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A Demonstration of Night Operations for Wildfire Water Delivery using Coulson *Firewatch* Airborne Command and Control System, and Night Vision Goggle equipped S-61

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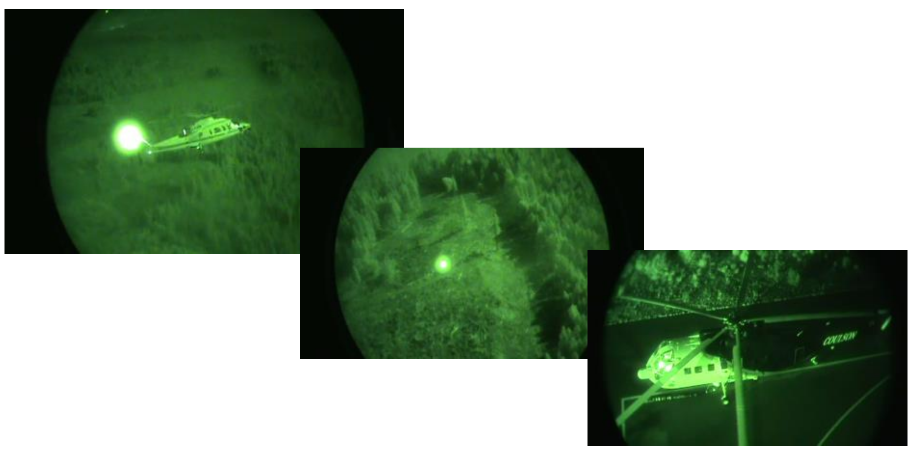

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Report prepared by FPInnovations, Wildland Fire Operations Research

For Coulson Aviation

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Abstract

A series of demonstration flights on the coordinated use of night vision systems (NVIS) were documented. The concept demonstrated was a coordinated night water delivery operation using a command and control aircraft with night vision goggles (NVG) and infrared (IR) capability to identify, record, and designate hotspot targets with a laser, and a heavy helicopter flown with NVG to drop water. The demonstration showed that the concept is feasible. Potentially, night water delivery operations could give fire managers another tool to fight problem wildfires, and ultimately reduce suppression costs.

Introduction

In 2009 as a result of the Station fire in California, the public and elected officials called for an examination of night time use of helicopters to help gain control of wildfires. For many years military and emergency services have used night vision systems to achieve their objectives. Considerable technological improvements in night vision hardware and systems now allow night operations to be conducted effectively and safely. Law enforcement, night pursuits, border patrol and Medivac/EMS operations have all taken advantage of modern technology to enable both day and night operations.

With these advancements, it seems appropriate that fire suppression agencies closely examine the use of aerial suppression resources for night operations. Night flying has been implemented within wildland fire suppression programs on a limited basis with little information published.

This paper documents a series of demonstration flights using night vision systems, an infrared camera and a laser targeting system to identify targets and direct helicopter water drops. The concept of a coordinated night water delivery operation was demonstrated, using a command and control aircraft with night vision goggles (NVG) and infrared (IR) capability to identify, record, and designate hotspot targets with a laser, and a heavy helicopter flown with NVG to drop water. Seven objectives were set to assess the potential of this technology as a command and control platform to effectively manage a drop zone and provide an overhead view to enhance overall safety.

The ever increasing costs of fighting wildfires with declining resources means that a new approach is needed to improve the performance on large fires. Night water delivery under NVG may allow agencies to gain an advantage on large fires or problem fire sectors when the fire behaviour is lower during the night/early morning hours and ultimately reduce suppression costs. Agencies could implement the process with an agency helicopter coordinator in a command and control aircraft to assess and detect hotspots, and direct water delivery aircraft to the location with the laser targeter. The objective isn't to put the fire out but rather to reduce the intensity, until ground crews can access the fire in the morning. Adding night operations could provide fire managers with another tool to help bring wildfires under control sooner with less impact on communities and at lower overall suppression cost.

The Coulson S-76 Firewatch program was developed from the USFS Firewatch program to provide real-time fire intelligence through georeferenced IR and visual images, combined with data downlink to move the information from the fire to the fire center. The S-76 Firewatch contains the camera operator and helicopter coordinator to direct and manage aerial water delivery to the fire. The aircraft is fast and has enough room for additional personnel, such as information or plans officers. The S-61 aircraft is equipped with a 4000 litre belly tank with a snorkel for filling and had been used as the water delivery aircraft. Its gel injection system enables the direct injection of water enhancers into the tank during fill.

This test was to demonstrate the coordinated night-time operation of these aircraft using night vision systems. The S-76 provided the target identification and designation of hotspots through IR imagery, as well as scene and aircraft management from a safe altitude above the S-61 water delivery operations.

This report was commissioned by Coulson Aviation, a member of the FPInnovations Wildland Fire Operations Research Program. The goal of Coulson was to have an independent third party observe and document the demonstration tests and produce this report outlining the results.

Research objectives

The following objectives define the scope of this evaluation. The purpose of this exploratory research project is to:

- Demonstrate the ability of Night Vision Systems to identify hotspots and direct water delivery operations.
- Document water delivery accuracy on small burning targets.
- Demonstrate the ability to identify people on the fireline through Night Vision Systems and thermal imaging cameras.
- Compare aircraft drop cycle times, drop heights and speeds between night and day operations.
- Estimate water delivery rates (litres per hour) under Night Vision Systems based on fill time, loiter at target times, and transit times.
- Document the ability of the pilot to identify aerial hazards, and compare daylight visibility to thermal and night vision enhanced images.
- Document the ability of the pilot to connect successive water drops to build fireline during night operations.

