Project Note
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# Improving the visual assessment method of measuring cup amounts in airtanker drop tests

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## Introduction

The cup-and-grid method for assessing airtanker drops (Suter 2000) is both time and labour intensive; as a result, it is very expensive. Typically, the cup-and-grid method requires cups be capped, marked, collected and weighed after each drop. Weights in grams are converted to GPC (USG/100ft$^2$), data is analyzed and contour plots are created.

In 2011, we had the opportunity to test an alternative method for assessing the cup amounts in a drop grid (Mooney and Ault 2011). The alternative method still employed a grid of cups, but instead of collecting and weighing each cup, the grid crew estimated the amount in each cup while in the field. The crew recorded the amounts in broad classifications (empty; ¼ full; ½ full; etc.), not in GPC. And although we tried to standardize how the crew estimated the amounts, it was still very subjective.

We had another opportunity this year to use the alternative method. This time, however, I created a template that would help reduce the subjectivity of our grid crew's cup estimates. This approach directly measured the volume in each cup in GPC (USG/100ft$^2$). This saved time overall and provided immediate results. This report describes how I created the template and summarizes its benefits for drop testing.

## Methods

### Cup Selection

Any clear cup that has a reference mark—either as part of the cup design or added manually—is acceptable. Cups with a diameter of 4 inches or more will collect a measurable amount at the lowest coverage levels. We used clear plastic cups with 4.25 inch diameter, 1.75 inch high, and a reference mark at 1.5 inches (a molded rim).

### Calculations

GPC (USG/100ft$^2$) is the metric typically used for measuring coverage levels. I converted this to USG/ft$^2$ and then to ml/ft$^2$. Since the area of a 4.25 inch diameter cup is 0.09852 ft$^2$, I multiplied this by ml/ft$^2$ for each coverage level to get the amount (ml) per cup (Table1).

**Table 1. Volume calculations for direct GPC measurement in a 4.25 inch cup.**

| GPC | USG/ft$^2$ | ml/ft$^2$ | ml/cup |
|---|---|---|---|
| 0.5 | 0.005 | 18.93 | **1.86** |
| 1 | 0.01 | 37.85 | **3.73** |
| 2 | 0.02 | 75.71 | **7.46** |
| 4 | 0.04 | 151.42 | **14.92** |
| 6 | 0.06 | 227.12 | **22.38** |
| 8 | 0.08 | 302.83 | **29.83** |
| 10 | 0.10 | 378.54 | **37.29** |
| 12 | 0.12 | 454.25 | **44.75** |
| 14 | 0.14 | 529.96 | **52.21** |
| 20 | 0.20 | 757.08 | **74.58** |
| 25 | 0.25 | 946.35 | **93.23** |

## Calibration

Using a graduated cylinder, I poured each amount into a cup, precisely as shown in Table 1. I then tilted the cup towards me until the bottom water line touched the reference line on the cup. Holding the template to the base of the cup, I used a ruler to mark the water line on the template (Figure 1). I repeated the process for each coverage level to create a complete template (Figure 2).


Figure 1. Template calibration with measured amount of water for GPC7
(coloured water used for visibility)

