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Helitorch Redesign: Field Test Results and Modifications

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Background

The Alberta Agriculture and Forestry (AFF) Wildfire Management Branch Ignition Specialists Working Group has endorsed a collaborative project to develop a redesigned helitorch. The goal of this project is to have an acceptable and proven replacement helitorch based on extensive testing.

Alberta's Ignition Specialists Working Group, MYAC Consulting Inc., and FPInnovations have been working together to design, construct, and test a helitorch prototype. Each group has distinct roles:

- Alberta's Ignition Specialists Working Group assists with prototype design and field testing.
- MYAC Consulting Inc. provides engineering and construction expertise.
- FPInnovations provides project oversight and administrative support.

Preliminary engineering concepts and drawings were supplied through the University of Alberta Mechanical Engineering MEC E 460 Design Project class. Field testing was conducted during AFF wildfire field exercises and actual fire operations.

This Info Note summarizes the field tests conducted to date and the modifications made to the prototype as a result. For information about the design and construction of the prototype, please see our Info Note 2017 no. 32, *Helitorch Redesign*.

Loon River Field Tests

In June 2017, the first field tests of the prototype were conducted at the Loon River Fire Base north of Red Earth Creek, Alberta. The basic mixing design proved satisfactory, and the tests yielded successful gel mixing and production via the pump and fuel reservoir. The field tests included a basic flight test to establish the flight characteristics of the prototype. The key issue encountered during the flight test was a tendency for the prototype to yaw during flight. For this reason, ignition tests were postponed.

Post-Testing Modifications

Following the Loon River field tests, the project team made modifications to the prototype to resolve identified design issues (Figure 1). During the summer of 2017 the project team:

- replaced the three leg/steel post barrel attachments with two-barrel rings and cable tensioners
- replaced the three-cable suspension system with a two-cable and spreader-bar system
- added a wind brake to stabilize and improve helitorch aerodynamics
- added a quick detach system to improve barrel switch-out time
- redesigned the discharge valve (Figure 2) (note: the redesigned valve is still being evaluated and has not yet been installed on the prototype)

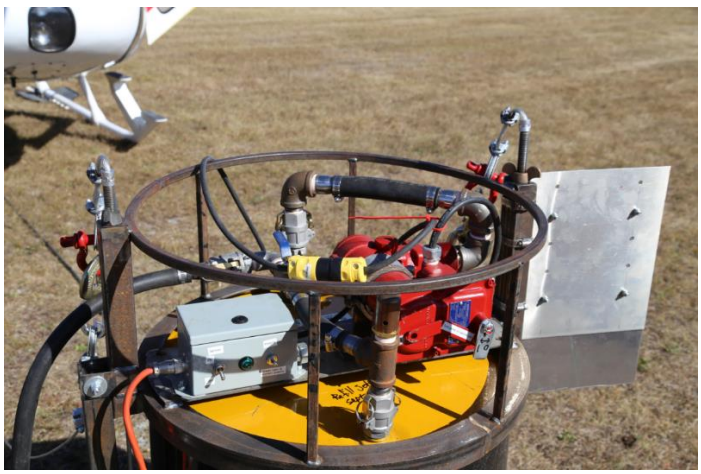

Figure 1. Modifications to the helitorch prototype following the Loon River field tests in 2017.

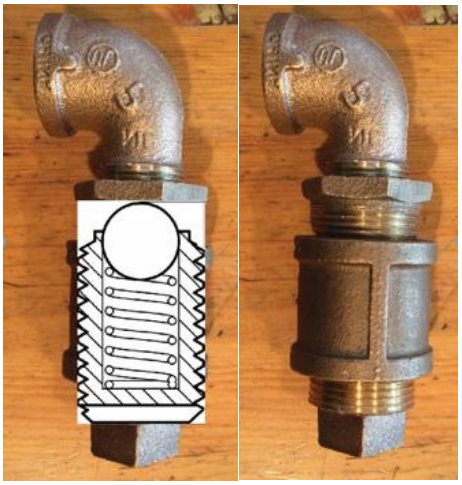

Figure 2. Current discharge valve on therightt; sketch of the redesigned interior of the valve on the left.