Methodology

Data collection flights were conducted on July 27/28, 2010 and October 20/21/22, 2010. The following methods were used to answer the objectives.

Identification of hotspots and direction of water delivery operations

Seven hotspot targets (BBQ briquettes) were placed on the ground in standing timber. The targets were surveyed for position using a Garmin 60 CSx in position averaging mode for approximately 5 minutes. Targets were spaced approximately 100 metres apart in varied terrain and forest cover along the approaches to the runway at Port Alberni.

The Firewatch platform, equipped with an infrared camera, was used to test and demonstrate its ability to identify small discrete hotspots. In the July flights, a handheld laser pointer was used to illuminate or pin point the hotspots. The laser was held outside the Firewatch helicopter, pointing the way for S-61 bucket drops. In the October flights a gimballed laser pointer integrated into the IR camera head was used. Firewatch maintained an above ground height (AGL) of 2000 feet during the target identification and laser pointing procedures.

The ability of Firewatch to identify the targets and to use the laser pointer to guide the S-61 pilot wearing night vision goggles was recorded as yes or no.

Water delivery accuracy on small burning targets

Targets numbered 1 through 5 were used to determine water delivery accuracy. The targets were illuminated by the IR laser from the S-76, and the S-61 pilot with NVG flew to the designated target. Visible water in the target pans was used to indicate an accurate drop. The test documents whether the drop successfully hit the target. Reported hotspot positions from the S-76 Firewatch system was compared with the ground truth survey of the hotspot targets.

Identification of people on the fireline

Two approaches were used to assess the risk of making drops on humans: using the Night Vision systems and using infrared thermal imaging from Firewatch..

Personnel situated at the hotspots assisting with the demonstration were the test cases to assess the ability of the two systems to identify humans on the ground. The targets were located in wooded areas. Infrared reflectors, strobe lights, and flashlights were also used by the personnel to determine if these devices could improve the identification of people in the drop zone.

Drop cycle times, drop heights and speeds

Height and speed data was obtained from a Latitude Technologies data recording system. The data was used to calculate drop cycle times and a comparison was made between the drops made during the day to those done at night. The same water source was used for all of the drops, and the target locations for night and day operations were the same.

Water delivery rates

The water source on Turtle Lake was approximately 1.5 kilometres from the targets. The times for transit back and forth between the lake and the target, setting up for the drop, filling the tank and other activities were documented during similar drop cycles. These results were used to estimate S-61 water delivery rates under night operations when the pilot is aided with NVG and aided overhead by the Firewatch platform.

Identification of aerial hazards

The NVG and thermal images of potential hazards will be observed and described, including other aircraft in the area. The pilots will be interviewed for their impressions and concerns. During the daylight runs, specific objects for study may be identified.

Building fireline

The water drops will be observed including a sequence of drops that combine to form a continuous line. The coordination between personnel in the two aircraft and the laser targeting of the tag point functions will be documented, with respect to enabling the creation of a fireline.

Test locations and conditions

The initial flights to demonstrate the night vision technology were held on the evening of July 27, and into the early morning of July 28, 2010 at the Port Alberni Airport. The night was clear with a waning gibbous, 95% illuminated moon. Temperature was 16º C with relative humidity ranging between 71% and 92%.

A second set of flights incorporated an integrated laser targeting device (linked to the gimballed infrared camera) and NVG recording was performed on the nights of October 20/21 and October 21/22, at the Port Alberni Airport. The nights were clear with ground fog patches with a waxing gibbous moon, 96.7% to 100% full illumination. The temperature was 7.5º C with relative humidity of 97% on October 20 and 89% on the 21st.

