



COLORADO

Center of Excellence for Advanced Technology Aerial Firefighting

Department of Public Safety



Photo Credit: LA County



Photo Credit: LA County

Night Aerial Firefighting Operations Interim Report

CoE-18-001.8

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Introduction

The mission of the Colorado Center of Excellence for Advanced Technology Aerial Firefighting (CoE) is to research, test, and evaluate existing and new technologies that support efficient, effective, and sustainable aerial firefighting capabilities. A current CoE project that furthers this mission is studying the feasibility of night aerial firefighting operations. This interim report summarizes the CoE's work on night operations to date, outlines the current capabilities of public safety aviation resources in Colorado, provides an overview of existing night firefighting programs, and proposes several potential paths forward for further research to better support policymakers in their decisions regarding night aerial firefighting.

Background and Purpose

In its enabling legislation, found in Colo. Rev. Stat. §24-33.5-1228, the CoE is tasked with evaluating new and existing technologies for integration into tactical fire scenarios in a variety of settings, such as initial attack, night operations, and operations in the wildland-urban interface (WUI).

The Colorado Division of Fire Prevention and Control's (DFPC's) wildfire management goal is to "keep all wildfires with values at risk smaller than 100 acres and to suppress all fires in WUI areas at less than 10 acres, 98% of the time" (Colorado Division of Fire Prevention and Control, 2014). Several enabling goals are also specified, including the ability to deliver appropriate aviation suppression resources to every fire within 60 minutes of the request. DFPC's ability to achieve its wildfire management goal and the subordinate goals, as currently stated, may be enhanced by the capability to deliver aerial fire suppression at night.

Under current policy, single engine air tankers (SEATs) and helicopters are limited to flight during official daylight hours. Daylight hours range from 30 minutes prior to sunrise until 30 minutes after sunset (National Wildfire Coordinating Group, 2017). Night operations, including both active fire suppression and intelligence gathering, are a way to extend the firefighting hours.

The use of helicopters and air tankers to battle wildfires during daytime hours is widespread. Use of tanked helicopters to perform water-dropping missions on wildland fires at night is not common in the United States and occurs only in Southern California. The demand is high for these resources in areas in and surrounding the Los Angeles Basin. There are numerous city and county fire departments in the



Photo Credit: LA County

Photo 1: LA County Firehawk Making a Night Drop

area that currently operate agency-owned aircraft in night all-hazard operations, including night aerial firefighting.

No night aerial firefighting capability currently exists in Colorado. Private helicopter air ambulance (HAA) providers perform night emergency medical services operations in Colorado, but that is their only mission. In addition, Colorado Army National Guard (COARNG) helicopters are equipped to perform various missions at night, but their mission set does not include night aerial firefighting.

Presently—with the exception of Colorado’s Multi-Mission Aircraft and specific Southern California municipal, county, and U.S. Forest Service assets —air operations are out of the picture during the hours of darkness (i.e., during the night operational period). Helicopters, air tankers, lead planes, and air attack are unable to help out—not only with their fire suppression missions, but they cannot serve as “eyes in the sky” to spot and report hazardous conditions that are not visible from the ground.

Nighttime aerial delivery of water, retardant, or suppressant by helicopters using night-vision goggles (NVGs) may allow agencies to gain an advantage on fires in the WUI, help keep smaller fires in check, reduce the occurrence of large fires, and allow agencies to perform water-dropping missions when the fire intensity is lower during the night and early morning hours. This may help to reduce fire-suppression costs and improve firefighters’ chances of protecting values at risk.

However, nighttime aerial attack also comes with increased training, equipment, and personnel costs, as well as lower production (i.e., gallons of water delivered by flight hour). Currently, air operations on wildfires all but cease as nightfall approaches. State and federal restrictions require that aerial firefighters land 30 minutes after official sunset and remain grounded until 30 minutes before official sunrise. Some fire agencies are not satisfied with this situation and have explored how to be more effective in fighting fires at night.

Table 1. Night Operations Timeline

May 2014	Governor Hickenlooper signs Senate Bill 14-164 establishing the CoE and mandating research into night operations.
2015	The CoE hires five staff members and officially identifies night operations as a CoE project.
January 2016	The CoE hosts a Night Aerial Firefighting Operations Summit to help the 125 attendees learn more about night aerial firefighting from recognized experts, practitioners, vendors, and innovators.
September 2016	CoE staff members travel to Southern California to see night operations conducted and interview practitioners about the practical aspects of running a night aerial firefighting program.
2016–2017	The CoE continues to research and communicate with existing or potential night operations practitioners.

Considerable anecdotal evidence supports the position that night aerial firefighting can enhance the overall effectiveness and reduce costs of fighting wildfires, but knowledge gaps and data limitations make direct quantification of the cost-efficiency difficult. Due to the presence of uncontrolled factors, it is also nearly impossible to measure how the suppression and outcomes vary on fires where night aerial firefighting assets were utilized versus fires where they were not. Therefore, it is important to note that—while night operations are thought to benefit or reduce the overall suppression costs—the benefit has not been quantified.

