

Since swells present a rising and falling surface, try to time the lift with a rising swell. When operating over salt water, pay attention to corrosion, and rinse the aircraft frequently with fresh water. Maintenance personnel should be informed of any salt water operations.

Moving Bodies Of Water

Rapidly moving water, such as that found in rivers, flood plains and urban concrete channels, present some unique challenges. In these cases, the bucket will act as a drag chute in the fast current and may overpower the helicopter. Be alert and ready to release the water or jettison the bucket itself. Since the current will tend to pull the helicopter downstream, it is safest to face the helicopter upstream against the current. This will place the aircraft in a nose-low attitude, which is safer than being drug downstream and having the helicopter in an extreme tail low attitude where a tail rotor strike in the water could occur.

During mornings in the mountains, down-canyon winds will usually be found. This will allow the helicopter to take-off into the wind and into the current. This offers the best control but does mean a climb upstream. As the day progresses, the winds will shift up-canyon, and then the pilot must decide on which is the greater to overcome - the current or the wind. This is a judgment call, and each situation will require its own decision. If confronted with these problems, remember to look for bends in a river that may yield the best winds, and look for pools where the speed of the current is the lowest.

Safety Training and PPE

For those crews that have never been to formal water survival training, it is a must prior to engaging in overwater bucket fills, especially if you plan to use moving bodies of water. The entire crew should go to a facility that has an actual aircraft fuselage to train in.

After conducting the training, the unit will need to obtain personal flotation devices, which range from full vests to horse collar type vests and contain a "come home bottle" that usually has five minutes of breathable air with a mouth piece and regulator. Flight crews must also be equipped with and use personal protective clothing approved for both aviation and wildland firefighting, which includes fire shelters.

Remote Helispots/Dip Tanks

Occasionally, portable tanks will be set up due to a lack of natural water sources. It is necessary to come to a stationary hover during dip and lift off to prevent damage to the tank. A person on the ground can be helpful in guiding the helicopter.

Filling portable tanks may also be required. Use techniques similar to dipping out of one. Come to a stationary hover centered over the tank, being careful not to bump the full bucket against the sides of the tank, and release the water. Be aware of any movement of an empty tank from rotor wash. It may be necessary for ground personnel to place some large rocks in the tank to hold it down. After a few drops have been made into the tank, the water will hold it in position.

Dropping Procedures

Controlling drop density is done with varying airspeeds and altitudes. It is recommended that initially the pilot start with an airspeed of 60 knots or above (consult the flight manual for the best single engine climb speed or the best autorotational airspeed) and a bucket altitude above the drop zone of approximately 50 feet. As the pilot develops his flying technique with this starting point, departure from it can be practiced for different conditions.

On light fuels (grasses), fly at higher airspeeds up to 90 knots to lay the longest line. If length is not needed but a greater width in a small space is required, then go slower but at a higher altitude. The greater altitude will allow the water/foam to aerate more and be dispersed over a larger area.

Heavier fuels or more concentrated areas such as brush piles may dictate a slower or lower drop to help concentrate the water. This is a compromise on safety, as low airspeeds and altitudes do not allow any margin for error or mechanical failure. A slow drop at a high altitude may provide the wetting necessary without undue rotor wash, but it may place the aircraft in a critical part of the height-velocity envelope. Experience has shown that low airspeeds usually do not offer as much benefit as expected for the increased risk.

Water Bucket Flight Techniques

Flying a water bucket is straightforward. Use good basic technique, keeping the ball centered, avoiding slipping and skidding and keeping turns coordinated. Clumsy or careless use of the pedals will initiate sideways oscillations of the bucket. When a bucket is full of water, it is stable and should not present any problems for the pilot. When empty, it may have a tendency to swing at certain airspeeds. As with other external loads, airspeed must be adjusted accordingly.

To stop fore and aft swinging from pilot induced oscillations, slightly increase airspeed and then maintain it. Notice any fore and aft movement of the cyclic stick; you may not be aware that you are inducing it.

If a pilot is having difficulty flying the bucket, review basic flying techniques.

WIND CONSIDERATIONS

For precise water drops, a correction for wind must be made. The higher the drop, the greater the drift will be. In high wind conditions, it may be necessary to lower the drop altitude. If possible, do a turn after the drop; a visual check can inform the pilot on the degree of drift. This information can be used to adjust the next drop. An error towards the unburned area of the line is more efficient than having the water land inside the burn.

Approach and Departures

When approaching the drop zone, it is important to plan both the approach and departure routes. The safest way into the drop zone allows for the safest way out and considers the possibility of a bucket malfunction and the inability to release the water.

Plan flight routes to avoid flying over personnel and equipment, and plan an escape route when setting up for a drop. A loss of power, failure of bucket to open, wind shift or other unforeseen situation could seriously jeopardize safety.

Always be prepared to jettison the water, or if necessary, the entire load. Keep the cargo hook release armed when in the drop area. Keep airspeed high enough to achieve the best autorotational glide or single engine performance.

Plan all maneuvers so that they may be completed even if the load does not jettison. Be on guard for a power settling situation while loaded. Avoid abrupt maneuvers that increase loading, particularly near the ground.

Occasionally, there may be a call for an aircraft to land on a fire site, which is usually an unimproved area. Like any unimproved landing, a proper recon for obstacles on the ground, sloping terrain and debris must be made.