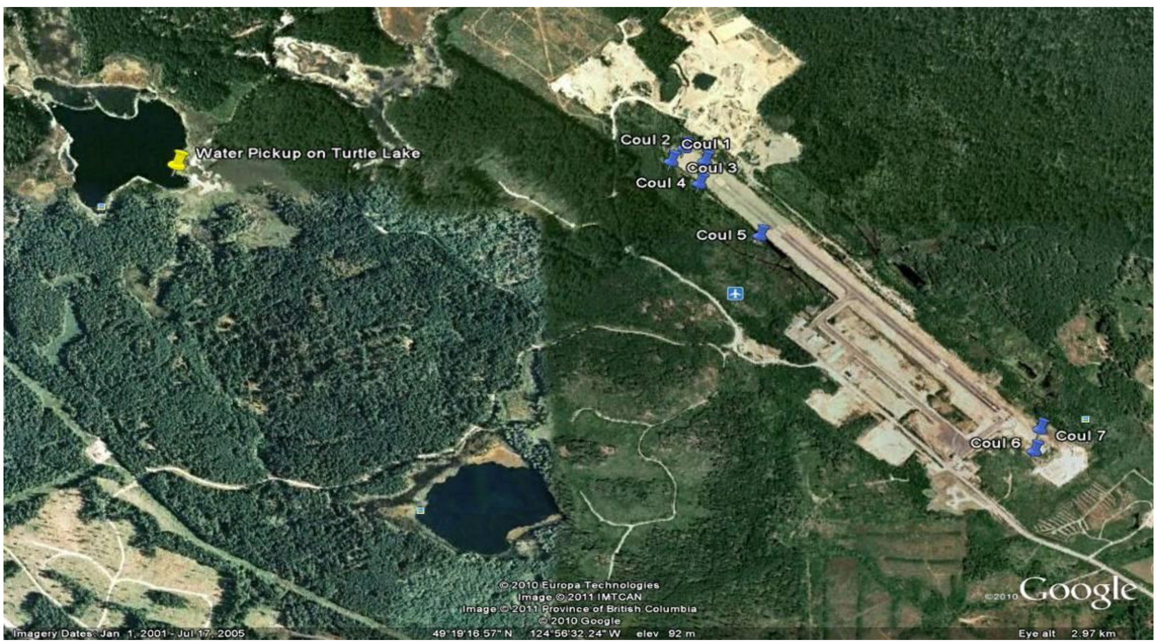

Figure 1. Test site locations for water pickup and simulated hotspot targets.

Equipment

A Sikorsky S-61 helicopter (Figure 2) with fixed tank and snorkel was piloted using Generation 3 ITT F4949 FOM1600 Night Vision Goggles (NVG) (Figure 3). The frequency response of the goggles is 665 to 925 nanometres. This covers from the red portion of the visible spectrum to the low end of non-visible near infrared spectrum. Both pilot and co-pilot were under NVG for all tests. The night vision provides a near daylight view with green to black hues. The devices are visual only and a separate set of goggles was used for recording the test. The S-61 aircraft was IFR certified. The co-pilot was NVG certified and represented the NVG supplier.

Figure 2. Coulson S-61 with 4000 litre belly tank and snorkel.

Figure 3. ITT F4949 FOM 1600 Night Vision Goggles.

A Sikorsky S-76 helicopter (Firewatch) (Figure 4) operated as a command and control platform and was equipped with an Axsys V-9 IR multispectral infrared camera, and Aerocomputers mapping system. The camera was mounted in a gyro stabilized ball mount. NVG was worn by the Firewatch co-pilot while the pilot maintained and operated under VFR conditions for the flights.

For the July flights, the trial laser targeting device was a 5mW handheld red laser. For the October flights, the laser targeting system was integrated into the gimballed camera head. The laser was a Class IIIB Near IR Laser operating at 830 nm at 30 mW.

Neither helicopter had been permanently modified for NVG cockpit equipment or exterior lighting.

Both aircraft were IFR certified and the NVG supplier explained normal VFR aircraft would not be suitable for permanent NVG operations without extensive cockpit and lighting modifications.; Both test aircraft were able to operate without the modifications using a temporary setup for NVG. The NVG Supplier also stated that IFR aircraft require less modification to be formally adapted for night flight with NVG.

Figure 4. S-76 Firewatch helicopter with infrared camera and gyro stabilized ball under the aircraft nose.

Results and discussion

Identification of hotspots and direction of water delivery operations

July flights

The seven targets were easily seen on the IR image in the S-76. The table shows the reported position as computed by the S-76 Firewatch compared to the surveyed position. The pilots in the S-61 were able to see all targets illuminated by the laser in both tests.

Table 1. July: Position accuracy and target visibility results

Point number	Reported position offset (m) +/- 1.5 m	Targets seen in IR image	Illuminated target seen in NVG
		S-76 Firewatch	S-61
1	19.403	Y	Y
2	12.967	Y	Y
3	3.518	Y	Y
4	20.196	Y	Y
5	6.485	Y	Y
6	Not Recorded	Y	Y
7	13.045	Y	Y
Average	12.602	-	-

The positions recorded in Table 1 showed an average deviation of 12.602 m. The lower values show that the system is capable of accurate positioning.

The hotspots were easily seen on the IR equipment from altitudes of approximately 2000 feet AGL, and the laser was placed on the hotspots for the S61 to see under NVG. A screen capture showing the IR hotspots and the georeferenced targets from the S-76 is shown in Figure 5. The demonstration flying height of 2000 feet AGL allows the IR camera to look more directly down through the canopy and detect hotspots at the surface. The test laser was handheld and proved to be somewhat difficult to hold on the target. However, the S-61 pilots were able to easily see the laser point on the ground with the NVG, fly to the targets, and deliver water to the spot in all cases.