To date, the CoE's research has focused on evaluating operations, cost, safety, and effectiveness of current night helicopter operations in Southern California. Information gathered indicates that the cost and complexity of implementing a night aerial firefighting program in any form would be substantial, regardless of the particular path chosen by the State. Night aerial supervision and intelligence, surveillance, and reconnaissance are also topics of research and will be part of any final recommendation; however, that subject is not explored intensively in this interim report.

The purpose of this interim report is to update stakeholders on the information gathered to date on night aerial firefighting operations. The report also sets out the additional data that must be gathered before a recommendation can be made to decision-makers on the feasibility of developing a night aerial firefighting program in Colorado. Finally, this report outlines the CoE's plan to collect the additional data required to support an informed recommendation.

Discussion of Helicopter Night Operations

For successful integration of night operations into aerial fire suppression, the incident commander and general staff should understand the capabilities and limitations of night helicopter operations. Tactics utilized during night helicopter operations differ substantially from daytime operations. In particular, night operations require greater oversight and are more directed and controlled than daytime operations. While night air operations are a possible application for night vision imaging system–approved helicopters and aerial supervision aircraft, practitioners must follow established procedures to provide the greatest margin of safety.

Benefits of Helicopter Night Operations

There are a number of potential benefits to night aerial firefighting operations:

- Night water delivery for direct attack and structure protection at night may be more effective due to lower fire intensity and higher humidity, particularly when supported by ground crews.
- More rapid initial attack on small fires may suppress those fires and limit subsequent daytime growth.
- Active suppression during the night, versus monitoring or “holding” actions, may shorten suppression times.

It has long been known that wildfires “lay down” at night, becoming more quiescent as temperatures drop and humidity increases. Unfortunately, air operations on wildfires all but cease as nightfall approaches.

Limitations of Helicopter Night Operations

The above benefits are qualified by the following limitations:

- The only night helicopter missions that are currently approved are water/retardant dropping and flights supporting this mission. This restriction appears in the FIRESCOPE (**F**irefighting **R**esources of **S**outhern **C**alifornia **O**rganized for **P**otential **E**mergencies) Night Flying Guidelines, the Interagency Helicopter Operations Guide (IHOG), and the U.S. Forest Service (USFS) National Night Air Operations Plan.
- Crew schedules must be modified to ensure appropriate rest/work periods; additional crews and appropriate night dispatch staffing are also required. Dual pilot operations are required by the USFS.
- Only ground-fill operations from approved helispots are currently practical. This decreases production to approximately 50% of daytime operations. Helicopters must be equipped with fixed tanks and require additional ground crew and pumping equipment.
- Night flight hours may be limited per agency direction. USFS limits nighttime flight hours to 6 flight hours (United States Department of Agriculture, 2015).
- Pilot night flying currency with night vision imaging systems must be maintained.

Current Aviation Assets and Response Capabilities in Colorado

DFPC Aviation Program

DFPC owns and contracts for aviation assets used on wildland fires in Colorado. However, DFPC is a secondary response organization and does not have initial attack responsibility. In addition, if there is a need for DFPC aviation assets on a non-wildfire mission within Colorado or on a wildfire mission outside Colorado, DFPC may authorize the use of these assets for those missions. Currently, neither the Colorado Department of Public Safety nor DFPC have helicopters, helicopter pilots, or crews equipped or qualified to perform night missions. All DFPC aircraft, whether State-owned or contracted, are operated in adherence to the standards required by the Department of the Interior (DOI) and USFS so that they can be used on federally managed incidents both in Colorado and out of state.

Multi-Mission Aircraft

DFPC owns two Pilatus PC-12 fixed-wing Multi-Mission Aircraft (MMA). The aircraft are equipped with L3 WESCAM MX-15 sensors that perform a variety of missions that exploit the aircrafts' unique capabilities. The MMA missions include the following:

- Establishing situational awareness, which refers to collecting data to establish and maintain a detailed understanding of an evolving situation; this data is then provided to key decision-makers and local responders
- Performing early fire start detection, fire perimeter mapping, and intensity mapping
- Locating and mapping high-fire-intensity locations with georeferenced imagery to display the extent and effect of wildfires
- Generating incident assessments of newly detected fires and transmitting them to local fire managers
- Providing access routes to responding units, thus adding a valuable overhead perspective to the overall situational awareness for fire, all-risk incidents, and search and rescue



Photo Credit: DFPC

Photo 2: DFPC PC-12 Multi-Mission Aircraft

- Monitoring fire spread and threats to containment boundaries
- Determining fire threat to values at risk
- Performing aerial supervision

The MMA can perform night missions, but have no water- or retardant-dropping capabilities since they typically operate 10,000 feet above ground level (AGL).

Air Tankers

DFPC currently has exclusive-use contracts for two Air Tractor AT-802F SEATs that perform aerial delivery of water, suppressants, and retardant.

Each SEAT can carry up to 800 gallons of water or retardant. SEATs are not currently used for nighttime firefighting.

Using SEATs in conjunction with other aircraft over an incident is standard practice.