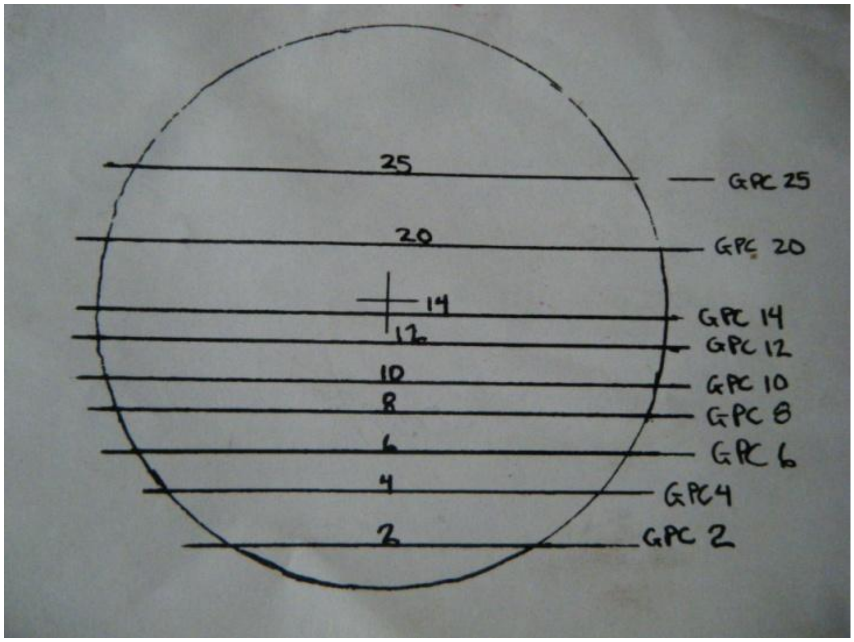


**Figure 2. Template created for a 4.25 inch cup.**

Using the Template

1. The template was aligned to the bottom of the cup with the horizontal graduation marks perpendicular to gravity.
2. The cup was tilted until the bottom water level touched the reference mark.
3. The GPC was recorded where the top water line touched a graduation mark. If the amount was less than the lowest graduation mark, then TRACE was recorded.
4. The cup was dried and placed back in the holder for the next drop.

## Results

We tested the template in Salmon Arm, BC during helicopter drop tests in June 2012. After each drop, teams of two systematically went through the grid measuring the cups that had water in them. One person measured the amount against the template (Figure 3) and the second recorded the amount for each cup location. A third person would follow the teams, drying the cups and setting them back in the holders for the next drop. For consistency, each team covered the same rows for each drop. This systematic approach ensured that each cup location was captured. After the data was collected, a colleague presented the point data as a rough coverage level pattern (Figure 4).

**Figure 3. Using the template to directly measure coverage level.**

## Drop 16: Jun 13-2012 16:00 HRS

**Speed: 10 knots Height: 55 feet**

Flight Direction →

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **6** | | | | | | | | | | | | | | | | | **6** |
| **5** | | | <2 | <2 | | | | | | | | | | | | | **5** |
| **4** | T | <2 | >14 | >14 | >14 | 6 | 6 | 2 | T | T | T | | | | | | **4** |
| **3** | | T | <2 | >14 | >14 | 2 | 2 | T | T | | T | T | T | T | T | T | **3** |
| **2** | | | | <2 | | T | T | T | | | T | | | | | | **2** |
| **1** | | | | | | | | | | | | | | | | | **1** |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | |

**Figure 4. Presentation of direct measurement point data (in GPC) from drop tests.**

## Discussion

The calibrated template improves upon the visual assessment method of measuring cup amounts by eliminating subjective measurement error. By calibrating the template to the cup, a level of precision and accuracy is achieved. It also directly measures GPC—which, after all, is the desired output of drop testing. The results were immediately available and measured in units understood by fire professionals. The grid crews reported that the template was easy to use. It was also easy to train users to give accurate, consistent measurements.

Measuring cup amounts in the field did slightly increase the time it took to reset the grid between drops, but it eliminated the need to sort and weigh each cup—a process that can take two or more hours per drop. Also, measuring cup amounts in the field means fewer cups are used overall. When cups are removed from the grid to be weighed, new cups are needed to replace them. Because the sort and weigh function can take hours, cups often cannot get re-used between drops.

The template must be tailored to the cup and the GPC classes used in your project. If more precision is desired, a different cup and template would be required.

## References

Mooney, C; Ault, R. 2011. Visual Assessment Method of Measuring Airtanker Drops. Project Note, FPInnovations Wildfire Operations Research. December 2011.

Suter, Ann. 2000. Drop testing airtankers: a discussion of the cup-and-grid method. USDA Forest Service. Technology and Development Program, Missoula MT. Technical Report TE92P32.