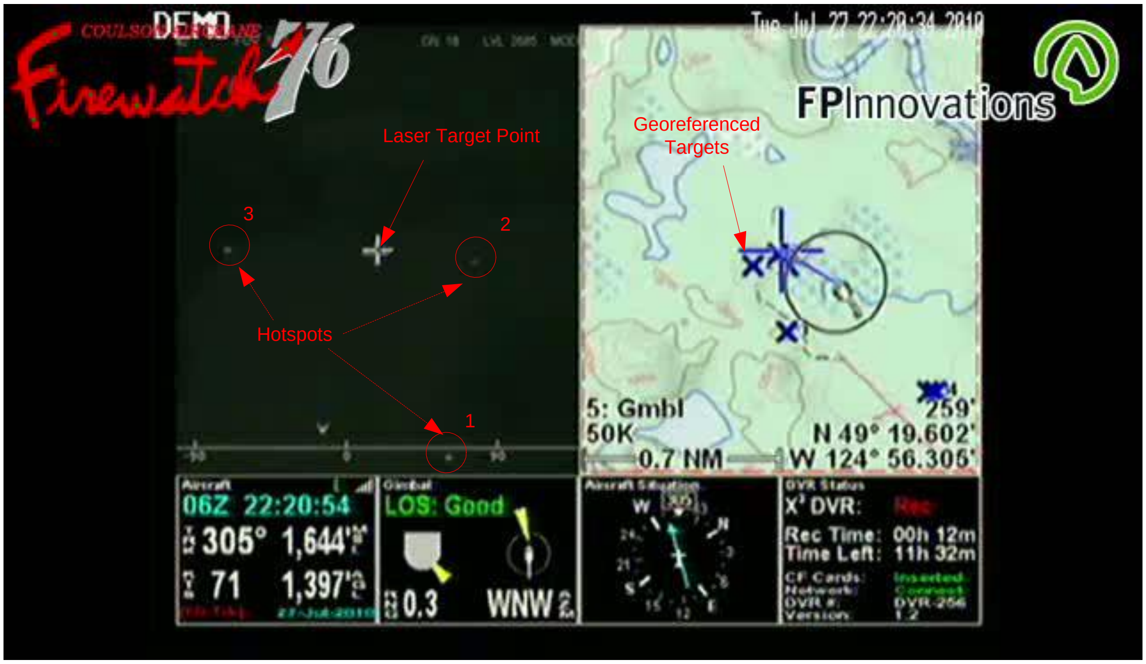

Figure 5. Screen shot from the S76 showing IR screen and map screen for targeting and recording hotspots.

October flight

The October flight was designed to show the integrated laser and how it fit into the night operations. The laser was stabilized by the gimbal and could track a single point on the ground regardless of the aircraft heading or attitude. This enabled a stationary target on the ground that was bright and clearly visible from the S-61 through NVG. It was a distinct improvement over the handheld laser from the July flights. The hotspots were clearly visible in the IR image and the laser was bore-sight aligned with the IR camera, so when the camera crosshairs were placed on the target, the laser illuminated that spot on the ground (Figures 6 and 7).

Figure 6. NVG view of the S-76 and IR laser target designator illuminating the ground.

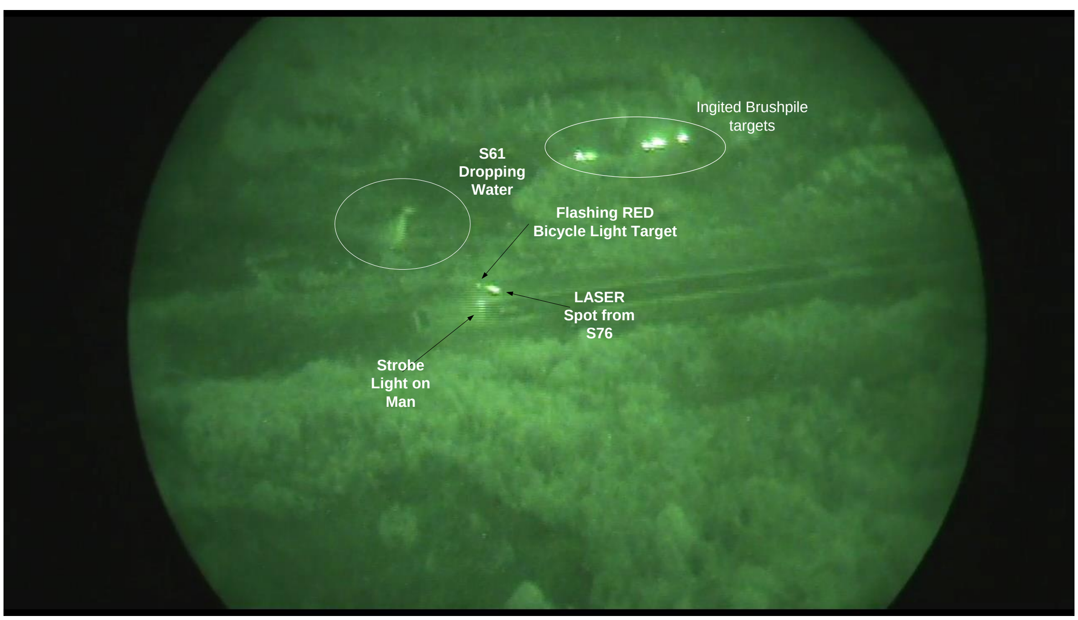

Figure 7. Overall NVG view of the Oct first drop. Note laser target designator spot at the drop area.

From discussions with personnel on the ground, it was felt that the laser target designator could also be used to guide ground crews or equipment to hotspots during night operations, if they were equipped with NVG or if the laser frequency was in the visible light range. The laser as tested in October was in the near IR range, just out of human visual sight, and thus not visible without NVG. Precautions and laser safety procedures would need to be in place if the laser target designator is used around people on the ground.

The glowing embers of the hotspots were not visible with the NVG equipment from the air. Generally the hotspots could not be seen with NVG unless there was flame (visible light) present at the targets. IR cameras detect energy with a wavelength of 3-8 micrometres in the form of heat, whereas NVG devices amplify existing light from visible red to near infrared from 665 to 925 nanometres. In general, the hotspot targets were not visible at all with the NVG alone and therefore should not be relied on for hotspot detection.

Water delivery accuracy on small burning targets

July flight

Six drops were required to douse the five targets. The first drop missed the target likely due to pilot unfamiliarity with NVG. The successive five drops hit the targets directly as designated by the laser pointer.