Photo Credit: DOI

Photo 3: SEAT Making a Drop on a Wildland Fire

Depending on location, operator, and availability, SEATs are capable of dropping suppressants, water, or retardant. Because of the load capacities of the SEATs (500–800 gallons), quick turn-around times are a prime consideration.

The unique factors that allow helicopters to fly safely at night at low altitudes (below 500 feet AGL) are not present in fixed-wing aircraft and have traditionally been thought to preclude the possibility of using fixed-wing aircraft for night operations. However, the CoE is aware of the experimental use of larger fixed-wing aircraft in Australia and is in touch with one company that is investigating the use of Large Air Tankers (LATs), such as the C-130, for night drops. Due to the requirement to fly higher at night, smaller aircraft would likely be less effective. Oregon is planning to evaluate night drops using SEATs in 2018. They are working with CO Fire Aviation Inc., which is the company currently providing Colorado's contracted SEATs.

Helicopters

DFPC currently contracts for two Type 2 Bell 205A-1++ helicopters on exclusive-use, 120-day contracts. These helicopters are located in Cañon City and Montrose, Colorado, and are staffed by 12-person DFPC helitack crews that are available 7 days/week during the mandatory availability period.

The DFPC Type 2 helicopters have no night-flying capability, but are used for a variety of daytime missions, including the following:

- Personnel transport for fire suppression during both initial attack (i.e., helitack) and large fire support
- Reconnaissance flights for gathering intelligence on fire behavior and fire mapping
- Detection flights for wildfires
- Aerial supervision
- Water or retardant/suppressant delivery with water buckets suspended on long or short lines
- Equipment and cargo transport operations, both internal and external, with a long line
- Aerial ignition operations for wildland and prescribed fires using plastic sphere dispensers
- Search and rescue

Personnel involved with helicopter operations adhere to the operational procedures as outlined in IHOG, the Interagency Aerial Ignition Guide, and applicable Federal Aviation Regulations.

While the aircraft may carry emergency medical personnel, they do not operate in a medevac role. Neither of the helicopters are equipped for hoist operations and the crews are not trained to perform that mission. However, the helicopter program will be moving toward providing short-haul capability in 2019. Short-haul is a mission that enables technical insertion and extraction capability. Using a helicopter for short-haul requires operators either to upgrade to a multi-engine helicopter operating with a Part 133 authorization, or to operate a single-engine helicopter as a public-use helicopter for the State of Colorado. To be classified as a public-use helicopter, the aircraft must be owned by the State or on an exclusive-use contract for more than 90 days.

Colorado Army National Guard

COARNG is a federal resource that is often deployed to assist on state emergencies after the



Photo 4: DFPC Bell 205A-1++ Preparing for Bucket Work

Governor has issued a Declaration of Emergency and Executive Order committing COARNG resources when civilian resources are limited. The COARNG mission is to protect life and property and preserve peace, order, and public safety when all other governmental resources have been exhausted (Colorado National Guard, 2017).

State emergency response missions include blizzards, floods, wildland fires, earthquakes, and hurricanes. Other missions include supporting local jurisdictions with search and rescue, protecting public resources, and supporting civil authorities. COARNG does not make their aircraft available for tactical night aerial firefighting missions.

COARNG units, when activated in Colorado and approved for federal use by letter, may be utilized on federal incidents each year for fire suppression, medevac, or extraction/hoist operations as indicated in the letter of approval. The UH/HH-60 (Black Hawk) helicopter is the primary heavy lift platform available for wildland fire use.

Colorado State Patrol

The Colorado State Patrol Aircraft Section owns and operates five fixed-wing aircraft: three

Table 2: Colorado Army National Guard Aviation Resources

Aircraft Type	# Available	Missions
UH-60A/L Black Hawk Helicopter	12	Blizzards, floods, wildland fires with water buckets (600-gallon capacity), earthquakes, hurricanes, search and rescue, protection of public resources, and support for civil authorities
CH-47 Chinook Helicopter	8	Firefighting with water buckets (2,000-gallon capacity), equipment and cargo transport operations, personnel transport
UH-72A Lakota Helicopter	9	Medevac with or without hoist extraction, command and control, damage assessments, detection flights for wild-fires, aerial supervision, search and rescue (hoist-capable)
C-130 Modular Airborne Fire-fighting System	2	Non-initial attack wildland firefighting (3,000-gallon capacity)

Cessna 182T's, one Beechcraft King Air B200, and one Cessna 340A. Four aircraft are based in Centennial and one Cessna 182T is based in Grand Junction. The aircraft are used for a variety of Colorado public safety missions, including:

- Law enforcement
- Passenger and cargo transport

- Observation and aerial photography
- Medical flights to hospitals (King Air and Cessna 340A)
- Search and rescue

These fixed-wing aircraft are not currently utilized for wildland firefighting and have no tactical night operations capability beyond normal night flight.

