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Visual assessment method of measuring cup amounts in airtanker drops

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Background

The standard procedure for drop testing airtankers is the cup-and-grid method (Suter 2000). The US Forest service began using it in the mid-1950s and researchers with the Canadian Forest Service had used it back in the 1960s. Although there have been changes over the years (cup size, cup holders and cup spacing), the mechanics of the procedure remain the same. Scientists with the Missoula Technology and Development Center have, however, refined their data analysis to increase precision, using advanced interpolation to estimate points between cups. Drop testing is both labour and time intensive and, as a result, very expensive; but it is a required step for aviation companies seeking certification of their aircraft with the Interagency Airtanker Board (IAB).

Apart from the certification requirements, drop testing can provide valuable information for the makers and users of the aircraft: for engineers at aviation companies at the development stage of a new tank design; for fire management agencies making a decision between two delivery platforms; and for air attack officers conducting their aerial suppression strategy. But gathering this kind of internal information through drop testing is not feasible for most organizations. Recently, researchers in Australia have been using a modified version of the cup-and-grid method[1] and in October 2011 we had the opportunity to test it.

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. The modified version, or alternative method, still employed a grid of cups, but instead of collecting and weighing each cup, a grid crew estimated the amount in each cup, emptied and dried the cup, and placed it back in the holder. Cup amounts were entered into a spreadsheet to create a rough drop pattern.

Methods

Researchers established a grid of 460 feet long and 160 feet wide.[2] It consisted of 24 rows with 9 cups in each row; cups and rows were placed 20 feet apart. Cups were clear plastic, approximately 5 inches in diameter and approximately 2 inches deep. Each cup was held in place on the ground by a cup holder (Figure 1). Each cup holder was clearly labelled to identify its location in the grid.

[1] R. Lieskovsky. Personal Communication, October 2011.
[2] Grid size is dependent on the aircraft being tested and the test matrix, not the procedure itself.

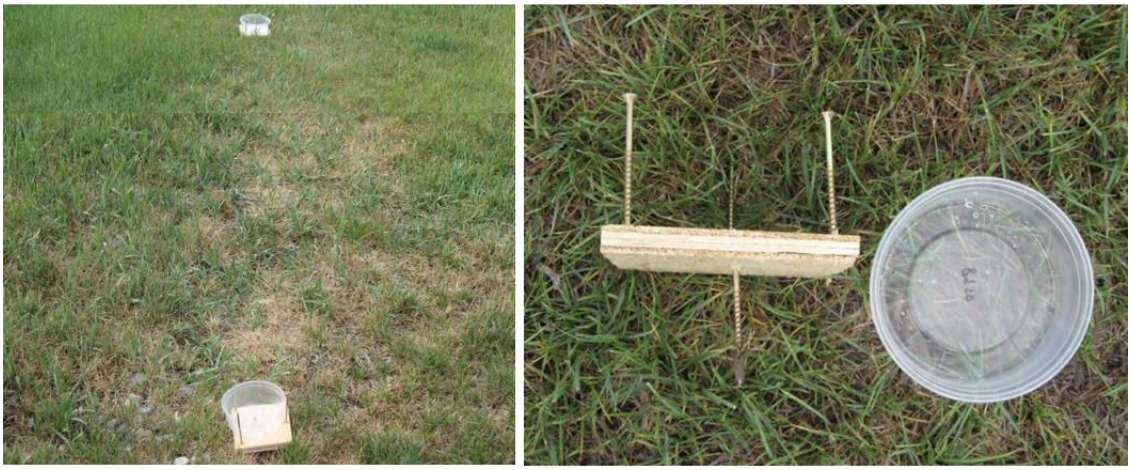

Figure 1. Cup holders and plastic cups used for drop tests.

Four data collection teams were each assigned to six rows of the grid. Each team consisted of an amount estimator, a data recorder and a cup drier. After a drop, each cup was removed from the cup holder, the amount was estimated and recorded. The cup was then emptied, dried and placed back into the holder. At no time were the cups collected and removed from the grid. Teams were briefed before the drops commenced on how to visually classify the cup amounts into one of six categories:

- none/dry
- trace
- 1/16 inch
- 1/8 inch
- 1/4 inch
- >1/4 inch

The teams were provided data sheets to record estimated cup amounts for their assigned rows. Completed data sheets were passed on to a technician who then entered the data into a prepared excel spreadsheet where each cell represented a cup location on the grid. The amount category for each cup was entered at its location. Each amount category was assigned a colour so the resulting image was a rough estimate of the drop pattern.

Results

Eleven drops were conducted over two days. All drops were with water. Data collection and data presentation generally took less than 1 hour. The drop pattern diagram (Figure 2) provided relative coverage levels.