October flight

Target 1 was the only hotspot lit for the October test as the laser designator was the primary objective of the test. The target was illuminated with the laser from about 2000 ft AGL from the S-76, and a ground target indicator (red flashing headlamp) was near the hotspot as well. The target flasher was clearly visible from the aircraft under NVG. From the ground, the target flasher was visually dim and hard to see from any distance.

Two drops were made on target 1, and both were direct hits. Figures 8-12 show the results from the first drop. Upon completion of the last drop, 21 mm of water was contained in the pan (Figure 13).

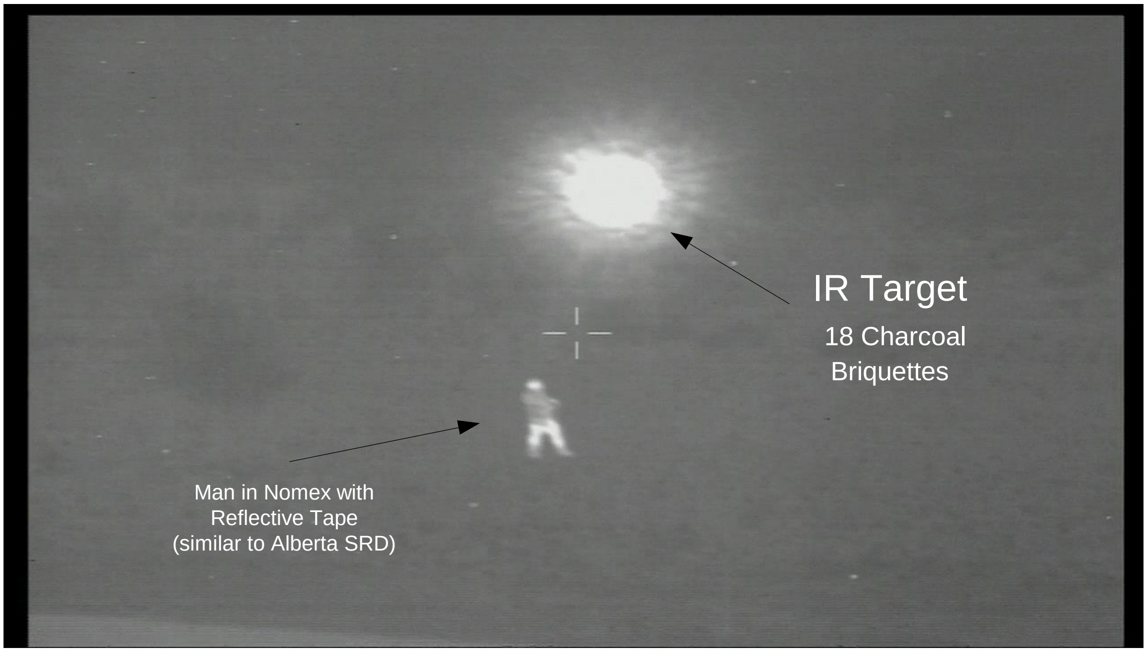

Figure 8. IR hotspot and ground personnel from S76 IR camera at ~2000 ft AGL, just prior to the first water drop in the October test.

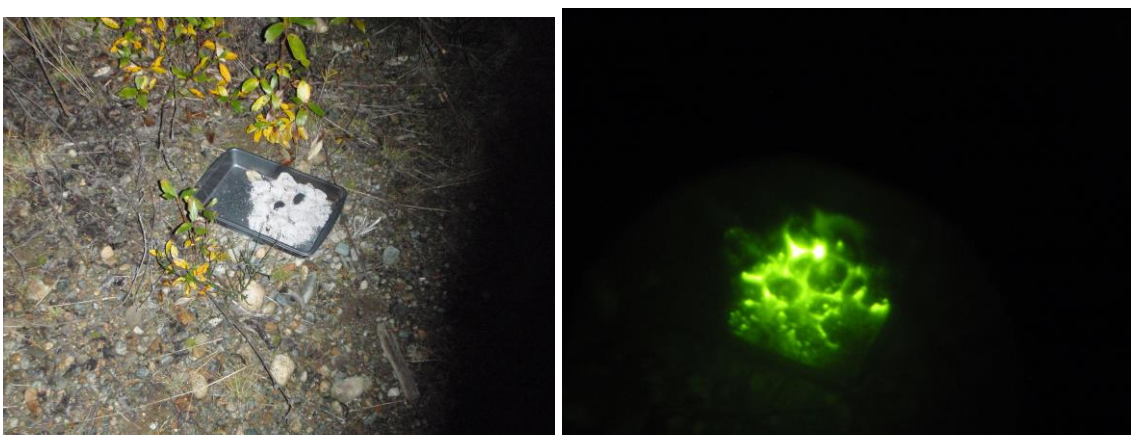

Figure 9. IR hotspot from the ground in visual (with flash) and NVG. There was no visible flame the time of the drop and the hotspot was not visible in NVG from the helicopter.