Civil Air Patrol

The Civil Air Patrol (CAP) is both a federally chartered nonprofit organization and an auxiliary of the U.S. Air Force. The CAP headquarters in Colorado is located at Peterson Air Force Base in Colorado Springs, with aircraft scattered around the state. CAP is an all-volunteer organization whose missions include the following:

- Search and rescue assistance
- Disaster relief
- Homeland security
- Counter–drug operations support
- Cadet leadership training

Federal Resources Available for Wildland Firefighting in Colorado

Fixed-Wing

The two primary federal organizations with wildland fire responsibility on federal lands in Colorado are USFS and DOI. Both USFS and DOI have substantial aerial firefighting resources at their disposal, but they are not always located in-state or dedicated to wildland fires in a particular state. The use of these resources is coordinated through Interagency Dispatch Centers and Geographic Area Coordination Centers.

Very Large Air Tankers (VLATs) and LATs are national resources that are primarily used for initial attack and extended attack fires on a priority basis. USFS is the only federal agency with

Table 3: National Wildfire Coordinating Group Airtanker Classifications

Type of Airtankers	Capacity (Gallons)	Number Available Nationwide
VLAT	10,000+	3
Type 1	3,000–9,999	Approximately 17
Type 2	1,800–2,999	4
Type 3/SEAT	Up to 1,799	Approximately 100

current or recent contracts for VLATs or LATs. The remaining fixed-wing resources are a mix of USFS Type 2 and Type 3 aircraft and Bureau of Land Management SEATs. No fixed-wing federal aircraft currently perform night firefighting operations.

Helicopters

Firefighting helicopters in the United States are classified in IHOG according to their water- and passenger-carrying capacity. Performance requirements are listed in Table 4.

These helicopters perform a variety of daytime tactical aircraft missions, such as delivering aerial fire suppressants, transporting firefighters and rappellers, providing platforms for aerial supervision, and performing aerial ignition. They also conduct logistical missions, such as fire-perimeter mapping, detection and reconnaissance, emergency medical evacuation, search and rescue, and equipment and supply delivery. There is currently only one USFS night-flying helicopter program and it is located on the Angeles National Forest. Its mission is to perform night aerial firefighting operations on four national forests in Southern California.

Table 4: National Wildfire Coordinating Group Helicopter Types and Performance Requirements

	Type 1	Type 2	Type 3
Approximate Number Available to Federal Agencies in 2017 (Exclusive-Use Only)	28	43	72
Useful Load at 59°F, Sea Level (pounds)	5,000	2,500	1,200
Passenger Seats	15 or more	9–14	4–8
Retardant- or Water-Carrying Capacity (gallons)	700+	300	100
Maximum Gross Takeoff/Landing Weight (pounds)	12,501+	6,000–12,500	Up to 6,000

Night Operations in the United States

U.S. Forest Service—Angeles National Forest

Overview

The only USFS night firefighting helicopter program operates on the Angeles National Forest and provides support for both initial attack and large wildland fires. The aircraft is a Type 2 Bell 205A-1++ on an exclusive-use contract (180 days). The only night helicopter mission that is approved is water dropping and flights supporting that mission (i.e., transporting essential helitack crewmembers to the night helispot to fill the helicopter tank and performing training flights) (United States Department of Agriculture, 2015). This program has been operational since 2013.

USFS night operations utilize preplanned and approved night helispots with ground-fill operations only. This policy resulted from the 2010 USFS study on night helicopter operations that concluded that (1) the agency could design, implement, and operate a safe helicopter night operations program, and (2) there would be significant hazards, organizational challenges, and implementation considerations that would need to be resolved.

The USFS study also stated that the missions of water- and retardant-dropping using a fixed tank with ground-fill, aerial supervision, and aerial ignition with a plastic sphere dispenser could benefit the agency and directed that an implementation plan be developed (United States Department of Agriculture, 2010).



Photo Credit: CoE

Photo 5: Angeles NF H-531 Crew-member Briefs CoE Staff at Fox Field

**Table 5: Flight Data from Angeles National Forest
(United States Department of Agriculture, 2017)**

	2013	2014	2015	2016	2017	Average
Night Flight Hours (Aided and Unaided)	63.4	57.4	63.2	97.8	119.2	80.2
Day Flight Hours	149.3	50.6	123.9	235.6	194.1	150.7
Percentage Night Flight Hours	27%	42%	22%	22%	37%	30%
Night Gallons Delivered	101,265	60,500	61,380	97,500	127,700	89,669
Day Gallons Delivered	187,980	58,700	129,704	269,992	430,800	215,435
Flight hours are for all mission types—including water delivery, cargo delivery, and passenger transport—therefore, gallons per hour of flight cannot be calculated.						

Governing Documents and Safety

In 2010, USFS recognized the value of reengaging in night flying operations because the greatest opportunity to engage fire is when wind speeds are low, temperature is low, and relative humidity is high. These conditions most often occur at night. Under these conditions, there are niche opportunities when tactical night operations could make the difference in the desired outcome—representing multimillion dollar or lifesaving differences. Therefore, in 2010 a committee was formed and a Night Helicopter Operations Study was developed, which included a risk assessment of 67 hazards with 109 risk-mitigation measures for those identified hazards.

In 2012, the night helicopter program on the Angeles National Forest was approved by the Chief of USFS; specifically, one helicopter limited to water delivery only when specific criteria for operations (shown below) are met.