Ram River Field Tests

In September 2017, field tests were conducted at the Ram River airstrip and on wildfire RWF-063-17 west of Rocky Mountain House, Alberta. These field tests included flight trials using both full and empty fuel barrels, as well as ignition tests. These flight trials demonstrated that the modifications made after the field tests in June had positive results: the prototype exhibited stable flight characteristics when the barrel was full and empty, and exhibited successful gel ignition.

Following the Ram River field tests, the project team identified the need for further developments and testing such as:

- upgrade parts from steel to aluminum to reduce the weight of the prototype
- construct a second prototype
- conduct more field tests during active operations

The project team presented a progress update to the Ignition Specialists Working Group at the AFF's Ignition Specialists Workshop on October 5, 2017. The working group was encouraged by the work completed to date and endorsed the continuation of the project.

At the AFF's Ignition Specialists Workshop on April 25, 2018, the project team again presented an overview of the helitorch prototype the Ignition Specialists Working Group, this time reviewing and discussing the recommendations from the 2017 field tests to guide the direction of the project.

Hummingbird Field Tests

In May 2018, the project team had the opportunity to conduct field tests at the Hummingbird prescribed burn west of Rocky Mountain House, Alberta. Although the team had not yet completed the modifications following the Ram River field tests, the Hummingbird prescribed burn provided an excellent opportunity to further test the prototype during active operations.

While preparing for the Hummingbird field tests, the project team had the opportunity to discuss previous field tests with both the ignition specialist and the pilot who had participated in those tests. The pilot noted the prototype had not flown smoothly during the Ram River field tests and that it had experienced ignition problems. Another pilot (one who had not participated in the Ram River field tests) suggested that the torch head design and the vane could be working against each other and could account for the "choppy" flight.

The Hummingbird field test began with test burns of the prescribed burn unit and continued with the operational burning of the entire unit. The prototype helitorch exhibited 'flaring' almost immediately. Upon returning to the burn pit, the ignition specialist determined that the flaring was caused by poor fuel mixing. The cause of the poor fuel mixing was believed to be the prototype's inability to mix Flash 21A & 21B according to the product's specifications, which is to add and mix Flash 21A first, then add Flash 21B and mix some more. However, during the field test both Flash 21A & 21B had been added to the fuel drum simultaneously and mixing occurred as the pump circulated the mixture during use. To correct this issue, a second barrel was mixed before take-off following the product's recommended approach: Flash 21A was added to the fuel barrel and circulated, then Flash 21B was added and circulated. The second barrel produced a better mix with less flaring.

The field tests continued with a third barrel; however, the mix was not considered ideal and some scorching to the torch head was detected. Based on these findings and the need for two helitorches to meet the prescribed burn objectives, these field tests were suspended.

Post-Test Modifications

Following the Hummingbird field tests, the project team met several times throughout July and August of 2018 to discuss upgrades that would improve the safety and functionality of the prototype. Those discussions yielded the following changes:

- The pump and ignition switches were relocated on the panel box (Figure 3) and passive metal tabs were added to prevent inadvertent activation of the pump or the ignitor when the discharge boom is in the “up” position and the discharge valve is set to discharge. A green light was also added to the top of the panel box to indicate correct polarity.

Figure 3. Switch realignment and polarity light addition.

- The length of the suspension cables were lengthened from 6.5 metres (21 feet) to 9 metres (30 feet) (Figure 4). This extra length allows an additional safety buffer of 2.5 metres (8 feet) for staff working underneath a helicopter or within the periphery of the rotor blades while the aircraft is under power.

Figure 4. Suspension cables lengthened to 9 metres.

- The steel cable attachment points were redesigned. Custom turnbuckles were fabricated to provide a solid steel attachment point for the suspension cables (Figure 5).