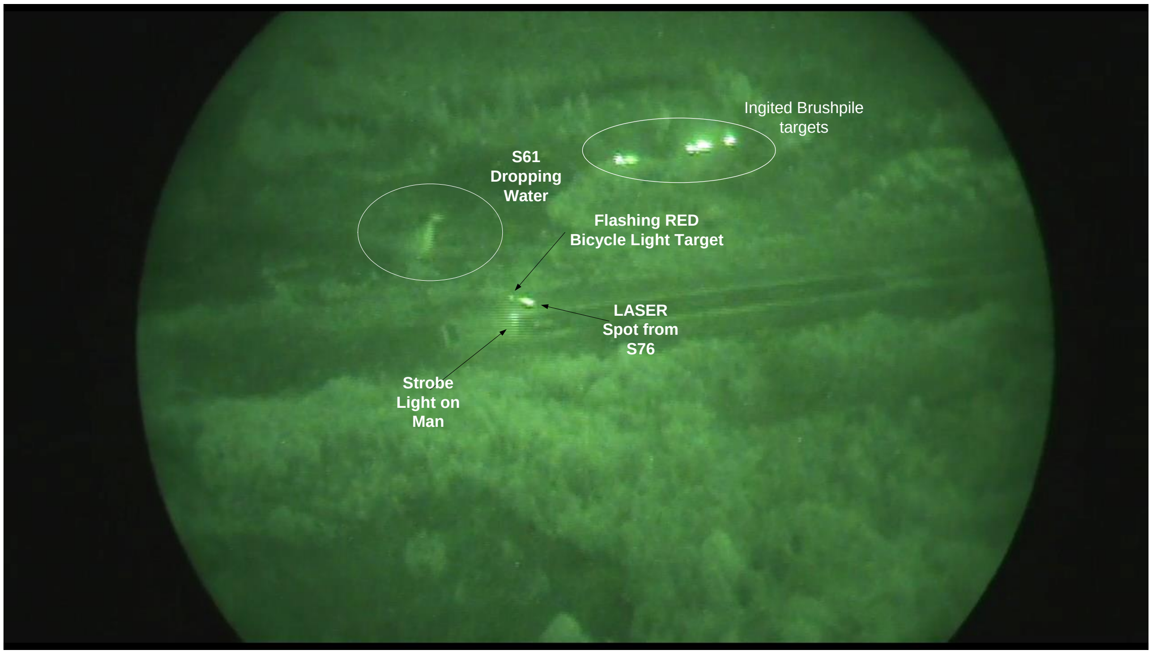

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Figure 10. High level NVG view of the test with laser designator from the S-76 and ground flasher at the target. The man on the ground had reflective clothing and a white strobe beacon.

Figure 11. Target after the first drop and flashing beacon for aiding water delivery. The flash was clearly visible in the S-61 under NVG. Note the amount of water in the pan was enough to extinguish the briquettes.

Figure 12. Target after Drop 1 in IR showing residual heat.

Figure 13. Water accumulated in hotspot target pan after two drops from the S-61 during night operations.

The pilot stated that accuracy of the S-61 water delivery may have been aided by the lower pilot stress load since the target was located and identified by the S-76 Firewatch platform. This made the job easier since he only had to fly to the laser spot, and the drop could be made accurately with less pilot stress. The pilots concentrated on the task as there few if any other aircraft were in the area. The pilot stated that because the S-61 aircraft was IFR certified, cockpit management while flying was easier when compared to VFR cockpits thus lowering his overall stress level. The vertical separation between S-76 and S-61 during this exercise was 1000-2000 feet.

Identification of people on the fireline

People on the ground were easily recognised by both NVG and IR images. Reflectors on some of the ground personnel stood out on the NVG with external illumination and on the IR images. Supplemental IR beacons, strobes, glow sticks or supplemental IR/visual illumination for the reflectors would make fireline personnel even more visible in the NVG. Personnel on the ground not wearing IR reflectors were easily seen in the thermal IR image, and the movement of the person was easily seen in the NVG. The NVG provided an almost daylight view, under the full moon conditions of the July flights. The pilots in the water delivery aircraft could easily identify personnel around the drop site.

Most agencies require a lead-in aircraft for water drops and an audible siren to warn ground personnel of the approaching water drop. The S-76 Firewatch platform can look for people in the drop zone with the IR camera and inform the S-61 pilot if required.

For the October flight, an inexpensive emergency strobe light was attached to a person near the drop zone and the flash was very noticeable in the NVG image. Figure 10 shows the strobe light on the image which was clearly identifiable in real time. The brief pulses of the S-61 landing lights provided additional illumination that made the reflector strips on the person stand out in the NVG image. The IR image in the S-76 showed people on the ground easily even though the strobe and reflector strips were not visible in the thermal image. Figures 14 and 15 clearly show the man in the IR image. Any movement of individuals makes identification easier in both NVG and IR images.

Figure 14. IR identification of people with the drop zone.

Figure 15. IR image of man and hotspot. Image from 2000 feet AGL, zoomed in. Note reflective stripe on shirt is barely visible.

There is a safety concern regarding the laser operation. The 30mW 810 nm laser cannot be seen with the naked eye without the aid of NVG equipment. The laser has sufficient power to potentially damage eyes with direct and prolonged exposure. The laser operator needs to identify personnel on the ground with the IR image and must be warned not to point the laser at people. Ground personnel should also be informed of the potential hazard and trained to avoid looking directly at the IR beam from the helicopter. They could be equipped with NVG to see the beam without directly looking at it. People should be absent from the drop area, with the operation being directed from the air by an agency helicopter coordinator. If manpower safety on the ground at night is a concern, it could be possible to keep people off the fireline at night when NVG water delivery operations are being utilized and allow them back on the fireline at daybreak when night operations cease.