Photo 6: Angeles NF H-531 Making Night Water Drops

One of the following engagement criteria must be met before night helicopter water-dropping missions can be performed:

- Lives are being, or will be, threatened
- Structures are being, or will be, threatened
- Resources of significant economic value are being, or will be, threatened
- Excessively high suppression costs will be prevented

These criteria, the NVG Mission Go/No-Go Checklist, and the Preflight Weather Operations Checklist are all part of the Nighttime Operational Risk Assessment completed by the flight crew before engaging in night firefighting operations.

The oversight and quality assurance of the night helicopter program is essential and is performed by the National Night Helicopter Steering Committee (for specific operational details, see the *USFS National Night Air Operations Plan*). The night-flying helicopter is hosted on the Angeles National Forest and supports wildland fire suppression on USFS-protected lands, including WUI areas within and adjacent to the Angeles, Cleveland, and San Bernardino National Forests and the southern half of the Los Padres National Forest. The use of the aircraft is coordinated through the Angeles National Forest and follows normal dispatch protocols. From the time of the first night helicopter program, the technology has improved dramatically. The military and other agencies have gained significant experience that was leveraged when USFS re-engaged in the program. One of the hazards identified was the need for aerial supervision at night, due to the high volume of cooperating aircraft that engage in

night aerial suppression efforts in Southern California. This triggered a highly successful side benefit, a Night Air Attack Program.

The Night Helicopter and Night Air Attack programs both utilize highly capable crews and aircraft. Furthermore, both programs have added new technology and supplemental training. In addition, both the Night Helicopter and the Night Air Attack program are staffed over the nighttime period (1900–0700). The helicopter program is staffed 24 hours per day with a day and night crew. This staffing—which requires detailed planning for transitions—includes pilots, mechanics, fuel-truck drivers, and agency personnel.

Knowledge of this program is not widespread, as with any new program. Outside of Southern California, much of the fire community is unaware of the program attributes since there is no current structure in place to manage night operations with helicopters.

The conditions governing the use of USFS assets in night aviation operations are found in the *USFS National Night Air Operations Plan*, which was developed based on the risk assessment conducted as part of the 2010 Night Helicopter Operations Study. The National Night Air Operations Plan and the Aviation Safety Management System adopted by USFS in 2009 are essential since they ensure that the hazard mitigations and risk management policy are engineered into night-flying procedures. The intent of the Aviation Safety Management System is to improve the aviation culture by increasing hazard identification, reducing risk-taking behavior, identifying lessons learned, and correcting procedures to prevent accidents.

The FIREScope Night Flying Guidelines is the interagency document on night flying programs in California and is utilized by all departments who conduct night flying (FIREScope Aviation Operations Specialist Group, 2013).

The USFS and DOI aviation programs contribute information about incidents, hazards, maintenance, and airspace issues to SAFECOM (Aviation Safety Communiqué), a common database of aviation mishaps. During the period between 2013 and 2017, there were 16 SAFECOM reports submitted in relation to night operations (United States Department of Interior, 2017). Overall, the incidents that occurred were minor and included such events as unscheduled maintenance, a laser pointed directly into the cockpit from the ground, lack of communication, exceeded pilot duty-day limits between day and night pilot transitions, and jettisoned external loads and water. See Table 6 for more information.

Table 6. USFS Night-Flying Helicopter SAFECOMS 2013-2016 (United States Department of Agriculture, 2017)							
	Communication on Incident	Communication	Fatigue	Mechanical	Operational	Procedural	Safety
FY 13		1		3		3	
FY 14		1		6		5	
FY 15				7		2	1
FY 16	1			3	1		1
Average	0.25	0.5	0	4.75	1	2.5	0.5

City and County Fire Departments in Southern California

Overview

Supporting wildland firefighting operations is one of several missions of city and county air operations programs in the Southern California region. These programs also typically include hoist-air rescue, short-haul air rescue, shoreline rescue, helicopter swift-water rescue, NVG operations, patient transport, vehicle rescue, large animal rescue, fire mapping, infrared detection, disaster assessment, high-rise fire assistance, and support for law enforcement missions. Following is a discussion of how governments in Southern California have addressed local and regional needs for helicopters in general and for nighttime firefighting operations in particular.

Governing Documents and Safety

Aviation resources are one of a number of tools available to accomplish fire management objectives. The governing documents utilized in night aerial firefighting are predominately the current versions of the FIRESCOPE Night Flying Guidelines, IHOG, the *USFS National Night Air Operations Plan*, and applicable go/no-go checklists.