Landing in the burned area presents a condition similar to the "white-out" that snow landings present. The fine ash remaining after an area has been burnt over must be dealt with in the same manner as powder snow. Several water drops on the area can eliminate this problem. The pilot can also make a low, slow pass over the proposed landing zone and see how much ash is stirred up.

Water Dropping Hazards

Water dropping presents several hazards that must be constantly considered, including the hazards of low level flight, steep terrain, poor visibility and aircraft congestion on larger fires. A vigilant eye must be kept for unannounced aircraft, such as news crews.

Aerial firefighting operations are frequently conducted in steep terrain, with turbulent wind conditions and reduced visibility due to smoke. The airspace around a fire is often congested, with many aircraft working in a small area, and the potential of a midair collision or a wire strike is ever present. You must constantly think about safety and know your own limitations.

Side Bar

How Fires Live & Breathe

Once your aircraft and personnel have been trained and licensed, it's time to fight fire.

Law enforcement officers often joke, "How hard can it be, you just put the wet stuff on the red stuff, right?" But it is a little more complex than that. The basics involve the theory of combustion and related factors that effect wildland fires.

Fire is the combustion of a fuel in the presence of oxygen. Heat is needed to start and maintain combustion. The three factors that make up combustion are heat, fuel and oxygen, commonly called the "fire triangle." By removing any one of these three elements, you can interrupt the combustion process. The most common method of removing heat is through the application of water.

In wildland firefighting, the major factors that affect fire behavior are fuel types, wind, weather and terrain. These factors will also affect the strategy and tactics you select to fight the fire. Fuel types are categorized as light, medium and heavy. In many areas of the country, you will find a combination of these fuel types, which dictates that any aerial firefighting effort must be in support of a ground firefighting force.

Following is a description of the major factors that affect fire behavior:

Light Fuel - Grass is a light and flashy fuel that is greatly affected by relative humidity. When a rainstorm occurs, most grasses' moisture content will rapidly increase with the increase in humidity. In low humidity conditions, the opposite is true, with wind being a large contributor to grass losing its moisture level as fast as the surrounding air. Light fuels such as grass can ignite easily, burn fast and are responsible for the vast majority of firefighting injuries and deaths.

Medium Fuel - Brush and heavier vegetation absorb and lose moisture much more slowly than light fuels and are therefore less affected by rain or changing humidity levels. This was evident during the 2003 California Fire Sieges, where areas of the state had declared fire season closed after receiving a few inches of rain. Medium fuels such as Chaparral-type brush are often ignited by direct flame contact from underlying grass or due to radiant heat, often called "pre-heating," by an approaching wind-driven fire. Due to their density, medium fuels will have a tendency to burn longer and hold heat even after water has been dropped on them.

Heavy Fuels - Woody fuels composed of timber and other types of trees hold moisture very well, which is why they are often standing after a fire moves through. But they are also quite dangerous after several years of drought conditions. These types of fuel are the most difficult to extinguish because of poor penetration of water drops due to the high heat and thickness of the overlying canopy.

Wind - One of the major driving forces behind any wildland fire is wind. Wind is a source of oxygen, but it is also a propelling force in the movement of a fire. In calm conditions, the movement or rate of spread of a fire is often slow and can be managed quite easily with the right amount of resources and proper coordination between air and ground units. In a wind-driven fire, superheated air is pushed forward, which causes radiant

heating, or what is also known as "pre-heating." In addition to this issue, the possibility of fire embers being carried into the air and creating spot fires is something that must always be monitored and prepared for in your tactics and strategy.

Knowledge of prevailing wind patterns is essential in fighting wildland fires. In very general terms, mountainous terrain will have up-canyon drafts as a result of solar heating and rising air, while down canyon winds will be experienced in the late evening and continue until the late morning. Similar effects can be found near large bodies of water, with daily onshore and nightly offshore winds. As with any rule, there is always an exception, as is the case with the Santa Ana winds, or "Chinook Winds," outside of California. These winds blow in the opposite direction and are usually very hot and dry.

Weather - In addition to winds, relative humidity and thunderstorms can adversely affect fire behavior and should be briefed for both air and ground crews. Relative humidity affects the rate of burning, and when it is low, light fuels and grass are more susceptible to ignition and will burn more rapidly after they ignite. Frontal weather must always be monitored, because the associated wind shifts may cause a change in the direction, rate of spread and intensity of the fire.

Online Firefighting Resources

Here are helpful links to assist you in either becoming an aerial firefighting asset or to improve your current skill set:

U.S. Forest Service Aviation Management www.fs.fed.us/fire

U.S. Forest Service Aviation Tech Tips
www.fs.fed.us/eng/pubs/html/95571307/95571307.html

U.S. Department of Interior Bureau of Land Management Fire and Aviation
www.blm.gov/nifc/st/en/prog/fire/Aviation.html

Department of Interior Aviation Management Operational Procedures
amd.nbc.gov/library/opm/06-21.PDF

NIMS Law Enforcement Helicopter Typing
www.nimsonline.com/resource_typing/Law%20Enforcement%20AviationHelicopters%97Patrol%20%20Surveillance.htm

NIMS Firefighting Helicopter Typing
www.nimsonline.com/resource_typing/Helicopters,%20Firefighting.htm

Dept. of Interior Office of Aviation Safety
205.173.2.3/oassol.nsf/Available+Solicitations?OpenView

National Interagency Fire Center Training and Qualifications
www.nifc.gov/training_qual.html

The Wildfire Page by Tom Eggleston
sonnet1.sonnet.com/usr/wildfire/firlocal.html