The Axsys camera manual has the following laser safety warning:

If your system is equipped with the class 3B laser pointer:

- *The operating system provides several safety interlocks to avoid inadvertent actuation of the laser device. These are not to be defeated, and must remain in perfect working order.*
- *The laser pointer may never be fired when the aircraft is below 500 feet AGL (above ground level).*
- *All persons involved with the mission must have thorough training and knowledge of the specific operational and safety requirements of the laser device.*

Ultimately the safety of the system rests with the IR operators, and they must have the knowledge to operate the device responsibly. Agencies would need to ensure that company policies and procedures are in place and that staff are trained and compliant.

Drop cycle times, drop height and speeds

Aircraft mission data collected from the Latitude Technologies WebSentinel was analysed to give the average height and speed of the S-61 during water drops and the S-76 altitude during laser targeting (Table 2). The altitude and position record shows that there was vertical and horizontal separation between the aircraft.

Table 2. Approximate flight parameters during NVG demonstration

Date	Mission	Min	Sec	S-61 Alt (m AGL)	S-61 drop speed (knots)	S-76 Alt (m AGL)	Comments
July 27 2010	Day	6	36	70	51	574	Runway drops
October 21 2010	Day	4	21	41	51	124	Gel test drops
July 27 2010	Night	6	51	76	45	419	First NVG experience for pilot
October 20 2010	Night	4	9	22	42	188	
October 21 2010	Night	6	3	17	41	122	Includes brush pile drops (further)

Overall the drop heights and speeds under the night operations were similar to those of daylight operations.

Mission planning would specify altitude separation and conflict procedures to ensure a level of flight safety during night operations.

Water delivery rates

The water source on Turtle Lake was approximately 1.5 kilometres from the target giving an approximately 6 minute turn around on targets 1-5 (Table 2).

The rates calculated from the time information show no differences in the rate of water delivery between NVG night operations and daylight operations. Fill times, loiter and transit times would not be appreciably different as pilot experience with NVG increases. The 4000 litre load of the S-61 could be delivered at the same rate as daytime operations.

It is of note that the S-61 coupled with the long snorkel, was able to fill directly from field water sources without the blinding downwash from water sources that have prevented medium helicopters under NVG from operating at anything other than airport hydrants (San Diego Fire Night Operations). The S-61 pilot reported no problems filling the tank from the small lake under NVG.

Water delivery cost analysis

When looking at water delivery rates, a cost analysis provides a theoretical scenario of water delivery to a fire. Table 3 compares three scenarios: Bell 212 medium helicopters; Sikorsky S-61 heavy helicopters; and S-61 helicopters with 24 hour availability through NVG. The night option also includes the S-76 Firewatch command and control aircraft for target identification and control of the operation. While keeping the total operation cost for a 24 hour period constant, the dollar amount spent per litre delivered is different for each scenario. The cost per litre for the B212 is roughly three times that of the S-61 delivered water. Also, the night operation with two S-61s and the S-76 is $0.0026 more expensive per litre than during day operations that would not require the S-76. Note, by increasing the number of S-61s for the night operation to 3 or more, the cost per litre becomes lower than the 4 S-61s, day only, but the overall cost would be higher with more helicopters.

The night operation scenario uses the S-76 for the same period as the S-61s. If the S-76 was only operated for one 8 hour period for the night operation, the cost reduction would be $14,500 per day. The benefit of the S-76 Firewatch platform is that other fire intelligence/mapping functions can be performed in conjunction with the water delivery operations so the scenario assigns the S-76 to the full aeial suppression period.

The other point to notice is that the amount of water delivered for the same cost is 2.8 times when using the S-61 platform compared to the B212 platform. The volume delivered is the same for four S-61s during an 8 h daytime period, as two S-61s working 16 h including the night. Since the water drops are also at night, it could be said that the volume was used more effectively as the fire will be at a lower intensity during the night time period.

Table 3. Theoretical cost analysis for night operations versus day operations

			Night Operations	
Heli Type	**Bell 212**	**S61**	**S61**	**S76**
Water Delivery Helicopters (no.)	7	4	2	1
Day Rate per Helicopter	$0	$14,000	$14,000	$0
Hour Rate (Wet)	n/a	$4,000	$4,000	$1,500
Hour Rate (Dry)	$2,750	n/a	n/a	n/a
Fuel Cost/Hour	$500	inc	inc	inc
Extra Crew Shift for Night Ops	n/a	n/a	$3,000	$2,500
Daily Flight Hours (Max)	8	8	16	16
Duty Day Hours	12	12	24	24
Cost Per Day Total	$182,000	$184,000	$162,000	$26,501
			$188,501	
Cruise Speed (knots)	80	105	105	150
Endurance hrs	1.5	3.0	3.5	2.5
Tank Capacity (Litres)	1,333	4,000	4,000	
Fill Time (sec)	70	40	40	
Turnaround Time (min)	6	4	4	
Drops per Hour per Heli	10	15	15	
Drops per day per heli	80	120	240	
Drops per Day per group (Max)	560	480	480	
Transit/Fuel Cycle adjustment (20 min /cycle)	0.81	0.89	0.89	
Drops per day adjusted for fuel cycle	453.60	427.20	427.20	
Calculated Litres Delivered per day (adjusted)	**604,649**	**1,708,800**	**1,708,800**	
Cost per Litre Delivered to Fire	**$0.3010**	**$0.1077**	**$0.1103**	

Identification of aerial hazards

NVG provided near daylight views but specific aerial hazards were not identified during the test. Tower lights or any lighted structure would show up easily in the NVG, but wires may be more difficult to see. The thermal IR image is capable of seeing the power lines due to heating, but guy wires may be harder to see. Aircraft were easily spotted using NVG from their navigation lights or beacons and with the IR from their exhaust. Figure 16 shows the S-61 with landing lights and the rotating beacon on the S-76. A reconnaissance flight during daylight hours to identify aerial hazards and review planned approach and exits from the fire and water delivery sites would be a benefit to the operation.