Demographics and Environment

“The Angeles National Forest, along with the other national forests in Southern California, is located in one of the driest, most fire-prone areas in the United States and abuts the major population centers of greater Los Angeles” (Government Accountability Office, 2011). Fires have been suppressed in the area for decades, resulting in significant accumulation of brush and other flammable fuels. Local chaparral vegetation comprises several plant species, including chamise; scrub oak, and manzanita, whose thick, waxy leaves are particularly well adapted to drought. The area is one of the most fire-hazardous landscapes in North America (Government Accountability Office, 2011). Fires in this landscape tend to exhibit extreme fire behavior because the vegetation’s characteristics and the steep slopes facilitate fires’ rapid upslope spread. Dry and hot weather characteristic of the region also contribute to the severity of local fires. In addition, continuing development in the WUI—where human development meets or intermixes with undeveloped wildland—has placed an increasing number of homes at risk of damage from wildland fire in this area. California has experienced a number of fires that have destroyed hundreds, and in some cases even thousands, of homes and other structures.

Although USFS is the predominant federal firefighting agency in terms of the amount of resources devoted to



Photo 7: S-70A Making Water Drops to Protect Structures



Photo Credit: CoE

Photo 8: Ventura County Fire Helicopters in Hangar

firefighting, federal and nonfederal firefighting entities generally share their firefighting personnel, equipment, and supplies and work together to fight fires—regardless of which entity has jurisdiction over the burning lands (Government Accountability Office, 2011). Agreements between cooperating entities govern these cooperative fire-protection efforts and contain general provisions for sharing firefighting assets and costs.

As an example, Los Angeles County Fire Department (LACFD) ground and air resources are currently configured to

provide a robust initial attack response to reported wildland fires in portions of the county. Through agreements, LACFD air and ground resources also respond to reported wildland fires in those areas that border other entities, such as USFS, Los Angeles Fire Department, and CAL FIRE. LACFD serves as one of six Contract Counties for CAL FIRE, providing wildland fire protection in state responsibility areas within their jurisdictions. Additionally, LACFD responds with resources when structures are threatened, even in federal response areas (Conklin & de Decker, 2016).

These resources, including aircraft, respond en masse to “blitz” the fire quickly and to prevent it from growing beyond the control of local resources. During the initial response/attack phase, LACFD aims to contain more than 95% of all fires in wildland areas and limit growth to less than 10 acres (Conklin & de Decker, 2016).

Aircraft

Existing helicopter night operations programs in Southern California use a mix of Type 1 and Type 2 helicopters. All of the night firefighting helicopters are equipped with external tanks ranging from 360–1,000 gallons in capacity, as well as with snorkels for daytime hover-fill operations. Hover-fill operations are considered too risky for nighttime use, so only ground-filling at known, approved landing sites is allowed at night.



Photo Credit: CoE

Photo 9: LA City Fire Department AW-139

Helicopter Air Ambulance Night Operations

Helicopters provide a means of transporting people in urgent need of medical assistance during both daytime and nighttime. These operations and the risks involved are different from airborne water drops at night. HAAs usually operate in settings where the major hazard is flying at night. Nighttime firefighting missions add many hazards on top of this, including difficult and unknown terrain and operations that approach the helicopters' performance limits.

The great benefit of HAAs is the helicopters' ability to operate off-airport at disaster scenes, highway accidents, and other inaccessible areas. However, on-scene operations often present problems, such as inadequate information about weather and obstacles. Many operations are single-pilot, which creates higher workloads and greater demands on pilot skill (Negroni & Veillette, 2010). A number of parallels exist between HAA operations and conducting safe night aerial firefighting operations. However, there are no HAA programs that operate with hoist capability in Colorado since commercial HAA companies are limited (as compared to public aircraft) in that they operate as civil aircraft and, as such, are prohibited by 14 CFR 135 (Air Carrier and Operator Certification) from performing hoist operations.

CoE Next Steps

The CoE has developed a good understanding of the tactical requirements for night operations. However, strategic information answering the question “Should the Colorado Department of Public Safety and DFPC develop night helicopter firefighting operations capabilities?” is incomplete. There is no current data by which the CoE can measure or estimate the demand for night operations in Colorado, both from a fire standpoint and from an all-hazards standpoint. The CoE will be focusing on a number of next steps to gather data on fires and all-hazards operations that would benefit from night operations.

Challenges for Data Collection

The biggest challenge for data collection is the classic “chicken and egg” problem. Since no night aerial firefighting operations are performed in Colorado at this time, there is no record of demand or requests for such resources. Emergency operators know there is not a night operations capability in the state, so they do not request it. To tackle this, the CoE will investigate and develop information that will demonstrate the demand or lack of demand based on current operations in the state.

Specifically, the CoE will do the following (with a focus on Colorado responses):

- Identify incidents that occurred at night or at a threshold of near night (i.e., events where aerial operations would be considered if it were not night/nearly night)
- Contact incident commanders for those incidents to discuss whether night operations would have been viable/ordered if they were available
- Investigate what those incident commanders would have ordered (e.g., intelligence, firefighting, rescue)
- Mine for data on fires (e.g., number, start time, whether they would have benefitted from night-flying capability)
- Obtain qualitative data on hoist capabilities from stakeholders
- Determine cultural readiness for night operations in Colorado

Sources for this might include the following:

- National Fire Incident Reporting System
- Large departments’ records
- WUI departments’ records
- National response data (i.e., federal fires)
- COARNG responses (e.g., day and night hoist rescues, day and night search and rescue missions flown)
- Interviews with fire decision-makers in Colorado

In addition, the CoE will continue to monitor and exchange information with current night operations practitioners by doing the following:

- Contacting current operators for response data regarding fire and all hazards
- Investigating records in the National Fire Incident Reporting System to try to extract response data

Potential Paths Forward for Night Operations in Colorado

While the CoE has gathered significant data on night operations, further research is required prior to making any specific recommendation regarding night operations in Colorado. However, the CoE has developed a non-exhaustive list of potential operating models for Colorado. The goal of our further research is to identify if any of these, or other identified models, make sense for Colorado and to understand the pros and cons of each scenario.

