

## Lift Charge Loss for a Shell to Remain in Mortar

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I recently needed an estimate of the amount of lift powder that would have to be missing from a spherical aerial shell, for it to remain in its mortar upon firing. Since that apparently has never been reported in the literature and because it was easy to determine, a brief study was conducted to discover this. Although there is little reason for the typical pyrotechnist to need the answer to this question, nonetheless it is a somewhat interesting number; thus, the motivation for this short article.

In this study, only plastic spherical aerial shells were tested and the mortars used were all high-density polyethylene. Information about the materials and conditions for the tests are listed in the table below. Each shell size was test fired using Goex 4FA fireworks (blasting) Black Powder. However, because smaller shells are often lifted using finer grained powder, the 3- and 4-inch spherical shells were also tested using Goex 2Fg sporting grade Black Powder. In each case the lift powder was placed in a small plastic bag with a Daveyfire SA-2000 electric match. The bag of lift powder was then taped directly to the bottom of

the test shells, thus providing little dead space below the shell other than that resulting from its spherical shape. The shell weights and nominal lift weights were those used in previous studies, and are felt to be typical for spherical shells. The temperature during the tests was approximately 70 °F (21 °C). For each size shell, a series of test firings was conducted, each time adjusting the amount of lift powder until a quantity was found that was just sufficient to cause the shell to clear the top of the mortar upon firing.

For the conditions of these tests, it required an average of approximately 14 percent of the nominal lift charge weight to cause the test aerial shells just barely to exit the mortar. There is no estimate of the statistical uncertainty for these results because of the limited number of tests performed.

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Shell Size (in.)	3	4	5	6
Mortar Length (in.)	2.22	22.5	26.5	26.5
Mortar Diameter (in.)	2.98	3.91	4.93	5.93
Shell Weight (lb.)	0.30	0.80	1.5	2.5
Shell Diameter (in.)	2.62	3.72	4.68	5.63
Nominal Lift Weight (oz.)	0.5	1.0	1.7	2.7
Minimum 4FA Lift to Exit (oz.)	0.09	0.13	0.25	0.36
Percent of Nominal	18	13	15	13
Minimum 2F Lift to Exit (oz.)	0.07	0.11	—	—
Percent of Nominal	14	11	—	—

To convert inches (in.) to mm, multiply by 25.4.

To convert pounds (lb.) to g, multiply by 454.

To convert ounces (oz.) to g, multiply by 28.