The still images of the NVG scene do not come close to the real-time view through the goggles. The images were brighter, and the higher contrast showed objects and their features more clearly. The visibility afforded by movement in the scenes is also not shown in the still pictures. The NVG provided a very clear situational awareness of the surroundings.

Figure 16. NVG view of other aircraft during the operation. Movement of the aircraft and the flashing beacons made identification unmistakeable.

The aircraft used in this test were unmodified for NVG and were flown with the cockpit lights off and small temporary NVG compatible lights to shine on the instruments. Modifications for NVG would need to be done to the interior and exterior lights to provide safety and comply with regulations for a approved operation.

Building fireline

The laser targeting from the S-76 Firewatch demonstrated that the S-61 could see the designated point on the ground. Making drops and building line with the S-61 being directed by the S-76 Firewatch platform was possible. IR images from the S-76 gave a clear picture of precisely where the drop occurred (Figure 17). The liquid dropped on the target quickly cooled the ground and fuel. The S-76 IR device could see a defined drop boundary and thus enabled the operator to direct the next drop accordingly. The camera has the ability to lock on a spot on the ground so even if the drop end point cannot be seen directly for the next drop, the end point can be designated with the laser from the previous water drop. Holes and missed spots in the line would be quite evident while using the IR device.

Figure 17. Thermal IR image from S76 of S61 tagging on to a line drop. Note the previous drop on the right of the image.

Conclusion

A series of demonstration flights on the coordinated use of night vision systems (NVIS) were documented. The concept of a coordinated night water delivery operation was demonstrated, using a command and control aircraft with night vision goggles (NVG) and infrared (IR) capability to identify, record, and designate hotspot targets with a laser, and a heavy helicopter flown with NVG to drop water. The flights demonstrated that this concept is feasible. The seven objectives set defined a practical look at the combined capabilities of the NVG equipment, the S-61 helitanker and the laser targeting in the S-76 IR camera. The demonstration showed an efficient, safe and complementary system. The S-76 Firewatch platform was capable of directing the operation, detecting the potential targets down to 30 cm^2 in size, identifying them to the S-61 with the laser, and mapping and video recording of the operation.

The key to the success of these flights was S-76 Firewatch detecting hotspots using the IR thermal camera and then targeting the hotspot with the laser. The laser then guided the S-61 to the target location. The combined partnership of the command and control aircraft (S-76) and the water delivery aircraft (S-61) showed that the concept of NVG night water delivery operations is achievable and efficient. An agency helicopter coordinator would ensure that the operation maintains efficiency and would direct the operation to meet the agency's goals.

The direction to the S-61 from the S-76 was also done at a higher flight altitude than the S-61 operations to maintain separation and achieve night operation safety. Mission planning would dictate flight levels for aircraft to minimize traffic conflicts. The integration of the laser targeter in the S-76 meant that targets can be identified at a different flight level than the water delivery aircraft, enabling a safe, efficient and effective operation.

This test was a demonstration of the capability for night operations and would not become officially operational without considerable effort on all sides, including by not only:

- Companies would need to modify and certify the aircraft and cockpits for compatibility. IFR aircraft would have an advantage over VFR aircraft for this process.
- Pilots and operational procedures, especially related to safety, would have to be added, modified and approved.
- Agencies would have to amend procedures for night operations and train helicopter coordinators for this application.
- Training of ground personnel for working in and around NVG operations would need to be developed and implemented.

This demonstration of NVG night operation shows that the concept of using helicopter tankers in support of wildland fire operations at night is feasible. Potentially, night water delivery operations could give fire managers another tool to fight problem wildfires, and ultimately reduce suppression costs.

A Coulson-made video of the test is available at:
http://www.youtube.com/watch?v=XtumSgg85m8

This shows the aircraft operations at night during the tests and presents video evidence that the water can be delivered accurately under night-time conditions.

References

Gibos, K.; Ault, R. 2009 Evaluation of rotary-wing thermal infrared service delivery using simulated wildfire hotspots. FPInnovations Web Report , http://fire.feric.ca , August 19, 2009.

Appendix A Test Hotspot Locations

Test Location Near Port Alberni Airport, BC

Coulson Test Point 1
Location: N49.32645 W124.93725
Elevation: 83 m

Coulson Test Point 2
Location: N49.32687 W124.93806
Elevation: 83 m


Coulson Test Point 3
Location: N49.32644 W124.93860
Elevation: 82 m


Coulson Test Point 4
Location: N49.32574 W124.93747
Elevation: 77 m


Coulson Test Point 5
Location: N49.32408 W124.93505
Elevation: 82 m

Coulson Test Point 6
Location: N49.31723 W124.92415
Elevation: 72 m


Coulson Test Point 7
Location: N49.31792 W124.92391
Elevation: 70 m