Scenario 1: No Night Aerial Firefighting Operations in Colorado

The first option is to forgo the creation of night aerial firefighting operations capability in Colorado at this time. The major drawbacks of night aerial firefighting operations are the safety risks, costs, and complexities of the program. Limited data exists as to the efficacy of night aerial firefighting operations and no data exists on the efficacy of such efforts in Colorado or a geographically similar state. While anecdotal qualitative data about the efficacy of night operations in Southern California has been obtained, quantitative data has not.

Night aerial firefighting is a costly and complex endeavor. Existing programs in California all utilize helicopters with fixed tanks, not buckets, to perform nighttime water drops. The cost of helicopters able to perform at high elevations, lift a useful amount of water in a fixed tank, and deliver that water at a rate sufficient to impact firefighting efforts—in addition to the costs of hiring and training crews—would be high. Sikorsky offered their S-70i platform to Los Angeles County at approximately \$20 million per aircraft (fiscal year 2015 dollars). Purchasing or leasing only one aircraft under any scenario would be a questionable choice since another aircraft with hoist capability would be necessary for a rescue in the event of mishaps with the first one. As explained earlier, no agency in Colorado—including COARNG—provides this capability on a timeline acceptable in an emergency response scenario.

Scenario 2: Night Operations Statewide—Wildfire Only

In this option, a statewide night operations program for wildland firefighting would be implemented. Such a program would be a costly proposition, but would allow DFPC to respond to fire emergencies anywhere in the state in a short amount of time. This program would require several helicopters and crews to be dispersed across the state to allow for effective initial attack response. The State could opt to contract for these services during the usual fire season to reduce the overall cost of the program. However, this would mean that services would not be available year-round. Alternatively, the State could purchase helicopters and hire crews and staff. This would provide improved availability, but at a considerable cost. It is likely that such a program would only be successful if it was provided free of charge to State and county agencies, at least until established.

Scenario 3: Night Operations Statewide—All Hazards

Building upon Scenario 2, one path to making those costs more palatable to the taxpayer is to offer a broader range of services, including HAA, structure (high-rise) fire support, law enforcement, search and rescue, emergency management, and other missions.

An all-hazards approach to night operations would allow the State to spread the cost of expensive resources over a broader range of services provided and is the approach used for all current night operations, with the exception of the Angeles National Forest program. An all-hazards approach also improves availability and training. For example, Federal Aviation Administration regulations and interagency guidelines, such as FIRESCOPE and IHOG, require a certain number of night-flying hours for a pilot to keep his skills proficient. Night firefighting missions are unlikely to provide pilots with sufficient NVG time to keep current, especially during the slow part of the fire season. Broadening the mission set would allow pilots to keep current by flying missions, rather than by undergoing recurring State-funded training.

Scenario 4: Location-Specific Night Operations

Another option for the State is to stand up a night-capable aviation program where it makes the most sense and not address the issue statewide at this time. Such a program could serve the most populated areas of the state with the highest risk to the WUI, and would keep the cost down by not attempting to solve the problem for less populous areas at this time. In addition to simpler startup and lower costs than a statewide program, this approach has the benefit of allowing pilots to become more familiar with the areas where they will operate at night—a factor recognized by both IHOG and FIRESCOPE as important to safe nighttime firefighting. A limited-area night operations program could still be the backbone of an all-hazard public safety aviation program. Other areas of the state might be served by the program, but with longer response times. Sound policies that would allow practitioners to manage service demands according to an agreed-upon set of priorities would control which missions were executed.

Scenario 5: Expanded MMA Intelligence, Surveillance, and Reconnaissance at Night

One option to maximize the return on an existing investment is to extend the times when current assets may operate. The State's MMA currently fly primarily during the day. An inexpensive way to leverage the MMA would be to fly mapping and detection missions at night. Tasking the MMA with night missions would offer the chance to collect and process information in time for planning and morning briefing. This scenario would require increased staffing levels for the MMA program and would also be impacted by aircraft availability.

Scenario 6: Extended Daytime Flight Hours

Another opportunity for increasing capability at low cost is extending the hours during which helicopters are available for water drops without crossing over into nighttime. The current

practices, procedures, and culture result in an environment in which helicopters used to fight wildland fires may not lift from helibases until several hours after sunrise. Those hours could be used to control the fire in much the same way night hours could be, but with considerably less risk and at much lower cost. This approach requires no additional equipment or training, but would require competent guidance from experienced leaders in wildfire aviation to be successfully adopted as the new norm. Scenario 5 could be used in combination with this option to enable early morning helicopter operations based on fresh intelligence from the MMA.