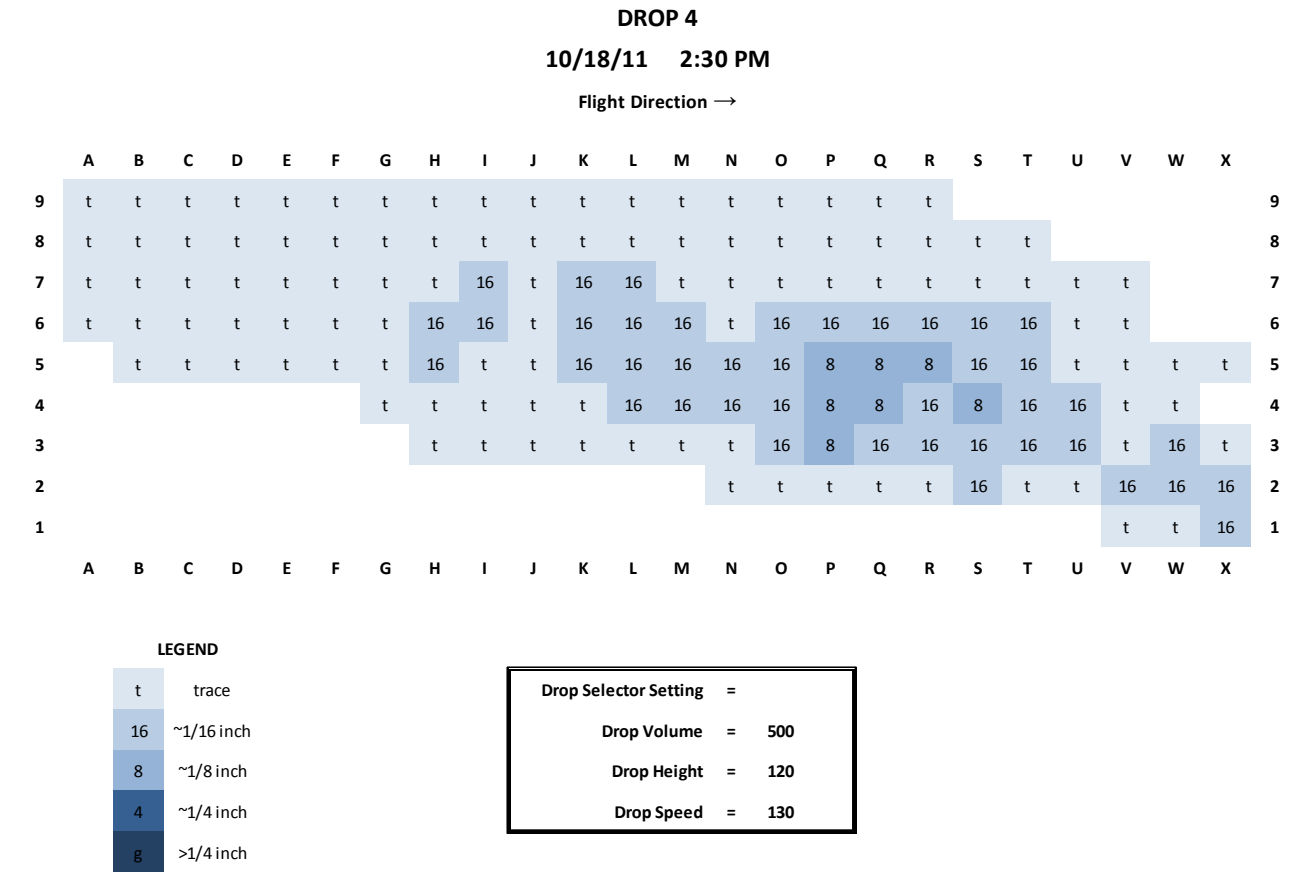

Figure 2. Relative coverage level pattern map.

Conclusions

This alternative method of measuring cup amounts provided the organization with the information they needed without the expense of an all-out drop test, and in much less time. Data collection and production of an estimated coverage level pattern map was quick and efficient. The process required much fewer grid workers, only one data technician, and no specialized equipment or software programs. The level of accuracy was sufficient for the purposes of the aircraft engineers in these tests.

This visual assessment method offers a low-cost alternative for engineers who wish to assess their tank system prior to the formal (and costly) IAB[3] certification process. This procedure would also be useful for anyone (aviation managers, etc.) who need only to obtain a general idea of the drop pattern and relative coverage levels. The quick turnaround of the pattern maps provides the opportunity for testers to change drop

[3] The United States Forest Service Interagency Airtanker Board (IAB) is the body governing the criteria for airtanker performance and the airtanker certification process.

parameters (drop setting levels, drop heights, and speeds, etc.) between drops as they deem necessary to better understand the capabilities and limitations of an aircraft's delivery system.

Recommendations

Amount categories should be identified and refined after a test drop. Although a test drop is normally for the benefit of the pilot(s), it would in this case provide much needed reference information for grid workers and engineers.

The amount estimator role on each team should be filled by the same person for all drops if possible. Although it is not a difficult role, experienced estimators would improve the consistency of results over the course of the tests.

Row assignment should also remain consistent through-out the tests. This would make it easier to help identify whether a data anomaly was caused by the tank system or in the data estimation process.

References

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.