Figure 5. Custom turnbuckle attachment points.

- A chain was added to tension the top and bottom rings together to augment barrel capture.

Shunda Field Tests

In September 2018, field tests were conducted at the Shunda airstrip west of Rocky Mountain House, Alberta. These field tests included flights with both empty and full barrels at various speeds while the pilot conducted maneuvers to mimic helitorch operations. The prototype was also flight-tested without the aluminum wind brake that had been added in 2017.

The helitorch prototype performed very well exhibiting stable flight characteristics. Wind drag during flight did cause the discharge arm to move to approximately the five o’clock position, but it remained stable in that position. As the helicopter slowed to ignition speed, the discharge arm returned to the desired three o’clock position allowing the pilot to clearly see the discharge head.

Post-Testing Modifications

Following the Shunda field tests, the project team made several modifications to the prototype over the winter of 2018/2019:

- A removable mix funnel was constructed to allow Flash 21 A & B to be added through an inlet port (Figure 6). This eliminated the need to open the fuel barrel to add Flash 21 A & B. Instructions for operating this closed-barrel mixing system are provided in Appendix A.

Figure 6. Mix funnel attached to an inlet port.

- The outlet valve was replaced with a diaphragm type valve (Figure 7). This unit was custom-made and is expected to be maintenance free.

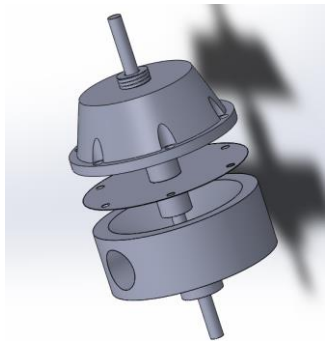

Figure 7. Diaphragm type valve.

- The button frame of the torch was replaced with two barrel sling hooks. The two hooks make it easier to install a new fuel barret are are rated for 454 kg (1000 lb) working load and 1800 kg (4000 lb) ultimate load. The total external payload for the torch and a full fuel barrel is 222 kg (489 lb). Since aircraft acceleration can double the weight of external payload, the project team chose hooks that would provide the required strength in that situation.
- Load-rated carabiners and a short electrical cord were added. This configuration allows ground crews to easily swap out torches—an empty torch can be dropped off and exchanged with a full torch within a minute. This means that mixing (using a ground power unit) and all functional tests can be completed on the ground before the helicopter arrives. This should provide a significant time savings on burn operations.

In addition to these modifications to the original prototype, the project team completed the construction of a second prototype made of aluminum.

Finally, when cleaning the torch after use the current practice is to remove the entire torch from the gelled fuel drum. A standpipe could be designed that has a cam lock fitting that connects to the stand pipe fitting on the torch and be long enough to reach a container sitting on the ground next to it. This can be made of stiff rubber.

Summary and Next Steps

After several field tests of the original prototype, a number of modifications have been identified and completed. Table 1 summarizes the modifications made to the original prototype helitorch since it was constructed in 2017. Additional funding received in June 2018 allowed the project team to continue with upgrades to the original prototype and to construct a second unit made of aluminium.

Future work includes changing out the plunger type head with a simple check valve and testing the electrical ignition system for issues. Operational field tests using both prototypes will continue as opportunities arise.

Table 1. Modifications to the helitorch prototype by year.

Year	Modification
2017	Replace three-leg steel post with two barrel rings Replace three-cable suspension with two-cable Add wind brake Add quick detach Redesign discharge valve
2018	Steel to aluminum Build second prototype Pump ignition switch Increase suspension cable length Redesign steel attachment points
2019	Attach mix funnel Redesign outlet valve to diaphragm type Add barrel sling hooks Add carabiners and short electrical cord for multiple barrel use

Table note

References

Finn, D., Ackerman, M., Campbell, R. (2017) *Helitorch redesign.* InfoNote No. 32, 2 p.

For more information

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