Scenario 7: Unmanned Aerial Systems Night Operations

One of the steps that could be taken to reduce the risk to pilots from night operations is removing the pilots from the aircraft. Unmanned aerial systems (UAS) are already capable of performing certain missions on wildfires.

Short-Term

The regulatory scheme currently in place only allows UAS operators to fly aircraft with a total weight of 55 pounds or less in most situations. This type of aircraft can only be used to gather intelligence (information), but nighttime use is a possibility. By default, flight at night or beyond line-of-sight is prohibited, but waiver processes exist that allow extension into night operations.

Long-Term

As the regulations are further refined, new concepts in UAS operations will be developed or become part of the mainstream. Platforms like Lockheed Martin's optionally piloted K-MAX could become even more valuable to firefighters when regulations and contracts allow this large UAS to be utilized for night operations and beyond line-of-sight. This would allow incident commanders to order water drops from a Type 1 helicopter at night without exposing the pilot to the risks of flying low at night while wearing NVGs. This solution has substantial promise for the future, but is not currently feasible due to the current state of technology and regulations.

Appendix: Night Vision Goggle Systems and Programs

The basic operating principle of night-vision goggles (NVGs) involves receiving and intensifying the available light and then displaying that available light-image to the human eye (Parush, Gauthier, Arseneau, & Tang, 2011). Regulations pertaining to NVGs and their operation can be found in Parts 61 and 91 of the Federal Aviation Regulations. These regulations present civil NVG users with a foundation for the development of NVG training programs, operating procedures, and instructor minimum standards. The Federal Aviation Administration (FAA) must approve NVGs for operation (Baseil, Blondeau, Bryan, & Crowe, 2013).

Flight with image-intensifying NVGs can significantly enhance night-flying operations. Compared with unaided vision, they improve a pilot's visual capability, but they do not turn night into day and they have many limitations of which the pilot must be aware. These include reduced visual acuity, absence of color and depth perception cues, and severe restriction of visual fields (Rash, 2010).

These limitations have been shown to contribute to spatial disorientation accidents and incidents. Awareness of the limitations of NVGs and proficiency in their use are key to the successful completion of a NVG mission; consequently, the increased risk of spatial disorientation during flight with NVGs should be stressed during both training and operations (Previc & Ercoline, 2004).



Photo 10: Ventura County Fire Department Captain Mel Lovo with Night Vision Goggles

When pilots are properly trained in the use of NVGs, they can better manage risk during night operations. However, pilot workload initially increases when using NVGs. Pilots must learn a new set of skills to use NVGs properly and take advantage of the benefits. NVGs are not simple-to-operate devices that pilots can just pick up and use.

Advantages Compared to Unaided Night Flight

NVGs enhance night operational safety, but enable operations in an inherently more challenging environment (i.e., night flight). They do this by improving night situational awareness and increasing pilots' ability to see and avoid obstructions at night.

Disadvantages of NVG-Aided Flight

NVGs increase fatigue (due to eyestrain and increased helmet weight), reduce depth perception, and limit peripheral vision. In addition, transitioning from aided to unaided flight requires adaptation time.

Night Vision Imaging Systems

NVGs are only one part of an entire Night Vision Imaging System (NVIS). An NVIS consists of an FAA-approved NVG-compatible lighting system, properly trained flight and maintenance crews, and an FAA-accepted maintenance program for both the NVIS lighting system and the NVGs. If any part of the NVIS lighting system is not working properly or the NVGs are beyond their service date, then NVG operations cannot be performed. Pilots must ensure that they are always in a situation where, if any part of the NVIS fails, they can fly to an appropriate landing site using visual flight rules.

Operators must know what NVG performance specifications they need. As of 2017, three manufacturers provide FAA-approved NVGs: ITT's F4949, NIVISYS, and L-3's M949 (Night vision goggle systems, n.d.). Within each of these models are varying levels of performance. Operators must know what level of performance they need and which model of NVG will provide them with that level of performance.

Integration into Aircraft

The integration of an NVIS into an aircraft crew station usually requires very little modification with respect to the crew compartment space (i.e., volume). The primary aircraft requirements are as follows:

- Adequate helmet and NVIS motion envelope
- Acceptable visual fields of view
- Windshield transparency in the NVIS range
- Compatible cockpit lighting and displays
- Compatible interior (i.e., cabin) and exterior lighting

Overcoming Workload

Pilots well trained in the use and limitations of NVGs will be better prepared for the increased mental workload associated with NVG flight, as well as better prepared to overcome night flight stresses, including the following:

- Working outside the crewmembers' circadian rhythm envelope
- Fatigue due to eyestrain (particularly if using poorly maintained or incorrectly adjusted NVGs)

- Increased helmet weight
- Lack of visual cues
- Aggressive scanning techniques that are required to deal with the restricted field of view of NVGs
- Possible crew rest/duty cycle issues

Operators wishing to pursue NVG authorization can access inspector guidance at www.faa.gov.

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